Appendix E

Supporting Information

PR&G Analysis Report

Water Budget and Depletion Technical Memo

NRCS Soil Map Report

NRCS Farmland Classification Map Report and Farmland Conversion Impact Rating Forms

Biological Assessment (Includes Spiranthes diluvialis Survey Reports)

Engineering Technical Memorandums

Cultural Resource Survey

Public Participation Plan

PR&G Analysis Report

Duchesne County Water Efficiency Project
Eastern Duchesne Watershed
Duchesne County, Utah

PR&G Analysis Report

Final

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United States Department of Agriculture
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1.0 Introduction

A Natural Resources Conservation Service (NRCS) Watershed Plan and Environmental Assessment (Plan-EA) is being prepared for the Duchesne County Water Efficiency Project (Project) for the Eastern Duchesne Watershed located in Duchesne County, Utah. The Project is authorized under the NRCS Watershed and Flood Prevention Operations Program and funded through the Watershed Protection and Flood Prevention Act of 1954 (PL 83-566). Duchesne County Water Conservancy District (DCWCD) is cooperating in the Project as the Sponsoring Local Organization. The Project consists of agricultural water management improvements primarily to conserve irrigation water resources and improve surface and groundwater quality.

The intent of this memorandum is to document Project compliance with Principles, Requirements, and Guidelines for Federal Investments in Water Resources (PR&G) per the *Principles and Requirements for Federal Investments in Water Resources* (Council on Environmental Quality [CEQ] 2013), the *Final Interagency Guidelines* (CEQ 2014), and *NRCS Decision Memorandum for the Acting Chief on PR&G for NRCS Watershed Programs* (NRCS 2018).

2.0 RP&G Evaluation Process Overview

The PR&G evaluation process is based on an eight-step watershed planning process and was completed for the Project as described in this section. The NRCS nine-step planning process was also followed in conjunction with the PR&G evaluation process. The PR&G eight-step evaluation process includes consideration of the federal objective, PL 83-566 general purposes, guiding principles, and ecosystem services. Guiding principles were used to assist in decision making and weighing tradeoffs of Project alternatives, and the use of an ecosystem services framework to describe the comprehensive set of benefits that people receive from nature characterized as ecological goods and services provided by a healthy, functioning environment. The guiding principles are outlined in the PR&G documents and include:

1) Healthy and Resilient Ecosystems
2) Sustainable Economic Development
3) Floodplains (avoiding unwise use of floodplains)
4) Public Safety (reducing public health and safety risks)
5) Environmental Justice
6) Watershed Approach

Ecosystem services benefits have been organized into four service categories that are reflected in the Department of Agriculture Departmental Manual (DM9500-13) and include:

1) Provisioning services are tangible goods provided for direct human use and consumption, such as food, fiber, water, timber, or biomass.
2) Regulating services maintain a world in which it is possible for people to live, providing critical benefits that buffer against environmental catastrophe – examples include flood and disease control, water filtrations, climate stabilization or crop pollination.

3) Supporting services refer to the underlying processes maintaining conditions for life on earth, including nutrient cycling, soil formation, and primary production.
4) Culture services make the world a place in which people want to live – recreational use, spiritual, aesthetic viewsheds, or tribal values.

The guiding principles and service categories were evaluated for those that were critical to the decision maker, the analysis, and the stakeholders. A measurement of change in services was determined, where applicable, between the Future without Federal Investment (FWOFI) Alternative, also referred to as the No Action Alternative, and the Future with Federal Investment (FWFI) Alternatives, also referred to as Action Alternatives. An evaluation framework was developed to compare the FWOFI and FWFI Alternatives and is attached in Appendix A. This framework was used to select the "best" alternative that maximized public benefits (environmental, economic, and social goals) with appropriate consideration of costs, and included consideration of the guiding principles and ecosystem services.

3.0 PR&G Eight-Step Evaluation Process

The PR&G eight step evaluation process was used in decision making as outlined in Sections 3.1 through 3.8 below.

3.1 Identify Problems and Opportunities

Problems and opportunities were identified during the Project scoping process. Input from the Sponsors, agencies, the public, organizations, and tribes were solicited as described in Sections 3.0 and Section 7.3.2 of the Plan-EA. A copy of the Scoping Report is provided in Appendix E of the Plan-EA. Engineering analysis was completed to further identify and evaluate problems as documented in the engineering TM attached in Appendix E of the Plan-EA. The purpose and need of the project was formulated with the problems and opportunities in consideration. Where the "purpose" identifies the fundamental reason why the action is being proposed and the "need" describes the problem/s that the proposed action is intended to address and explains the underlying causes of the problem/s. The purpose and need of the Project is included in Section 2.1 of the Plan-EA with information supporting the purpose and need and a description of the watershed problems identified in Sections 2.2 and 2.3 of the Plan-EA. The purpose and need of the Project as stated in the Plan-EA for reference is included below.

"The purpose of the Project is to provide agricultural water management improvements for irrigation water delivery efficiency and water conservation in the existing irrigation systems of the Eastern Duchesne Watershed. There is a need to reduce water loss, improve system reliability and safety, expand the system to meet existing user water rights, provide pressurized irrigation capabilities, improve water quality, and reduce problematic and costly operations and maintenance (O&M) issues in the current systems."

3.2 Inventory Existing Resource Conditions

Resources relevant to the proposed action were determined during the scoping process as described in Section 3.0 of the Plan-EA. The existing conditions of resources determined to be relevant are documented in Section 4.0 (Affected Environment) of the Plan-EA. The Affected Environment section of the Plan-EA provides the environmental baseline conditions for resources to be evaluated against alternative actions. The best available data and science was used to inventory the existing resource conditions at the level and scale of analysis determined reasonable for evaluating alternatives and impacts.

3.3 Forecast Future Conditions

A forecast of future conditions was made for resources, where reasonable to address, in the Affected Environment section (Section 4.0) of the Plan-EA. Additional future conditions forecasting was made for each alternative and associated implementation and O&M costs. Future forecasting of alternative impacts is described in Section 6.0 (Environmental Consequences) of the Plan-EA. The installation and O&M costs for future conditions of each alternative are provided in Section 5.5 of the Plan-EA.

3.4 Develop Array of Alternatives

Project alternatives were formulated following procedures outlined in the National Watershed Program Manual, National Watershed Program Handbook, and PR&G. Alternatives required in the initial consideration per PR&G include the FWOFI Alternative and the FWFI Alternatives consisting of a nonstructural alternative, locally preferred alternative, environmentally preferable alternative, and additional alternatives. Nonstructural alternatives to meet the Project purpose and need, and Project goals were determined not feasible. Therefore, the FWOFI Alternative, which does not include structural measures but rather maintains the existing irrigation systems, would be considered the nonstructural alternative.

Thirty-Six (36) Action Alternatives were developed for the seven sites for improvements to resolve the problems identified and to provide opportunities in the Eastern Duchesne Watershed for the PL 83-566 agricultural water management authorized purpose. A list of the alternatives developed is included below. Descriptions of alternative measures are provided in Section 5.4 and 5.5 of the Plan-EA.

- Site 1 (Yellowstone Feeder Canal): Four Action Alternatives were developed including two canal lining alternatives and two canal piping alternatives.
- Site 2 (Coyote Canal): Five Action Alternatives were developed including four canal piping alternatives and a riprap erosion control alternative.
- Site 3 (South Boneta Canal): Six Action Alternatives were developed including four canal piping alternatives, one canal lining alternative, and one canal realignment and piping alternative.
- Site 4 (Dry Gulch Class B Canal System): Five Action Alternatives were developed including four canal piping alternatives and one canal lining alternative.
- Site 5 (Dry Gulch Class C Canal System): Five Action Alternatives were developed including four canal piping alternatives and one canal lining alternative.
- Site 6 (Red Cap Extension Canals/Laterals): Five Action Alternatives were developed including four canal piping alternatives and one canal lining alternative.
- Site 7 (Gray Mountain Canal): Six Action Alternatives were developed including four canal lining alternatives and two piping alternatives.

Alternatives were removed from further consideration and analysis during the PR&G evaluation if they were determined infeasible, did not meet the purpose and need, conflicted with the federal objective or guiding principles, had exorbitant costs, or determined to be inferior due to other critical factors. In those cases, a brief discussion is included in the evaluation framework table (Attachment A) to identify the reasons for elimination of an alternative. A discussion of the alternatives eliminated and the reasons for elimination are also documented in Section 5.4 of the Plan-EA.

There were two Action Alternatives selected for evaluation in the framework table for each site, for a total of fourteen (14) Action Alternatives evaluated. The main issues identified for the irrigation systems in the Watershed were loss of water and degraded water quality both due to canal seepage. Standard measures to resolve this issue are straight forward and consist of either hard surface canal lining or piping. Selection between lining or piping was identified for each system based on the need to provide pressurized conveyance or maintain open flow conveyance. Two of the sites for improvement (Site 1 Yellowstone Feeder Canal and Site 7 Gray Mountain Canal) were determined to function proficiently maintaining an open flow and only require lining measures. However, piping measures were also explored for these two sites to compare lining versus. piping costs and support alternative selection. The remaining five sites were determined to need a pressurized system requiring piping measures.

Reasonable hard surface canal lining measures for site specific conditions were evaluated for both Sites 1 and 7. Based on site specific conditions (water velocity, stock and wildlife traffic, soil conditions, topography, etc.), feasibility of construction, and costs, concrete or membrane lining options were selected. Several alternatives for concrete and membrane lining were explored to identify the options that maximized the benefits for the least cost to determine the best option. Two alternatives for both sites were selected for further evaluation in the framework table based on this selection process for the best option. These alternatives consisted of the best-chosen concrete liner alternative (Alternative 1) and membrane liner alternative (Alternative 2).

Reasonable piping measures for site specific conditions were evaluated for Sites 2 through 6. The selection process for reasonable alternatives to evaluate in the framework table followed similar steps as described for Sites 1 and 7. Several alternatives for piping materials were explored to identify the options that maximized the benefits for the least cost, considering feasibility of construction and alignment. HDPE and PVC piping materials were selected as the best piping materials for Project alternatives based on the selection process. Two alternatives were evaluated for each site, using the best-chosen HDPE alternative (Alternative 1) and PVC alternative (Alternative 2).

The FWOFI Alternative (No Action Alternative) was also evaluated to provide a benchmark for comparison. The FWOFI Alternative consisted of continued O&M and repairs to maintain the current irrigation systems at each site.

3.5 Evaluate Effects of Individual Alternatives

The PR&G evaluation framework assessed two Action Alternatives for each site. Refer to the framework table provided in Attachment A. The framework table includes the guiding principles listed in Section 2.0 above and ecosystem services for provisioning, regulating, cultural, and supporting, as applicable. The ecosystem services determined to be applicable to Project measures for evaluation are listed below. Because short-term construction impacts would be avoided, minimized, and/or mitigated, only measurable long-term effects to ecosystem services are considered for the framework table and determination of applicability.

Provisioning Services

- Ecosystem Productivity
- Food (agricultural yield)

Regulating Services

- Climate
- Water Regulation (quality and quantity)
- Biological Regulation (plants and animals)

Cultural Services

- Peace and Sustainability
- Community Well-being
- Cultural/Historical Identity and Heritage

Supporting Services

- Water Cycling
- Nutrient Cycling
- Habitat and Biomass

An economic analysis was also completed for the FWOFI and FWFI alternatives evaluated in the framework tables for each site as described in Section 3.5.1 below.

3.5.1 Economic Evaluation and Comparison

The economic analysis was completed by Long Watershed Planning Economics, LLC. Seven (7) project areas or sites were analyzed in the evaluation. The sites consist of seven different irrigation systems proposed for agricultural water management improvements to conserve water resources and reduce impacts to surface and groundwater quality created by the systems, in addition to accomplishing the individual goals for each system. The existing conditions and problems of each irrigation system are identified in Section 2.3 of the Plan-EA. The economic analysis included the FWFI alternatives determined reasonable for evaluation as part of the alternative development process. The economic evaluation considered the benefits and costs of two FWFI alternatives for each of the seven (7) sites. The FWOFI or the No Action Alternative for each site was also evaluated. The FWOFI is the most likely future condition in the absence of federal action or federal funding which provides the baseline for comparison of the FWFI.

3.5.1.1 *Benefit Calculations*

Three primary economic benefits were identified for the analysis (Table 1). These include maintaining productivity, sediment damage reduction, and decreased O&M costs. Alternative measures also provide benefits to water quality and quantity; however, these are difficult to quantify and are addressed qualitatively.

Table 1. Benefit Categories for Consideration in Economic Analysis

Site No. / Site Name	Maintaining Productivity				Sediment Damage Reduction	Reduced O&M
	Reduced Water Seepage	Additional Irrigated Acreage	Increased Efficiency	Reduced Salinity		
Site 1 / Yellowstone Feeder Canal	X			X		X
Site 2 / Coyote Canal	X			X	X	X
Site 3/ South Boneta Canal	X		X	X		X
Site 4/ Dry Gulch Class B Canal System	X		X	X		X
Site 5/ Dry Gulch Class C Canal System	X		X	X		X
Site 6/ Red Cap Extension Canal	X	X	X	X		X
Site 7/ Gray Mountain Canal	X			X		X

Benefit Calculations for Maintaining Productivity

Maintenance of productivity is a claimable benefit under watershed protection, according to the NWPM 506.20. Two subcategories of benefits were calculated under this benefit, increased yield and additional irrigated acreage. Calculations for each are described below.

Increased Yield: To calculate increased yield, current crop acreages and crop types associated with the irrigation systems were first determined. This was accomplished through GIS analysis and results are included in Table 2. Costs and returns from these crop types were then calculated. Crop budgets from Utah State University Extension (Godfrey et. al 2006) were collected to represent the costs and returns from these crops. The budget chosen was alfalfa for pasture and grass hay for Duchesne County, Utah, as well as wheat for field and grain crops. Production costs were updated to current figures using the Producer Prices Paid Index (Economic Research Services 2022). State level current normalized prices were used for the price received.

Table 2. Crop Acreages by Project Site

Site No. / Site Name	Unit	Pasture	Hay/Turf	Fallow/ Idle	Field Crops	Grain/ Seeds	Total
Site 1/ Yellowstone Feeder Canal*	ac	13,353	21,165	1,832	318	48	**36,716**
Site 2/ Coyote Canal	ac	4,532	3,697	619	-	23	**8,871**
Site3/ South Boneta	ac	1,036	586	71	-	-	**1,693**
Site4/ Dry Gulch Irrigation Co. B	ac	2,976	7,179	510	-	5	**10,670**
Site5/ Dry Gulch Irrigation Co. C	ac	3,749	6,618	752	916	152	**12,187**
Site 6/ Arcadia Farms	ac	944	1,844	247	-	-	**3,035**
Site 7/ Gray Mountain Canal	ac	1,948	8,230	595	3,218	165	**14,156**

* Areas for Yellowstone Feeder Canal were adjusted accordingly to remove overlap of Site 2, Site 4, and Site 5 crop acreage totals.

Increased yield is based on reducing water seepage (loss) from the canal systems, thus increasing available water for irrigation. Water seepage analysis results for reduced seepage are shown in Table 3 below. The percent increase in water was calculated from the results (Table 3).

Table 3. Water Savings by Project Site

Site No	Site Name	Annual Amounts (ac-ft)			Percent Increase in Water
		Existing Seepage	Proposed Seepage	FWFI Seepage Reduction	
Site 1	Yellowstone Feeder Canal	2,960	1,102	1,858	63
Site 2	Coyote Canal	591	288	303	51
Site 3	South Boneta Canal	812	0	812	100
Site 4	Dry Gulch Class B Canal Total	20,172	854	19,318	96
Site 5	Dry Gulch Class C Canal	4,662	0	4,662	100
Site 6	Red Cap Extension Canals/Laterals	4,784	0	4,784	100
Site 7	Gray Mountain Canal	12,721	3,268	9,453	74
Total		**46,702**	**5,512**	**41,190**	**88**

FWFI = Future with Federal Investment

A benefit was calculated based on the crop type, acreage, water savings, and estimated yield increase from observed results of published studies (Table 4). Increased yield is based on reducing water seepage (loss) from the canal systems. According to several studies in the west identified in a USU study (Shewmaker et. al., 2013), the yield response of alfalfa (the predominant crop irrigated at all sites) to water is a linear function. For example, two functions identified by Shewmaker were y = 0.18x and y = 0.19x - 0.25, where y is yield in tons per acre and x is inches of water. When graphed, these yield response functions were very similar, and show a direct response to increased water.

More recent and local research test plots in Utah have shown a 20 percent reduction in yield (0.75 tons per acre) due to cutting water application by 25 percent, and 30 percent reduction in yield (1.2 tons per acre) for cutting water back by 50 percent (Yost et al. 2021). Using these findings as sideboards, an attempt was made of the potential yield response to increased water availability for each site in the Project.

Using the data from Table 2 and Table 3, a potential yield benefit was estimated for each site (Table 4). For ease of analysis and to account for uncertainty, two categories were used:

A 0.5 ton per acre benefit for water increases well over 50 percent; and

A 0.25 ton per acre benefit for increases near 50 percent.

Considering that a 50 percent decrease resulted in a 1.2 ton per acre drop in yield in the 2021 research project referenced above (Yost et. al 2021), these estimates appear conservative but are prudent considering the uncertainty of the use of all the saved water.

Alfalfa and grass/hay crops are the predominant crop at all sites, with percentages ranging from 85 percent to over 95 percent of total acreage. For the other crops (field crops and grain/seed), a 5 bushel per acre (bu/ac) yield increase was assumed, using the Duchesne County crop budget for wheat. With the baseline scenario from the crop budget, this amounts to a 7 percent increase. Fallow was idle and was not used in the analysis.

Table 4. Water Increase Economic Benefits for Crop Yield

Site No. / Site Name	Crop Type	% Water Increase	Crop Acreage	Yield Increase Used	Increase in Net Return ($/ac/yr)*	Total Increase per Year ($)
Site 1/ Yellowstone Feeder Canal	Pasture & Hay/Turf	63	34,518	0.25 ton/ac	35.12	1,212,272
	Other		366	5 bu/ac	25.48	9,326
					Site 1 Subtotal	***1,221,598***
Site 2 / Coyote Canal	Pasture & Hay/Turf	51	8,229	0.25 ton/ac	35.12	289,002
	Other		23	5 bu/ac	25.48	586
					Site 2 Subtotal	***289,588***
Site 3/ South Boneta Canal	Pasture & Hay/Turf	100	1,622	0.5 ton/ac	70.24	113,929
	Other		0	-	-	-
					Site 3 Subtotal	***113,929***
Site 4/ Dry Gulch Class B Canal System	Pasture & Hay/Turf	96	10,155	0.5 ton/ac	70.24	713,287
	Other		5	5 bu/ac	25.48	127
					Site 4 Subtotal	***713,414***
Site 5/ Dry Gulch Class C Canal System	Pasture & Hay/Turf	100	10,367	0.5 ton/ac	70.24	728,178
	Other		1,068	5 bu/ac	25.48	27,213
					Site 5 Subtotal	***755,391***
Site 6/ Red Cap Extension Canal	Pasture & Hay/Turf	100	2,788	0.5 ton/ac	70.24	195,829
	Other		0	-	-	-
					Site 6 Subtotal	***195,829***
Site 7 / Gray Mountain Canal	Pasture & Hay/Turf	74	10,178	0.5 ton/ac	70.24	714,903
	Other		3,383	5 bu/ac	25.48	86,199
					Site 7 Subtotal	***801,102***
					TOTAL INCREASE YIELD PER YEAR	**4,090,851**

* Estimated from crop budgets.

Other crop type includes field crops and grain/seeds

The increase in yield per year for each site was discounted to a present value and annualized over the project life equating to a total annual benefit of $3,912,800. The individual benefit for each site is listed in Table 6 below. Note that the Site 6 (Red Cap Extension Canals/Laterals) includes additional acres available for use, so that estimate includes the additional benefit.

<u>Additional Irrigated Acreage:</u> Only one of the seven sites (Site 6 for Red Cap Extension Canals/Laterals) had measures that would increase acreage available for irrigation (2,422 acres). This additional acreage benefit was estimated by applying estimated net returns per acre ($166) for alfalfa to the additional acreage, for a benefit of approximately $402,100 per year. This was discounted to a present value and annualized over the evaluation period to $384,600 per year.

Benefit Calculations for Sediment Damage

Approximately 9.42 ac-ft (15,200 CY) of sediment has eroded from the Coyote Canal and deposited in Brown’s Draw Reservoir. There is potential for an additional 6.76 ac-ft (10,900 CY) of material to be eroded over the next approximately 28 years and deposit in the reservoir. FWFI measures included in the Coyote Canal site will eliminate this issue.

Brown’s Draw Reservoir is a popular public fishing destination. It is approximately 151 acres in size. Most anglers here bait cast, fly fish, spin cast, and still fish (rainbow, tiger, and brown trout). It is open to underwater spearfishing for game fish from January 1 through December 31. No estimate could be found on annual visits or usage.

To estimate the benefit of sediment reduction measures, the cost of the FWOFI was calculated by assuming a dredging cost of $28.70 per cubic yard in year 30. Multiplying 10,900 cubic yards times $28.70 per cubic yard equates to $312,800. This amount was discounted to a present value and annualized over the project life equating to an annual benefit of $5,400.

Benefit Calculations for Reduced Salinity

Canal seepage has been identified as a large component of surface water and groundwater degradation in the Eastern Duchesne Watershed and in the downstream receiving waters. Alternative measures would reduce salinity loads to surface and groundwater. Salinity reduction was estimated based on tons per mile reduction values provided from a salinity control measures report for Unita Basin (URS 2014) and the NRCS Uintah Basin Salinity Coordinator (NRCS 2023). The lengths of canals piped, lined, or no longer flowing water were calculated for each of the seven sites for improvement and provided by Jones and DeMille Engineering (JDE). Based on the tons per mile of salinity load reduction and calculated lengths of canal modified, an estimated salinity reduction was calculated for alternative improvements for each canal system (Table 5).

Table 5. Salinity Reduction by Project Site

Site No. / Site Name	Length of Canal Piped, Lined, or No Longer Flowing (miles)	Salinity Reduction per Mile of Canal (tons/mile)	Estimated Salinity Reduction (tons)[3]	Estimated Salinity Reduction (tons/ac)
Site 1 / Yellowstone Feeder Canal	2.64	25[(1)]	66	0.002
Site 2 / Coyote Canal	0.84	80[(1)]	67	0.008
Site 3 / South Boneta Canal	2.44	80[(1)]	195	0.120
Site 4 / Dry Gulch Class B Canal System	17.90	118.7[(2)]	2,127	0.209
Site 5 / Dry Gulch Class C Canal System	5.42	80[(1)]	434	0.042
Site 6 / Red Cap Extension Canals/Laterals	25.40	80[(1)]	2,030	0.552
Site 7 / Gray Mountain Canal	1.98	240[(2)]	475	0.042

1 – NRCS 2023

2 – BOR 2023

3 – Rounded to nearest ton.

Salinity has a major impact on crop yields, and therefore agricultural land values, and the viability of farming. High levels of salinity limit a producer’s choices in responding to fluctuating market conditions as they may not profitably grow salt sensitive crops even during periods of high prices (Ripplinger et.al. 2016). This study estimated per acre revenue for crops would drop by an average of 43 percent with increased salinization.

Salinity also has serious ecological impacts, mainly on soil chemistry, and long term agricultural production. According to Shrivistava and Kumar (2014), it can have large impacts on irrigated agricultural land. The same study reports that crop yields affected by salinity are 20 to 50 percent of yields.

Based on the literature, it is clear that reduced salinity will have an impact. The project measures for the alternatives would reduce the salinity by a great deal, and therefore, increase or maintain crop revenues per acre and benefit habitat for aquatic organisms downstream. It is estimated that much cropland has been taken out of production due to salinity worldwide, especially in dryland climates (Water Education Foundation 2023). A conservative estimate of 20% yield increase due to less salinity in the irrigation water from implementation of alternative measures was used to calculate the economic benefits (Table 6). An adjustment was made for the amount of salinity reduced, from Table 5.

Table 6. Salinity Economic Benefits for Crop Yield

Site No. / Site Name	Increased Return Due to More Water ($/ac)	Acreage of main crops	Increased Return due to salininty reduction ($/ac)	Economic Benefit Total ($)	Adjustment for Amount of Salinity Reduced ($)
Site 1 / Yellowstone Feeder Canal	35.12	31,541	7.02	$221,546	$464
Site 2 / Coyote Canal	35.12	8,229	7.02	$57,804	$471
Site 3 / South Boneta Canal	70.24	1,622	14.05	$22,787	$2,739
Site 4 / Dry Gulch Class B Canal System	70.24	10,155	14.05	$142,657	$29,880
Site 5 / Dry Gulch Class C Canal System	70.24	10,366	14.05	$145,625	$6,097
Site 6 / Red Cap Extension Canals/Laterals	70.24	3,676	14.05	$51,641	$28,517
Site 7 / Gray Mountain Canal	70.24	11,441	14.05	$160,726	$6,673

Benefit Calculations for Reduced Operation and Maintenance

There is significant O&M associated with the existing canal systems. With the inception of the project, the O&M costs would be reduced for Alternative 1 which has been accounted for in the analysis. Alternative 2 also reduces O&M costs for Sites 2 through 6. Table 7 displays FWOFI and FWFI O&M costs. The annualized cost and benefits of the change in O&M are included in Table 8 and Table 9.

Table 7. FWOFI OM&R Costs

Site No. / Site Name	FWOFI O&M ($/year)	FWFI Alternative 1 O&M ($/year)	FWFI Alternative 2 O&M ($/year) and Replacement
Site 1 / Yellowstone Feeder Canal	17,600	1,700	6,000 (O&M) 1,153,000 (Replacement*)
Site 2 / Coyote Canal	16,600	600	1,200
Site 3 / South Boneta Canal	8,600	1,600	1,600
Site 4 / Dry Gulch Class B Canal System	22,800	9,600	9,600
Site 5 / Dry Gulch Class C Canal System	63,700	4,000	10,850
Site 6 / Red Cap Extension Canals/Laterals	41,800	12,800	12,800
Site 7 / Gray Mountain Canal	51,000	1,300	6,000 (O&M) 2,132,000 (Replacement**)

* Due to high wildlife/stock traffic and associated damage, the membrane liner would require complete replacement every 10 years, or four (4) times over the Project life.

** The membrane liner has a life of 20 years and would require complete replacement two (2) times over the Project life.

Alternative Benefits Summary

Table 8 summarizes the annual benefits calculated for each site. Annual costs were calculated using FY 2022 Water Resources Discount Rate (2.25%), annualized over 50 years, and 52-year period of analysis.

Table 8. Economic Benefits by Project Site

Item	Estimated Average Annual Benefit		Total
	Agriculture Related	Non-Agriculture Related	
Site 1 (Yellowstone Feeder Canal)			
Alternative 1 & 2 Maintaining Productivity (Onsite)	$1,168,400	$0	$1,168,400
Alternative 1 & 2 Reduced Salinity	$400	$0	$400
Alternative 1 Other: Reduced O&M (Onsite)	$16,800	$0	$16,800
Site 2 (Coyote Canal)			
Alternative 1 & 2 Maintaining Productivity (Onsite)	$277,000	$0	$277,000
Alternative 1 & 2 Sediment Reduction (offsite/public)	$5,400	$0	$5,400
Alternative 1 & 2 Reduced Salinity	$500	$0	$500
Alternative 1 & 2 Other: Reduced O&M (Onsite)	$15,900	$0	$15,900
Site 3 (South Boneta Canal)			
Alternative 1 & 2 Maintaining Productivity (Onsite)	$109,000	$0	$109,000
Alternative 1 & 2 Reduced Salinity	$2,600	$0	$2,600
Alternative 1 & 2 Other: Reduced O&M (Onsite)	$8,200	$0	$8,200
Site 4 (Dry Gulch Class B Canal System)			
Alternative 1 & 2 Maintaining Productivity (Onsite)	$682,400	$0	$682,400
Alternative 1 & 2 Reduced Salinity	$28,600	$0	$28,600
Alternative 1 & 2 Other: Reduced O&M (Onsite)	$21,800	$0	$21,800
Site 5 (Dry Gulch Class C Canal System)			
Alternative 1 & 2 Maintaining Productivity (Onsite)	$722,500	$0	$722,500
Alternative 1 & 2 Reduced Salinity	$5,800	$0	$5,800
Alternative 1 & 2 Other: Reduced O&M (Onsite)	$61,000	$0	$61,000

Item	Estimated Average Annual Benefit		Total
	Agriculture Related	Non-Agriculture Related	
Site 6 (Red Cap Extension Canals/Laterals)			
Alternative 1 & 2 Maintaining Productivity	$571,900	$0	$571,900
Alternative 1 & 2 Reduced Salinity	$27,300	$0	$27,300
Alternative 1 & 2 Other: Reduced O&M (Onsite)	$39,900	$0	$39,900
Site 7 (Gray Mountain Canal)			
Maintaining Productivity (Onsite)	$766,200	$0	$766,200
Alternative 1 & 2 Reduced Salinity	$6,400	$0	$6,400
Alternative 1 Other: Reduced O&M (Onsite)	$48,800	$0	$48,800

3.5.1.2 *Alternative Costs*

Alternative costs were calculated by JDE for installation of measures, and for operations, maintenance and replacement (OM&R) costs. The FWOFI alternatives do not include installation measures and consist of OM&R to maintain the existing systems as described in Section D.7.1 in Appendix D of the Plan-EA. The FWFI includes installation cost for construction, design engineering, construction engineering, administrative time, permitting, and real property rights, as applicable. The FWFI also includes the alternative OM&R costs after installation of alternative measures. The JDE detailed costs are enclosed in Attachment B for reference.

The annualized installation and OM&R costs were calculated for the FWFI using the GY 2022 Water Resources Discount Rate (2.25%), annualized over 50 years with a 52-year period of analysis. Calculated annual costs are provided in Table 9 for Alternative 1 and Table 10 for Alternative 2.

Table 9. Installation and O&M Costs Alternative 1

Improvements	Installation Cost ($)	Amortization of Installation Cost ($/year)	Amortization of O&M and Replacement Cost ($/year)	Total Annual Cost ($/year)
Site 1 (Yellowstone Feeder Canal)	3,082,000	99,900	1,600	101,500
Site 2 (Coyote Canal)	1,803,000	58,500	600	59,100
Site 3 (South Boneta Canal)	803,000	26,000	1,500	27,500
Site 4 (Dry Gulch Class B Canal System)	5,941,000	192,600	9,200	201,800
Site 5 (Dry Gulch Class C Canal System)	15,793,000	512,000	3,800	515,800
Site 6 (Red Cap Extension Canals/Laterals)	9,258,000	300,100	12,200	312,300
Site 7 (Gray Mountain Canal)	4,369,000	141,600	1,200	142,800
Total	**41,049,000**	**1,330,700**	**30,100**	**1,360,800**

Table 10. Installation and O&M Costs Alternative 2

Improvements	Amortization of Installation Cost ($/year)	Amortization of O&M and Replacement Cost ($/year)	Total Annual Cost ($/year)
Site 1 (Yellowstone Feeder Canal)	46,200	93,200	139,400
Site 2 (Coyote Canal)	134,400	1,100	135,500
Site 3 (South Boneta Canal)	84,600	1,500	86,100
Site 4 (Dry Gulch Class B Canal System)	569,000	9,200	578,200
Site 5 (Dry Gulch Class C Canal System)	1,303,600	10,400	1,314,000
Site 6 (Red Cap Extension Canals/Laterals)	800,600	12,200	812,800
Site 7 (Gray Mountain Canal)	85,200	95,300	180,500
Total	**3,023,600**	**222,900**	**3,246,500**

3.5.1.3 *Cost Benefit Comparison*

The FWOFI and FWFI alternatives costs and benefits were compared to determine a benefit cost ratio and total average annual economic benefits (Table 11). The results of the cost benefit comparison were incorporated into the evaluation framework tables included in Appendix A.

Table 11. Benefit Cost Ratios and Net Benefits by Project Site

Site	Alternative	Total Annual Costs	Total Annual Benefits	Benefit Cost Ratio	Net Annual Economic Benefit
Site 1 (Yellowstone Feeder Canal)	No Action	$1,600	-	-	($1,600)
	Alternative 1	$101,500	$1,185,700	11.7	1,084,100
	Alternative 2	$139,400	$1,185,700	8.5	1,046,300
Site 2 (Coyote Canal)	No Action	$600	-	-	($600)
	Alternative 1	$59,100	$298,800	5.1	$239,700
	Alternative 2	$135,500	$298,800	2.2	$163,300
Site 3 (South Boneta Canal)	No Action	$1,500	-	-	($1,500)
	Alternative 1	$27,500	$119,800	4.4	$92,300
	Alternative 2	$86,100	$119,800	1.4	$33,700
Site 4 (Dry Gulch Class B Canal System)	No Action	$9,200	-	-	($9,200)
	Alternative 1	$201,800	$732,800	3.6	$531,000
	Alternative 2	$578,200	$732,800	1.3	$154,600
Site 5 (Dry Gulch Class C Canal System)	No Action	$3,800	-	-	($3,800)
	Alternative 1	$515,800	$789,300	1.5	$273,500
	Alternative 2	$1,314,000	$789,300	0.6	($524,700)
Site 6 (Red Cap Extension Canals/Laterals)	No Action	$12,200	-	-	($12,200)
	Alternative 1	$312,300	$639,100	2.0	$326,800
	Alternative 2	$812,800	$639,200	0.8	($173,500)
Site 7 (Gray Mountain Canal)	No Action	$1,200	-	-	($1,200)
	Alternative 1	$142,800	$821,400	5.8	$678,600
	Alternative 2	$180,500	$821,400	4.6	$640,900

As with all projections of future costs and benefits, there is a degree of uncertainty assumed. Installation costs, O&M costs, usage of conserved resources, yield responses, and commodity and input prices will all fluctuate. This was accounted for as much as possible by assuming yield responses that were conservative, accounting for recent local research. Weather variations can affect benefits as well. For example, If the dry conditions continue out west, the conserved water could be more valuable. While economic estimates are not precise, the intention is that they are reasonably accurate and can assist in making good decisions.

3.5.1 Environmental Evaluation

An environmental evaluation was completed for each alternative included in detailed study. These include the FWOFI Alternative (No Action Alternative) and the FWFI Alternatives for Sites 1 through 7. The potential effects of each alternative were determined for relevant resource categories and are documented in Section 6.0 (Environmental Consequences) of the Plan-EA.

3.6 Compare Alternatives

A measurement of change in services was determined, where applicable, between the FWOFI Alternative FWFI Alternative/s for each site. The alternatives for each site meeting the guiding principles were noted in the framework table for side-by-side alternative comparison. The ecosystem services were also compared in the framework table. The PR&G evaluation comparison tables for decision making are included in Attachment A.

Alternatives were evaluated to determine the locally, environmentally, and socially preferred alternative plans. The locally preferred alternative was coordinated with the those having local interests and oversight for implementation authorities and responsibilities. The local entities included DCWCD, the canal companies (South Boneta Canal Company, Moon Lake Water Users Association, Dry Gulch Irrigation Company, and Uintah Indian Irrigation Project O&M Company), the Ute Indian Tribe, and irrigation stakeholders. The environmentally preferred alternative was selected based on evaluations and decision making performed during the NEPA process, and from the determination of environmental consequences as documented in Section 6.0 of the Plan-EA. Determination of the socially preferred alternative compared impacts or benefits for each alternative related to the social wellbeing of the community. Specifically for this project these comparison items included socioeconomic effects of the community.

3.7 Identify Recommended Alternative

NRCS must identify the federally assisted alternative that “best” maximizes public benefits (environmental, economic, and social goals) with appropriate consideration of costs, guiding principles, and ecosystem services. This alternative is known as the NRCS National Economic Efficiency (NEE) Alternative. The NEE Alternative for each site was also selected in consideration of the federal objective, as set forth in the Water Resources Development Act of 2007, that reflect national priorities, encourage economic development, and protect the environment through:

1) Seeking to maximize sustainable economic development.
2) Seeking to avoid the unwise use of floodplains and flood-prone areas and minimizing adverse impacts and vulnerabilities in any case in which a floodplain or flood-prone area must be used.
3) Protecting and restoring the functions of natural systems and mitigating any unavoidable damage to natural systems.

The FWFI alternatives are in line with the federal objective as outlined above. The FWFI alternatives were formulated to maximize sustainable economic development and result in substantial economic benefits for the agricultural community and irrigation providers. The FWFI alternatives improve agriculture water management of the watershed and avoid adverse impacts to floodplains. They include modifications to artificial irrigation systems to conserve water resources and reduce adverse impacts to surface and groundwater quality created by the artificial systems.

The intent of the Project is also in line with the PL 83-566 general purposes to

1) Prevent damage from erosion, floodwater, and sediment.
2) Further the conservation, development, utilization, and disposal of water.
3) Further the conservation and proper utilization of land.

The NEE alternative for each site was selected based on the “best” option determined from the comparison of alternatives included in the framework table in Attachment A. In comparing the FWOFI to the FWFI alternatives there was one clear “best” option determined. Both FWFI alternatives analyzed for each site resulted in similar benefits, but did not have the same costs. Alternative 1 for each site resulted in the least cost (installation and OM&R costs) over the evaluated life and was selected as the NEE alternative. This alternative provided the greatest cost-benefit, met the guiding principles, provided the greatest benefits for ecosystem services, and is in line with the federal objective and PL 83-566 general purposes. Alternative 1 was also determined to be the locally preferred, environmentally preferred, and socially preferred alternative. The Plan-EA incorporates a description of the decision-making process for selection of the NEE alternative in 8.1 (Rationale for Preferred Alternative Selection).

The environmental and social impacts are the same between Alternative 1 and Alternative 2 based on improvements proposed along the same alignment with matching disturbance footprints. However, the economic results vary greatly with Alternative 2 having a substantially lower economic benefit, or in some cases, a negative net benefit due to greater costs over the life of the Project. For this reason, Alternative 2 was not advanced for detailed study in the Plan-EA based on having the same non-economic impacts and higher cost that provided no additional social, environmental, or economic benefits.

3.8 Implement and Evaluate

The NEE alternative (Alternative 1) for each of the seven sites was evaluated in the Plan-EA and environmental consequences of the alternative are included in Section 6.0 of the Plan-EA. The No Action alternative was also evaluated in the Plan-EA to provide a baseline comparison. The effects of alternatives were determined for each resource relevant to the proposed action. The evaluation assessed the proposed alternatives against the baseline data presented in Section 4.0 (Affected Environment) of the Plan-EA.

An additional evaluation of the NEE alternative was completed that included information on implementing the proposed measures. This included recommended measures to be installed, avoidance/minimization measures, required permits and compliance, installation/financing, O&M, costs, cost share, and economic benefits. This is included in Section 8.0 (Preferred Alternative) of the Plan-EA.

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Appendix A

PR&G Framework and Tradeoff Table

Appendix B

Cost Estimates

Appendix A

PR&G Framework and Tradeoff Table

Site 1
Yellowstone Feeder Canal

PR&G Framework and Trade-off Analysis Table (Site 1 Yellowstone Feeder Canal)

Duchesne Water Efficiency Project
Eastern Duchesne Watershed

Alternatives Considered

Future Without Federal Investment (FWOFI): No Action Alternative
The No Action Alternative would not improve the irrigation system and O&M activities to maintain the existing system would continue.

Future With Federal Investment (FWFI): Action Alternatives
Alternative 1: Line 13,926 linear feet (2.64 miles) of Yellowstone Feeder Canal with concrete.
Alternative 2: Line 13,926 linear feet (2.64 miles) of Yellowstone Feeder Canal with membrane liner.
Alternative 3: Pipe 13,926 linear feet (2.64 miles) of Yellowstone Feeder Canal.
Alternative 4: Pipe entire length of Yellowstone Feeder Canal (10.6 miles).

Alternatives 3 and 4 were eliminated from evaluation in the table below because they did not meet the Project design criteria to maintain an open channel for wildlife and stock watering access. Additionally canal stability concerns were identified for Alternative 3 and Alternative 4 had exorbitant costs.

Alternative 1 and 2 are included in the evaluation below.

Please refer to Section 5.4 and 5.5 of the Plan-EA for further description of alternatives developed and justification for elimination.

Summary and Comparison

Item	FWOFI	FWFI		Comments
		Alternative 1 (Concrete Liner)	Alternative 2 (Membrane Liner)	
Alternative Plans				
Locally Preferred		✓		Duchesne County Water Conservancy District (DCWCD) and irrigation company stakeholders are in support of Alternative 1.
Nonstructural	✓	N/A	N/A	There is not a feasible non-structural alternative that would meet the purpose and need, therefore, the FWOFI of maintaining the existing systems would be the nonstructural alternative.
Environmentally Preferred		✓		All environmental impacts are the same between Alternative 1 and 2, except for meeting wildlife/stock crossing needs. Alternative 1 provides for stability and crossings for stock and wildlife while Alternative 2 does not.
Socially Preferred		✓		Alternative 1 is the socially preferred alternative approved by the irrigation stakeholders, agricultural beneficiaries, and sponsor.
National Economic Efficiency		✓		This was determined to be the combination of measures that provided the least cost while minimizing environmental impacts and maximizing social, environmental, and economic benefits.
Guiding Principles				
Healthy and Resilient Ecosystems		✓	✓	The FWFI measures support healthy and resilient ecosystems through water conservation that leaves more water in the natural systems. It also reduces input of TDS into natural systems improving water quality. The measures improve the health and function of the natural ecosystem.
Sustainable Economic Development		✓	✓	The FWFI measures improve the economic well-being of the local agricultural community while sustaining use and management of water resources for water conservation and improved water quality.
Floodplains		✓	✓	The FWFI does not transfer flood risk and is consistent with EO 11988 and 7CFR650.25.
Public Safety		✓	✓	There are no public and safety concerns for the FWFI Alternatives.
Environmental Justice		✓	✓	The FWFI Alternatives provide long-term socioeconomic benefits to subject populations, including minority and low income communities. There are no adverse impacts to subject populations.
Watershed Approach		✓	✓	The FWFI Alternatives solve the Watershed problems of water loss due to canal seepage and associated ground and surface water contamination from increased salinity and total dissolved solids. At the same time the measures increase crop production and reduce costly OM&R resulting in positive economic benefits for the Watershed.

Evaluation Framework and Tradeoffs			
Item	**FWOFI**	**FWFI**	
		Alternative 1 (Concrete Liner)	**Alternative 2 (Membrane Liner)**
Provisioning Services			
Ecosystem Productivity	Artificial irrigation systems continue to degrade surface water impacting ecosystem health of the downstream river systems. Canal seepage continues to result in more water diverted from natural systems to meet irrigation needs decreasing water availability in the natural systems.	Conserves irrigation water leaving more water in the natural systems and reduces input of total dissolved solids (TDS) into natural systems improving water quality. These measures improve the health and function of the ecosystems downstream and would result in increased productivity of the natural ecosystems connected to these waters.	Same as Alternative 1.
Food (agricultural yield)	No Change	Improves irrigation delivery efficiency and increases crop production on 34,884 acres of land.	Same as Alternative 1.
Regulating Services			
Climate	Climate change would continue to result in drought and decreased water availability.	Climate change would continue to cause drought, but alternative measures result in water conservation to better adapt and increase resilience to climate stressors.	Same as Alternative 1.
Water Regulation (quality and quantity)	Extra water would continue to be diverted to offset the water lost from canal seepage. Canal seepage would continue to degrade surface and groundwater sources from high input of TDS increasing salinity.	Reduces canal seepage by 1,858 acre-feet annually and salinity by 66 tons annually, improving surface and groundwater quality. This would provide more water in the natural systems and improve water quality in the Watershed and in the downstream receiving waters.	Same as Alternative 1.
Biological Regulation (plants and animals)	Degradation of water quality and quantity in the natural stream systems would continue to adversely impact plant communities, aquatic speceis, and wildlife species that inhabit those corridors, including those that may be federally-listed species, state-listed species, or migratory birds.	Improved water quantity and quality in natural stream systems would benefit plant communities, aquatic species, and wildlife species that inhabit those corridors, including those that may be federally-listed species, state-listed species, or migratory birds.	Similar to Alternative 1 but the membrane liner would not allow for stable wildlife crossings.
Cultural Services			
Peace and Sustainability (tribal, agricultural, and rural communities)	Continued decrease in crop yield and increased private pumping costs for rural agricultural communities and tribal communities that diminish the sustainability of the communities.	Improves irrigation water conveyance and conserves water resulting in increased agricultural production and sustainability for rural agricultural and tribal communities.	Same as Alternative 1.
Community Well-being (tribal, agricultural, and rural communities)	Continued decrease in crop yield and increased private pumping costs that add financial stressors and impact the well-being of rural agricultural and tribal communities.	Anticipated increased crop yields and decrease in private pumping costs that reduce finiancial stressors, improving the well-being of rural agricultral and tribal communities.	Same as Alternative 1.
Cultural/Historical Identity and Heritage	The canal system is a historic feature constructed by the CCC between 1935 and 1941. It is eligble for listing in the National Register of Historic Places.	Impacts to the historic canal would be mitigated in cooorditation with SHPO to maintain the historical identity.	Same as Alternative 1.
Supporting Services			
Water Cycling	Increased diversion of water resources to compensate for canal seepage would continue to alter the natural water cycling process.	Reduces the human impact to the natural water cycling process interrupted from diversion and conveyance of water for irrigation practices by keeping more water in the natural system.	Same as Alternative 1.
Habitat and Biomass	Degradation of water quality and reduced water quantities in natural systems would continue to adversely impact habitat and biomass of the natural systems.	Benefits water quality and quantity in the natural stream systems that would improve habitat and biomass.	Same as Alternative 1.
Nutrient Cycling	Input of TDS into the natural system caused by canal seepage would continue to impact the natural nutrient cycling process.	Reduces the input of TDS into the natural system from canal seepage reducing the human impact to the natural nutrient cycling process.	Same as Alternative 1.

Economic Analysis			
Item	FWOFI	FWFI	
		Alternative 1 (Concrete Liner)	Alternative 2 (Membrane Liner)
Costs			
Installation Federal PL 83-566	$0	$2,411,500	$1,113,000
Installation Sponsor	$0	$670,500	$313,000
Annual Installation Costs	$0	$99,900	$46,200
Annual O&M Costs	$16,800	$1,600	$93,200
Total Annual Costs	$16,800	$101,500	$139,400
Annual Benefits			
Agriculture - Crop Yield	-	$1,168,800	$1,168,800
O&M Cost Avoided	-	$16,800	$16,800
Total Annual Benefits	**-**	**$1,185,600**	**$1,185,600**
Cost Benefit Ratio and Net Benefits			
Cost-Benefit Ratio	**-**	**11.7**	**8.5**
Net Benefit	**-**	**$1,084,100**	**$1,046,200**
Decision-Making Conclusion	This alternative is provided for comparison purposes and is not selected as the NEE Alternative. It does not meet the purpose and need of the Project nor results in benefits to ecosystem services.	**Selected as the NEE Alternative:** Alternative 1 provides the highest benefit to ecosystem services, has the greatest cost-benefit, and is the locally/socially/environmentally preferred alternative that meets the project goals and objectives.	Alternative 2 has similar ecosystem benefits but does not provide an adequate design to prevent puncture of the lining from stock/wildlife, does not allow for stable wildlife/stock access or crossing, and only provides a 10-year service life. This would increase O&M costs and require replacement of the membrane liner four times over a 50-year period. Even though the installation cost are less than Alternative 1, the OM&R costs are greater resulting in a lower cost-benefit when compared to Alternative 1. Therefore, this alternative was not selected as the NEE Alternative.

Site 2
Coyote Canal

PR&G Framework and Trade-off Analysis Table (Site 2 Coyote Canal)

Duchesne Water Efficiency Project
Eastern Duchesne Watershed

Alternatives Considered

Future Without Federal Investment (FWOFI): No Action Alternative
The No Action Alternative would not improve the irrigation system and O&M activities to maintain the existing system would continue.

Future With Federal Investment (FWFI): Action Alternatives
Alternative 1: Pipe 4,413 linear feet of Coyote Canal using HDPE pipe and armor 477 linear feet.
Alternative 2: Pipe 4,413 linear feet of Coyote Canal using PVC pipe and armor 477 linear feet.
Alternative 3: Pipe 4,413 linear feet of Coyote Canal using metal pipe and armor 477 linear feet.
Alternative 4: Armor 4,890 linear feet of Coyote Canal with riprap over geotextile material.
Alternative 5: Pipe 4,413 linear feet of Coyote Canal with dual HDPE pipes and armor 477 linear feet.

Alternatives 3 and 5 were eliminated from evaluation in the table below because the costs to install the measures were greater than other alternatives without providing any additional benefits. Alternative 4 was eliminated from evaluation in the table below because it only met a service life of 10 years, did not meet the purpose and need of reducing water loss, and created logistical issues for access.

Alternative 1 and 2 are included in the evaluation below.

Please refer to Section 5.4 and 5.5 of the Plan-EA for further description of alternatives developed and justification for elimination.

Summary and Comparison

Item	FWOFI	FWFI		Comments
		Alternative 1 (HDPE)	Alternative 2 (PVC)	
Alternative Plans				
Locally Preferred		✓		Duchesne County Water Conservancy District (DCWCD) and irrigation company stakeholders are in support of Alternative 1.
Nonstructural	✓	N/A	N/A	There is not a feasible non-structural alternative that would meet the purpose and need, therefore, the FWOFI of maintaining the existing systems would be the nonstructural alternative.
Environmentally Preferred		✓	✓	All environmental impacts are the same between Alternative 1 and 2 resulting in no environmental preference between the two.
Socially Preferred		✓		Alternative 1 is the socially preferred alternative approved by the irrigation stakeholders, agricultural beneficiaries, and sponsor.
National Economic Efficiency		✓		This was determined to be the combination of measures that provided the least cost while minimizing environmental impacts and maximizing social, environmental, and economic benefits.
Guiding Principles				
Healthy and Resilient Ecosystems		✓	✓	The FWFI measures support healthy and resilient ecosystems through water conservation that leaves more water in the natural systems. It also reduces input of TDS into natural systems improving water quality. The measures improve the health and function of the natural ecosystem.
Sustainable Economic Development		✓	✓	The FWFI measures improve the economic well-being of the local agricultural community while sustaining use and management of water resources for water conservation and improved water quality.
Floodplains		✓	✓	The FWFI does not transfer flood risk and is consistent with EO 11988 and 7CFR650.25.
Public Safety		✓	✓	There are no public and safety concerns for the FWFI Alternatives.
Environmental Justice		✓	✓	The FWFI Alternatives provide long-term socioeconomic benefits to subject populations, including minority and low income communities. There are no adverse impacts to subject populations.
Watershed Approach		✓	✓	The FWFI Alternatives solve the Watershed problems of water loss due to canal seepage and associated ground and surface water contamination from increased salinity and total dissolved solids. At the same time the measures increase crop production and reduce costly OM&R resulting in positive economic benefits for the Watershed.

Evaluation Framework and Tradeoffs			
Item	FWOFI	FWFI	
		Alternative 1 (HDPE)	Alternative 2 (PVC)
Provisioning Services			
Ecosystem Productivity	Artificial irrigation systems continue to degrade surface water impacting ecosystem health of the downstream river systems. Canal seepage continues to result in more water diverted from natural systems to meet irrigation needs decreasing water availability in the natural systems.	Conserves irrigation water leaving more water in the natural systems and reduces input of total dissolved solids (TDS) into natural systems improving water quality. These measures improve the health and function of the ecosystems downstream and would result in increased productivity of the natural ecosystems connected to these waters.	Same as Alternative 1.
Food (agricultural yield)	No Change	Improves irrigation delivery efficiency and increases crop production on 8,252 acres of land.	Same as Alternative 1.
Regulating Services			
Climate	Climate change would continue to result in drought and decreased water availability.	Climate change would continue to cause drought, but alternative measures result in water conservation to better adapt and increase resilience to climate stressors.	Same as Alternative 1.
Water Regulation (quality and quantity)	Extra water would continue to be diverted to offset the water lost from canal seepage. Canal seepage would continue to degrade surface and groundwater sources from high input of TDS increasing salinity.	Reduces canal seepage by 303 acre-feet annually and salinity by 67 tons annually, improving surface and groundwater quality. This would provide more water in the natural systems and improve water quality in the Watershed and in the downstream receiving waters.	Same as Alternative 1.
Biological Regulation	Degradation of water quality and quantity in the natural stream systems would continue to adversely impact plant communities, aquatic speceis, and wildlife species that inhabit those corridors, including those that may be federally-listed species, state-listed species, or migratory birds.	Improved water quantity and quality in natural stream systems would benefit plant communities, aquatic species, and wildlife species that inhabit those corridors, including those that may be federally-listed species, state-listed species, or migratory birds.	Same as Alternative 1.
Cultural Services			
Peace and Sustainability (tribal, agricultural, and rural communities)	Continued decrease in crop yield and increased private pumping costs for rural agricultural communities and tribal communities that diminish the sustainability of the communities.	Improves irrigation water conveyance and conserves water resulting in increased agricultural production and sustainability for rural agricultural and tribal communities.	Same as Alternative 1.
Community Well-being (tribal, agricultural, and rural communities)	Continued decrease in crop yield and increased private pumping costs that add financial stressors and impact the well-being of rural agricultural and tribal communities.	Anticipated increased crop yields and decrease in private pumping costs that reduce finiancial stressors, improving the well-being of rural agricultral and tribal communities.	Same as Alternative 1.
Cultural/Historical Identity and Heritage	N/A	N/A	N/A
Supporting Services			
Water Cycling	Increased diversion of water resources to compensate for canal seepage would continue to alter the natural water cycling process.	Reduces the human impact to the natural water cycling process interrupted from diversion and conveyance of water for irrigation practices by keeping more water in the natural system.	Same as Alternative 1.
Habitat and Biomass	Degradation of water quality and reduced water quantities in natural systems would continue to adversely impact habitat and biomass of the natural systems.	Benefits water quality and quantity in the natural stream systems that would improve habitat and biomass.	Same as Alternative 1.

Economic Analysis			
Item	FWOFI	FWFI	
		Alternative 1 (HDPE)	Alternative 2 (PVC)
Costs			
Installation Federal PL 83-566	$0	$1,409,000	$3,248,000
Installation Sponsor	$0	$394,000	$898,000
Annual Installation Costs	$0	$58,500	$134,400
Annual O&M Costs	$15,900	$600	$1,100
Total Annual Costs	$15,900	$59,100	$135,500
Annual Benefits			
Agriculture - Crop Yield	-	$277,500	$277,500
Sediment Reduction	-	$5,400	$5,400
O&M Cost Avoided	-	$15,900	$15,900
Total Annual Benefits	**-**	**$298,800**	**$298,800**
Cost Benefit Ratio and Net Benefits			
Cost-Benefit Ratio	**-**	**5.1**	**2.2**
Net Benefit	**-**	**$239,700**	**$163,300**
Decision-Making Conclusion	This alternative is provided for comparison purposes and is not selected as the NEE Alternative. It does not meet the purpose and need of the Project nor results in benefits to ecosystem services.	**Selected as the NEE Alternative:** Alternative 1 provides the highest benefit to ecosystem services, has the greatest cost-benefit, and is the locally/socially/environmentally preferred alternative that meets the project goals and objectives.	Alternative 2 has the same ecosystem benefits but is at least double the installation and O&M cost of Alternative 1 without providing any additional benefits. Therefore, this alternative was not selected as the NEE Alternative.

Site 3
South Boneta Canal

PR&G Framework and Trade-off Analysis Table (Site 3 South Boneta Canal)

Duchesne Water Efficiency Project
Eastern Duchesne Watershed

Alternatives Considered

Future Without Federal Investment (FWOFI): No Action Alternative
The No Action Alternative would not improve the irrigation system and O&M activities to maintain the existing system would continue.

Future With Federal Investment (FWFI): Action Alternatives
Alternative 1: Pipe entire South Boneta Canal of 12,883 linear feet (2.44 miles) with HDPE pipe.
Alternative 2: Pipe entire South Boneta Canal of 12,883 linear feet (2.44 miles) with PVC pipe.
Alternative 3: Pipe entire South Boneta Canal of 12,883 linear feet (2.44 miles) with metal pipe.
Alternative 4: Line entire South Boneta Canal of 12,883 linear feet (2.44 miles) with a membrane liner.
Alternative 5: Pipe segments of the South Boneta Canal.
Alternative 6: Pipe and realign entire South Boneta Canal of 12,883 linear feet (2.44 miles) with HDPE pipe.

Alternatives 3 and 6 were eliminated from evaluation in the table below because the costs to install the measures were greater than other alternatives without providing any additional benefits. Alternatives 4 and 5 were eliminated from evaluation in the table below because they did not meet the purpose and need to increasing system pressures. Additionally, Alternative 4 only provides a service life of 25 years and Alternative 5 creates canal stability concerns.

Alternative 1 and 2 are included in the evaluation below.

Please refer to Section 5.4 and 5.5 of the Plan-EA for further description of alternatives developed and justification for elimination.

Summary and Comparison

Item	FWOFI	FWFI		Comments
		Alternative 1 (HDPE)	Alternative 2 (PVC)	
Alternative Plans				
Locally Preferred		✓		Duchesne County Water Conservancy District (DCWCD) and irrigation company stakeholders are in support of Alternative 1.
Nonstructural	✓	N/A	N/A	There is not a feasible non-structural alternative that would meet the purpose and need, therefore, the FWOFI of maintaining the existing systems would be the nonstructural alternative.
Environmentally Preferred		✓	✓	All environmental impacts are the same between Alternative 1 and 2 resulting in no environmental preference between the two.
Socially Preferred		✓		Alternative 1 is the socially preferred alternative approved by the irrigation stakeholders, agricultural beneficiaries, and sponsor.
National Economic Efficiency		✓		This was determined to be the combination of measures that provided the least cost while minimizing environmental impacts and maximizing social, environmental, and economic benefits.
Guiding Principles				
Healthy and Resilient Ecosystems		✓	✓	The FWFI measures support healthy and resilient ecosystems through water conservation that leaves more water in the natural systems. It also reduces input of TDS into natural systems improving water quality. The measures improve the health and function of the natural ecosystem.
Sustainable Economic Development		✓	✓	The FWFI measures improve the economic well-being of the local agricultural community while sustaining use and management of water resources for water conservation and improved water quality.
Floodplains		✓	✓	The FWFI does not transfer flood risk and is consistent with EO 11988 and 7CFR650.25.
Public Safety		✓	✓	There are no public and safety concerns for the FWFI Alternatives.
Environmental Justice		✓	✓	The FWFI Alternatives provide long-term socioeconomic benefits to subject populations, including minority and low income communities. There are no adverse impacts to subject populations.
Watershed Approach		✓	✓	The FWFI Alternatives solve the Watershed problems of water loss due to canal seepage and associated ground and surface water contamination from increased salinity and total dissolved solids. At the same time the measures increase crop production and reduce costly OM&R resulting in positive economic benefits for the Watershed.

Evaluation Framework and Tradeoffs			
Item	**FWOFI**	**FWFI**	
		Alternative 1 (HDPE)	**Alternative 2 (PVC)**
Provisioning Services			
Ecosystem Productivity	Artificial irrigation systems continue to degrade surface water impacting ecosystem health of the downstream river systems. Canal seepage continues to result in more water diverted from natural systems to meet irrigation needs decreasing water availability in the natural systems.	Conserves irrigation water leaving more water in the natural systems and reduces input of total dissolved solids (TDS) into natural systems improving water quality. These measures improve the health and function of the ecosystems downstream and would result in increased productivity of the natural ecosystems connected to these waters.	Same as Alternative 1.
Food (agricultural yield)	No Change	Improves irrigation delivery efficiency and increases crop production on 1,622 acres of land.	Same as Alternative 1.
Regulating Services			
Climate	Climate change would continue to result in drought and decreased water availability.	Climate change would continue to cause drought, but alternative measures result in water conservation to better adapt and increase resilience to climate stressors.	Same as Alternative 1.
Water Regulation (quality and quantity)	Extra water would continue to be diverted to offset the water lost from canal seepage. Canal seepage would continue to degrade surface and groundwater sources from high input of TDS increasing salinity.	Reduces canal seepage by 812 acre-feet annually and salinity by 195 tons annually, improving surface and groundwater quality. This would provide more water in the natural systems and improve water quality in the Watershed and in the downstream receiving waters.	Same as Alternative 1.
Biological Regulation (plants and animals)	Degradation of water quality and quantity in the natural stream systems would continue to adversely impact plant communities, aquatic speceis, and wildlife species that inhabit those corridors, including those that may be federally-listed species, state-listed species, or migratory birds.	Improved water quantity and quality in natural stream systems would benefit plant communities, aquatic species, and wildlife species that inhabit those corridors, including those that may be federally-listed species, state-listed species, or migratory birds.	Same as Alternative 1.
Cultural Services			
Peace and Sustainability (agricultural, and rural communities)	Continued decrease in crop yield and increased private pumping costs for rural agricultural communities that diminish the sustainability of the communities.	Improves irrigation water conveyance and conserves water resulting in increased agricultural production and sustainability for rural agricultural communities.	Same as Alternative 1.
Community Well-being (agricultural, and rural communities)	Continued decrease in crop yield and increased private pumping costs that add financial stressors and impact the well-being of rural agricultural communities.	Anticipated increased crop yields and decrease in private pumping costs that reduce finiancial stressors, improving the well-being of rural agricultral communities.	Same as Alternative 1.
Cultural/Historical Identity and Heritage	N/A	N/A	N/A
Supporting Services			
Water Cycling	Increased diversion of water resources to compensate for canal seepage would continue to alter the natural water cycling process.	Reduces the human impact to the natural water cycling process interrupted from diversion and conveyance of water for irrigation practices by keeping more water in the natural system.	Same as Alternative 1.
Habitat and Biomass	Degradation of water quality and reduced water quantities in natural systems would continue to adversely impact habitat and biomass of the natural systems.	Benefits water quality and quantity in the natural stream systems that would improve habitat and biomass.	Same as Alternative 1.

Economic Analysis			
Item	FWOFI	FWFI	
		Alternative 1 (HDPE)	Alternative 2 (PVC)
Costs			
Installation Federal PL 83-566	$0	$624,500	$2,043,000
Installation Sponsor	$0	$178,500	$567,000
Annual Installation Costs	$0	$26,000	$84,600
Annual O&M Costs	$8,200	$1,500	$1,500
Total Annual Costs	$8,200	$27,500	$86,100
Annual Benefits			
Agriculture - Crop Yield	-	$111,600	$111,600
O&M Cost Avoided	-	$8,200	$8,200
Total Annual Benefits	**-**	**$119,800**	**$119,800**
Cost Benefit Ratio and Net Benefits			
Cost-Benefit Ratio	**-**	**4.4**	**1.4**
Net Benefit	**-**	**$92,300**	**$33,700**
Decision-Making Conclusion	This alternative is provided for comparison purposes and is not selected as the NEE Alternative. It does not meet the purpose and need of the Project nor results in benefits to ecosystem services.	**Selected as the NEE Alternative:** Alternative 1 provides the highest benefit to ecosystem services, has the greatest cost-benefit, and is the locally/socially/environmentally preferred alternative that meets the project goals and objectives.	Alternative 2 has the same ecosystem benefits but is over triple the installation cost of Alternative 1 without providing any additional benefits. Therefore, this alternative was not selected as the NEE Alternative.

Site 4
Dry Gulch Class B Canal System

PR&G Framework and Trade-off Analysis Table (Site 4 Dry Gulch Class B Canal System)

Duchesne Water Efficiency Project
Eastern Duchesne Watershed

Alternatives Considered

Future Without Federal Investment (FWOFI): No Action Alternative
The No Action Alternative would not improve the irrigation system and O&M activities to maintain the existing system would continue.

Future With Federal Investment (FWFI): Action Alternatives
Alternative 1: Pipe 79,293 linear feet (15.02 miles) of the Class B Canal System with HDPE pipe.
Alternative 2: Pipe 79,293 linear feet (15.02 miles) of the Class B Canal System with PVC pipe.
Alternative 3: Pipe 79,293 linear feet (15.02 miles) of the Class B Canal System with metal pipe.
Alternative 4: Line 79,293 linear feet (15.02 miles) of the Class B Canal System with a membrane liner.
Alternative 5: Pipe segments of the Class B Canal System.

Alternatives 3 was eliminated from evaluation in the table below because the cost to install the measures were greater than other alternatives without providing any additional benefits. Alternatives 4 and 5 were eliminated from evaluation in the table below because they did not meet the purpose and need of increasing system pressures. Additionally, Alternative 4 only provides a service life of 25 years and Alternative 5 creates canal stability concerns.

Alternative 1 and 2 are included in the evaluation below.

Please refer to Section 5.4 and 5.5 of the Plan-EA for further description of alternatives developed and justification for elimination.

Summary and Comparison

Item	FWOFI	FWFI		Comments
		Alternative 1 (HDPE)	Alternative 2 (PVC)	
Alternative Plans				
Locally Preferred		✓		Duchesne County Water Conservancy District (DCWCD) and irrigation company stakeholders are in support of Alternative 1.
Nonstructural	✓	N/A	N/A	There is not a feasible non-structural alternative that would meet the purpose and need, therefore, the FWOFI of maintaining the existing systems would be the nonstructural alternative.
Environmentally Preferred		✓	✓	All environmental impacts are the same between Alternative 1 and 2 resulting in no environmental preference between the two.
Socially Preferred		✓		Alternative 1 is the socially preferred alternative approved by the irrigation stakeholders, agricultural beneficiaries, and sponsor.
National Economic Efficiency		✓		This was determined to be the combination of measures that provided the least cost while minimizing environmental impacts and maximizing social, environmental, and economic benefits.
Guiding Principles				
Healthy and Resilient Ecosystems		✓	✓	The FWFI measures support healthy and resilient ecosystems through water conservation that leaves more water in the natural systems. It also reduces input of TDS into natural systems improving water quality. The measures improve the health and function of the natural ecosystem.
Sustainable Economic Development		✓	✓	The FWFI measures improve the economic well-being of the local agricultural community while sustaining use and management of water resources for water conservation and improved water quality.
Floodplains		✓	✓	The FWFI does not transfer flood risk and is consistent with EO 11988 and 7CFR650.25.
Public Safety		✓	✓	There are no public and safety concerns for the FWFI Alternatives.
Environmental Justice		✓	✓	The FWFI Alternatives provide long-term socioeconomic benefits to subject populations, including minority and low income communities. There are no adverse impacts to subject populations.
Watershed Approach		✓	✓	The FWFI Alternatives solve the Watershed problems of water loss due to canal seepage and associated ground and surface water contamination from increased salinity and total dissolved solids. At the same time the measures increase crop production and reduce costly OM&R resulting in positive economic benefits for the Watershed.

Evaluation Framework and Tradeoffs			
Item	FWOFI	FWFI	
		Alternative 1 (HDPE)	Alternative 2 (PVC)
Provisioning Services			
Ecosystem Productivity	Artificial irrigation systems continue to degrade surface water impacting ecosystem health of the downstream river systems. Canal seepage continues to result in more water diverted from natural systems to meet irrigation needs decreasing water availability in the natural systems.	Conserves irrigation water leaving more water in the natural systems and reduces input of total dissolved solids (TDS) into natural systems improving water quality. These measures improve the health and function of the ecosystems downstream and would result in increased productivity of the natural ecosystems connected to these waters.	Same as Alternative 1.
Food (agricultural yield)	No Change	Improves irrigation delivery efficiency and increases crop production on 10,160 acres of land.	Same as Alternative 1.
Regulating Services			
Climate	Climate change would continue to result in drought and decreased water availability.	Climate change would continue to cause drought, but alternative measures result in water conservation to better adapt and increase resilience to climate stressors.	Same as Alternative 1.
Water Regulation (quality and quantity)	Extra water would continue to be diverted to offset the water lost from canal seepage. Canal seepage would continue to degrade surface and groundwater sources from high input of TDS increasing salinity.	Reduces canal seepage by 19,318 acre-feet annually and salinity by 2,127 tons annually, improving surface and groundwater quality. This would provide more water in the natural systems and improve water quality in the Watershed and in the downstream receiving waters.	Same as Alternative 1.
Biological Regulation (plants and animals)	Degradation of water quality and quantity in the natural stream systems would continue to adversely impact plant communities, aquatic speceis, and wildlife species that inhabit those corridors, including those that may be federally-listed species, state-listed species, or migratory birds.	Improved water quantity and quality in natural stream systems would benefit plant communities, aquatic species, and wildlife species that inhabit those corridors, including those that may be federally-listed species, state-listed species, or migratory birds.	Same as Alternative 1.
Cultural Services			
Peace and Sustainability (tribal, agricultural, and rural communities)	Continued decrease in crop yield and increased private pumping costs for rural agricultural communities and tribal communities that diminish the sustainability of the communities.	Improves irrigation water conveyance and conserves water resulting in increased agricultural production and sustainability for rural agricultural and tribal communities.	Same as Alternative 1.
Community Well-being (tribal, agricultural, and rural communities)	Continued decrease in crop yield and increased private pumping costs that add financial stressors and impact the well-being of rural agricultural and tribal communities.	Anticipated increased crop yields and decrease in private pumping costs that reduce finiancial stressors, improving the well-being of rural agricultral and tribal communities.	Same as Alternative 1.
Cultural/Historical Identity and Heritage	The portions of the canal system are historic feature constructed in the 1910s and eligble for listing in the National Register of Historic Places.	Impacts to historic canals would be mitigated in cooritation with SHPO to maintain the historical identity.	Same as Alternative 1.
Supporting Services			
Water Cycling	Increased diversion of water resources to compensate for canal seepage would continue to alter the natural water cycling process.	Reduces the human impact to the natural water cycling process interrupted from diversion and conveyance of water for irrigation practices by keeping more water in the natural system.	Same as Alternative 1.
Habitat and Biomass	Degradation of water quality and reduced water quantities in natural systems would continue to adversely impact habitat and biomass of the natural systems.	Benefits water quality and quantity in the natural stream systems that would improve habitat and biomass.	Same as Alternative 1.

Economic Analysis			
Item	FWOFI	FWFI	
		Alternative 1 (HDPE)	Alternative 2 (PVC)
Costs			
Installation Federal PL 83-566	$0	$4,618,000	$13,755,000
Installation Sponsor	$0	$1,323,000	$3,797,000
Annual Installation Costs	$0	$192,600	$569,000
Annual O&M Costs	$21,800	$9,200	$9,200
Total Annual Costs	$21,800	$201,800	$578,200
Annual Benefits			
Agriculture - Crop Yield	-	$711,000	$711,000
O&M Cost Avoided	-	$21,800	$21,800
Total Annual Benefits	**-**	**$732,800**	**$732,800**
Cost Benefit Ratio and Net Benefits			
Cost-Benefit Ratio	**-**	**3.6**	**1.3**
Net Benefit	**-**	**$531,000**	**$154,600**
Decision-Making Conclusion	This alternative is provided for comparison purposes and is not selected as the NEE Alternative. It does not meet the purpose and need of the Project nor results in benefits to ecosystem services.	**Selected as the NEE Alternative:** Alternative 1 provides the highest benefit to ecosystem services, has the greatest cost-benefit, and is the locally/socially/environmentally preferred alternative that meets the project goals and objectives.	Alternative 2 has the same ecosystem benefits but is triple the installation cost of Alternative 1 without providing any additional benefits. Therefore, this alternative was not selected as the NEE Alternative.

Site 5
Dry Gulch Class C Canal System

PR&G Framework and Trade-off Analysis Table (Site 5 Dry Gulch Class C Canal System)

Duchesne Water Efficiency Project
Eastern Duchesne Watershed

Alternatives Considered

Future Without Federal Investment (FWOFI): No Action Alternative
The No Action Alternative would not improve the irrigation system and O&M activities to maintain the existing system would continue.

Future With Federal Investment (FWFI): Action Alternatives
Alternative 1: Pipe 33,292 linear feet (6.31 miles) of the Class C Canal System with HDPE pipe.
Alternative 2:Pipe 33,292 linear feet (6.31 miles) of the Class C Canal System with PVC pipe.
Alternative 3:Pipe 33,292 linear feet (6.31 miles) of the Class C Canal System with metal pipe.
Alternative 4: Line 33,292 linear feet (6.31 miles) of the Class C Canal System with a membrane liner.
Alternative 5: Pipe segments of the Class C Canal System.

Alternatives 3 was eliminated from evaluation in the table below because the cost to install the measures were greater than other alternatives without providing any additional benefits. Alternatives 4 and 5 were eliminated from evaluation in the table below because they did not meet the purpose and need of increasing system pressures. Additionally, Alternative 4 only provides a service life of 25 years and Alternative 5 creates canal stability concerns.

Alternative 1 and 2 are included in the evaluation below.

Please refer to Section 5.4 and 5.5 of the Plan-EA for further description of alternatives developed and justification for elimination.

Summary and Comparison

Item	FWOFI	FWFI		Comments
		Alternative 1 (HDPE)	Alternative 2 (PVC)	
Alternative Plans				
Locally Preferred		✓		Duchesne County Water Conservancy District (DCWCD) and irrigation company stakeholders are in support of Alternative 1.
Nonstructural	✓	N/A	N/A	There is not a feasible non-structural alternative that would meet the purpose and need, therefore, the FWOFI of maintaining the existing systems would be the nonstructural alternative.
Environmentally Preferred		✓	✓	All environmental impacts are the same between Alternative 1 and 2 resulting in no environmental preference between the two.
Socially Preferred		✓		Alternative 1 is the socially preferred alternative approved by the irrigation stakeholders, agricultural beneficiaries, and sponsor.
National Economic Efficiency		✓		This was determined to be the combination of measures that provided the least cost while minimizing environmental impacts and maximizing social, environmental, and economic benefits.
Guiding Principles				
Healthy and Resilient Ecosystems		✓	✓	The FWFI measures support healthy and resilient ecosystems through water conservation that leaves more water in the natural systems. It also reduces input of TDS into natural systems improving water quality. The measures improve the health and function of the natural ecosystem.
Sustainable Economic Development		✓	✓	The FWFI measures improve the economic well-being of the local agricultural community while sustaining use and management of water resources for water conservation and improved water quality.
Floodplains		✓	✓	The FWFI does not transfer flood risk and is consistent with EO 11988 and 7CFR650.25.
Public Safety		✓	✓	There are no public and safety concerns for the FWFI Alternatives.
Environmental Justice		✓	✓	The FWFI Alternatives provide long-term socioeconomic benefits to subject populations, including minority and low income communities. There are no adverse impacts to subject populations.
Watershed Approach		✓	✓	The FWFI Alternatives solve the Watershed problems of water loss due to canal seepage and associated ground and surface water contamination from increased salinity and total dissolved solids. At the same time the measures increase crop production and reduce costly OM&R resulting in benefits for the Watershed.

Evaluation Framework and Tradeoffs			
Item	FWOFI	FWFI	
		Alternative 1 (HDPE)	Alternative 2 (PVC)
Provisioning Services			
Ecosystem Productivity	Artificial irrigation systems continue to degrade surface water impacting ecosystem health of the downstream river systems. Canal seepage continues to result in more water diverted from natural systems to meet irrigation needs decreasing water availability in the natural systems.	Conserves irrigation water leaving more water in the natural systems and reduces input of total dissolved solids (TDS) into natural systems improving water quality. These measures improve the health and function of the ecosystems downstream and would result in increased productivity of the natural ecosystems connected to these waters.	Same as Alternative 1.
Food (agricultural yield)	No Change	Improves irrigation delivery efficiency and increases crop production on 11,435 acres of land.	Same as Alternative 1.
Regulating Services			
Climate	Climate change would continue to result in drought and decreased water availability.	Climate change would continue to cause drought, but alternative measures result in water conservation to better adapt and increase resilience to climate stressors.	Same as Alternative 1.
Water Regulation (quality and quantity)	Extra water would continue to be diverted to offset the water lost from canal seepage. Canal seepage would continue to degrade surface and groundwater sources from high input of TDS increasing salinity.	Reduces canal seepage by 4,662 acre-feet annually and salinity by 434 tons annually, improving surface and groundwater quality. This would provide more water in the natural systems and improve water quality in the Watershed and in the downstream receiving waters.	Same as Alternative 1.
Biological Regulation (plants and animals)	Degradation of water quality and quantity in the natural stream systems would continue to adversely impact plant communities, aquatic speceis, and wildlife species that inhabit those corridors, including those that may be federally-listed species, state-listed species, or migratory birds.	Improved water quantity and quality in natural stream systems would benefit plant communities, aquatic species, and wildlife species that inhabit those corridors, including those that may be federally-listed species, state-listed species, or migratory birds.	Same as Alternative 1.
Cultural Services			
Peace and Sustainability (tribal, agricultural, and rural communities)	Continued decrease in crop yield and increased private pumping costs for rural agricultural communities and tribal communities that diminish the sustainability of the communities.	Improves irrigation water conveyance and conserves water resulting in increased agricultural production and sustainability for rural agricultural and tribal communities.	Same as Alternative 1.
Community Well-being (tribal, agricultural, and rural communities)	Continued decrease in crop yield and increased private pumping costs that add financial stressors and impact the well-being of rural agricultural and tribal communities.	Anticipated increased crop yields and decrease in private pumping costs that reduce finiancial stressors, improving the well-being of rural agricultral and tribal communities.	Same as Alternative 1.
Cultural/Historical Identity and Heritage	The portions of canal system are historic constructed between 1905 and 1907 and eligble for listing in the National Register of Historic Places.	Impacts to historic canals would be mitigated in cooditation with SHPO to maintain the historical identity.	Same as Alternative 1.
Supporting Services			
Water Cycling	Increased diversion of water resources to compensate for canal seepage would continue to alter the natural water cycling process.	Reduces the human impact to the natural water cycling process interrupted from diversion and conveyance of water for irrigation practices by keeping more water in the natural system.	Same as Alternative 1.
Habitat and Biomass	Degradation of water quality and reduced water quantities in natural systems would continue to adversely impact habitat and biomass of the natural systems.	Benefits water quality and quantity in the natural stream systems that would improve habitat and biomass.	Same as Alternative 1.

Economic Analysis			
Item	FWOFI	FWFI	
		Alternative 1 (HDPE)	Alternative 2 (PVC)
Costs			
Installation Federal PL 83-566	$0	$12,382,500	$31,538,000
Installation Sponsor	$0	$3,410,500	$8,672,000
Annual Installation Costs	$0	$512,000	$1,303,600
Annual O&M Costs	$61,000	$3,800	$10,400
Total Annual Costs	**$61,000**	**$515,800**	**$1,314,000**
Annual Benefits			
Agriculture - Crop Yield	-	$728,300	$728,300
O&M Cost Avoided	-	$61,000	$61,000
Total Annual Benefits	**-**	**$789,300**	**$789,300**
Cost Benefit Ratio and Net Benefits			
Cost-Benefit Ratio	**-**	**1.5**	**0.6**
Net Benefit	**-**	**$273,500**	**($524,700)**
Decision-Making Conclusion	This alternative is provided for comparison purposes and is not selected as the NEE Alternative. It does not meet the purpose and need of the Project nor results in benefits to ecosystem services.	**Selected as the NEE Alternative:** Alternative 1 provides the highest benefit to ecosystem services, has the greatest cost-benefit, and is the locally/socially/environmentally preferred alternative that meets the project goals and objectives.	Alternative 2 has the same ecosystem benefits but is 2.5 times greater than the installation cost of Alternative 1 without providing any additional benefits and would result in negative economic benefits. Therefore, this alternative was not selected as the NEE Alternative.

Site 6
Red Cap Extension Canals/ Laterals

PR&G Framework and Trade-off Analysis Table (Site 6 Red Cap Extension Canals/Laterals)

Duchesne Water Efficiency Project
Eastern Duchesne Watershed

Alternatives Considered

Future Without Federal Investment (FWOFI): No Action Alternative
The No Action Alternative would not improve the irrigation system and O&M activities to maintain the existing system would continue.

Future With Federal Investment (FWFI): Action Alternatives
Alternative 1: Pipe 106,161 linear feet (20.11 miles) of the Red Cap Extension Canals/Laterals System with HDPE pipe.
Alternative 2: Pipe106,161 linear feet (20.11 miles) of the Red Cap Extension Canals/Laterals System with PVC pipe.
Alternative 3: Pipe 106,161 linear feet (20.11 miles) of the Red Cap Extension Canals/Laterals System with metal pipe.
Alternative 4: Line 106,161 linear feet (20.11 miles) of the Red Cap Extension Canals/Laterals System with a concrete liner.
Alternative 5: Pipe segments and install a central pump station.

Alternatives 3 was eliminated from evaluation in the table below because the cost to install the measures were greater than other alternatives without providing any additional benefits. Alternatives 4 was eliminated from evaluation in the table below because it did not meet the purpose and need of increasing system pressures. Alternative 5 was eliminated from evaluation because installation costs were more than Alternative 1 and the annual O&M costs were substantially more without providing additional benefit.

Alternative 1 and 2 are included in the evaluation below.

Please refer to Section 5.4 and 5.5 of the Plan-EA for further description of alternatives developed and justification for elimination.

Summary and Comparison

Item	FWOFI	FWFI		Comments
		Alternative 1 (HDPE)	Alternative 2 (PVC)	
Alternative Plans				
Locally Preferred		✓		Duchesne County Water Conservancy District (DCWCD) and irrigation company stakeholders are in support of Alternative 1.
Nonstructural	✓	N/A	N/A	There is not a feasible non-structural alternative that would meet the purpose and need, therefore, the FWOFI of maintaining the existing systems would be the nonstructural alternative.
Environmentally Preferred		✓	✓	All environmental impacts are the same between Alternative 1 and 2 resulting in no environmental preference between the two.
Socially Preferred		✓		Alternative 1 is the socially preferred alternative approved by the irrigation stakeholders, agricultural beneficiaries, and sponsor.
National Economic Efficiency		✓		This was determined to be the combination of measures that provided the least cost while minimizing environmental impacts and maximizing social, environmental, and economic benefits.
Guiding Principles				
Healthy and Resilient Ecosystems		✓	✓	The FWFI measures support healthy and resilient ecosystems through water conservation that leaves more water in the natural systems. It also reduces input of TDS into natural systems improving water quality. The measures improve the health and function of the natural ecosystem.
Sustainable Economic Development		✓	✓	The FWFI measures improve the economic well-being of the local agricultural community while sustaining use and management of water resources for water conservation and improved water quality.
Floodplains		✓	✓	The FWFI does not transfer flood risk and is consistent with EO 11988 and 7CFR650.25.
Public Safety		✓	✓	There are no public and safety concerns for the FWFI Alternatives.
Environmental Justice		✓	✓	The FWFI Alternatives provide long-term socioeconomic benefits to subject populations, including minority and low income communities. There are no adverse impacts to subject populations.
Watershed Approach		✓	✓	The FWFI Alternatives solve the Watershed problems of water loss due to canal seepage and associated ground and surface water contamination from increased salinity and total dissolved solids. At the same time the measures increase crop production and reduce costly OM&R resulting in benefits for the Watershed.

Evaluation Framework and Tradeoffs			
Item	**FWOFI**	**FWFI**	
		Alternative 1 (HDPE)	**Alternative 2 (PVC)**
Provisioning Services			
Ecosystem Productivity	Artificial irrigation systems continue to degrade surface water impacting ecosystem health of the downstream river systems. Canal seepage continues to result in more water diverted from natural systems to meet irrigation needs decreasing water availability in the natural systems.	Conserves irrigation water leaving more water in the natural systems and reduces input of total dissolved solids (TDS) into natural systems improving water quality. These measures improve the health and function of the ecosystems downstream and would result in increased productivity of the natural ecosystems connected to these waters.	Same as Alternative 1.
Food (agricultural yield)	No Change	Improves irrigation delivery efficiency and increases crop production on 2,788 acres of land. Adds irrigation capabilities to an additional 2,422 acres of land.	Same as Alternative 1.
Regulating Services			
Climate	Climate change would continue to result in drought and decreased water availability.	Climate change would continue to cause drought, but alternative measures result in water conservation to better adapt and increase resilience to climate stressors.	Same as Alternative 1.
Water Regulation (quality and quantity)	Extra water would continue to be diverted to offset the water lost from canal seepage. Canal seepage would continue to degrade surface and groundwater sources from high input of TDS increasing salinity.	Reduces canal seepage by 4,784 acre-feet annually and salinity by 2,030 tons annually, improving surface and groundwater quality. This would provide more water in the natural systems and improve water quality in the Watershed and in the downstream receiving waters.	Same as Alternative 1.
Biological Regulation (plants and animals)	Degradation of water quality and quantity in the natural stream systems would continue to adversely impact plant communities, aquatic speceis, and wildlife species that inhabit those corridors, including those that may be federally-listed species, state-listed species, or migratory birds.	Improved water quantity and quality in natural stream systems would benefit plant communities, aquatic species, and wildlife species that inhabit those corridors, including those that may be federally-listed species, state-listed species, or migratory birds.	Same as Alternative 1.
Cultural Services			
Peace and Sustainability (tribal, agricultural, and rural communities)	Continued decrease in crop yield and increased private pumping costs for rural agricultural communities and tribal communities that diminish the sustainability of the communities.	Improves irrigation water conveyance and conserves water resulting in increased agricultural production and sustainability for rural agricultural and tribal communities.	Same as Alternative 1.
Community Well-being (tribal, agricultural, and rural communities)	Continued decrease in crop yield and increased private pumping costs that add financial stressors and impact the well-being of rural agricultural and tribal communities.	Anticipated increased crop yields and decrease in private pumping costs that reduce finiancial stressors, improving the well-being of rural agricultral and tribal communities.	Same as Alternative 1.
Cultural/Historical Identity and Heritage	The portions of canal system are historic constructed between 1937 and 1939 and eligble for listing in the National Register of Historic Places.	Impacts to historic canals would be mitigated in cooritation with SHPO to maintain the historical identity.	Same as Alternative 1.
Supporting Services			
Water Cycling	Increased diversion of water resources to compensate for canal seepage would continue to alter the natural water cycling process.	Reduces the human impact to the natural water cycling process interrupted from diversion and conveyance of water for irrigation practices by keeping more water in the natural system.	Same as Alternative 1.
Habitat and Biomass	Degradation of water quality and reduced water quantities in natural systems would continue to adversely impact habitat and biomass of the natural systems.	Benefits water quality and quantity in the natural stream systems that would improve habitat and biomass.	Same as Alternative 1.

Economic Analysis			
Item	FWOFI	FWFI	
		Alternative 1 (HDPE)	Alternative 2 (PVC)
Costs			
Installation Federal PL 83-566	$0	$7,226,000	$19,382,000
Installation Sponsor	$0	$2,032,000	$5,311,000
Annual Installation Costs	$0	$300,100	$800,600
Annual O&M Costs	$39,900	$12,200	$12,200
Total Annual Costs	$39,900	$312,300	$812,800
Annual Benefits			
Agriculture - Crop Yield	-	$599,200	$599,200
O&M Cost Avoided	-	$39,900	$39,900
Total Annual Benefits	**-**	**$639,100**	**$639,100**
Cost Benefit Ratio and Net Benefits			
Cost-Benefit Ratio	**-**	**2.0**	**0.8**
Net Benefit	**-**	**$326,800**	**($173,700)**
Decision-Making Conclusion	This alternative is provided for comparison purposes and is not selected as the NEE Alternative. It does not meet the purpose and need of the Project nor results in benefits to ecosystem services.	**Selected as the NEE Alternative:** Alternative 1 provides the highest benefit to ecosystem services, has the greatest cost-benefit, and is the locally/socially/environmentally preferred alternative that meets the project goals and objectives.	Alternative 2 has the same ecosystem benefits but is 2.6 times greater than the installation cost without providing any additional benefits, resulting in a negative economic benefit. Therefore, this alternative was not selected as the NEE Alternative.

Site 7
Gray Mountain Canal

PR&G Framework and Trade-off Analysis Table (Site 7 Gray Mountain Canal)

Duchesne Water Efficiency Project
Eastern Duchesne Watershed

Alternatives Considered

Future Without Federal Investment (FWOFI): No Action Alternative
The No Action Alternative would not improve the irrigation system and O&M activities to maintain the existing system would continue.

Future With Federal Investment (FWFI): Action Alternatives
Alternative 1: Line 13,926 linear feet (2.64 miles) of Gray Mountain Canal with concrete.
Alternative 2: Line 13,926 linear feet (2.64 miles) of Gray Mountain Canal with membrane liner (option 1).
Alternative 3: Line 35,000 (6.6 miles) of Gray Mountain Canal with membrane liner (option 2).
Alternative 4: Line 35,000 (6.6 miles) of Gray Mountain Canal with slip lined concrete.
Alternative 5: Pipe 38,230 (7.2 miles) of Gray Mountain Canal 63" HDPE and 84" steel pipe.
Alternative 6: Pipe 38,230 (7.2 miles) of Gray Mountain Canal 108" steel pipe.

Alternatives 3 through 6 were eliminated from evaluation in the table below because the construction costs were substantially greater to exorbitant at 4 to 15 times greater than other alternatives and the additional lined/piped lengths have lower seepage rates that did not provide enough benefit to substantiate the cost. Additionally, the membrane and slip lined concrete alternatives only provide a 20 and 25 year project life and would require complete replacement twice over the life of the project for the membrane liner alternative and once for the slip lined concrete alternative. The piping alternatives were found to be exorbitant.

Alternative 1 and 2 are included in the evaluation below.

Please refer to Section 5.4 and 5.5 of the Plan-EA for further description of alternatives developed and justification for elimination.

Summary and Comparison

Item	FWOFI	FWFI		Comments
		Alternative 1 (Concrete Liner)	Alternative 2 (Membrane Liner)	
Alternative Plans				
Locally Preferred		✓		Duchesne County Water Conservancy District (DCWCD) and irrigation company stakeholders are in support of Alternative 1.
Nonstructural	✓	N/A	N/A	There is not a feasible non-structural alternative that would meet the purpose and need, therefore, the FWOFI of maintaining the existing systems would be the nonstructural alternative.
Environmentally Preferred		✓		All environmental impacts are the same between Alternative 1 and 2.
Socially Preferred		✓		Alternative 1 is the socially preferred alternative approved by the irrigation stakeholders, agricultural beneficiaries, and sponsor.
National Economic Efficiency		✓		This was determined to be the combination of measures that provided the least cost while minimizing environmental impacts and maximizing social, environmental, and economic benefits.
Guiding Principles				
Healthy and Resilient Ecosystems		✓	✓	The FWFI measures support healthy and resilient ecosystems through water conservation that leaves more water in the natural systems. It also reduces input of TDS into natural systems improving water quality. The measures improve the health and function of the natural ecosystem.
Sustainable Economic Development		✓	✓	The FWFI measures improve the economic well-being of the local agricultural community while sustaining use and management of water resources for water conservation and improved water quality.
Floodplains		✓	✓	The FWFI does not transfer flood risk and is consistent with EO 11988 and 7CFR650.25.
Public Safety		✓	✓	There are no public and safety concerns for the FWFI Alternatives.
Environmental Justice		✓	✓	The FWFI Alternatives provide long-term socioeconomic benefits to subject populations, including minority and low income communities. There are no adverse impacts to subject populations.
Watershed Approach		✓	✓	The FWFI Alternatives solve the Watershed problems of water loss due to canal seepage and associated ground and surface water contamination from increased salinity and total dissolved solids. At the same time the measures increase crop production and reduce costly OM&R resulting in positive economic benefits for the Watershed.

Evaluation Framework and Tradeoffs			
Item	**FWOFI**	**FWFI**	
		Alternative 1 (Concrete Liner)	**Alternative 2 (Membrane Liner)**
Provisioning Services			
Ecosystem Productivity	Artificial irrigation systems continue to degrade surface water impacting ecosystem health of the downstream river systems. Canal seepage continues to result in more water diverted from natural systems to meet irrigation needs decreasing water availability in the natural systems.	Conserves irrigation water leaving more water in the natural systems and reduces input of total dissolved solids (TDS) into natural systems improving water quality. These measures improve the health and function of the ecosystems downstream and would result in increased productivity of the natural ecosystems connected to these waters.	Same as Alternative 1.
Food (agricultural yield)	No Change	Improves irrigation delivery efficiency and increases crop production on 13,561 acres of land.	Same as Alternative 1.
Regulating Services			
Climate	Climate change would continue to result in drought and decreased water availability.	Climate change would continue to cause drought, but alternative measures result in water conservation to better adapt and increase resilience to climate stressors.	Same as Alternative 1.
Water Regulation (quality and quantity)	Extra water would continue to be diverted to offset the water lost from canal seepage. Canal seepage would continue to degrade surface and groundwater sources from high input of TDS increasing salinity.	Reduces canal seepage by 9,453 acre-feet annually and salinity by 475 tons annually improving surface and groundwater quality. This would provide more water in the natural systems and improve water quality in the Watershed and in the downstream receiving waters.	Same as Alternative 1.
Biological Regulation (plants and animals)	Degradation of water quality and quantity in the natural stream systems would continue to adversely impact plant communities, aquatic speceis, and wildlife species that inhabit those corridors, including those that may be federally-listed species, state-listed species, or migratory birds.	Improved water quantity and quality in natural stream systems would benefit plant communities, aquatic species, and wildlife species that inhabit those corridors, including those that may be federally-listed species, state-listed species, or migratory birds.	Same as Alternative 1.
Cultural Services			
Peace and Sustainability (tribal, agricultural, and rural communities)	Continued decrease in crop yield and increased private pumping costs for rural agricultural communities and tribal communities that diminish the sustainability of the communities.	Improves irrigation water conveyance and conserves water resulting in increased agricultural production and sustainability for rural agricultural and tribal communities.	Same as Alternative 1.
Community Well-being (tribal, agricultural, and rural communities)	Continued decrease in crop yield and increased private pumping costs that add financial stressors and impact the well-being of rural agricultural and tribal communities.	Anticipated increased crop yields and decrease in private pumping costs that reduce finiancial stressors, improving the well-being of rural agricultral and tribal communities.	Same as Alternative 1.
Cultural/Historical Identity and Heritage	The canal system is a historic feature constructed in 1907 and is eligble for listing in the National Register of Historic Places.	Impacts to the historic canal would be mitigated in cooridtation with SHPO to maintain the historical identity.	Same as Alternative 1.
Supporting Services			
Water Cycling	Increased diversion of water resources to compensate for canal seepage would continue to alter the natural water cycling process.	Reduces the human impact to the natural water cycling process interrupted from diversion and conveyance of water for irrigation practices by keeping more water in the natural system.	Same as Alternative 1.
Habitat and Biomass	Degradation of water quality and reduced water quantities in natural systems would continue to adversely impact habitat and biomass of the natural systems.	Benefits water quality and quantity in the natural stream systems that would improve habitat and biomass.	Same as Alternative 1.

Economic Analysis			
Item	FWOFI	FWFI	
		Alternative 1 (Concrete Liner)	Alternative 2 (Membrane Liner)
Costs			
Installation Federal PL 83-566	$0	$3,423,500	$2,057,000
Installation Sponsor	$0	$945,500	$570,000
Annual Installation Costs	$0	$141,600	$85,200
Annual O&M Costs	$48,800	$1,200	$95,300
Total Annual Costs	**$48,800**	**$142,800**	**$180,500**
Annual Benefits			
Agriculture - Crop Yield	-	$772,600	$772,600
O&M Cost Avoided	-	$48,800	$48,800
Total Annual Benefits	**-**	**$821,400**	**$821,400**
Cost Benefit Ratio and Net Benefits			
Cost-Benefit Ratio	**-**	**5.8**	**4.6**
Net Benefit	**-**	**$678,600**	**$640,900**
Decision-Making Conclusion	This alternative is provided for comparison purposes and is not selected as the NEE Alternative. It does not meet the purpose and need of the Project nor results in benefits to ecosystem services.	**Selected as the NEE Alternative:** Alternative 1 provides the highest benefit to ecosystem services, has the greatest cost-benefit, and is the locally/socially/environmentally preferred alternative that meets the project goals and objectives.	Alternative 2 has the same ecosystem benefits but only provides a 20-year service life. O&M costs are higher and and replacement of the membrane liner twice over a 50-year period would be required. Even though the installation cost are less than Alternative 1, the OM&R costs are much greater resulting in a lower cost-benefit when compared to Alternative 1. Therefore, this alternative was not selected as the NEE Alternative.

Appendix B

Cost Estimates

Site 1 Yellowstone Feeder Canal
Alternative 1 (Concrete Lining)

Detailed Construction Cost Estimate

Item Description	Unit	Quantity	Unit Price	Price[1]
Clearing and Grubbing	LF	13,200	$3.50	$46,000
Canal Excavation and Preparation	CY	4,950	$30.00	$149,000
Borrow	TON	1,530	$30.00	$46,000
Rock Base Aggregate	TON	5,720	$30.00	$172,000
Geocomposite Liner	SY	41,000	$12.00	$492,000
Concrete	CY	3,315	$370	$1,227,000
Cut Off Wall	EA	20	$1,000	$20,000
			Construction Subtotal	**$2,152,000**
Mobilization	LS	1	$216,000	$216,000
Construction Staking	LS	1	$22,000	$22,000
Contingency (5% of Construction Subtotal)	LS	1	$108,000	$108,000
Resource Mitigation	LS	1	$1,000	$1,000
			TOTAL PROBABLE CONSTRUCTION COST	**$2,499,000**

1 – Rounded to the nearest thousand

Installation Cost

Item	Cost
Construction	$2,499,000
Design Engineering (assumed 10% of construction cost)[1]	$250,000
Construction Engineering (assumed 10% of construction cost)[1]	$250,000
Permitting	$8,000
Real Property Rights	$0
Natural Resource Rights	$0
Water Rights	$0
Relocation Payments	$0
Administrative (NRCS – assumed 1.5% of construction)	$37,500
Administrative (Sponsors – assumed 1.5% of construction)	$37,500
Total Installation Cost	**$3,082,000**

1 – Rounded to the nearest thousand

O&M and Replacement	
O&M (Annual)	$1,700

Site 1 Yellowstone Feeder Canal
Alternative 2 (Membrane Lining)

Detailed Construction Cost Estimate

Item Description	Unit	Quantity	Unit Price	Price[1]
Clearing and Grubbing	LF	13,200	$3.50	$46,000
Canal Excavation and Preparation	CY	4,950	$30.00	$149,000
Borrow	TON	1,530	$30.00	$46,000
Rock Base Aggregate	TON	5,720	$30.00	$172,000
Geocomposite Liner	SY	41,000	$12.00	$492,000
Ballast	CY	1,960	$45.00	$88,000
			Construction Subtotal	**$993,000**
Mobilization	LS	1	$99,000.00	$99,000
Construction Staking	LS	1	$10,000.00	$10,000
Contingency (5% of Construction Subtotal)	LS	1	$50,000.00	$50,000
Resource Mitigation	LS	1	$1,000.00	$1,000
			TOTAL PROBABLE CONSTRUCTION COST	**$1,153,000**

1 – Rounded to the nearest thousand

Installation Cost

Item	Cost
Construction	$1,153,000
Design Engineering (assumed 10% of construction cost)[1]	$115,000
Construction Engineering (assumed 10% of construction cost)[1]	$115,000
Permitting	$8,000
Real Property Rights	$0
Natural Resource Rights	$0
Water Rights	$0
Relocation Payments	$0
Administrative (NRCS – assumed 1.5% of construction)	$17,500
Administrative (Sponsors – assumed 1.5% of construction)	$17,500
Total Installation Cost	**$1,426,000**

1 – Rounded to the nearest thousand

Annual O&M and Replacement	
O&M (Annual)	$6,000
TOTAL	**$6,000**

Replacement Cost: The Membrane liner only provides a 10-year service life due to extensive stock and wildlife traffic and would need to be replaced 4 times over the 50-year Project life at a cost of $1,153,000 per replacement.

Site 2 Coyote Canal
Alternative 1 (HDPE)

Detailed Construction Cost Estimate

Item Description	Unit	Quantity	Unit Price	Price[1]
Rock Excavation	LF	1,000	$12.00	$12,000
Imported Pipe Bedding	LF	2,250	$10.00	$23,000
HDPE Pipe 54" DR 32.5 (63 psi)	LF	3,528	$115.73	$408,000
HDPE Pipe 63" DR 32.5 (63 psi)	LF	885	$156.99	$139,000
Install HDPE Pipe 54" DR 32.5 (63 psi)	LF	3,528	$40.00	$141,000
Install HDPE Pipe 63" DR 32.5 (63 psi)	LF	885	$45.00	$40,000
Pipe Inlet Screen Structure	LS	1	$275,000	$275,000
Dissipation Structure	LS	1	$30,000	$30,000
Channel Shaping	CY	1,000	$15.00	$15,000
Bank and Flowline Stabilization	SY	2,800	$40.00	$112,000
			Construction Subtotal	**$1,195,000**
Mobilization	LS	1	$120,000	$120,000
Construction Staking	LS	1	$12,000	$12,000
Traffic Control	LS	1	$12,000	$12,000
Resource mitigation	LS	1	$1,000	$1,000
Contingency (10% of Construction Subtotal)	LS	1	$120,000	$120,000
			TOTAL PROBABLE CONSTRUCTION COST	**$1,460,000**

1 – Rounded to the nearest thousand

Installation Cost

Item	Cost
Construction	$1,460,000
Design Engineering (assumed 10% of construction cost)[1]	$146,000
Construction Engineering (assumed 10% of construction cost)[1]	$146,000
Permitting	$7,000
Real Property Rights	$0
Natural Resource Rights	$0
Water Rights	$0
Relocation Payments	$0
Administrative (NRCS – assumed 1.5% of construction)	$22,000
Administrative (Sponsors – assumed 1.5% of construction)	$22,000
Total Installation Cost	**$1,803,000**

1 – Rounded to the nearest thousand

O&M and Replacement	
O&M (Annual)	$600

Site 2 Coyote Canal
Alternative 2 (PVC)

Detailed Construction Cost Estimate

Item Description	Unit	Quantity	Unit Price	Price[1]
Rock Excavation	LF	1,000	$12.00	$12,000
Imported Pipe Bedding	LF	2,250	$10.00	$23,000
PVC Pipe 36" DR 51 (80 psi)	LF	7,056	$206.09	$1,454,000
PVC Pipe 48" DR 51 (80 psi)	LF	1770	$371.15	$657,000
Install PVC Pipe 36" DR 51 (80 psi)	LF	7,056	$19.00	$134,000
Install PVC Pipe 48" DR 51 (80 psi)	LF	1770	$25.00	$44,000
Pipe Inlet Screen Structure	LS	1	$275,000	$275,000
Dissipation Structure	LS	1	$30,000	$30,000
Channel Shaping	CY	1,000	$15.00	$15,000
Bank and Flowline Stabilization	SY	2,800	$40.00	$112,000
			Construction Subtotal	**$2,756,000**
Mobilization	LS	1	$276,000.00	$276,000
Construction Staking	LS	1	$28,000.00	$28,000
Traffic Control	LS	1	$28,000.00	$28,000
Resource mitigation	LS	1	$1,000.00	$1,000
Contingency (10% of Construction Subtotal)	LS	1	$276,000.00	$276,000
			TOTAL PROBABLE CONSTRUCTION COST	**$3,365,000**

1 – Rounded to the nearest thousand

Installation Cost

Item	Cost
Construction	$3,365,000
Design Engineering (assumed 10% of construction cost)[1]	$337,000
Construction Engineering (assumed 10% of construction cost)[1]	$337,000
Permitting	$7,000
Real Property Rights	$0
Natural Resource Rights	$0
Water Rights	$0
Relocation Payments	$0
Administrative (NRCS – assumed 1.5% of construction)	$50,000
Administrative (Sponsors – assumed 1.5% of construction)	$50,000
Total Installation Cost	**$4,146,000**

1 – Rounded to the nearest thousand

O&M and Replacement	
O&M (Annual)	$1,200
TOTAL	**$1,200**

Site 3 South Boneta Canal
Alternative 1 (HDPE)

Detailed Construction Cost Estimate

Item Description	Unit	Quantity	Unit Price	Price[1]
HDPE Pipe 22" DR 32.5 (63 psi)	LF	12,883	$19.20	$247,000
Install HDPE Pipe 22" DR 32.5 (63 psi)	LF	12,883	$14.00	$180,000
			Construction Subtotal	**$427,000**
Mobilization	LS	1	$43,000	$43,000
Appurtenances (Air Release Valves, Valves, Drains, etc.)	LS	1	$124,000	$124,000
Construction Staking	LS	1	$4,000	$4,000
Resource mitigation	LS	1	$5,000	$5,000
Contingency (10% of Construction Subtotal)	LS	1	$43,000	$43,000
			TOTAL PROBABLE CONSTRUCTION COST	**$646,000**

1 – Rounded to the nearest thousand

Installation Cost

Item	Cost
Construction	$646,000
Design Engineering (assumed 10% of construction cost)[1]	$65,000
Construction Engineering (assumed 10% of construction cost)[1]	$65,000
Permitting	$8,000
Real Property Rights	$0
Natural Resource Rights	$0
Water Rights	$0
Relocation Payments	$0
Administrative (NRCS – assumed 1.5% of construction)	$9,500
Administrative (Sponsors – assumed 1.5% of construction)	$9,500
Total Installation Cost	**$803,000**

1 – Rounded to the nearest thousand

O&M and Replacement	
O&M (Annual)	$1,600

Site 3 South Boneta Canal
Alternative 2 (PVC)

Detailed Construction Cost Estimate

Item Description	Unit	Quantity	Unit Price	Price[1]
PVC Pipe 22" DR 41 (100 psi)	LF	12,883	$95.19	$1,226,000
Install PVC Pipe 22" DR 41 (100 psi)	LF	12,883	$14.00	$180,000
			Construction Subtotal	**$1,406,000**
Mobilization	LS	1	$141,000	$141,000
Appurtenances (Air Release Valves, Valves, Drains, etc.)	LS	1	$408,000	$408,000
Construction Staking	LS	1	$14,00	$14,000
Resource mitigation	LS	1	$5,000	$5,000
Contingency 10%	LS	1	$141,000	$141,000
			TOTAL PROBABLE CONSTRUCTION COST	**$2,115,000**

1 – Rounded to the nearest thousand

Installation Cost

Item	Cost
Construction	$2,115,000
Design Engineering (assumed 10% of construction cost)[1]	$212,000
Construction Engineering (assumed 10% of construction cost)[1]	$212,000
Permitting	$8,000
Real Property Rights	$0
Natural Resource Rights	$0
Water Rights	$0
Relocation Payments	$0
Administrative (NRCS – assumed 1.5% of construction)	$31,500
Administrative (Sponsors – assumed 1.5% of construction)	$31,500
Total Installation Cost	**$2,610,000**

1 – Rounded to the nearest thousand

O&M and Replacement	
O&M (Annual)	$1,600

Site 4 Dry Gulch Class B
Alternative 1 (HDPE)

Detailed Construction Cost Estimate

Item Description	Unit	Quantity	Unit Price	Price[1]
HDPE Pipe 8" DR 17 (125 psi)	LF	1,130	$5.50	$6,000
HDPE Pipe 8" DR 21 (100 psi)	LF	2,030	$4.50	$9,000
HDPE Pipe 8" DR 26 (80 psi)	LF	474	$3.60	$2,000
HDPE Pipe 10" DR 26 (80 psi)	LF	2,060	$5.70	$12,000
HDPE Pipe 10" DR 32.5 (63 psi)	LF	8,033	$4.60	$37,000
HDPE Pipe 12" DR 32.5 (63 psi)	LF	1,670	$6.30	$11,000
HDPE Pipe 16" DR 26 (80 psi)	LF	1,955	$12.40	$24,000
HDPE Pipe 16" DR 32.5 (63 psi)	LF	8,540	$10.00	$85,000
HDPE Pipe 18" DR 17 (125 psi)	LF	1,214	$23.80	$29,000
HDPE Pipe 18" DR 21 (100 psi)	LF	792	$19.50	$15,000
HDPE Pipe 18" DR 26 (80 psi)	LF	1,426	$15.90	$23,000
HDPE Pipe 18" DR 32.5 (63 psi)	LF	1,646	$12.80	$21,000
HDPE Pipe 20" DR 32.5 (63 psi)	LF	9,625	$15.80	$152,000
HDPE Pipe 22" DR 32.5 (63 psi)	LF	2,697	$19.20	$52,000
HDPE Pipe 24" DR 21 (100 psi)	LF	1,849	$34.10	$63,000
HDPE Pipe 24" DR 26 (80 psi)	LF	1,214	$27.80	$34,000
HDPE Pipe 28" DR 32.5 (63 psi)	LF	3,803	$31.00	$118,000
HDPE Pipe 30" DR 32.5 (63 psi)	LF	6,800	$35.70	$243,000
HDPE Pipe 32" DR 32.5 (63 psi)	LF	2,641	$40.50	$107,000
HDPE Pipe 34" DR 32.5 (63 psi)	LF	6,394	$45.70	$292,000
HDPE Pipe 36" DR 32.5 (63 psi)	LF	3,855	$51.40	$198,000
HDPE Pipe 42" DR 32.5 (63 psi)	LF	9,445	$70.00	$661,000
Install HDPE Pipe 8" DR 17 (125 psi)	LF	1,130	$10.00	$11,000
Install HDPE Pipe 8" DR 21 (100 psi)	LF	2,030	$10.00	$20,000
Install HDPE Pipe 8" DR 26 (80 psi)	LF	474	$10.00	$5,000
Install HDPE Pipe 10" DR 26 (80 psi)	LF	2,060	$10.00	$21,000
Install HDPE Pipe 10" DR 32.5 (63 psi)	LF	8,033	$10.00	$80,000
Install HDPE Pipe 12" DR 32.5 (63 psi)	LF	1,670	$10.00	$17,000
Install HDPE Pipe 16" DR 26 (80 psi)	LF	1,955	$12.00	$23,000
Install HDPE Pipe 16" DR 32.5 (63 psi)	LF	8,540	$12.00	$102,000
Install HDPE Pipe 18" DR 17 (125 psi)	LF	1,214	$13.00	$16,000
Install HDPE Pipe 18" DR 21 (100 psi)	LF	792	$13.00	$10,000
Install HDPE Pipe 18" DR 26 (80 psi)	LF	1,426	$13.00	$19,000
Install HDPE Pipe 18" DR 32.5 (63 psi)	LF	1,646	$13.00	$21,000
Install HDPE Pipe 20" DR 32.5 (63 psi)	LF	9,625	$14.00	$135,000
Install HDPE Pipe 22" DR 32.5 (63 psi)	LF	2,697	$14.00	$38,000
Install HDPE Pipe 24" DR 21 (100 psi)	LF	1,849	$15.00	$28,000

Item Description	Unit	Quantity	Unit Price	Price[1]
Install HDPE Pipe 24" DR 26 (80 psi)	LF	1,214	$15.00	$18,000
Install HDPE Pipe 28" DR 32.5 (63 psi)	LF	3,803	$17.00	$65,000
Install HDPE Pipe 30" DR 32.5 (63 psi)	LF	6,800	$18.00	$122,000
Install HDPE Pipe 32" DR 32.5 (63 psi)	LF	2,641	$19.00	$50,000
Install HDPE Pipe 34" DR 32.5 (63 psi)	LF	6,394	$20.00	$128,000
Install HDPE Pipe 36" DR 32.5 (63 psi)	LF	3,855	$21.00	$81,000
Install HDPE Pipe 42" DR 32.5 (63 psi)	LF	9,445	$22.00	$208,000
I-Canal North PRV Station #1	LS	1	$34,000	$34,000
Bluebell PRV Station #1	LS	1	$104,000	$104,000
Bluebell PRV Station #2	LS	1	$39,000	$39,000
I-Canal South PRV Station #2	LS	1	$78,000	$78,000
			Construction Subtotal	**$3,667,000**
Mobilization	LS	1	$367,000	$367,000
Appurtenances (Air Release Valves, Valves, Drains, etc.)	LS	1	$367,000	$367,000
Construction Staking	LS	1	$37,000	$37,000
Resource mitigation	LS	1	$5,000	$5,000
Contingency (10% of Construction Subtotal)	LS	1	$366,000	$367,000
			TOTAL PROBABLE CONSTRUCTION COST	**$4,810,000**

1 – Rounded to the nearest thousand

Installation Cost

Item	Cost
Construction	$4,810,000
Design Engineering (assumed 10% of construction cost)[1]	$481,000
Construction Engineering (assumed 10% of construction cost)[1]	$481,000
Permitting	$25,000
Real Property Rights (assumed $560/acre for 85.4 acres of land)	$48,000
Natural Resource Rights	$0
Water Rights	$0
Relocation Payments	$0
Administrative (NRCS – assumed approximately 1% of construction)	$48,000
Administrative (Sponsors – assumed approximately 1% of construction)	$48,000
Total Installation Cost	**$5,941,000**

1 – Rounded to the nearest thousand

O&M and Replacement	
O&M (Annual)	$9,600

Site 4 Dry Gulch Class B
Alternative 2 (PVC)

Detailed Construction Cost Estimate

Item Description	Unit	Quantity	Unit Price	Price[1]
PVC Pipe 8" DR 25 (165 psi)	LF	3,634	$19.04	$69,000
PVC Pipe 10" DR 25 (165 psi)	LF	10,093	$30.62	$309,000
PVC Pipe 12" DR 25 (165 psi)	LF	1670	$43.04	$72,000
PVC Pipe 16" DR 41 (100 psi)	LF	10,495	$50.15	$526,000
PVC Pipe 18" DR 32.5 (125 psi)	LF	1,214	$79.33	$96,000
PVC Pipe 18" DR 41 (100 psi)	LF	3,864	$63.14	$244,000
PVC Pipe 20" DR 41 (100 psi)	LF	9,625	$77.89	$750,000
PVC Pipe 22" DR 41 (100 psi)	LF	2,697	$95.19	$257,000
PVC Pipe 24" DR 41 (100 psi)	LF	3,063	$112.50	$345,000
PVC Pipe 30" DR 51 (80 psi)	LF	10603	$141.35	$1,499,000
PVC Pipe 36" DR 51 (80 psi)	LF	12,890	$206.09	$2,657,000
PVC Pipe 42" DR 51 (80 psi)	LF	9,445	$282.37	$2,667,000
Install PVC Pipe 8" DR 25 (165 psi)	LF	3,634	$10.00	$36,000
Install PVC Pipe 10" DR 25 (165 psi)	LF	10,093	$10.00	$101,000
Install PVC Pipe 12" DR 25 (165 psi)	LF	1670	$10.00	$17,000
Install PVC Pipe 16" DR 41 (100 psi)	LF	10,495	$12.00	$126,000
Install PVC Pipe 18" DR 32.5 (125 psi)	LF	1,214	$13.00	$16,000
Install PVC Pipe 18" DR 41 (100 psi)	LF	3,864	$13.00	$50,000
Install PVC Pipe 20" DR 41 (100 psi)	LF	9,625	$14.00	$135,000
Install PVC Pipe 22" DR 41 (100 psi)	LF	2,697	$14.00	$38,000
Install PVC Pipe 24" DR 41 (100 psi)	LF	3,063	$15.00	$46,000
Install PVC Pipe 30" DR 51 (80 psi)	LF	10603	$16.00	$170,000
Install PVC Pipe 36" DR 51 (80 psi)	LF	12,890	$19.00	$245,000
Install PVC Pipe 42" DR 51 (80 psi)	LF	9,445	$22.00	$208,000
I-Canal North PRV Station #1 (61+25, 10-in PRV, mechanical parts, vault, installation)	LS	1	$34,000	$34,000
Bluebell PRV Station #1 (145+20, Two 14-in PRV, mechanical parts, vault, installation)	LS	1	$104,000	$104,000
Bluebell PRV Station #2 (224+40, 12-in PRV, mechanical parts, vault, installation)	LS	1	$39,000	$39,000
I-Canal South PRV Station #2 (13+20, Two 12-in PRV, mechanical parts, vault, installation)	LS	1	$78,000	$78,000
			Construction Subtotal	**$10,934,000**
Mobilization	LS	1	$1,093,000	$1,093,000
Appurtenances (Air Release Valves, Valves, Drains, etc.)	LS	1	$1,093,000	$1,093,000
Construction Staking	LS	1	$109,000	$109,000
Resource mitigation	LS	1	$5,000	$5,000
Contingency (10% of Construction Subtotal)	LS	1	$1,093,000	$1,093,000
			TOTAL PROBABLE CONSTRUCTION COST	**$14,327,000**

1 – Rounded to the nearest thousand

Installation Cost

Item	Cost
Construction	$14,327,000
Design Engineering (assumed 10% of construction cost)[1]	$1,433,000
Construction Engineering (assumed 10% of construction cost)[1]	$1,433,000
Permitting	$25,000
Real Property Rights (assumed $560/acre for 85.4 acres of land)	$48,000
Natural Resource Rights	$0
Water Rights	$0
Relocation Payments	$0
Administrative (NRCS – assumed approximately 1% of construction)	$143,000
Administrative (Sponsors – assumed approximately 1% of construction)	$143,000
Total Installation Cost	**$17,552,000.00**

1 – Rounded to the nearest thousand

O&M and Replacement	
O&M (Annual)	$9,600

Site 5 Dry Gulch Class C
Alternative 1 (HDPE)

Detailed Construction Cost Estimate

Item Description	Unit	Quantity	Unit Price	Price[1]
HDPE Pipe 8” DR 21 (100psi)	LF	1,404	$4.50	$6,000
HDPE Pipe 10” DR 32.5 (63) psi	LF	1,200	$4.60	$6,000
HDPE Pipe 12” DR 26 (80) psi	LF	1,971	$7.80	$15,000
HDPE Pipe 16” DR 32.5 (63) psi	LF	200	$10.00	$2,000
HDPE Pipe 72” DR 32.5 (63) psi	LF	28,517	$282.66	$8,061,000
Install HDPE Pipe 8” DR 21 (100) psi	LF	1,404	$10.00	$14,000
Install HDPE Pipe 10” DR 21 (63) psi	LF	1,200	$10.00	$12,000
Install HDPE Pipe 12” DR 21 (80) psi	LF	1,971	$10.00	$20,000
Install HDPE Pipe 16” DR 21 (63) psi	LF	200	$12.00	$2,000
Install HDPE Pipe 72” DR 21 (63) psi	LF	28,517	$55.00	$1,568,000
PRV Station #1 (184+80, Seven 14-in PRV's, mechanical parts, vault/Station Building, installation)	LS	1	$ 494,000	$494,000
PRV Station #2 (285+12, End, seven 14-in PRV's, mechanical parts, vault/Station Building, installation)	LS	1	$ 494,000	$494,000
			Construction Subtotal	**$10,694,000**
Mobilization	LS	1	$535,000	$535,000
Appurtenances (Air Release Valves, Drains, etc.)	LS	1	$962,000	$962,000
Construction Staking	LS	1	$107,000	$107,000
Resource mitigation	LS	1	$1,000	$1,000
Contingency (5% of Construction Subtotal)	LS	1	$535,000	$535,000
			TOTAL PROBABLE CONSTRUCTION COST	**$12,834,000**

1 – Rounded to the nearest thousand

Installation Cost

Item	Cost
Construction	$12,834,000
Design Engineering (assumed 10% of construction cost)	$1,283,000
Construction Engineering (assumed 10% of construction cost)	$1,283,000
Permitting	$8,000
Real Property Rights (assumed $560/acre for 6.34 acres of land)	$4,000
Natural Resource Rights	$0
Water Rights	$0
Relocation Payments	$0
Administrative (NRCS – assumed 1.48% of construction)	$190,500
Administrative (Sponsors – assumed 1.48% of construction)	$190,500
Total Installation Cost	**$15,793,000**

1 – Rounded to the nearest thousand

O&M and Replacement	
O&M (Annual)	$4,000

Site 5 Dry Gulch Class C
Alternative 2 (PVC)

Detailed Construction Cost Estimate

Item Description	Unit	Quantity	Unit Price	Price[1]
PVC Pipe 8" DR 25 (165 psi)	LF	1,404	$19.04	$27,000
PVC Pipe 10" DR 25 (165 psi)	LF	1,200	$30.62	$37,000
PVC Pipe 12" DR 25 (165 psi)	LF	1,971	$43.04	$85,000
PVC Pipe 16" DR 41 (100 psi)	LF	200	$50.15	$10,000
PVC Pipe 42" DR 51 (80 psi)	LF	85,551	$282.37	$24,157,000
Install PVC Pipe 8" DR 25 (165 psi)	LF	1,404	$10.00	$14,000
Install PVC Pipe 10" DR 25 (165 psi)	LF	1,200	$10.00	$12,000
Install PVC Pipe 12" DR 25 (165 psi)	LF	1,971	$10.00	$20,000
Install PVC Pipe 16" DR 41 (100 psi)	LF	200	$12.00	$2,000
Install PVC Pipe 42" DR 51 (80 psi)	LF	85,551	$22.00	$1,882,000
PRV Station #1 (184+80, Seven 14-in PRV's, mechanical parts, vault/Station Building, installation)	LS	1	$494,000	$494,000
PRV Station #2 (285+12, End, seven 14-in PRV's, mechanical parts, vault/Station Building, installation)	LS	1	$494,000	$494,000
			Construction Subtotal	**$27,234,000**
Mobilization	LS	1	$1,362,000	$1,362,000
Appurtenances (Air Release Valves, Drains, etc.)	LS	1	$2,451,000	$2,451,000
Construction Staking	LS	1	$272,000	$272,000
Resource mitigation	LS	1	$1,000	$1,000
Contingency (5% of Construction Subtotal)	LS	1	$1,362,000	$1,362,000
			TOTAL PROBABLE CONSTRUCTION COST	**$32,682,000**

1 – Rounded to the nearest thousand

Installation Cost

Item	Cost
Construction	$32,682,000
Design Engineering (assumed 10% of construction cost)	$3,268,000
Construction Engineering (assumed 10% of construction cost)	$3,268,000
Permitting	$8,000
Real Property Rights (assumed $560/acre for 6.34 acres of land)	$4,000
Natural Resource Rights	$0
Water Rights	$0
Relocation Payments	$0
Administrative (NRCS – assumed 1.48% of construction)	$490,000
Administrative (Sponsors – assumed 1.48% of construction)	$490,000
Total Installation Cost	**$40,210,000**

1 – Rounded to the nearest thousand

O&M and Replacement	
O&M (Annual)	$10,850

Site 6 Red Cap
Alternative 1 (HDPE)

Detailed Construction Cost Estimate

Item Description	Unit	Quantity	Unit Price	Price[1]
Rock Excavation	LF	30,000	$12.00	$360,000
Imported Pipe Bedding	LF	30,000	$10.00	$300,000
HDPE Pipe 8" DR 26 (80 psi)	LF	3,122	$3.60	$11,000
HDPE Pipe 8" DR 32.5 (63 psi)	LF	4,777	$2.90	$14,000
HDPE Pipe 12" DR 26 (80 psi)	LF	3,550	$7.80	$28,000
HDPE Pipe 12" DR 32.5 (63 psi)	LF	1,273	$6.30	$8,000
HDPE Pipe 16" DR 26 (80 psi)	LF	2,452	$12.40	$30,000
HDPE Pipe 16" DR 32.5 (63 psi)	LF	4,382	$10.00	$44,000
HDPE Pipe 18" DR 26 (80 psi)	LF	758	$15.90	$12,000
HDPE Pipe 20" DR 26 (80 psi)	LF	3,924	$19.60	$77,000
HDPE Pipe 20" DR 32.5 (63 psi)	LF	20,796	$15.80	$329,000
HDPE Pipe 24" DR 26 (80 psi)	LF	2,890	$27.80	$80,000
HDPE Pipe 24" DR 32.5 (63 psi)	LF	29,839	$22.40	$668,000
HDPE Pipe 26" DR 32.5 (63 psi)	LF	1,929	$26.70	$52,000
HDPE Pipe 28" DR 32.5 (63 psi)	LF	4,523	$31.00	$140,000
HDPE Pipe 36" DR 32.5 (63 psi)	LF	6,507	$51.40	$334,000
HDPE Pipe 42" DR 32.5 (63 psi)	LF	6,345	$70.00	$444,000
HDPE Pipe 48" DR 32.5 (63 psi)	LF	9,094	$91.20	$829,000
Install HDPE Pipe 8" DR 26 (80 psi)	LF	3,122	$10.00	$31,000
Install HDPE Pipe 8" DR 32.5 (63 psi)	LF	4,777	$10.00	$48,000
Install HDPE Pipe 12" DR 26 (80 psi)	LF	3,550	$10.00	$36,000
Install HDPE Pipe 12" DR 32.5 (63 psi)	LF	1,273	$10.00	$13,000
Install HDPE Pipe 16" DR 26 (80 psi)	LF	2,452	$12.00	$29,000
Install HDPE Pipe 16" DR 32.5 (63 psi)	LF	4,382	$12.00	$53,000
Install HDPE Pipe 18" DR 26 (80 psi)	LF	758	$13.00	$10,000
Install HDPE Pipe 20" DR 26 (80 psi)	LF	3,924	$14.00	$55,000
Install HDPE Pipe 20" DR 32.5 (63 psi)	LF	20,796	$14.00	$291,000
Install HDPE Pipe 24" DR 26 (80 psi)	LF	2,890	$15.00	$43,000
Install HDPE Pipe 24" DR 32.5 (63 psi)	LF	29,839	$15.00	$448,000
Install HDPE Pipe 26" DR 32.5 (63 psi)	LF	1,929	$16.00	$31,000
Install HDPE Pipe 28" DR 32.5 (63 psi)	LF	4,523	$17.00	$77,000
Install HDPE Pipe 36" DR 32.5 (63 psi)	LF	6,507	$21.00	$137,000
Install HDPE Pipe 42" DR 32.5 (63 psi)	LF	6,345	$22.00	$140,000
Install HDPE Pipe 48" DR 32.5 (63 psi)	LF	9,094	$25.00	$227,000
Pipe Inlet Screen Structure	LS	1	$275,000	$275,000
Mainline Meters	EACH	2	$20,000	$40,000
Turnouts	EACH	70	$8,000	$560,000

Item Description	Unit	Quantity	Unit Price	Price[1]
			Construction Subtotal	**$6,304,000**
Mobilization	LS	1	$315,000	$315,000
Appurtenances (Air Release Valves, Drains, etc.)	LS	1	$441,000	$441,000
Construction Staking	LS	1	$63,000	$63,000
Traffic Control	LS	1	$63,000	$63,000
Resource mitigation	LS	1	$5,000	$5,000
Contingency (5% of Construction Subtotal)	LS	1	$315,000	$315,000
			TOTAL PROBABLE CONSTRUCTION COST	**$7,506,000**

1 – Rounded to the nearest thousand

Installation Cost

Item	Cost
Construction	$7,506,000
Design Engineering (assumed 10% of construction cost)[1]	$751,000
Construction Engineering (assumed 10% of construction cost)[1]	$751,000
Permitting	$25,000
Real Property Rights (assumed $560/acre for 66.47 acres)	$37,000
Natural Resource Rights	$0
Water Rights	$0
Relocation Payments	$0
Administrative (NRCS – assumed 1.25% of construction)	$94,000
Administrative (Sponsors – assumed 1.25% of construction)	$94,000
Total Installation Cost	**$9,258,000**

1 – Rounded to the nearest thousand

O&M and Replacement	
O&M (Annual)	$12,800

Site 6 Red Cap
Alternative 2 (PVC)

Detailed Construction Cost Estimate

Item Description	Unit	Quantity	Unit Price	Price[1]
Rock Excavation	LF	30,000	$12.00	$360,000
Imported Pipe Bedding	LF	30,000	$10.00	$300,000
PVC Pipe 8" DR 25 (165 psi)	LF	7,899	$19.04	$150,000
PVC Pipe 12" DR 25 (165 psi)	LF	4,823	$43.04	$208,000
PVC Pipe 16" DR 41 (100 psi)	LF	6,834	$50.15	$343,000
PVC Pipe 18" DR 41 (100 psi)	LF	758	$63.14	$48,000
PVC Pipe 20" DR 41 (100 psi)	LF	24,720	$77.89	$1,925,000
PVC Pipe 24" DR 41 (100 psi)	LF	32,729	$112.50	$3,682,000
PVC Pipe 30" DR 51 (80 psi)	LF	6452	$141.35	$912,000
PVC Pipe 36" DR 51 (80 psi)	LF	6,507	$206.09	$1,341,000
PVC Pipe 42" DR 51 (80 psi)	LF	6,345	$282.37	$1,792,000
PVC Pipe 48" DR 51 (80 psi)	LF	9,094	$371.15	$3,375,000
Install PVC Pipe 8" DR 25 (165 psi)	LF	7,899	$10.00	$79,000
Install PVC Pipe 12" DR 25 (165 psi)	LF	4,823	$10.00	$48,000
Install PVC Pipe 16" DR 41 (100 psi)	LF	6,834	$12.00	$82,000
Install PVC Pipe 18" DR 41 (100 psi)	LF	758	$13.00	$10,000
Install PVC Pipe 20" DR 41 (100 psi)	LF	24,720	$14.00	$346,000
Install PVC Pipe 24" DR 41 (100 psi)	LF	32,729	$15.00	$491,000
Install PVC Pipe 30" DR 51 (80 psi)	LF	6452	$16.00	$103,000
Install PVC Pipe 36" DR 51 (80 psi)	LF	6,507	$19.00	$124,000
Install PVC Pipe 42" DR 51 (80 psi)	LF	6,345	$22.00	$140,000
Install PVC Pipe 48" DR 51 (80 psi)	LF	9,094	$25.00	$227,000
Pipe Inlet Screen Structure	LS	1	$275,000.00	$275,000
Mainline Meters	EACH	2	$20,000.00	$40,000
Turnouts	EACH	70	$8,000.00	$560,000
			Construction Subtotal	**$16,961,000**
Mobilization	LS	1	$848,000	$848,000
Appurtenances (Air Release Valves, Drains, etc.)	LS	1	$1,187,270	$1,187,000
Construction Staking	LS	1	$170,000	$170,000
Traffic Control	LS	1	$170,000	$170,000
Resource mitigation	LS	1	$5,000	$5,000
Contingency (5% of Construction Subtotal)	LS	1	$848,000	$848,000
			TOTAL PROBABLE CONSTRUCTION COST	**$20,189,000**

1 – Rounded to the nearest thousand

Installation Cost

Item	Cost
Construction	$20,189,000
Design Engineering (assumed 10% of construction cost)[1]	$2,019,000
Construction Engineering (assumed 10% of construction cost)[1]	$2,019,000
Permitting	$25,000
Real Property Rights (assumed $560/acre for 66.47 acres)	$37,000
Natural Resource Rights	$0
Water Rights	$0
Relocation Payments	$0
Administrative (NRCS – assumed 1.25% of construction)	$202,000
Administrative (Sponsors – assumed 1.25% of construction)	$202,000
Total Installation Cost	**$24,693,000**

1 – Rounded to the nearest thousand

O&M and Replacement	
O&M (Annual)	$12,800

Site 7 Gray Mountain Canal
Alternative 1 (Concrete Lining)

Detailed Construction Cost Estimate

Item Description	Unit	Quantity	Unit Price	Price[1]
Clearing and Grubbing	LF	10,620	$3.50	$37,000
Canal Excavation and Preparation	CY	14,868	$30.00	$446,000
Rock Base Aggregate	TON	5,576	$30.00	$167,000
Geocomposite Liner	SY	35,396	$12.00	$425,000
Concrete	CY	3,929	$370	$1,454,000
Turnouts	EA	8	$8,500	$68,000
Bridge/Road Crossing	EA	3	$69,000	$207,000
Access Road	LF	10,620	$12.00	$127,000
			Construction Subtotal	**$2,931,000**
Mobilization	LS	1	$293,000.00	$293,000
Construction Staking	LS	1	$29,000.00	$29,000
Resource Mitigation	LS	1	$1,000.00	$1,000
Contingency (10% of Construction Subtotal)	LS	1	$293,000.00	$293,000
			TOTAL PROBABLE CONSTRUCTION COST	**$3,547,000**

1 – Rounded to the nearest thousand

Site 7 Installation Cost

Item	Cost
Construction	$3,547,000
Design Engineering (assumed 10% of construction cost)[1]	$355,000
Construction Engineering (assumed 10% of construction cost)[1]	$355,000
Permitting	$5,000
Real Property Rights	$0
Natural Resource Rights	$0
Water Rights	$0
Relocation Payments	$0
Administrative (NRCS – assumed 1.5% of construction)	$53,500
Administrative (Sponsors – assumed 1.5% of construction)	$53,500
Total Installation Cost	**$4,369,000**

1 – Rounded to the nearest thousand

O&M and Replacement	
O&M (Annual)	$1,300

Site 7 Gray Mountain Canal
Alternative 2 (Membrane Lining)

Detailed Construction Cost Estimate

Item Description	Unit	Quantity	Unit Price	Price[1]
Clearing and Grubbing	LF	10,620	$3.50	$37,000
Canal Excavation and Preparation	CY	14,868	$30.00	$446,000
Rock Base Aggregate	TON	5,576	$30.00	$167,000
Geocomposite Liner	SY	35,396	$12.00	$425,000
Ballast	CY	6,300	$45.00	$284,000
Turnouts	EA	8	$8,500.00	$68,000
Bridge/Road Crossing	EA	3	$69,000.00	$207,000
Access Road	LF	10,620	$12.00	$127,000
			Construction Subtotal	**$1,761,000**
Mobilization	LS	1	$176,000	$176,000
Construction Staking	LS	1	$18,000	$18,000
Resource Mitigation	LS	1	$1,000	$1,000
Contingency (10% of Construction Subtotal)	LS	1	$176,000	$176,000
			TOTAL PROBABLE CONSTRUCTION COST	**$2,132,000**

1 – Rounded to the nearest thousand

Site 7 Installation Cost

Item	Cost
Construction	$2,132,000
Design Engineering (assumed 10% of construction cost)[1]	$213,000
Construction Engineering (assumed 10% of construction cost)[1]	$213,000
Permitting	$5,000
Real Property Rights	$0
Natural Resource Rights	$0
Water Rights	$0
Relocation Payments	$0
Administrative (NRCS – assumed 1.5% of construction)	$32,000
Administrative (Sponsors – assumed 1.5% of construction)	$32,000
Total Installation Cost	**$2,627,000**

1 – Rounded to the nearest thousand

Annual O&M	
O&M (Annual)	$6,000
TOTAL	**$6,000**

Replacement Cost: The membrane liner only provides a 20-year service life and would need to be replaced 2 times over the 50-year Project life at a cost of $2,132,000 per replacement.

Water Budget and Depletion Technical Memo

Technical Memo: Water Budget & Depletion

1.0 Introduction

A water budget was created for the Duchesne County Water Efficiency Project in order to determine the difference in water use between the future without project implementation and the future with project implementation. Changes in anticipated depletion detailed in this document are limited to changes in anticipated consumptive use. Please see the UT Dept of Water Resources diagram below in Figure 1 for reference. In this case, consumptive use is limited to changes in evapotranspiration (ET), what's boxed in red below.

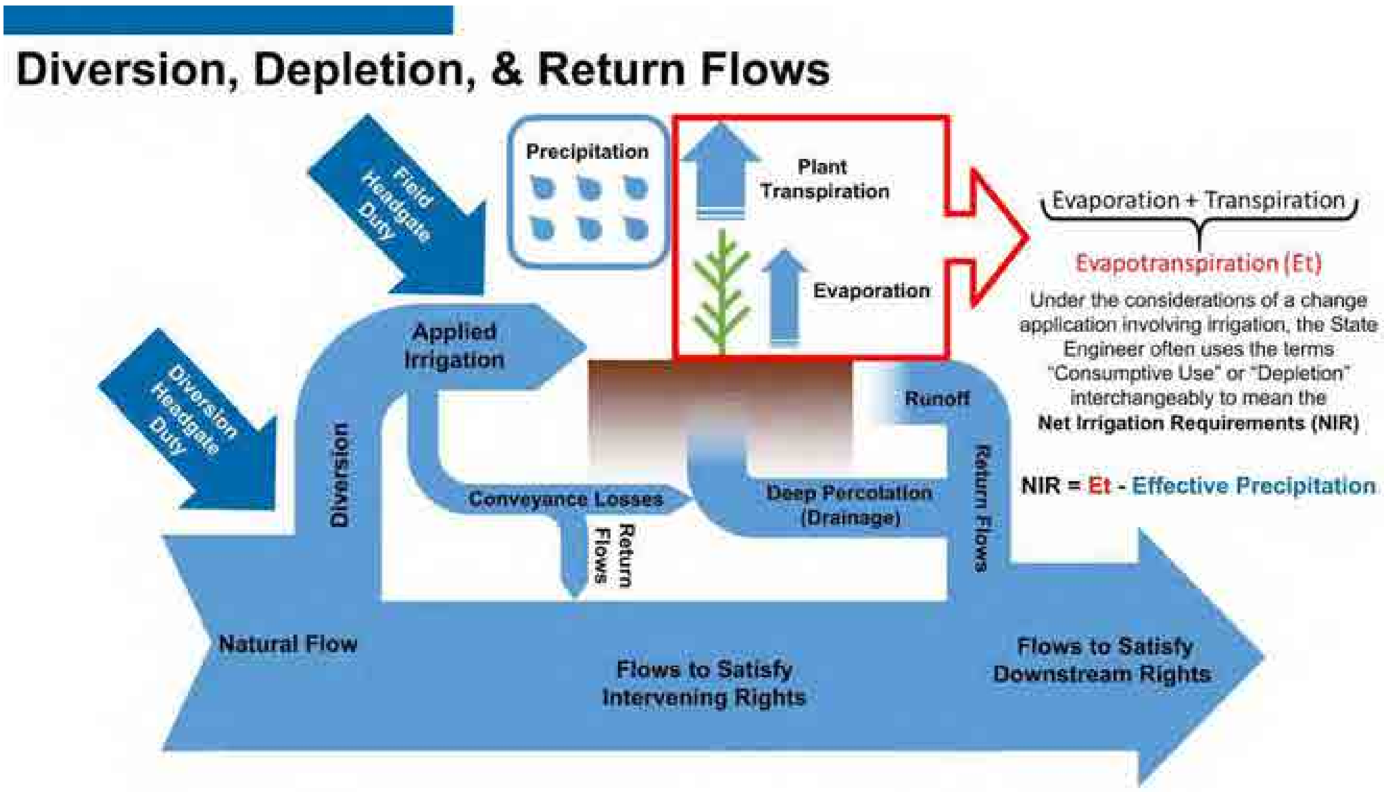


Figure 1 Diversion, Depletion, & Return Flows (Utah Department of Water Resources)

Increased or decreased consumption due to changes in crop type, extended irrigation seasons, or increased irrigated acreage made possible by the increased efficiency of the improved system on-farm is beyond the scope of this project. Benefits claimed from these improvements or depletions increased are not claimed by this project since they are beyond the project's scope and control. A water budget was used to determine whether the cumulative impacts of the project would be a net accretion or net depletion within the Eastern Duchesne Watershed. Figure 2 below shows a map of the Eastern Duchesne Watershed with reservoirs, rivers, and project canals. It also illustrates the location of the project sites and their relationship with the natural rivers in the drainage as well as the storage reservoirs operated by the water users. For this area, an average year of water flows in the Lake Fork and Duchesne Rivers is approximately 1,015,805 acre-feet annually.

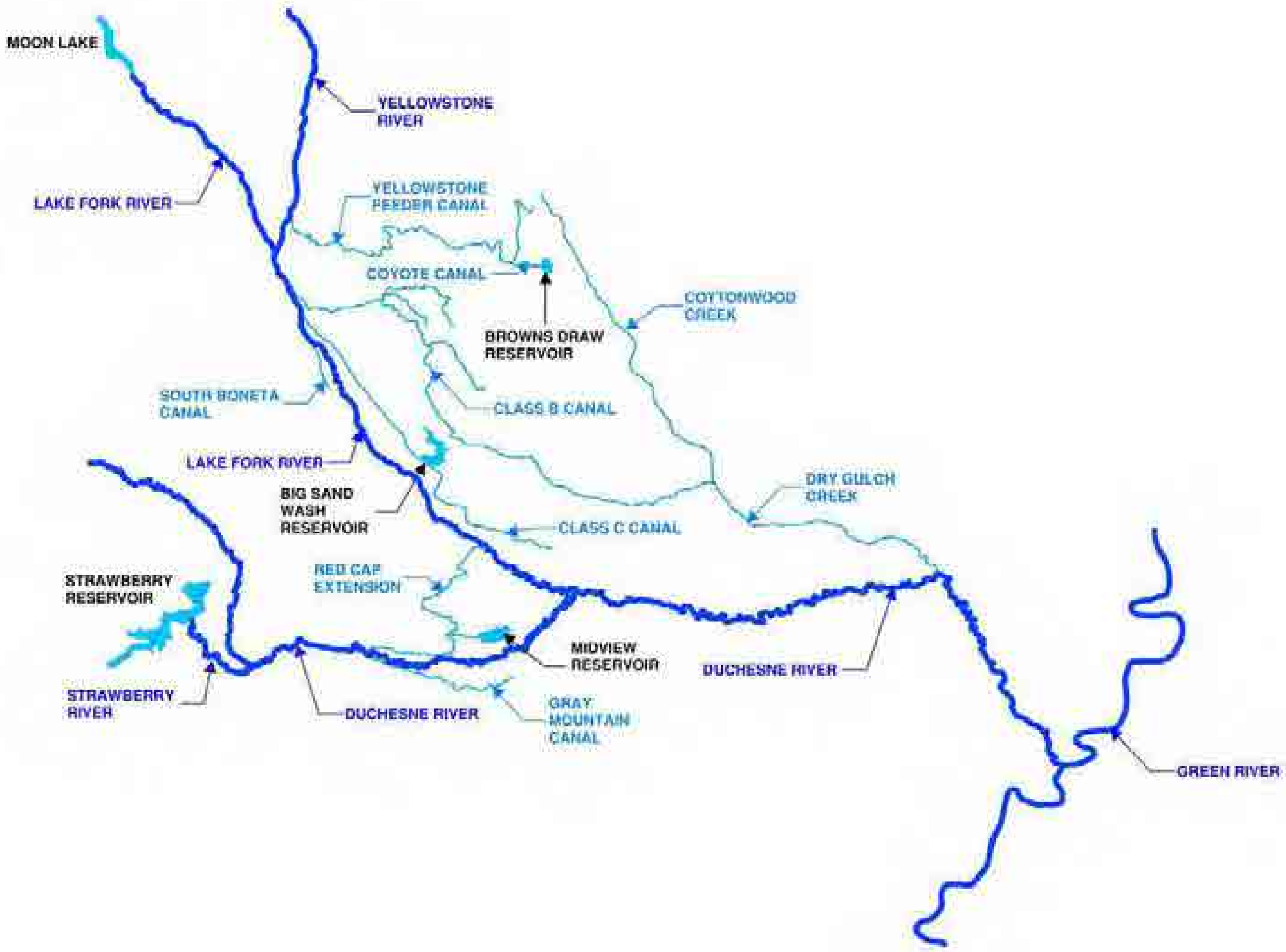


Figure 2 Map of the East Duchesne Watershed

Currently conditions estimate phreatophytes depletion at 24,714 acre-feet per year. With the completion of this project, phreatophyte consumptive use will be eliminated from the overall water budget. This elimination, along with improved system efficiency allows for a lengthened irrigation season and the possibility of additional irrigated acreage. The lengthened irrigation season results in increased crop consumptive use of an estimated 13,547 acre-feet. Additionally, the completed project would allow for 2,422 acres to be irrigated in addition to currently irrigated acreage. This increases consumptive use by 5,443 acre-feet. Overall, the increase in crop consumptive use results in a net accretion of 5,724 acre-feet per year as a result of the Duchesne County Water Efficiency Project. Other factors affecting the water quality and quantity include water conservation of agricultural users based on new meters installed by the project and also reduction in seepage that decreases salinity in the return flows ultimately benefiting the Colorado River system.

2.0 Project Water Budget

2.1 Increased Irrigation Efficiency and Crop Consumptive Use

The Eastern Duchesne Watershed currently supports approximately 87,328 acres of cropland that includes primarily alfalfa, grass hay, various grains, and pasture for livestock production. The existing irrigation type broken down by service areas within the watershed is shown in Table 2.1 below. Maps are also included in the Appendix C of the Plan-EA document.

Table 2.1 Existing Irrigation Type

Site No.	Service Area Name	Flood Irrigation (acres)	Sprinkler Irrigation (acres)	Dry Crop (acres)	Sub-irrigated (acres)	Total (acres)
1	Yellowstone Feeder Canal*	22,425	12,088	999	1,204	36,716
2	Coyote Canal	5,015	3,268	310	278	8,871
3	South Boneta	688	949	38	18	1,693
4	Class B Canal	3,935	6,597	97	41	10,670
5	Class C Canal	3,266	8,425	259	237	12,187
6	Red Cap Extension	1,804	1,160	51	20	3,035
7	Gray Mountain Canal	1,834	10,941	456	925	14,156
	Total	**38,967**	**43,428**	**2,210**	**2,723**	**87,328**
*Yellowstone Feeder Canal acreages were adjusted to not include any other overlapping service areas acreages.						

Implementation of the project will increase efficiency of the system and could lengthen irrigation seasons. All of the projects have an upstream reservoir or are managed through the Moon Lake Exchange, trading flows from the Yellowstone River by replacing them with Moon Lake Reservoir storage in the Lake Fork that is fed by the Yellowstone. These reservoirs store water for deployment later in the growing season. Later season flows from the reservoirs provide many ecological benefits. Increased irrigation season length translates into an increase in crop consumptive use which should be accounted for.

2.2 Extended Irrigation Season

Consumptive use of alfalfa and pasture were obtained from “Consumptive Use of Irrigated Crops in Utah”, USU Research Report 145 for the Altamont area which is in the project vicinity. The assumed pre-project average condition is that producers’ irrigation season ends at the end of August. Conservative projected water savings as a result of project completion will allow all seven sites’ shareholders to extend their irrigation season at least through September. The consumptive uses are detailed below in Table 2.2.

Table 2.2 Crop Consumptive Use - Extended Season

Crop Type	Annual Consumptive Use (Inches)	Annual Consumptive Use (Feet)
Alfalfa (Apr-Sep)	26.97	2.25
Alfalfa (Apr-Aug)	23.47	1.96
Pasture (Apr-Sep)	20.29	1.69
Pasture (Apr-Aug)	17.72	1.48
Increase in Consumptive Use – Extended Alfalfa Season (Sprinkler)	3.5	0.29
Increase in Consumptive Use – Extended Pasture Season (Flood)	2.57	0.21

Lands currently in sprinkler irrigation were assumed to be producing alfalfa, and the lands that are flood irrigated are assumed to be producing pasture. Annual consumptive use was determined for an irrigation season between April and August for both alfalfa and pasture, which represents the consumptive use of the crops during a shorter irrigation season. The annual consumptive use was then determined for alfalfa and pasture for an extended irrigation season from April to September. The differences between the short season and extended irrigation season consumptive use was then multiplied by the appropriate acreage to determine the increased consumptive use due to the extended irrigation season resulting from the project. The table below summarizes the results of those calculations.

Table 2.3 Increased Consumptive Use Due to Extended Irrigation Season

Irrigation Type	Consumptive Use Increase (ac-ft)
Sprinkler	6,680
Flood	6,867
Total	13,547

The irrigation season would be extended by approximately one month in the areas with a longer irrigation season potential after the project is completed.

2.3 Additional Irrigated Acreage

Completing this project would allow for an additional 2,422 acres to be irrigated at the Red Cap Extension service area, which holds Class II and Class III water rights with "temporarily not accessible" and "permanently not accessible" status due to gravity flow open channels unable to deliver water. The project would install flood turnouts at the appropriate locations for this additional acreage. Without knowing the plans of the irrigators located on this land, the conservative approach of assuming alfalfa production was used in the calculations to determine additional depletion. An additional project benefit would be an extended irrigation season. The crop consumptive use was estimated and depletion from the added acreage is shown below in Table 2.4.

Table 2.4 Crop Consumptive Use – Additional Acreage

Crop Type	Annual Consumptive Use (Inches)	Annual Consumptive Use (Feet)
Alfalfa (Apr-Aug)	26.97	2.25

Crop consumptive use was then multiplied by the additional acreage at the Red Cap Extension site to determine the increased consumptive use. The table below summarizes the additional depletion due to the added acreage.

Table 2.5 Increased Consumptive Use Due to Additional Acreage

Item	Consumptive Use Increase (ac-ft)
Additional Acreage	5,443

2.4 Phreatophytes Consumption

A phreatophyte is a deep-rooted plant that often grows near rivers and canals where abundant water supply is available. Phreatophytes consume canal seepage losses. Phreatophyte water consumption can be substantial with some Utah-specific estimations projecting more water consumed by phreatophytes than irrigated crops. Salinity and on-farm NRCS projects in the Uintah Basin attribute phreatophytes consumptive use to 60% of the seepage losses of canals and ditches. Using that same percentage, a total of 24,714 acre-feet of water of the 41,190 acre-feet of estimated seepage for this project would be used by phreatophytes as a depletion in the existing system. Piping and lining canals eliminates phreatophyte consumptive use in those areas, resulting in an accretion that could be utilized in multiple beneficial ways including a longer irrigation season, additional irrigated acreage, and potentially increased streamflows due to reduced diversions. If the saved water is used to extend the irrigation season, crop consumptive use increases due to the increased crop production. As stated above, in recent water years, the irrigation season has been from April to August or early September depending on water availability. With water savings being applied to the farms, the irrigation season could potentially increase in length until the end of September.

Table 2.6 shows the breakdown of seepage and phreatophyte consumptive use by service area within the Eastern Duchesne Watershed. Also included in Appendix A are representative photos of each canal illustrating the vegetation and phreatophytes along the canals in areas that will be piped. Some areas will remain post project due to the natural hydrology, on-farm irrigation practices, or available groundwater. However, the canal has allowed the majority of the plants to establish.

Table 2.6 Phreatophytes Consumptive Use

Service Area Name	Existing Seepage (ac-ft)	Proposed Seepage (ac-ft)	Seepage Reduction (ac-ft)	Existing Phreatophyte Consumptive Use (ac-ft)	Proposed Phreatophyte Consumptive Use (ac-ft)	Phreatophyte Consumptive Use Savings (ac-ft)
Yellowstone Feeder Canal	2,960	1,102	1,858	1,776	661	1,115
Coyote Canal	591	288	303	355	173	182
South Boneta	812	0	812	487	0	487
Class B Canal	20,172	854	19,318	12,103	512	11,591
Class C Canal	4,662	0	4,662	2,797	0	2,797
Red Cap Extension	4,784	0	4,784	2,870	0	2,870
Gray Mountain Canal	12,721	3,268	9,453	7,633	1,961	5,672
Totals	**46,702**	**5,512**	**41,190**	**28,021**	**3,307**	**24,714**

3.0 Other Water Budget Considerations

There are other depletion and/or accretions that could occur after the project is implemented, but some are not associated directly to the scope of the project. These items include on-farm irrigation conversions, changes in diversion, and metering of irrigation flows. They are beyond the scope of this project and not considered.

3.1 Diversion

Water flows remaining within the natural streams will need to be evaluated and analyzed after project implementation to quantify the true effects of the project. It is anticipated that instream flow rates will increase after project implementation. Converting open channel canals to pipelines with minimal to no leakage will nearly eliminate transmission losses. Less water will need to be diverted from the river to meet on-farm needs.

While outside project scope, anticipated conversion from flood irrigation to sprinklers will reduce the water application rate to fields. Lower immediate demand results in more water staying within the river system. Post-project flow data will be published on the website www.duchesneriver.org and will be used to compare pre- and post-project flow records. This fulfills some funding sources' requirements to track and meter diverted flows.

3.2 Metering

On the subject of metering, two of the seven projects, Red Cap/Arcadia Farms and Class B Canal, have a large number of on-farm connections served by the proposed pipelines. These connections will be equipped with a meter for both flood and sprinkler connections. Based on a study from Weber Basin Water Conservancy District in Utah, residential irrigation volumes were reduced between 20 and 29% due to being metered. There is not a known specific study about agricultural irrigation, but these two projects have minimal metering on-farm at the current time and it is anticipated that measurement will further conserve water. With a conservative value of 5% savings due to metering, approximately 2,000 acre-feet of water could be conserved from these two sites. Metering is also expected to improve leak detection and repair. This is not included in the water budget below, but offers a contingency and buffer for other calculations and assumptions that are included in the calculations.

4.0 Conclusion

The cumulative impact of the Duchesne County Water Efficiency Project is a net accretion of water within the Eastern Duchesne Watershed. The existing system's current phreatophyte consumptive use will be eliminated resulting in a gain of available water to put to beneficial use. This may be accomplished by including more acreage irrigated or a longer irrigation season. Lengthened irrigation seasons and additional irrigated acreage will increase consumptive use. Net increase in crop consumptive use would result in a net accretion of 5,724 acre-feet per year. Table 4.1 below summarizes the project impacts.

Table 4.1 Project Impact

Item	Accretion/(Depletion) acre-feet	Source of value in table above
Current Phreatophyte Consumptive Use – Eliminated by Project Measures	24,714	Table 2.6
Projected Crop Consumptive Use – Extended Sprinkler Season	(6,680)	Table 2.3
Projected Crop Consumptive Use – Extended Flood Season	(6,867)	Table 2.3
Projected Crop Consumptive Use – Additional Irrigate Acreage	(5,443)	Table 2.5
Projected Cumulative Impact	**5,724**	

Other depletions or accretions not listed above may occur in the future but are not associated directly with the effects of the project. These potential changes are not taken into account in this water budget as they are not guaranteed. The efficiency increase of the project expects to increase river flows as less water will need to be diverted. This is expected especially during times of high flow. Monitoring river flows will quantify benefits realized from this project.

5.0 References

"Consumptive Use of Irrigated Crops in Utah." Research Report 145. Utah Agricultural Experiment Station. Utah State University. Logan, Utah. https://waterrights.utah.gov/docSys/v912/a912/a912044e.pdf

"Final Environmental Impact Statement." Uintah Basin Unit Expansion – Colorado River Salinity Control Program. Utah. December 1991.

"Henrys Fork Salinity Control Project Plan and Final Environmental Impact Statement." USDA. April 2013.

Appendix A: Photos of Canals

Photos included are courtesy of Todd Sherman of Wetland Resources and were included in the 2021 ULT Survey Report.

Figure 1: South Boneta Canal

Figure 2: Red Cap Extension Canal

Figure 3: Ditch Off Red Cap Canal

Figure 4: Gray Mountain Canal

Figure 5: Class C Canal

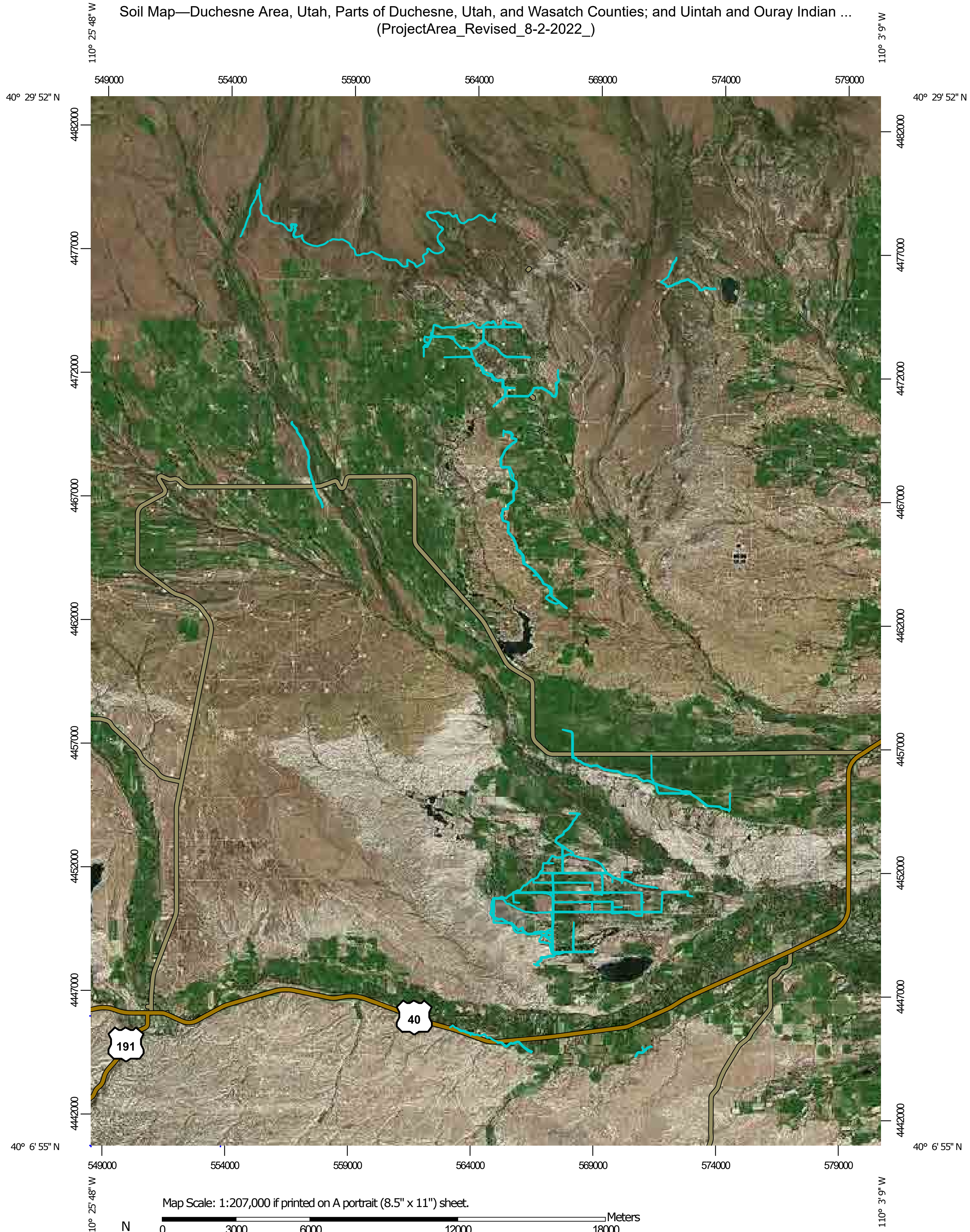
Figure 6: Coyote Canal

Figure 7: Coyote Canal Lower Reach

Figure 8: Class B Canal

Figure 9: Class B Canal

NRCS Soil Map Report



Map Scale: 1:207,000 if printed on A portrait (8.5" x 11") sheet.

Meters: 0, 3000, 6000, 12000, 18000

Feet: 0, 10000, 20000, 40000, 60000

N

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 12N WGS84

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Duchesne Area, Utah, Parts of Duchesne, Utah, and Wasatch Counties
Survey Area Data: Version 8, Sep 7, 2021

Soil Survey Area: Uintah and Ouray Indian Reservation, Utah
Survey Area Data: Version 4, Sep 8, 2021

Your area of interest (AOI) includes more than one soil survey area. These survey areas may have been mapped at different scales, with a different land use in mind, at different times, or at different levels of detail. This may result in map unit symbols, soil properties, and interpretations that do not completely agree across soil survey area boundaries.

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Jan 1, 1999—Dec 31, 2003

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
23	Blackston loam, 0 to 2 percent slopes	33.2	4.1%
24	Blackston loam, 0 to 6 percent slopes	2.9	0.4%
27	Boreham loam, 0 to 4 percent slopes	0.3	0.0%
52	Clapper-Montwel complex, 2 to 40 percent slopes	14.8	1.8%
61	Crib loam, 1 to 3 percent slopes	29.7	3.7%
94	Greybull-Utaline-Badland complex, 4 to 40 percent slopes	3.7	0.5%
108	Honlu sandy loam, 1 to 8 percent slopes	8.0	1.0%
120	Jenrid sandy loam, 0 to 4 percent slopes	0.0	0.0%
125	Lambsen loam, 1 to 3 percent slopes	0.3	0.0%
127	Lapoint-Pointla complex, 2 to 4 percent slopes	11.3	1.4%
147	Montwel-Hideout complex, 2 to 20 percent slopes	21.3	2.6%
162	Nolava-Nolava, wet complex, 0 to 2 percent slopes	6.2	0.8%
176	Parohtog loam, 0 to 2 percent slopes	0.0	0.0%
223	Stygee silty clay loam, 0 to 2 percent slopes	61.3	7.6%
225	Sugun sandy loam, 0 to 4 percent slopes	8.2	1.0%
242	Turzo loam, 0 to 4 percent slopes	110.7	13.7%
243	Turzo-Umbo complex, 0 to 2 percent slopes	16.2	2.0%
244	Turzo-Umbo complex, 2 to 4 percent slopes	1.4	0.2%
251	Umbo clay loam, 0 to 2 percent slopes	50.0	6.2%
252	Umbo silty clay loam, 0 to 2 percent slopes	29.4	3.6%
280	Yarts-Samala, very stony-Silka, frequently flooded complex, 0 to 40 percent slopes	13.0	1.6%
285	Water	14.6	1.8%

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
541	Gash, occasionally flooded-Fluvaquentic Haplustolls family, frequently flooded complex, 0 to 4 percent slopes	7.6	0.9%
ALB	Kaiar-Walknolls-Honlu complex, 2 to 15 percent slopes	5.4	0.7%
APC	Grunnell-Pariette-Persayo complex, 2 to 15 percent slopes	1.2	0.1%
BMD	Gapmesa-Mespun-Hideout complex, 0 to 20 percent slopes	18.6	2.3%
CeC	Cedarview, very stony-Lapoint complex, 2 to 10 percent slopes	9.4	1.2%
CnD	Odome-Casmos-Chipeta association, 1 to 10 percent slopes	12.0	1.5%
EwB	Effington-Rairdent complex, 1 to 8 percent slopes	10.8	1.3%
FaB	Rairdent clay loam, 0 to 8 percent slopes	1.3	0.2%
GME	Gerst-Clapper-Bullpen complex, 12 to 65 percent slopes, extremely stony	17.8	2.2%
HhD	Hanksville-Chipeta-Badland complex, 2 to 8 percent slopes	7.7	1.0%
MaB	Mikim loam, 3 to 5 percent slopes	7.1	0.9%
MbA	Breezy-Bunkwater-Hickerson complex, 1 to 6 percent slopes	1.5	0.2%
MpB	Billiesdraw-Altonah, extremely stony-Utahn complex, 1 to 8 percent slopes	11.6	1.4%
NcC	Neola, rubbly-Lapoint complex, 2 to 10 percent slopes	4.7	0.6%
SJC	Heldt silty clay loam, 2 to 8 percent slopes	40.5	5.0%
SKB	Sagers-Vickel complex, 0 to 8 percent slopes	0.9	0.1%
TKG	Paynecanal-Duffson complex, 10 to 50 percent slopes, extremely stony	2.8	0.3%
UdA	Stygee silty clay loam, wet, saline, 0 to 3 percent slopes	35.5	4.4%
VgA	Blonhue-Blackston complex, 0 to 4 percent slopes	0.3	0.0%

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
VKE	Chickenhill-Buddson family complex, 10 to 40 percent slopes, very stony	3.6	0.4%
ZaB	Gapmesa-Vonid-Kaiar complex, 2 to 8 percent slopes	75.8	9.4%
ZbB	Solirec-Hazmaz complex, 2 to 8 percent slopes	1.4	0.2%
ZcB	Bluehon-Lapoint-Hazmaz complex, 2 to 5 percent slopes	1.5	0.2%
Subtotals for Soil Survey Area		**715.7**	**88.4%**
Totals for Area of Interest		**809.5**	**100.0%**

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
NOTCOM	No Digital Data Available	93.7	11.6%
Subtotals for Soil Survey Area		**93.7**	**11.6%**
Totals for Area of Interest		**809.5**	**100.0%**

NRCS Farmland Classification Map Report and Farmland Conversion Impact Rating Forms

U.S. Department of Agriculture

FARMLAND CONVERSION IMPACT RATING

PART I *(To be completed by Federal Agency)*	Date Of Land Evaluation Request 9-3-2024
Name of Project East Duchesne Watershed Plan	Federal Agency Involved NRCS
Proposed Land Use Permanent access road - Site 4	County and State Duchesne, Utah
PART II *(To be completed by NRCS)*	Date Request Received By NRCS 9/3/24 — Person Completing Form: Terron Pickett

Does the site contain Prime, Unique, Statewide or Local Important Farmland? *(If no, the FPPA does not apply - do not complete additional parts of this form)*	YES ☑	NO ☐	Acres Irrigated 74660	Average Farm Size 1175
Major Crop(s) Forage (hay/haylage), all	Farmable Land In Govt. Jurisdiction Acres: 1055301 % n/a		Amount of Farmland As Defined in FPPA Acres: 10553 % n/a	
Name of Land Evaluation System Used Irrigated Alfalfa Productivity Index	Name of State or Local Site Assessment System		Date Land Evaluation Returned by NRCS 9-26-24	

PART III *(To be completed by Federal Agency)*		Alternative Site Rating			
		Site A	Site B	Site C	Site D
A. Total Acres To Be Converted Directly		0.7			
B. Total Acres To Be Converted Indirectly		0			
C. Total Acres In Site		0.7			
PART IV *(To be completed by NRCS)* Land Evaluation Information					
A. Total Acres Prime And Unique Farmland		0			
B. Total Acres Statewide Important or Local Important Farmland		0.7			
C. Percentage Of Farmland in County Or Local Govt. Unit To Be Converted		0.0001			
D. Percentage Of Farmland in Govt. Jurisdiction With Same Or Higher Relative Value		n/a			
PART V (To be completed by NRCS) Land Evaluation Criterion Relative Value of Farmland To Be Converted (Scale of 0 to 100 Points)		57			
PART VI *(To be completed by Federal Agency)* Site Assessment Criteria *(Criteria are explained in 7 CFR 658.5 b. For Corridor project use form NRCS-CPA-106)*	**Maximum Points**	Site A	Site B	Site C	Site D
1. Area In Non-urban Use	(15)	15			
2. Perimeter In Non-urban Use	(10)	10			
3. Percent Of Site Being Farmed	(20)	0			
4. Protection Provided By State and Local Government	(20)	0			
5. Distance From Urban Built-up Area	(15)	15			
6. Distance To Urban Support Services	(15)	10			
7. Size Of Present Farm Unit Compared To Average	(10)	0			
8. Creation Of Non-farmable Farmland	(10)	0			
9. Availability Of Farm Support Services	(5)	5			
10. On-Farm Investments	(20)	20			
11. Effects Of Conversion On Farm Support Services	(10)	0			
12. Compatibility With Existing Agricultural Use	(10)	0			
TOTAL SITE ASSESSMENT POINTS	160	75	0	0	0
PART VII ***(To be completed by Federal Agency)***					
Relative Value Of Farmland *(From Part V)*	100	57	0	0	0
Total Site Assessment *(From Part VI above or local site assessment)*	160	75	0	0	0
TOTAL POINTS ***(Total of above 2 lines)***	260	132	0	0	0

Site Selected: A	Date Of Selection 9-26-2024	Was A Local Site Assessment Used? YES ☐ NO ☑

Reason For Selection:

Site A is preferred based on project design. The farmlands are not subject to provisions of the Farmland Policy Protection Act as the total score is less than 160.

Name of Federal agency representative completing this form: Jenna Jorgensen	Date: 9-26-2024

(See Instructions on reverse side) **Form AD-1006 (03-02)**

U.S. Department of Agriculture

FARMLAND CONVERSION IMPACT RATING

PART I *(To be completed by Federal Agency)*	Date Of Land Evaluation Request 9-3-2024
Name of Project East Duchesne Watershed Plan	Federal Agency Involved NRCS
Proposed Land Use Permanent access road - Site 5	County and State Duchesne, Utah
PART II *(To be completed by NRCS)*	Date Request Received By NRCS 9-3-24 / Person Completing Form: Terron Pickett

Does the site contain Prime, Unique, Statewide or Local Important Farmland? *(If no, the FPPA does not apply - do not complete additional parts of this form)*	YES ☑ NO ☐	Acres Irrigated 74660	Average Farm Size 1175
Major Crop(s) Forage (hay/haylage), all	Farmable Land In Govt. Jurisdiction Acres: n/a % n/a	Amount of Farmland As Defined in FPPA Acres: n/a % n/a	
Name of Land Evaluation System Used Irrigated Alfalfa Productivity Index	Name of State or Local Site Assessment System	Date Land Evaluation Returned by NRCS 9-26-24	

PART III *(To be completed by Federal Agency)*		Site A	Site B	Site C	Site D
A. Total Acres To Be Converted Directly		0.5			
B. Total Acres To Be Converted Indirectly		0			
C. Total Acres In Site		0.5			
PART IV *(To be completed by NRCS)* Land Evaluation Information					
A. Total Acres Prime And Unique Farmland		0			
B. Total Acres Statewide Important or Local Important Farmland		0.5			
C. Percentage Of Farmland in County Or Local Govt. Unit To Be Converted		0.0000			
D. Percentage Of Farmland in Govt. Jurisdiction With Same Or Higher Relative Value		n/a			
PART V (To be completed by NRCS) Land Evaluation Criterion Relative Value of Farmland To Be Converted (Scale of 0 to 100 Points)		57			
PART VI *(To be completed by Federal Agency)* Site Assessment Criteria *(Criteria are explained in 7 CFR 658.5 b. For Corridor project use form NRCS-CPA-106)*	**Maximum Points**	Site A	Site B	Site C	Site D
1. Area In Non-urban Use	(15)	15			
2. Perimeter In Non-urban Use	(10)	10			
3. Percent Of Site Being Farmed	(20)	0			
4. Protection Provided By State and Local Government	(20)	0			
5. Distance From Urban Built-up Area	(15)	15			
6. Distance To Urban Support Services	(15)	10			
7. Size Of Present Farm Unit Compared To Average	(10)	0			
8. Creation Of Non-farmable Farmland	(10)	0			
9. Availability Of Farm Support Services	(5)	5			
10. On-Farm Investments	(20)	20			
11. Effects Of Conversion On Farm Support Services	(10)	0			
12. Compatibility With Existing Agricultural Use	(10)	0			
TOTAL SITE ASSESSMENT POINTS	160	75	0	0	0
PART VII ***(To be completed by Federal Agency)***					
Relative Value Of Farmland *(From Part V)*	100	57	0	0	0
Total Site Assessment *(From Part VI above or local site assessment)*	160	75	0	0	0
TOTAL POINTS *(Total of above 2 lines)*	260	132	0	0	0

Site Selected: A	Date Of Selection 9-26-2024	Was A Local Site Assessment Used? YES ☐ NO ☑

Reason For Selection:

Site A is preferred based on project design. The farmlands are not subject to provisions of the Farmland Policy Protection Act as the total score is less than 160.

Name of Federal agency representative completing this form: Jenna Jorgensen	Date: 9-26-2024

(See Instructions on reverse side) **Form AD-1006 (03-02)**

U.S. Department of Agriculture

FARMLAND CONVERSION IMPACT RATING

PART I *(To be completed by Federal Agency)*	Date Of Land Evaluation Request 9-3-2024
Name of Project East Duchesne Watershed Plan	Federal Agency Involved NRCS
Proposed Land Use Permanent access road - Site 6	County and State Duchesne, Utah
PART II *(To be completed by NRCS)*	Date Request Received By NRCS 9-3-24 / Person Completing Form: Terron Pickett

Does the site contain Prime, Unique, Statewide or Local Important Farmland? *(If no, the FPPA does not apply - do not complete additional parts of this form)*	YES ✓ NO ☐	Acres Irrigated 74660	Average Farm Size 1175
Major Crop(s) Forage (hay/haylage), all	Farmable Land In Govt. Jurisdiction Acres: n/a % n/a	Amount of Farmland As Defined in FPPA Acres: n/a % n/a	
Name of Land Evaluation System Used Irrigated Alfalfa Productivity Index	Name of State or Local Site Assessment System	Date Land Evaluation Returned by NRCS 9-26-24	

PART III *(To be completed by Federal Agency)*		Alternative Site Rating			
		Site A	Site B	Site C	Site D
A. Total Acres To Be Converted Directly		0.5			
B. Total Acres To Be Converted Indirectly		0			
C. Total Acres In Site		0.5			
PART IV *(To be completed by NRCS)* Land Evaluation Information					
A. Total Acres Prime And Unique Farmland		0			
B. Total Acres Statewide Important or Local Important Farmland		0.5			
C. Percentage Of Farmland in County Or Local Govt. Unit To Be Converted		0.0000			
D. Percentage Of Farmland in Govt. Jurisdiction With Same Or Higher Relative Value		n/a			
PART V (To be completed by NRCS) Land Evaluation Criterion Relative Value of Farmland To Be Converted (Scale of 0 to 100 Points)		54			
PART VI *(To be completed by Federal Agency)* Site Assessment Criteria *(Criteria are explained in 7 CFR 658.5 b. For Corridor project use form NRCS-CPA-106)*	**Maximum Points**	Site A	Site B	Site C	Site D
1. Area In Non-urban Use	(15)	15			
2. Perimeter In Non-urban Use	(10)	10			
3. Percent Of Site Being Farmed	(20)	0			
4. Protection Provided By State and Local Government	(20)	0			
5. Distance From Urban Built-up Area	(15)	15			
6. Distance To Urban Support Services	(15)	10			
7. Size Of Present Farm Unit Compared To Average	(10)	0			
8. Creation Of Non-farmable Farmland	(10)	0			
9. Availability Of Farm Support Services	(5)	5			
10. On-Farm Investments	(20)	20			
11. Effects Of Conversion On Farm Support Services	(10)	0			
12. Compatibility With Existing Agricultural Use	(10)	0			
TOTAL SITE ASSESSMENT POINTS	160	75	0	0	0
PART VII ***(To be completed by Federal Agency)***					
Relative Value Of Farmland *(From Part V)*	100	54	0	0	0
Total Site Assessment *(From Part VI above or local site assessment)*	160	75	0	0	0
TOTAL POINTS *(Total of above 2 lines)*	260	129	0	0	0

Site Selected: A	Date Of Selection 9-26-2024	Was A Local Site Assessment Used? YES ☐ NO ✓

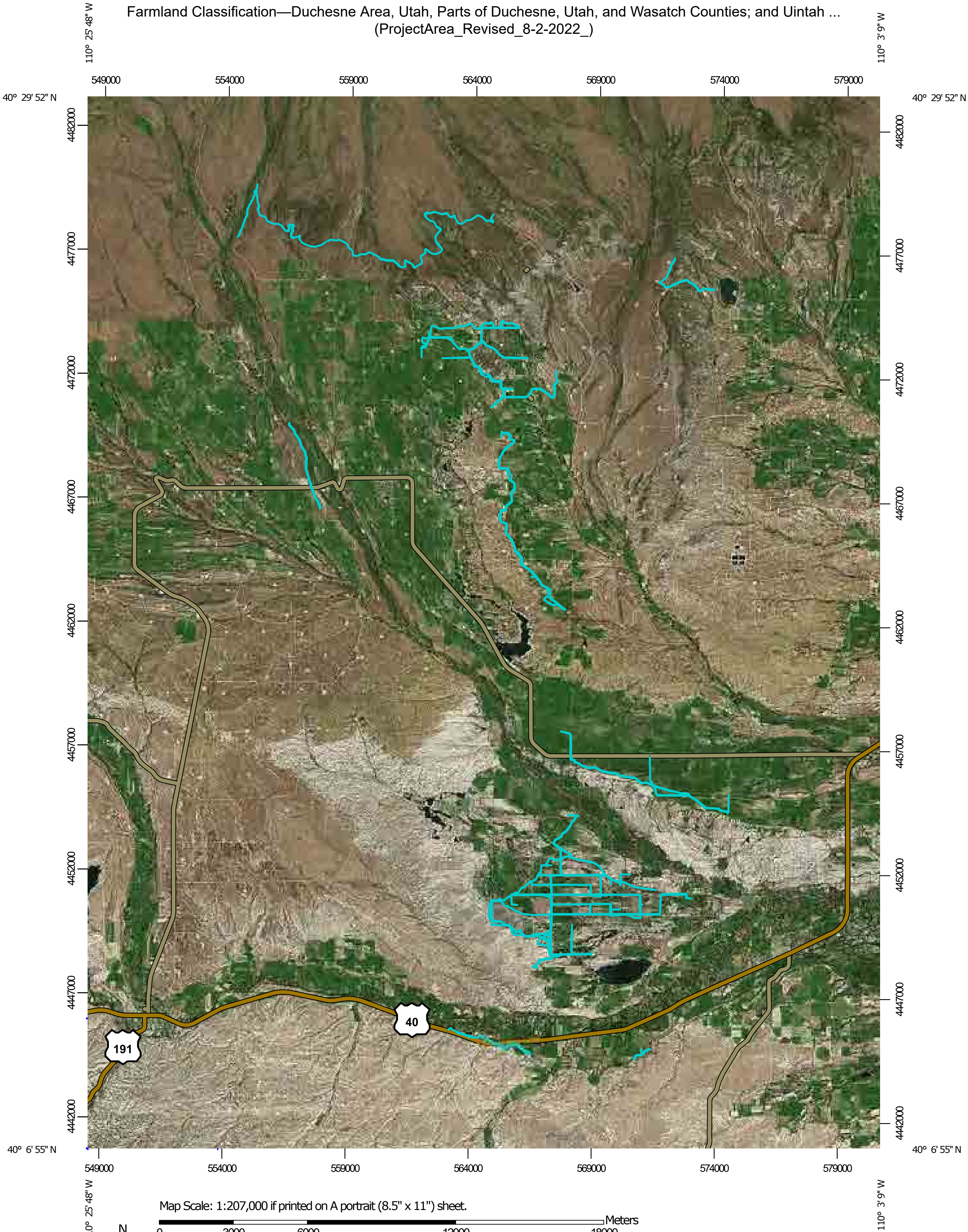
Reason For Selection:

Site A is preferred based on project design. The farmlands are not subject to provisions of the Farmland Policy Protection Act as the total score is less than 160.

Name of Federal agency representative completing this form: Jenna Jorgensen	Date: 9-26-2024

(See Instructions on reverse side) **Form AD-1006 (03-02)**

Farmland Classification—Duchesne Area, Utah, Parts of Duchesne, Utah, and Wasatch Counties; and Uintah ...
(ProjectArea_Revised_8-2-2022_)



Map Scale: 1:207,000 if printed on A portrait (8.5" x 11") sheet.

N

Meters: 0, 3000, 6000, 12000, 18000

Feet: 0, 10000, 20000, 40000, 60000

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 12N WGS84

MAP LEGEND

Area of Interest (AOI)

- Area of Interest (AOI)

Soils

Soil Rating Polygons

- Not prime farmland
- All areas are prime farmland
- Prime farmland if drained
- Prime farmland if protected from flooding or not frequently flooded during the growing season
- Prime farmland if irrigated
- Prime farmland if drained and either protected from flooding or not frequently flooded during the growing season
- Prime farmland if irrigated and drained
- Prime farmland if irrigated and either protected from flooding or not frequently flooded during the growing season
- Prime farmland if subsoiled, completely removing the root inhibiting soil layer
- Prime farmland if irrigated and the product of I (soil erodibility) x C (climate factor) does not exceed 60
- Prime farmland if irrigated and reclaimed of excess salts and sodium
- Farmland of statewide importance
- Farmland of statewide importance, if drained
- Farmland of statewide importance, if protected from flooding or not frequently flooded during the growing season
- Farmland of statewide importance, if irrigated
- Farmland of statewide importance, if drained and either protected from flooding or not frequently flooded during the growing season
- Farmland of statewide importance, if irrigated and drained
- Farmland of statewide importance, if irrigated and either protected from flooding or not frequently flooded during the growing season
- Farmland of statewide importance, if subsoiled, completely removing the root inhibiting soil layer
- Farmland of statewide importance, if irrigated and the product of I (soil erodibility) x C (climate factor) does not exceed 60
- Farmland of statewide importance, if irrigated and reclaimed of excess salts and sodium
- Farmland of statewide importance, if drained or either protected from flooding or not frequently flooded during the growing season
- Farmland of statewide importance, if warm enough, and either drained or either protected from flooding or not frequently flooded during the growing season
- Farmland of statewide importance, if warm enough
- Farmland of statewide importance, if thawed
- Farmland of local importance
- Farmland of local importance, if irrigated
- Farmland of unique importance
- Not rated or not available

Soil Rating Lines

- Not prime farmland
- All areas are prime farmland
- Prime farmland if drained
- Prime farmland if protected from flooding or not frequently flooded during the growing season
- Prime farmland if irrigated
- Prime farmland if drained and either protected from flooding or not frequently flooded during the growing season
- Prime farmland if irrigated and drained
- Prime farmland if irrigated and either protected from flooding or not frequently flooded during the growing season

- Prime farmland if subsoiled, completely removing the root inhibiting soil layer
- Prime farmland if irrigated and the product of I (soil erodibility) x C (climate factor) does not exceed 60
- Prime farmland if irrigated and reclaimed of excess salts and sodium
- Farmland of statewide importance
- Farmland of statewide importance, if drained
- Farmland of statewide importance, if protected from flooding or not frequently flooded during the growing season
- Farmland of statewide importance, if irrigated
- Farmland of statewide importance, if drained and either protected from flooding or not frequently flooded during the growing season
- Farmland of statewide importance, if irrigated and drained
- Farmland of statewide importance, if irrigated and either protected from flooding or not frequently flooded during the growing season
- Farmland of statewide importance, if subsoiled, completely removing the root inhibiting soil layer
- Farmland of statewide importance, if irrigated and the product of I (soil erodibility) x C (climate factor) does not exceed 60
- Farmland of statewide importance, if irrigated and reclaimed of excess salts and sodium
- Farmland of statewide importance, if drained or either protected from flooding or not frequently flooded during the growing season
- Farmland of statewide importance, if warm enough, and either drained or either protected from flooding or not frequently flooded during the growing season
- Farmland of statewide importance, if warm enough
- Farmland of statewide importance, if thawed
- Farmland of local importance
- Farmland of local importance, if irrigated
- Farmland of unique importance
- Not rated or not available

Soil Rating Points

- Not prime farmland
- All areas are prime farmland
- Prime farmland if drained
- Prime farmland if protected from flooding or not frequently flooded during the growing season
- Prime farmland if irrigated
- Prime farmland if drained and either protected from flooding or not frequently flooded during the growing season
- Prime farmland if irrigated and drained
- Prime farmland if irrigated and either protected from flooding or not frequently flooded during the growing season
- Prime farmland if subsoiled, completely removing the root inhibiting soil layer
- Prime farmland if irrigated and the product of I (soil erodibility) x C (climate factor) does not exceed 60
- Prime farmland if irrigated and reclaimed of excess salts and sodium
- Farmland of statewide importance
- Farmland of statewide importance, if drained
- Farmland of statewide importance, if protected from flooding or not frequently flooded during the growing season
- Farmland of statewide importance, if irrigated

- Farmland of statewide importance, if drained and either protected from flooding or not frequently flooded during the growing season
- Farmland of statewide importance, if irrigated and drained
- Farmland of statewide importance, if irrigated and either protected from flooding or not frequently flooded during the growing season
- Farmland of statewide importance, if subsoiled, completely removing the root inhibiting soil layer
- Farmland of statewide importance, if irrigated and the product of I (soil erodibility) x C (climate factor) does not exceed 60
- Farmland of statewide importance, if irrigated and reclaimed of excess salts and sodium
- Farmland of statewide importance, if drained or either protected from flooding or not frequently flooded during the growing season
- Farmland of statewide importance, if warm enough, and either drained or either protected from flooding or not frequently flooded during the growing season
- Farmland of statewide importance, if warm enough
- Farmland of statewide importance, if thawed
- Farmland of local importance
- Farmland of local importance, if irrigated
- Farmland of unique importance
- Not rated or not available

Water Features

- Streams and Canals

Transportation

- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background

- Aerial Photography

The soil surveys that comprise your AOI were mapped at 1:24,000.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Duchesne Area, Utah, Parts of Duchesne, Utah, and Wasatch Counties
Survey Area Data: Version 8, Sep 7, 2021

Soil Survey Area: Uintah and Ouray Indian Reservation, Utah
Survey Area Data: Version 4, Sep 8, 2021

Your area of interest (AOI) includes more than one soil survey area. These survey areas may have been mapped at different scales, with a different land use in mind, at different times, or at different levels of detail. This may result in map unit symbols, soil properties, and interpretations that do not completely agree across soil survey area boundaries.

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Jan 1, 1999—Dec 31, 2003

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Farmland Classification

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
23	Blackston loam, 0 to 2 percent slopes	Prime farmland if irrigated	33.2	4.1%
24	Blackston loam, 0 to 6 percent slopes	Not prime farmland	2.9	0.4%
27	Boreham loam, 0 to 4 percent slopes	Prime farmland if irrigated	0.3	0.0%
52	Clapper-Montwel complex, 2 to 40 percent slopes	Not prime farmland	14.8	1.8%
61	Crib loam, 1 to 3 percent slopes	Not prime farmland	29.7	3.7%
94	Greybull-Utaline-Badland complex, 4 to 40 percent slopes	Not prime farmland	3.7	0.5%
108	Honlu sandy loam, 1 to 8 percent slopes	Not prime farmland	8.0	1.0%
120	Jenrid sandy loam, 0 to 4 percent slopes	Not prime farmland	0.0	0.0%
125	Lambsen loam, 1 to 3 percent slopes	Farmland of statewide importance	0.3	0.0%
127	Lapoint-Pointla complex, 2 to 4 percent slopes	Farmland of statewide importance	11.3	1.4%
147	Montwel-Hideout complex, 2 to 20 percent slopes	Not prime farmland	21.3	2.6%
162	Nolava-Nolava, wet complex, 0 to 2 percent slopes	Prime farmland if irrigated	6.2	0.8%
176	Parohtog loam, 0 to 2 percent slopes	Farmland of statewide importance	0.0	0.0%
223	Stygee silty clay loam, 0 to 2 percent slopes	Not prime farmland	61.3	7.6%
225	Sugun sandy loam, 0 to 4 percent slopes	Not prime farmland	8.2	1.0%
242	Turzo loam, 0 to 4 percent slopes	Not prime farmland	110.7	13.7%
243	Turzo-Umbo complex, 0 to 2 percent slopes	Prime farmland if irrigated	16.2	2.0%
244	Turzo-Umbo complex, 2 to 4 percent slopes	Prime farmland if irrigated	1.4	0.2%
251	Umbo clay loam, 0 to 2 percent slopes	Farmland of statewide importance	50.0	6.2%
252	Umbo silty clay loam, 0 to 2 percent slopes	Farmland of statewide importance	29.4	3.6%

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
280	Yarts-Samala, very stony-Silka, frequently flooded complex, 0 to 40 percent slopes	Farmland of statewide importance	13.0	1.6%
285	Water	Not prime farmland	14.6	1.8%
541	Gash, occasionally flooded-Fluvaquentic Haplustolls family, frequently flooded complex, 0 to 4 percent slopes	Not prime farmland	7.6	0.9%
ALB	Kaiar-Walknolls-Honlu complex, 2 to 15 percent slopes	Not prime farmland	5.4	0.7%
APC	Grunnell-Pariette-Persayo complex, 2 to 15 percent slopes	Not prime farmland	1.2	0.1%
BMD	Gapmesa-Mespun-Hideout complex, 0 to 20 percent slopes	Not prime farmland	18.6	2.3%
CeC	Cedarview, very stony-Lapoint complex, 2 to 10 percent slopes	Not prime farmland	9.4	1.2%
CnD	Odome-Casmos-Chipeta association, 1 to 10 percent slopes	Not prime farmland	12.0	1.5%
EwB	Effington-Rairdent complex, 1 to 8 percent slopes	Not prime farmland	10.8	1.3%
FaB	Rairdent clay loam, 0 to 8 percent slopes	Not prime farmland	1.3	0.2%
GME	Gerst-Clapper-Bullpen complex, 12 to 65 percent slopes, extremely stony	Not prime farmland	17.8	2.2%
HhD	Hanksville-Chipeta-Badland complex, 2 to 8 percent slopes	Not prime farmland	7.7	1.0%
MaB	Mikim loam, 3 to 5 percent slopes	Not prime farmland	7.1	0.9%
MbA	Breezy-Bunkwater-Hickerson complex, 1 to 6 percent slopes	Not prime farmland	1.5	0.2%
MpB	Billiesdraw-Altonah, extremely stony-Utahn complex, 1 to 8 percent slopes	Not prime farmland	11.6	1.4%
NcC	Neola, rubbly-Lapoint complex, 2 to 10 percent slopes	Not prime farmland	4.7	0.6%
SJC	Heldt silty clay loam, 2 to 8 percent slopes	Not prime farmland	40.5	5.0%

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
SKB	Sagers-Vickel complex, 0 to 8 percent slopes	Not prime farmland	0.9	0.1%
TKG	Paynecanal-Duffson complex, 10 to 50 percent slopes, extremely stony	Not prime farmland	2.8	0.3%
UdA	Stygee silty clay loam, wet, saline, 0 to 3 percent slopes	Prime farmland if irrigated and reclaimed of excess salts and sodium	35.5	4.4%
VgA	Blonhue-Blackston complex, 0 to 4 percent slopes	Farmland of statewide importance	0.3	0.0%
VKE	Chickenhill-Buddson family complex, 10 to 40 percent slopes, very stony	Not prime farmland	3.6	0.4%
ZaB	Gapmesa-Vonid-Kaiar complex, 2 to 8 percent slopes	Not prime farmland	75.8	9.4%
ZbB	Solirec-Hazmaz complex, 2 to 8 percent slopes	Not prime farmland	1.4	0.2%
ZcB	Bluehon-Lapoint-Hazmaz complex, 2 to 5 percent slopes	Not prime farmland	1.5	0.2%
Subtotals for Soil Survey Area			**715.7**	**88.4%**
Totals for Area of Interest			**809.5**	**100.0%**

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
NOTCOM	No Digital Data Available		93.7	11.6%
Subtotals for Soil Survey Area			**93.7**	**11.6%**
Totals for Area of Interest			**809.5**	**100.0%**

Description

Farmland classification identifies map units as prime farmland, farmland of statewide importance, farmland of local importance, or unique farmland. It identifies the location and extent of the soils that are best suited to food, feed, fiber, forage, and oilseed crops. NRCS policy and procedures on prime and unique farmlands are published in the "Federal Register," Vol. 43, No. 21, January 31, 1978.

Rating Options

Aggregation Method: No Aggregation Necessary

Biological Assessment

Biological Assessment
Amendment 1

East Duchesne Watershed Plan

Duchesne County, Utah

Prepared By:

Jones & DeMille Engineering
1535 South 100 West
Richfield, Utah 84701
(435) 896-8266

Prepared For:

U.S. Department of Agriculture
Natural Resources Conservation Service
125 South State Street Room 6416
Salt Lake City, Utah 84138
(801) 524-4560

January 27, 2025

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Appendices

Appendix A. Maps

Appendix B. Technical Memo: Water Budget & Depletion

Appendix C. USFWS Official Species List

Appendix D. Survey Reports

1. Introduction

This Biological Assessment (BA) analyzes the potential effects to federally listed species and designated critical habitat from the implementation of the Eastern Duchesne Watershed Plan project in Duchesne County, Utah. The Duchesne County Water Conservancy District (DCWCD), the project sponsor, proposes to provide agricultural water management improvements for irrigation water delivery efficiency and water conservation in the existing irrigation systems of the Eastern Duchesne Watershed.

Much of the irrigation infrastructure within the Eastern Duchesne Watershed was constructed over 100 years ago to support agricultural activities. The watershed currently supports approximately 88,236 acres of cropland, and the existing irrigation distribution systems consist primarily of unlined open canals. Flood irrigation practices, irrigation delivery methods, and outdated infrastructure in the watershed have resulted in substantial water losses, primarily through canal seepage.

The Natural Resources Conservation Service (NRCS) is providing technical and financial assistance to the DCWCD for the project, and is the lead federal agency.

The project occurs on private and Uinta and Ouray Indian Reservation lands; the Bureau of Indian Affairs (BIA) is not a cooperating agency but will likely adopt the environmental compliance documentation prepared by the NRCS for authorization of project easements. Project activities will also likely require Nationwide or Individual Permits from the U.S. Army Corps of Engineers (USACE). This BA has been prepared for the NRCS to identify the project's potential impacts on federally listed species, including critical habitat for such, and make an effects determination in accordance with the Endangered Species Act (ESA) of 1973 (7 U.S.C. 136, 16 U.S.C. 1531 et seq.), as amended.

1.1. Consultation to Date

- October 31, 2020 - Jenna Jorgensen (Jones and DeMille Engineering; JDE) emailed Rita Reisor (U.S. Fish and Wildlife Service [USFWS]) the Ute ladies'-tresses (ULT; *Spiranthes diluvialis*) survey report and results from protocol surveys in 2020.
- November 24, 2020 – Derek Hamilton (NRCS) and Jenna Jorgensen met virtually with Rita to discuss the ULT survey results and compensatory mitigation approaches.
- January 13, 2022 – Rita and Jenna met virtually to collaborate on the BA content, identify appropriate conservation measures, and discuss compensatory mitigation for the project.
- June 13, 2023 – Rita , Derek, and Jenna met virtually to discuss compensatory mitigation for the project.
- February 28, 2024 – Derek and Jenna met virtually with George Weekley and Kate Lunz to discuss depletion impacts.
- August 6, 2024 – NRCS submitted Final BA to USFWS

2. Project Description

2.1. Project Location

The proposed project is located in eastern Duchesne County. More specifically, the project occurs within the following sections within the Uintah Special Base and Meridian (see Map 1 in Appendix A).

T1N, R4W, Sections 27, 28, 36

T1N, R3W, Sections 29, 30, 31

T1N, R2W, Section 31

T1S, R4W, Sections 21, 22, 27, 34

T1S, R3W, Sections 7, 8, 9, 15, 16, 17, 18, 20, 21, 22, 28, 33

T1S, R2W, Sections 5, 6

T2S, R3W, Sections 4, 9, 10, 15, 34

T3S, T3W, Sections 1, 2, 10, 11, 14, 15, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 34, 35

T3S, T2W, Sections 6, 7, 8, 19, 20, 30

T4S, T3W, Sections 5, 8, 9, 12,

T4S, R2W, Section 7

2.2. Project Details

The project consists of piping or lining existing irrigation canals. Project activities and disturbance would generally occur within a 100-foot-wide area associated with each linear project feature. Construction access would follow the existing irrigation company access roads, where provided. Improvements to access roads (e.g., grubbing, grading, placement of gravel) or new access roads would be required within the existing irrigation company rights-of-way as needed, to provide appropriate construction equipment/vehicle access. Staging would occur within the irrigation company rights-of-way as needed. Areas temporarily disturbed from staging would be restored after construction. New access roads would be left in place, where applicable, to maintain appropriate maintenance access.

Yellowstone Feeder Canal

Approximately 13,926 linear feet (2.6 miles) of the Yellowstone Feeder Canal would be lined in ten separate sections. The treated sections would be lined from top of bank to top of bank with a geomembrane liner, then covered with a minimum of 3 inches of shotcrete or concrete. Project activities would occur outside of irrigation season. These measures would be constructed between December and April of 2025 and 2026, outside of the irrigation delivery season or storage flow windows.

Figure 2-1: Yellowstone Feeder Canal (JDE, 2016)

Coyote Canal

Approximately 4,413 linear feet (0.8 miles) of pipeline would be installed to replace the open-channel canal. The diversion structure would be replaced and a dissipation structure would be constructed at the pipe outlet. Approximately 477 linear feet of canal would be graded and stabilized by placement of riprap to reduce erosion. These measures would be constructed over one season from March to May of 2025, outside of the irrigation season.

Figure 2-2: Coyote Canal (Todd Sherman, 2021)

South Boneta Canal

Approximately 12,833 feet (2.4 miles) of pipeline would be installed to replace the open-channel South Boneta Canal. A new diversion structure would be constructed on the Lake Fork River. These measures would be constructed over one season from November of 2024 to April of 2025, outside of the irrigation season.

Figure 2-3: South Boneta Canal (Todd Sherman, 2021)

DGIC Class B Canal

Approximately 79,293 linear feet (15.0 miles) of pipeline would be installed to replace the DGIC Class B Canal and associated ditches. The Class B Canal includes the Bluebell Lateral Canal, F Canal, and I Canal (north and south ditches). Approximately 14.0 miles of canal would be dewatered by operation of the pipeline. Three new pipe inlet structures would be constructed at the pipeline intakes and a control structure would be installed at one pipeline split location. Four pressure reducing valves (PRVs) would be installed on the pipeline. These measures would be constructed over two seasons, outside of the irrigation season, from November 2025 through April 2026.

Figure 2-4: Class B Canal (Todd Sherman, 2021)

DGIC Class C Canal

Project activities consist of installing approximately 33,292 linear feet (6.3 miles) of pipeline to replace 6.0 miles of the DGIC Class C Canal. The pipeline would largely be buried within the canal channel, and the canal would be dewatered by operation of the pipeline. These measures would be constructed over a single season from October of 2025 to April of 2026, outside of the irrigation season.

Figure 2-5: Class C Canal (Todd Sherman, 2021)

Red Cap Extension

Approximately 106,161 linear feet (20.1 miles) of pipeline would be installed to replace 25.5 miles of canals and ditches. A new pipe inlet structure would be constructed at the pipeline intake and the adjoining wasteway reconstructed to stabilize the canal. These measures would be constructed over two seasons from October of 2025 to April of 2026, outside of the irrigation season.

Figure 2-6: Red Cap Extension Canal (Todd Sherman, 2021)

Grey Mountain Canal

Approximately 10,475 feet (2.0 miles) of the Grey Mountain Canal would be lined in three sections. The treated sections would be lined from top of bank to top of bank with a geomembrane liner, then covered with a minimum of 3 inches of shotcrete or concrete. These measures would be constructed over a single season from mid-October of 2025 to April of 2026, outside of the irrigation season.

Figure 2-7: Gray Mountain Canal (Todd Sherman, 2021)

2.3. Water Changes

The canals lose an estimated 46,702 acre-feet of water to seepage annually; phreatophytes consume canal seepage and reduce return flows to the river. Based on estimates from other irrigation projects in the Uinta Basin, phreatophytes are expected to consume 60 percent, or 28,021 acre-feet, of the seepage. Seepage that is not consumed percolates through adjacent soils and mobilizes naturally occurring salts, which are eventually carried downstream to the Colorado River.

The project would reduce canal seepage by an estimated 41,190 acre-feet annually (88 percent) and would reduce the annual salt load to the Colorado River by 5,394 tons annually. The reduced seepage would also eliminate approximately 24,714 acre-feet of annual losses due to phreatophyte consumption; the loss of these consumptive uses would be considered an accretion to Colorado River flows.

The project would allow for increased consumptive use by crops due to an extended irrigation season and additional irrigated acreage; these volumes are estimated to be 13,547 and 5,443 acre-feet annually, respectively. These consumptive uses would be considered depletions to Colorado River flows.

The estimates for accretions and depletions due to implementation of the project are summarized in Table 2-1.

Table 2-1. Water change estimates for projects in the Eastern Duchesne Watershed

Impact type	Estimated Accretion (acre-feet)
Current phreatophyte consumptive use eliminated by project measures	24,714
Projected crop consumptive use from extended season	-13,547
Projected crop consumptive use from additional irrigated acreage	-5,443
Total	**5,724**

The project would result in net water accretions to the Colorado River of approximately 5,724 acre-feet annually. Other changes in return flows were considered, such as those from reduced diversions, transition from flood irrigation to sprinklers, and metering; however, estimates were not included as these possible actions are not guaranteed. Additional details about the water change analysis is provided in the *Technical Memo: Water Budget & Depletion* in Appendix B.

2.4. Maintenance

Maintenance includes performance of work, preventing deterioration of facility components, and repairing damage or replacing the facility components as needed. Repairing damages to completed facilities caused by normal deterioration, droughts, flooding, or vandalism is considered maintenance. Maintenance includes both routine and as-needed measures.

2.5. Conservation Measures

The following conservation measures are proposed:

1. Three years of protocol surveys will be completed where possible, prior to any ground disturbing activity. Areas without three years of survey will be assumed occupied.
2. Project design will minimize impacts to occupied and suitable ULT habitat as much as practicable while still accomplishing project purposes. Staging will not occur within suitable ULT habitat.

3. Where ULT occur within 300 feet of temporary disturbance, project activities will occur outside of flowering season to avoid impacts due to dust and vibration.
4. In areas of pipeline installation through suitable or occupied ULT habitat during conditions when the ground is wet, geotextile matting (or similar product) will be used as a barrier between heavy equipment and the soil surface to reduce rutting from the equipment.
5. In areas of pipeline installation through suitable or occupied ULT habitat that would not be directly dewatered, topsoil will be excavated and stockpiled separately from subsoil in a manner to maintain vegetation, and restored to pre-construction conditions as soon as practicable.
   a. Stockpiled topsoil will be prevented from drying out and killing the vegetation by spraying with water, covering with wet permeable material, or other similar methods to maintain viable plant stock.
6. Soils will not be stockpiled or disposed of in suitable or occupied habitat.
7. Pipelines may be installed by boring under the surface of occupied ULT habitat if necessary to avoid disturbance during flowering season.
8. To avoid unnecessary disturbance to suitable ULT habitat, flagging or machine control technology will be used to assist in the navigation of equipment.
9. All project personnel will be educated about the sensitive nature of the habitat, instructed to stay within the authorized project limits, and instructed on the specific avoidance and minimization measures implemented.
10. Disturbed areas will be seeded with a native mix, or a USFWS approved mix, appropriate for the respective land use and soil conditions.
11. Equipment will be cleaned to remove noxious weeds/seeds and petroleum products prior to accessing project sites.
12. Fueling of machinery will occur in confined, designated upland areas to prevent spillage into waterways and wetlands. All fueling areas will have spill cleanup kits available.
13. Fill materials will be free of waste, pollutants, and noxious weeds and seeds.
14. Disturbed areas will be monitored for noxious weeds for three years following construction. Noxious weeds discovered in suitable habitat within and adjacent to the disturbed areas will be controlled with herbicides or manual treatments. The following conditions apply to the use of herbicides:
   a. No herbicide shall be applied within 2,500 feet of suitable or occupied ULT habitat during the blooming period (July-September).
   b. A Pesticide Use Permit (PUP) shall be approved through authorizing federal or State agency.
   c. No aerial or broadcast herbicide treatments shall be applied for vegetation management within 2,500 feet of suitable or occupied ULT habitat.
   d. For noxious weed control within 2,500 feet of suitable or occupied Ute ladies'-tresses habitat, manual spot treatments (i.e. backpack sprayers) shall be used.
   e. Treatments shall not be done when wind speeds exceed 6 miles per hour.
   f. Drift reducing agents shall be used when practical.
   g. A reduced application rate shall be used.
   h. Pump pressure shall be reduced, per label instructions.
   i. Droplet size shall be increased to the largest size possible while still effectively covering the target vegetation. This could be accomplished using larger nozzles or reduced pressure.

j. Herbicides shall be stored in spill proof containers away from special status plant habitats.
k. Herbicide containers, such as backpack sprayers, will be filled off-site and with secondary spill containment in place (such as a plastic bucket or tray).

15. Only water (no chemicals, reclaimed production water, or oil field brine) will be used for dust abatement measures within suitable habitat.
16. Because vegetation clearing will likely occur during migratory bird breeding and nesting season (February 1 – August 31), a migratory bird survey will be conducted prior to construction activities. The result of the survey will dictate any timing and spatial stipulations to be implemented per the Utah Field Office Guidelines for Raptor Protection from Human and Land Use Disturbances (Romin and Muck 2002).

2.6. General Setting

The project is located in the eastern portion of Duchesne County, within the Uinta Mountains and Uinta Basin sections of the Colorado Plateau physiographic province. Elevations of the project area range from approximately 5,100 feet to 7,200 feet asl. The linear project features cross foothills and valleys that are dominated by agricultural development. Russian olive (*Elaeagnus angustifolia*) is the predominant tree species in the valleys where water is present, and juniper (*Juniperus osteosperma*) is the predominant tree species in foothill areas.

3. Species Considered

3.1. Species that May Be Present

An official species list was obtained from the Information for Planning and Consultation (IPaC) system on May 11, 2024 (see Appendix C). The species listed as threatened or endangered that “may be present in the area of the proposed action” are listed in Table 3-1 below.

Table 3-1. Listed species that may be present in the area of the proposed action, and rationale for further consideration in this Biological Assessment

Species	Status	Species Likely Occurrence in the Project Area and Consideration in this BA
Mexican spotted owl (*Strix occidentalis lucida*)	Threatened	Not considered. The nearest critical habitat for this species is located approximately 26 miles away. The nearest modeled habitat (2000 model) is over 6 miles away. Suitable canyon nesting habitat (USFWS 2012) does not occur within 1 mile of the project area. There would be no effect to Mexican spotted owl.
Yellow-billed cuckoo (*Coccyzus americanus*)	Threatened	Not considered. The nearest critical habitat for this species is located approximately 6 miles away. Suitable riparian nesting habitat of appropriate patch size and configuration below 8,500 feet in elevation (USFWS 2017) does not occur within one-half (0.5) mile of the project area. There would be no effect to yellow-billed cuckoo.

Species	Status	Species Likely Occurrence in the Project Area and Consideration in this BA
Bonytail chub (*Gila elegans*)	Endangered	**Considered**. The nearest critical habitat for this species is approximately 44 miles downstream, in the Green River. Impacts to water quantity and quality would affect occupied habitat for bonytail chub.
Colorado pikeminnow (*Ptychocheilus lucius*)	Endangered	**Considered**. The nearest critical habitat for this species is at least 11 miles downstream, in the Green River. Impacts to water quantity and quality would affect occupied habitat for Colorado pikeminnow.
Humpback chub (*Gila cypha*)	Threatened	**Considered**. The nearest critical habitat for this species is approximately 44 miles downstream, in the Green River. Impacts to water quantity and quality would affect occupied habitat for humpback chub.
Razorback sucker (*Xyrauchen texanus*)	Endangered	**Considered**. The nearest critical habitat for this species is at least 11 miles downstream, in the Green River. Impacts to water quantity and quality would affect occupied habitat for razorback sucker.
Monarch butterfly (*Danaus plexippus*)	Proposed	**Considered**. Suitable habitat that provides nectar sources (USFWS 2020a) is present in the project area.
Pariette cactus (*Sclerocactus brevispinus*)	Threatened	Not considered. The species' current known range is over 6 miles away from the project area (USFWS 2022a). Suitable habitat consisting of fine gravelly hills on clay badlands (USFWS 2020b) does not occur within the project area. There would be no effect to Pariette cactus.
Uinta Basin hookless cactus (*Sclerocactus wetlandicus*)	Threatened	Not considered. The species' current known range is over 6 miles away from the project area (USFWS 2022b). Suitable habitat consisting of cobble- and gravel-derivative soils (USFWS 2020b) do not occur within the project area. There would be no effect to Uinta Basin hookless cactus.
Ute ladies'-tresses (ULT; *Spiranthes diluvialis*)	Threatened	**Considered**. The species is present in the project area.

The NRCS has determined that there would be no effect to the following species as a result of the proposed action: Mexican spotted owl, yellow-billed cuckoo, Pariette cactus, and Uinta Basin hookless cactus.

3.2. Critical Habitat

There is no designated critical habitat within or adjacent to the project area, but critical habitat for native Colorado River fish species would be affected by water changes associated with the proposed action.

3.3. ULT Survey Results

Survey reports from 2020, 2021, 2022, and 2023 are attached as Appendix D and summarized here.

Wetland Resources (Todd Sherman) conducted protocol surveys for ULT from August 24 through August 30, 2020; the survey covered areas of the project that occurred on private property and a 300-foot buffer; tribal reservation lands were not surveyed in 2020 due to access permit requirements. Plants and suitable habitat were identified on the South Boneta Canal and the DGIC Class B Canal; suitable habitat but no plants were identified in the DGIC Class C Canal. Suitable habitat was not identified in association with the Coyote Canal or the Gray Mountain Canal. Suitable habitat and plants were identified along the Lake Fork River at the north end of the South Boneta Canal.

Between August 2 and August 27, 2021, Wetland Resources surveyed the suitable habitat that was identified in 2020 and the project areas and a 300-foot buffer on tribal reservation lands. Additional suitable habitat was identified in association with the Yellowstone Feeder Canal, the DGIC Class B Canal, and the Red Cap Extension (Arcadia Farms) irrigation system, but plants were only found on the South Boneta Canal and the DGIC Class B Canal. Suitable habitat was not identified in association with the Coyote Canal or the Gray Mountain Canal. Additional plants were identified along the Lake Fork River.

Between August 2 and August 26, 2022, Wetland Resources surveyed the suitable habitat that was identified in 2020 and 2021, as well as suitable habitat associated with canals that would be abandoned with implementation of the project. Additional suitable habitat was identified in association with the DGIC Class B Canal and the Red Cap Extension (Arcadia Farms) irrigation system. Plants were only found in the survey areas associated with the South Boneta Canal and the DGIC Class B Canal.

Between August 7 and August 30, 2023, Wetland Resources surveyed the suitable habitat that had not been surveyed in 2020. This included the Yellowstone Feeder Canal, portions of the DGIC Class B Canal, the tribal reservation portion of the Class C Canal, and the Red Cap Extension (Arcadia Farms). ULT were found in association with the DGIC Class B Canal.

Survey results are summarized in Table 3-2. Note that the Gray Mountain Canal and Coyote Canal were not included because suitable habitat does not occur in association with those canals or the 300-foot buffer.

Table 3-2. ULT Survey Results

Project Measure	Suitable Habitat Surveyed (acres)	Number of Plants Identified				
		2020	2021	2022	2023	Total
Yellowstone Feeder Canal	0.2	-	0	0	0	**0**
South Boneta Canal	16.7	0	6	53	-	**59**
South Boneta Canal--Lake Fork River	0.7	4	19	0	-	**23**
DGIC Class B Canal--South	31.8	6	0	41	-	**47**
DGIC Class B Canal--North	96.3	-	374	868	426	**1,668**
DGIC Class B Canal--Abandoned	5.4	-	-	49	*	**49**
DGIC Class C Canal--Section 1	7.6	0	0	0	-	**0**
DGIC Class C Canal--Section 2	3.1	-	0	0	0	**0**
Red Cap Extension	67.0	-	0	0	0	**0**
Red Cap Extension--Abandoned	0.7	-	-	0	0	**0**
Total	**229.5**	**10**	**399**	**1,011**	**426**	**1,846**

*Access denied by landowner

3.4. Species Carried Forward

Downstream habitat for native Colorado River fish species would be impacted by changes in water quantity and quality. Monarch butterfly was identified as likely to occur in the project area due to the presence of suitable vegetation, and ULT are known to occur within the area. Therefore, these species are being carried forward in this BA for further analysis.

Bonytail chub, Colorado pikeminnow, humpback chub, and razorback sucker

Habitat for native Colorado River fish species is largely a function of river flow and temperature regimes; the species are adapted to the hydrologic regime of the Colorado River. Hydrology affects factors such as food supply, water quality, habitat fragmentation, and suitability for predator or competition species (USFWS 1998). These species do not occur within the project area, but occupy downstream waters in the Green and Colorado rivers, where critical habitat is also designated. Colorado pikeminnow, bonytail, and razorback sucker have also been documented in the Duchesne River (USFWS 2023a).

Monarch butterfly

The Monarch butterfly is currently proposed for listing under the ESA. The insect is migratory in western North America, and overwintering occurs along the Pacific Coast. Monarch butterflies lays eggs and feed on milkweed (*Asclepias* spp.), and feed on other nectar-producing plants during breeding and migration (USFWS 2020a).

Ute ladies'-tresses

ULT is a perennial orchid that is known to occur in natural landscape features such as moist meadows associated with perennial stream terraces, floodplains, oxbows, seasonally flooded river terraces, sub irrigated or spring-fed abandoned stream channels and valleys, and lake shores; the species also occurs in man-made features such as irrigation canals, berms, levees, irrigated meadows, excavated gravel pits, roadside barrow pits, reservoirs, and other human-modified wetlands. Known populations occur at elevations between 4,300 and 7,000 feet above sea level (Fertig et al. 2005). The species is currently believed or known to occur in Arizona, Colorado, Idaho, Montana, Nebraska, Nevada, South Dakota, Utah, Washington, and Wyoming (USFWS 2023b).

4. Project Action Area

The Action Area for Colorado River fish species consists of all project features and extends to waters within the 246,000-square mile Colorado River Basin.

The Action Area for the monarch butterfly and ULT consists of all project features and extends 300 feet beyond the disturbance limits to address potential indirect impacts of dust and vibration. It also includes canals that would be dewatered by the proposed action and 300 feet beyond to address impacts of dewatering. This Action Area encompasses approximately 3,859 acres, and includes numerous canals and ditches, irrigated fields and pastures, roadways, residential properties, and undeveloped uplands vegetated with juniper and other shrub-steppe species.

Ongoing activities within the Action Areas include agricultural development, residential development, and public infrastructure construction and maintenance.

5. Effects Analysis

5.1. Direct and Indirect Effects – Native Colorado River Fish

Habitat

Construction and maintenance of the project would not affect occupied and critical habitats occupied by native Colorado River fish; operation of the project measures would result in changes to water quantity and quality that would impact occupied and critical habitats in the Duchesne, Green, and Colorado rivers. There would be a net accretion of 5,724 acre-feet in return flows to the rivers as a result of the project. The reduction is seepage would also result in a reduction of salt loading into the Colorado River by an estimated 5,394 tons annually. These impacts would result in improved water quantity and quality that would improve occupied and critical habitat quality for native fish in the Duchesne, Green, and Colorado rivers.

Species

No native Colorado River fish are expected to be killed or injured as a direct result of project activities, which do not occur in occupied aquatic habitats. Improved habitat due to operation of the project could increase survival, reproduction, and recruitment of populations of native Colorado River fish downstream of the project.

Determination

Due to the lack of adverse impacts and the anticipated beneficial impacts to habitat, implementation of the Proposed Action **may affect but would not adversely affect critical habitat for native Colorado River fish** and **may affect and would not likely adversely affect the bonytail chub, Colorado pikeminnow, humpback chub, and razorback sucker**.

5.2. Direct and Indirect Effects – Monarch Butterfly

Habitat

The presence of milkweed was not noted during listed plant surveys in 2020, 2021, 2022, or 2023, but flowering plants that could provide nectar for butterflies occur throughout the 3,859-acre Action Area. Up to 804.4 acres would be directly disturbed by project activities; however, flowering plants would remain adjacent to the disturbed areas. Operation of the project measures would not be expected to affect suitable habitat or flowering plants.

Species

No monarch butterflies are expected to be killed or injured as a result of project activities. Monarch butterflies would avoid the immediate area of project disturbance during construction and maintenance and feed on available flowering plants outside of the project area. Operation of the project measures would not affect monarch butterflies.

Determination

Due to the localized disturbance area, the temporary timeframe of disturbance, and the availability of alternate nectar sources in the larger area, implementation of the Proposed Action would not adversely affect and **would not likely jeopardize the continued existence of the monarch butterfly**.

5.3. Direct and Indirect Effects – Ute Ladies'-tresses (ULT)

Habitat

Yellowstone Feeder Canal

Approximately 0.2 acres of suitable habitat occurs on benches on both sides of the canal where it crosses a natural drainage and a small area below the canal where seepage creates habitat (see map 2 in Appendix A). Up to 0.1 acres of suitable habitat would be lost through lining of the canal and 0.1 acres would be lost through dewatering by eliminating canal seepage. No occupied habitat was identified in 3 years of survey.

South Boneta Canal

Piping of the canal would eliminate approximately 16.7 acres of suitable habitat; 6.7 acres of suitable habitat would be eliminated by burial of the pipeline within the canal channel, and the remaining 10.0 acres would eventually be eliminated by dewatering of the habitat through eliminating canal seepage (see map 3 in Appendix A). Approximately 6.6 acres of occupied habitat (suitable habitat with 300 feet of ULT) would be permanently lost.

Approximately 0.7 acres of suitable habitat that was identified along 640 feet of the Lake Fork River as part of the 300-foot buffer would not be directly impacted by project activities. The anticipated diversion design is not anticipated to change flow patterns or stream channel composition downstream.

DGIC Class B Canal

Approximately 32.0 acres of suitable habitat were mapped on private lands in association with sections of the southern portion of the Class B Canal (see map 5 in Appendix A). Because the hydrology in the area is unclear, this analysis assumes that all 32.0 acres of suitable habitat would be obliterated by pipeline burial in the canal channel or eventually eliminated by dewatering of the habitat through eliminating canal seepage. Approximately 2.5 acres of occupied habitat would be permanently lost in the southern portion of this canal.

An additional 96.3 acres of habitat on private and tribal lands were identified in association with the northern portion of the canal and additional proposed pipeline segments. Piping and the associated abandonment of canals would eliminate approximately 29.5 acres of suitable habitat through dewatering of the soils (see map 5 in Appendix A). Approximately 1.1 acres of occupied habitat would be permanently lost in the northern portion of this canal.

Approximately 72.0 acres of suitable habitat would not be permanently affected, as the habitat would not be dewatered and buried pipeline impacts would be temporary during construction per the conservation measures. This suitable habitat appears to be supported by hydrology beyond the canals.

DGIC Class C Canal

Approximately 10.7 acres of suitable habitat occurs at the western end of the project. Approximately 1.2 acres of suitable habitat along the canal banks would be eliminated by burial of the pipeline within the canal channel. Based on aerial imagery of the area, it appears that the remaining 9.5 acres of suitable habitat is supported by hydrology beyond canal seepage and habitat is expected to persist after the canal is dewatered. Suitable habitat would be outside the disturbance footprint, and any impacts associated with construction would be temporary and indirect in this location (see map 6 in Appendix A). No occupied habitat was identified in 3 years of survey.

Red Cap Extension (Arcadia Farms)

Suitable habitat occurs in association with portions of the canals and ditches that make up the Red Cap Extension (Arcadia Farms) irrigation system (see map 7 in Appendix A). Approximately 67.0 acres of suitable habitat would be lost; approximately 6.4 acres within the canal channel would be obliterated by piping of the canal and the remaining 60.6 acres would eventually be eliminated by dewatering of the habitat through eliminating canal seepage. No occupied habitat was identified in 3 years of survey.

Additionally, approximately 0.7 acres of suitable habitat would be lost by dewatering connected canals and ditches where suitable habitat occurs but would not be obliterated by pipeline installation. No occupied habitat was identified in 2 years of survey.

Species

Yellowstone Feeder Canal

Suitable habitat was surveyed in 2021, 2022, and 2023; no ULT were located. If ULT were to occur in the suitable habitat in the canal, they would be eliminated by shaping and lining of the canal. If plants were to occur in the suitable habitat below the canal, they would eventually be eliminated by dewatering of the habitat through eliminating canal seepage.

South Boneta Canal

Suitable habitat was surveyed in 2020, 2021, and 2022. No ULT were identified in 2020; in 2021, 6 ULT were located in a wet area downslope from the canal and in 2022, 50 ULT were identified in the wet areas below the canal and 3 ULT were identified along the banks of the canal. Piping of the South Boneta Canal would result in a permanent loss of 59 ULT individuals (see map 3 in Appendix A); the 3 ULT in the canal would be eliminated by burial of the pipeline within the canal channel, and the 56 plants below the canal would eventually be eliminated by dewatering of the habitat through eliminating canal seepage.

Along the Lake Fork River, ULT were found in 2020 and 2021, but not 2022; 11 ULT were identified within 300 feet upstream of the diversion location, and 12 were identified within 300 feet downstream. Although construction of a new diversion structure would occur in suitable habitat, identified ULT locations would be avoided. The anticipated diversion design is not anticipated to change flow patterns or stream channel composition downstream. Indirect impacts to ULT that occur along the Lake Fork River would be minimized by completing construction outside of flowering season.

DGIC Class B Canal

In 2020, 6 ULT were identified in association with sections of the southern portion of the Class B Canal: 1 within the canal and 5 in an adjacent wet meadow. No ULT were identified in these areas in 2021, but 41 ULT were found in the wet meadow in 2022. Although identified ULT locations would be outside of the direct disturbance footprint, dewatering of the habitat by piping the canal would result in the permanent loss of 47 ULT (see map 5 in Appendix A).

A population of ULT (32 in 2021, 8 in 2022, and 10 in 2023) was located along a ditch on the northern portion of the canal that would be replaced with a pipeline. Piping would eliminate habitat through dewatering of the soil. The project would result in a permanent loss of 50 ULT (see map 7 in Appendix A).

Another population of ULT were located in a wet meadow on both sides of 7000 North; 342 ULT were counted in 2021, 858 in 2022, and 416 in 2023. The pipeline would be buried on the south side of the road, and would avoid direct impacts to ULT. Indirect impacts to 1,616 ULT due to dust and vibration would be avoided by completing construction outside of flowering season. Suitable habitat would not be affected as the habitat would not be dewatered and buried pipeline impacts would be temporary during construction per the conservation measures.

Another 2 ULT were identified in 2022 approximately 0.25 miles south of 7000 North, adjacent to the canal; no ULT were identified in this location in 2021 or 2023. The suitable habitat where these plants were found appears to be supported by hydrology beyond the canal, and may even be hydrologically connected to the large populations to the north. There would be no pipeline installation in this area, and suitable habitat would likely not be affected or dewatered.

A population of 49 ULT were identified along one canal in the northern end of the project in 2022; this area was not surveyed in 2023 because the landowner did not grant permission to access his property. Abandonment of the canal would likely eliminate habitat through dewatering of the soils, and would result in a permanent loss of 49 ULT (see map 7 in Appendix A).

DGIC Class C Canal

No ULT were identified along this canal during 3 years of protocol surveys (see map 6 in Appendix A). If ULT were to occur in the suitable habitat in the canal, they would be eliminated by burial of the pipeline within the canal channel. Indirect impacts due to dust and vibration would be avoided by completing construction outside of flowering season. Suitable habitat outside of the canal would not be affected as the habitat would not be dewatered and buried pipeline impacts would be temporary during construction per the conservation measures.

Red Cap Extension (Arcadia Farms)

No ULT were identified in surveys in 2021, 2022, or 2023 (see map 7 in Appendix A). If ULT were to occur in the suitable habitat in the canals, they would be eliminated by pipeline burial within the canal. If ULT were to occur in the suitable habitat below the canal, they would eventually be eliminated by dewatering of the habitat through eliminating canal seepage.

Total impacts

The impacts of implementation of the full project are summarized in Table 5-1 .

Table 5-1. Impact summary for ULT individuals, suitable habitat, and occupied habitat

Project Measure	Permanent loss of occupied habitat (acres)	Permanent loss of individuals—direct and indirect (numbers)	Permanent loss of suitable habitat (acres)	Temporary impact of suitable habitat (acres)
Yellowstone Feeder Canal	0	0	0.2	0
South Boneta Canal	6.6	59	16.7	0
South Boneta Canal--Lake Fork River	0	0	0	0.7
DGIC Class B Canal--South	2.5	47	32	72
DGIC Class B Canal--North	1.1	50	29.5	***
DGIC Class B Canal--Abandoned	5.4*	49	**	***
DGIC Class C Canal--Sections 1 & 2	0	0	1.2	9.5
Red Cap Extension	0	0	67.7	0
Red Cap Extension--Abandoned	0.7*	-	0	0
Total	**16.3**	**205**	**147.3**	**82.2**

*Occupancy assumed throughout all suitable habitat because of less than 3 years of survey
** Included in the 29.5 acres of permanent loss of suitable habitat for DGIC Class B Canal--North
*** Included in the 72 acres of temporary impact of suitable habitat for DGIC Class B Canal--South

The project would result in the loss of at least 205 individual ULT and approximately 147.3 acres of suitable habitat. A total of 16.3 acres of occupied habitat (suitable habitat with 300 feet of identified ULT individuals) would be permanently lost, and 82.2 acres of suitable habitat would be indirectly affected. The project **may affect and is likely to adversely affect ULT.**

5.4. Interrelated and Interdependent Effects

The project is not part of a larger action, nor would any other actions be dependent upon this project; therefore, there are no interrelated or interdependent effects of the proposed action.

5.5. Cumulative effects

Non-federal activities that are likely to occur in the foreseeable future and that have potential to cause cumulative effects include modified irrigation or agricultural practices, limited residential development, and roadway maintenance.

Future non-federal activities could impact habitat for native Colorado River fish, mainly through modified irrigation practices.

Cumulative effects to monarch butterfly are not anticipated as most future non-federal actions would be expected occur in localized areas of existing disturbance where milkweed and other flowering plants are scarce. Abundant flowering plants would remain available throughout the larger area.

Future non-federal activities could impact suitable and occupied ULT habitat; however, the project occurs in relatively remote areas of the county where landowners are anticipated to maintain most existing uses. Impacts would vary by individual landowner.

6. Mitigation

Numerous options for compensatory mitigation for impacts to ULT were considered and pursued; the options consisted of:

1. Acquisition of a conservation easement for occupied habitat on the Lake Fork River: ULT were found within the 300-foot buffer along the river and would not be impacted by the project. Upon initial contact in 2021, the landowner seemed supportive of the idea, but was not responsive to subsequent attempts at communication.
2. Acquisition of a conservation easement for occupied habitat on the north side of 7000 North in Altonah: A large number of ULT were found within the 300-foot buffer in a field that would not be impacted by the project. The landowner was initially willing to talk and considered a conservation easement, but ultimately decided against it.
3. Acquisition of a conservation easement for occupied habitat on the south side of 7000 North in Altonah: The landowners were opposed to the project and would not consider an easement.
4. Invasive species removal for occupied habitat on the north side of 7000 North in Altonah: The landowner would support a one-time treatment to remove Russian olive in the field immediately northwest of the high-density population. Upon review by Wetland Resources, the predominant vegetation was identified as native willow and much of the area was too wet to support ULT.
5. Invasive species removal for occupied habitat on Water Hollow east of DGIC Class B Canal: Upon review by Wetland Resources, the suitable habitat was not occupied in 2023 and treatment was deemed ineffective.

6. Contribution to the Ute-ladies'-tresses Conservation Fund: This program assigns a mitigation ratio of 6:1 (habitat enhancement area to impacted habitat area) to calculate the compensatory fee, where 1 acre of impacts to occupied habitat results in 6 acres of compensation. The compensatory fee is determined by multiplying the occupied habitat by $3,971.

Permanent impacts to ULT will be offset through a monetary contribution to the ULT Conservation Fund. The calculation is 16.3 acres of occupied habitat lost multiplied by $3,971, resulting in a voluntary contribution of $64,727.30 to the fund. Contribution to the fund will occur prior to construction.

Temporary impacts to individual ULT and suitable habitat will be mitigated by adherence to the conservation measures.

7. Conclusion and Determination of Effect

Considering all the potential effects disclosed above, we determine that the proposed action:

- **May affect, but is not likely to adversely affect** the bonytail chub, Colorado pikeminnow, humpback chub, and razorback sucker.
- **May affect but would not adversely affect critical habitat for** the bonytail chub, Colorado pikeminnow, humpback chub, and razorback sucker.
- **May affect, and is likely to adversely affect** Ute ladies'-tresses.
- **Would not likely jeopardize the continued existence** of the monarch butterfly.
- Would have **no effect** on all other species listed in the IPaC report.

8. Literature Cited

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Appendix A. Maps

Maps not available for public due to sensitive nature of species location data

Appendix B. Technical Memo: Water Budget & Depletion

Please refer to memo already included in Appendix E of the Plan-EA

Appendix C. USFWS Official Species List

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Utah Ecological Services Field Office
2369 West Orton Circle, Suite 50
West Valley City, UT 84119-7603
Phone: (801) 975-3330 Fax: (801) 975-3331

In Reply Refer To: 05/11/2024 16:22:27 UTC
Project Code: 2023-0001492
Project Name: DCWCD Watershed Plan

Subject: List of threatened and endangered species that may occur in your proposed project location or may be affected by your proposed project

To Whom It May Concern:

The enclosed species list identifies threatened, endangered, proposed, and candidate species, as well as proposed and final designated critical habitat, that may occur within the boundary of your proposed project and/or may be affected by your proposed project. The species list fulfills the requirements of the U.S. Fish and Wildlife Service (Service) under section 7(c) of the Endangered Species Act (Act) of 1973, as amended (16 U.S.C. 1531 *et seq.*).

New information based on updated surveys, changes in the abundance and distribution of species, changed habitat conditions, or other factors could change this list. Please feel free to contact us if you need more current information or assistance regarding the potential impacts to federally proposed, listed, and candidate species and federally designated and proposed critical habitat. Please note that under 50 CFR 402.12(e) of the regulations implementing section 7 of the Act, the accuracy of this species list should be verified after 90 days. This verification can be completed formally or informally as desired. The Service recommends that verification be completed by visiting the IPaC website at regular intervals during project planning and implementation for updates to species lists and information. An updated list may be requested through the IPaC system by completing the same process used to receive the enclosed list.

The purpose of the Act is to provide a means whereby threatened and endangered species and the ecosystems upon which they depend may be conserved. Under sections 7(a)(1) and 7(a)(2) of the Act and its implementing regulations (50 CFR 402 *et seq.*), Federal agencies are required to utilize their authorities to carry out programs for the conservation of threatened and endangered species and to determine whether projects may affect threatened and endangered species and/or designated critical habitat.

A Biological Assessment is required for construction projects (or other undertakings having similar physical impacts) that are major Federal actions significantly affecting the quality of the human environment as defined in the National Environmental Policy Act (42 U.S.C. 4332(2)(c)). For projects other than major construction activities, the Service suggests that a biological evaluation similar to a Biological Assessment be prepared to determine whether the project may affect listed or proposed species and/or designated or proposed critical habitat. Recommended contents of a Biological Assessment are described at 50 CFR 402.12.

If a Federal agency determines, based on the Biological Assessment or biological evaluation, that listed species and/or designated critical habitat may be affected by the proposed project, the agency is required to consult with the Service pursuant to 50 CFR 402. In addition, the Service recommends that candidate species, proposed species and proposed critical habitat be addressed within the consultation. More information on the regulations and procedures for section 7 consultation, including the role of permit or license applicants, can be found in the "Endangered Species Consultation Handbook" at:

https://www.fws.gov/sites/default/files/documents/endangered-species-consultation-handbook.pdf

Migratory Birds: In addition to responsibilities to protect threatened and endangered species under the Endangered Species Act (ESA), there are additional responsibilities under the Migratory Bird Treaty Act (MBTA) and the Bald and Golden Eagle Protection Act (BGEPA) to protect native birds from project-related impacts. Any activity, intentional or unintentional, resulting in take of migratory birds, including eagles, is prohibited unless otherwise permitted by the U.S. Fish and Wildlife Service (50 C.F.R. Sec. 10.12 and 16 U.S.C. Sec. 668(a)). For more information regarding these Acts, see https://www.fws.gov/program/migratory-bird-permit/what-we-do.

The MBTA has no provision for allowing take of migratory birds that may be unintentionally killed or injured by otherwise lawful activities. It is the responsibility of the project proponent to comply with these Acts by identifying potential impacts to migratory birds and eagles within applicable NEPA documents (when there is a federal nexus) or a Bird/Eagle Conservation Plan (when there is no federal nexus). Proponents should implement conservation measures to avoid or minimize the production of project-related stressors or minimize the exposure of birds and their resources to the project-related stressors. For more information on avian stressors and recommended conservation measures, see https://www.fws.gov/library/collections/threats-birds.

In addition to MBTA and BGEPA, Executive Order 13186: *Responsibilities of Federal Agencies to Protect Migratory Birds*, obligates all Federal agencies that engage in or authorize activities that might affect migratory birds, to minimize those effects and encourage conservation measures that will improve bird populations. Executive Order 13186 provides for the protection of both migratory birds and migratory bird habitat. For information regarding the implementation of Executive Order 13186, please visit https://www.fws.gov/partner/council-conservation-migratory-birds.

We appreciate your concern for threatened and endangered species. The Service encourages Federal agencies to include conservation of threatened and endangered species into their project planning to further the purposes of the Act. Please include the Consultation Code in the header of this letter with any request for consultation or correspondence about your project that you submit to our office.

Attachment(s):

- Official Species List

OFFICIAL SPECIES LIST

This list is provided pursuant to Section 7 of the Endangered Species Act, and fulfills the requirement for Federal agencies to "request of the Secretary of the Interior information whether any species which is listed or proposed to be listed may be present in the area of a proposed action".

This species list is provided by:

Utah Ecological Services Field Office
2369 West Orton Circle, Suite 50
West Valley City, UT 84119-7603
(801) 975-3330

PROJECT SUMMARY

Project Code: 2023-0001492
Project Name: DCWCD Watershed Plan
Project Type: Irrigation
Project Description: Watershed Planning for agricultural water management
Project Location:

The approximate location of the project can be viewed in Google Maps: https://www.google.com/maps/@40.34572555,-110.13934964442151,14z

Counties: Duchesne and Uintah counties, Utah

ENDANGERED SPECIES ACT SPECIES

There is a total of 10 threatened, endangered, or candidate species on this species list.

Species on this list should be considered in an effects analysis for your project and could include species that exist in another geographic area. For example, certain fish may appear on the species list because a project could affect downstream species. Note that 4 of these species should be considered only under certain conditions.

IPaC does not display listed species or critical habitats under the sole jurisdiction of NOAA Fisheries[1], as USFWS does not have the authority to speak on behalf of NOAA and the Department of Commerce.

See the "Critical habitats" section below for those critical habitats that lie wholly or partially within your project area under this office's jurisdiction. Please contact the designated FWS office if you have questions.

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1. NOAA Fisheries, also known as the National Marine Fisheries Service (NMFS), is an office of the National Oceanic and Atmospheric Administration within the Department of Commerce.

BIRDS

NAME	STATUS
Mexican Spotted Owl *Strix occidentalis lucida* There is **final** critical habitat for this species. Your location does not overlap the critical habitat. Species profile: https://ecos.fws.gov/ecp/species/8196	Threatened
Yellow-billed Cuckoo *Coccyzus americanus* Population: Western U.S. DPS There is **final** critical habitat for this species. Your location does not overlap the critical habitat. Species profile: https://ecos.fws.gov/ecp/species/3911	Threatened

FISHES

NAME	STATUS
Bonytail *Gila elegans* There is **final** critical habitat for this species. Your location does not overlap the critical habitat. This species only needs to be considered under the following conditions: ▪ Water depletions in the upper Colorado River basin adversely affect this species and its critical habitat. Effects of water depletions must be considered even outside of occupied range. Species profile: https://ecos.fws.gov/ecp/species/1377	Endangered
Colorado Pikeminnow *Ptychocheilus lucius* Population: Wherever found, except where listed as an experimental population There is **final** critical habitat for this species. Your location does not overlap the critical habitat. This species only needs to be considered under the following conditions: ▪ Water depletions in the upper Colorado River basin adversely affect this species and its critical habitat. Effects of water depletions must be considered even outside of occupied range. Species profile: https://ecos.fws.gov/ecp/species/3531	Endangered
Humpback Chub *Gila cypha* There is **final** critical habitat for this species. Your location does not overlap the critical habitat. This species only needs to be considered under the following conditions: ▪ Water depletions in the upper Colorado River basin adversely affect this species and its critical habitat. Effects of water depletions must be considered even outside of occupied range. Species profile: https://ecos.fws.gov/ecp/species/3930	Threatened
Razorback Sucker *Xyrauchen texanus* There is **final** critical habitat for this species. Your location does not overlap the critical habitat. This species only needs to be considered under the following conditions: ▪ Water depletions in the upper Colorado River basin adversely affect this species and its critical habitat. Effects of water depletions must be considered even outside of occupied range. Species profile: https://ecos.fws.gov/ecp/species/530	Endangered

INSECTS

NAME	STATUS
Monarch Butterfly *Danaus plexippus* No critical habitat has been designated for this species. Species profile: https://ecos.fws.gov/ecp/species/9743	Candidate

FLOWERING PLANTS

NAME	STATUS
Pariette Cactus *Sclerocactus brevispinus* No critical habitat has been designated for this species. Species profile: https://ecos.fws.gov/ecp/species/2966	Threatened
Uinta Basin Hookless Cactus *Sclerocactus wetlandicus* No critical habitat has been designated for this species. Species profile: https://ecos.fws.gov/ecp/species/9037	Threatened
Ute Ladies'-tresses *Spiranthes diluvialis* No critical habitat has been designated for this species. Species profile: https://ecos.fws.gov/ecp/species/2159	Threatened

CRITICAL HABITATS

THERE ARE NO CRITICAL HABITATS WITHIN YOUR PROJECT AREA UNDER THIS OFFICE'S JURISDICTION.

YOU ARE STILL REQUIRED TO DETERMINE IF YOUR PROJECT(S) MAY HAVE EFFECTS ON ALL ABOVE LISTED SPECIES.

IPAC USER CONTACT INFORMATION

Agency: Jones and DeMille Engineering
Name: Jenna Jorgensen
Address: 1535 S. 100 W.
City: Richfield
State: UT
Zip: 84701
Email jenna.j@jonesanddemille.com
Phone: 4358935203

LEAD AGENCY CONTACT INFORMATION

Lead Agency: Natural Resources Conservation Service

Appendix D. Survey Reports

Spiranthes diluvialis Survey

Duchesne County Water Conservancy District
Duchesne County, Utah

September 2020
Wetland Resources

Spiranthes diluvialis
Survey

Duchesne County Water Conservancy District
Canal Piping Project

Prepared for:

Jones and DeMille Engineering
Jenna Jorgensen, Project Manager
1535 South 100 West
Richfield, Utah 84701
(435) 896-8266

Prepared by:

Wetland Resources
182 East 300 North
Logan, Utah 84321
(435) 753-4517

September 2020

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1.0 **Introduction** 1
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Appendix A: Maps

Appendix B: Photos

Appendix C: Surveyor Qualifications

A. Introduction

Wetland Resources conducted a survey for Ute ladies'-tresses (*Spiranthes diluvialis*) (ULT) for a for a canal piping project in Duchesne County, Utah. The survey area consists of five separate canals located in Duchesne County, and a 300-foot buffer around each canal (Appendix A: Map 1). The survey was conducted for Jones and DeMille Engineering, who is providing engineering and environmental services to the Duchesne County Water Conservancy District for this project. The survey was conducted August 24 through 30, 2020 during the ULT blooming season.

The survey area is situated in the Uinta Basin on the south side of the Uinta Mountains. Elevations in the survey area range from 5300 feet above mean sea level to 6500 feet above mean sea level. A majority of the survey area adjacent to the five canals is currently used for agriculture, including livestock grazing and cultivated fields.

B. Methodology

The assessment of ULT suitable habitat criteria and disqualifiers were conducted in accordance with the U.S. Fish and Wildlife Service (USFWS) protocol (USFWS 1992, 2007, and 2011) and supplemental publications and studies (Arft 1995; Fertig 2005). It was determined that ULT was blooming in the region by a visit on August 24, 2020 to the known ULT sites along the Duchesne River and Lake Fork River, which are both near the survey area (Photo 1).

Spiranthes diluvialis is typically found associated with alluvial deposits of silty, sandy, gravelly, or cobbly soil (USFWS 1992). The species may occasionally also be found in highly organic soils or peat. The species seems to prefer well drained soils with fairly high moisture content. Soils may exhibit some gleying or mottling but are generally not strongly anaerobic. Spiranthes diluvialis is found in some heavily disturbed sites, for example, old gravel mines that have since been developed into wetlands, and along well traveled footpaths built on old berms. The species is also found in grazed pastures with introduced pasture grasses. Spiranthes diluvialis is found with grasses, sedges, and rushes, in shrubs, and riparian trees such as willow species. It rarely occurs in deeply shaded sites and prefers partially shaded open glades or pastures and meadows in full sunlight. Specifically, the following criteria was used to determine suitable ULT habitat (USFWS 1992):

1. Seasonally high water table (within 18 inches of the soil surface for at least one week sometime during the growing season, growing season defined as when soil temperatures are above 41 degrees Fahrenheit).
2. In or near wet meadows, stream channels, or flood plains.
3. Vegetation falling into the Facultative Wet or Obligate Wet classification, including introduced pasture grasses.
4. Jurisdictional wetlands as specified under the Clean Water Act.

The following criteria was used to disqualify certain habitats within the survey area that do not support potential ULT habitat (USFWS 2007):

1. Appropriate hydrology not present, typically indicated by:
   - area is comprised of mostly upland vegetation
   - area dries up by mid-July, with water table lower than 12 - 18 inches below the soil surface

2. Heavy clay soils present
3. Soils strongly alkaline
4. Site heavily disturbed, such as, for example:
    - stream banks channelized and stabilized by heavy rip-rap
    - highway rights-of-way built on filled or compacted soil or rock material
    - construction sites where construction has either stripped the topsoil or where construction has been completed within the last 5 years but the area has not been revegetated
5. Stream banks steep, transition from stream margin to upland areas abrupt
6. Site characterized by standing water with cattails, bulrushes, and other emergent aquatic vegetation (note that margins of such areas may be suitable habitat).
7. Riparian areas, stream banks, or wetlands vegetated with dense rhizomatous species such as reed canary grass (*Phalaris arundinacea*), tamarisk or salt cedar (*Tamarix ramosissima*), teasel (*Dipsacus sylvestris*), common reed (*Phragmites australis*), or saltgrass (*Distichlis spicata*)
8. Riparian areas overgrazed or otherwise managed such that the vegetation community is comprised of upland native or weedy species or is unvegetated. (note that the orchid can tolerate rather extreme overgrazing as long as it has not resulted in a drop in the water table as indicated by conversion of the riparian or wet meadow pasture vegetation community to mostly upland species).
9. Potential habitat is no longer in a natural condition, for example, has been converted to agricultural uses and is now plowed and cropped, or has been converted to lawns or golf courses (note that wet meadow pastures with a mix of native and non-native pasture grasses, including pastures that are regularly hayed, are suitable potential habitat).
10. Wetland is a brackish playa or pothole not fed by springs or not in the floodplain of or hydrologically connected with a riparian system or other source of fresh water (note that fens and wetlands associated fresh water springs are suitable potential habitat).

Areas that were determined to contain suitable ULT habitat were surveyed using a 100% coverage pedestrian survey with transect widths of 5 feet.

C. Results and Discussion

The survey area includes many palustrine emergent (PEM) wetlands that provide varying degrees of suitability for ULT habitat. Some of the canal banks also provide suitable ULT habitat. A detailed description of each of the five canals is provided below. The areas of suitable ULT habitat were mapped, and can be found on Maps 2 through 6 in Appendix A. Photos of the survey area are provided in Appendix B.

The areas that were not surveyed for ULT met the criteria provided by the USFWS for disqualified habitat (USFWS 2007). Primarily these areas were dominated by upland vegetation and did not have appropriate hydrology to support ULT (Disqualifying Factor 1). These areas were primarily agricultural fields dominated by upland grasses. In addition, some wetlands and canal banks were also disqualified as suitable habitat because they were dominated by dense stands of *Salix exigua* or *Phalaris arundinacea* (Disqualifying Factor 7).

South Boneta Canal

The banks of the South Boneta Canal provide suitable ULT habitat throughout the survey area (Map 2). The habitat along the canal banks is only 1 to 3 feet wide, and is dominated by *Agrostis stolonifera, Juncus balticus, Hordeum jubatum, Carex rostrata,* and *Carex nebrascensis* (Photos 2 and 3). There is moderate grazing of the canal banks on some properties and not on others. There is very little suitable ULT habitat west of the canal within the 300-foot buffer because it is a steep dry hillside. There are several areas of wet meadow habitat east of the canal in the 300-foot buffer that provide suitable ULT habitat. These wet meadows are dominated by similar wetland species as the canal banks. The wet meadows are not currently being grazed, and the vegetation is generally too dense for ULT habitat, but some areas are not as densely vegetated. The 300-foot buffer also includes the Lake Fork River at the northern end of the survey area. The banks of the Lake Fork River provide high-quality ULT habitat, and a known reference population is located less than two miles downstream. Four ULT individuals were identified along the banks of the Lake Fork River within the 300-buffer (Map 7) (Photos 4 and 5). Associated species growing with the ULT individuals included *Eleocharis palustris, Carex nebrascensis,* and *Agrostis stolonifera.*

DGIC Class B Canal

The banks of the DGIC Class B Canal provide suitable ULT habitat in some areas and not in others (Map 3). Where there is suitable ULT habitat along the canal banks it is only 1 to 3 feet wide, and is dominated by *Agrostis stolonifera, Juncus balticus, Hordeum jubatum, Eleocharis palustris, Alopecurus pratensis,* and *Carex nebrascensis* (Photos 6 and 7). Other sections of the canal support a dense overstory of *Elaeagnus angustifolia* and *Salix exigua*, and were not considered suitable ULT habitat (Photo 8). There is moderate grazing of the canal banks on some properties and not on others. There are several areas of wet meadow habitat within the 300-foot buffer that provide suitable ULT habitat (Photo 9). Some of these wet meadow habitats appear to be hydrologically supported by seepage from the canal, while others appear to be supported by natural groundwater discharge zones. These wet meadows are dominated by similar wetland species as the canal banks. The vegetation in some of the adjacent wet meadows is too dense for ULT habitat, but some areas are not as densely vegetated and provide suitable habitat. Five ULT individuals were identified in a wet meadow within the 300-buffer near the northern end of the survey area (Map 8) (Photo 10). The wet meadow supports *Carex nebrascensis, Agrostis stolonifera, Juncus balticus,* and *Trifolium fragiferum.* A single ULT individual was identified growing on the canal bank near the southern end of the survey area (Map 9) (Photo 11). Associated species growing with this individual include *Eleocharis palustris, Agrostis stolonifera, Juncus balticus, Trifolium fragiferum,* and *Melilotus officinalis.*

Coyote Canal

There is no suitable ULT habitat along the Coyote Canal or within the associated 300-buffer (Map 4). This canal has very steep banks comprised of cobble and sand (Photos 12 and 13). There are very few benches along the canal that support wetland vegetation, and those that do have a dense overstory of *Salix exigua* and *Juniperus osteosperma* and do not provide any suitable ULT habitat (Photo 14). The natural drainage on the south side of the canal within the 300-buffer is dry and supports an extremely dense stand of *Salix exigua* (Photo 15). There is a headgate at the top end of this drainage where it splits from the Coyote Canal that has been filled in and is no longer operational.

DGIC Class C Canal

This canal provides suitable ULT habitat only at the far western end of the survey area (Map 5). Most of the length of the canal is comprised of very steep banks that are regularly maintained (Photo 16 and 17). There are no benches along most of the canal, just steep banks dominated by dense stands of *Phalaris arundinacea* and *Salix exigua*. The pond at the east end of the canal is an irrigation water holding pond with variable water levels, and does not support any ULT habitat. The suitable ULT habitat occurs on the canal banks (Photo 18) and on an adjacent slope below a groundwater discharge zone (Photo 19). The canal banks and the slope are both moderately grazed and are dominated by *Carex nebrascensis, Agrostis stolonifera, Eleocharis palustris, Juncus balticus, Juncus torreyi,* and *Trifolium fragiferum.* No individuals were found within the survey area.

Gray Mountain Canal

There is no suitable ULT habitat along the Gray Mountain Canal or within the associated 300-buffer (Map 6). This canal has very steep banks that are regularly maintained. Much of the length of this canal is built on the side of an arid rocky slope, which does not provide suitable soil conditions for ULT along the canal banks (Photo 20). The edges of the canal support wetland vegetation, but it is dense (Photo 21) and inundated by the canal, which is too wet of conditions for ULT (Photo 22). The edges of the canal are dominated by *Phalaris arundinacea, Alopecurus pratense,* and *Salix exigua.*

REFERENCES

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US Fish and Wildlife Service. 2011. USFWS Utah Field Office Guidelines for Conducting and Reporting Botanical Inventories and Monitoring of Federally Listed, Proposed, and Candidate Plants.

APPENDIX A: MAPS

Maps not available for public due to sensitive nature of species location data

APPENDIX B: PHOTOS

Photos not included due to sensitive location information

APPENDIX C: SURVEYOR QUALIFICATIONS

TODD SHERMAN - WETLAND ECOLOGIST

Todd received his Masters from Utah State University's Department of Landscape Architecture and Environmental Planning in 1996 where his research focused on wetland ecosystems of the Intermountain West, and the planning issues associated with these unique environments. Todd is a certified Senior Professional Wetland Scientist (SPWS #1345) whose experience includes ULT surveys, jurisdictional wetland delineation, wetland functional assessment, vegetation analysis and plant community mapping, Section 404 permitting, wetland restoration design, construction supervision and long-term monitoring of wetland mitigation sites, and stream revegetation design. Todd has been conducting ULT surveys since 2001 on over 100 projects throughout the Intermountain West.

Spiranthes diluvialis Survey

Duchesne County Water Conservancy District
Duchesne County, Utah

September 2021
Wetland Resources

Spiranthes diluvialis Survey

Duchesne County Water Conservancy District Canal Piping Project

Prepared for:

Jones and DeMille Engineering
Jenna Jorgensen, Project Manager
1535 South 100 West
Richfield, Utah 84701
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Wetland Resources
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September 2021

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Appendix A: Maps

Appendix B: Photos

Appendix C: Surveyor Qualifications

A. INTRODUCTION

Wetland Resources conducted a survey for Ute ladies'-tresses (*Spiranthes diluvialis*) (ULT) for a for an irrigation water piping project in Duchesne County, Utah. The survey area consists of seven separate irrigation systems located in Duchesne County, and a 300-foot buffer around each of the proposed pipeline corridors (Appendix A: Map 1). The survey was conducted for Jones and DeMille Engineering, who is providing engineering and environmental services to the Duchesne County Water Conservancy District for this project. The survey was conducted August 2 through 27, 2021 during the ULT blooming season.

The survey area is situated in the Uinta Basin on the south side of the Uinta Mountains. Elevations in the survey area range from 5300 feet above mean sea level to 6500 feet above mean sea level. A majority of the survey area is currently used for agriculture, including livestock grazing and cultivated fields.

B. METHODOLOGY

The assessment of ULT suitable habitat criteria and disqualifiers were conducted in accordance with the U.S. Fish and Wildlife Service (USFWS) protocol (USFWS 1992, 2007, and 2011) and supplemental publications and studies (Arft 1995; Fertig 2005). It was determined that ULT was blooming in the region by a visit on July 27, 2021 to a known ULT site along the Lake Fork River (Photo 1), which is near the survey area.

Spiranthes diluvialis is typically found associated with alluvial deposits of silty, sandy, gravelly, or cobbly soil (USFWS 1992). The species may occasionally also be found in highly organic soils or peat. The species seems to prefer well drained soils with fairly high moisture content. Soils may exhibit some gleying or mottling but are generally not strongly anaerobic. Spiranthes diluvialis is found in some heavily disturbed sites, for example, old gravel mines that have since been developed into wetlands, and along well traveled footpaths built on old berms. The species is also found in grazed pastures with introduced pasture grasses. Spiranthes diluvialis is found with grasses, sedges, and rushes, in shrubs, and riparian trees such as willow species. It rarely occurs in deeply shaded sites and prefers partially shaded open glades or pastures and meadows in full sunlight. Specifically, the following criteria was used to determine suitable ULT habitat (USFWS 1992):

1. Seasonally high water table (within 18 inches of the soil surface for at least one week sometime during the growing season, growing season defined as when soil temperatures are above 41 degrees Fahrenheit).
2. In or near wet meadows, stream channels, or flood plains.
3. Vegetation falling into the Facultative Wet or Obligate Wet classification, including introduced pasture grasses.
4. Jurisdictional wetlands as specified under the Clean Water Act.

The following criteria was used to disqualify certain habitats within the survey area that do not support potential ULT habitat (USFWS 2007):

1. Appropriate hydrology not present, typically indicated by:
    - area is comprised of mostly upland vegetation
    - area dries up by mid-July, with water table lower than 12 - 18 inches below the

soil surface

2. Heavy clay soils present
3. Soils strongly alkaline
4. Site heavily disturbed, such as, for example:
    - stream banks channelized and stabilized by heavy rip-rap
    - highway rights-of-way built on filled or compacted soil or rock material
    - construction sites where construction has either stripped the topsoil or where construction has been completed within the last 5 years but the area has not been revegetated
5. Stream banks steep, transition from stream margin to upland areas abrupt
6. Site characterized by standing water with cattails, bulrushes, and other emergent aquatic vegetation (note that margins of such areas may be suitable habitat).
7. Riparian areas, stream banks, or wetlands vegetated with dense rhizomatous species such as reed canary grass (*Phalaris arundinacea*), tamarisk or salt cedar (*Tamarix ramosissima*), teasel (*Dipsacus sylvestris*), common reed (*Phragmites australis*), or saltgrass (*Distichlis spicata*)
8. Riparian areas overgrazed or otherwise managed such that the vegetation community is comprised of upland native or weedy species or is unvegetated. (note that the orchid can tolerate rather extreme overgrazing as long as it has not resulted in a drop in the water table as indicated by conversion of the riparian or wet meadow pasture vegetation community to mostly upland species).
9. Potential habitat is no longer in a natural condition, for example, has been converted to agricultural uses and is now plowed and cropped, or has been converted to lawns or golf courses (note that wet meadow pastures with a mix of native and non-native pasture grasses, including pastures that are regularly hayed, are suitable potential habitat).
10. Wetland is a brackish playa or pothole not fed by springs or not in the floodplain of or hydrologically connected with a riparian system or other source of fresh water (note that fens and wetlands associated fresh water springs are suitable potential habitat).

Areas that were determined to contain suitable ULT habitat were surveyed using a 100% coverage pedestrian survey with transect widths of 6 feet.

C. Results and Discussion

The survey area includes many palustrine emergent (PEM) wetlands that provide varying degrees of suitability for ULT habitat. Some of the canal banks also provide suitable ULT habitat. A detailed description of each of the seven irrigation systems is provided below. The areas of suitable ULT habitat were mapped, and can be found on Maps 2 through 12 in Appendix A. Photos of the survey area are provided in Appendix B.

The areas that were not surveyed for ULT met the criteria provided by the USFWS for disqualified habitat (USFWS 2007). Primarily these areas were dominated by upland vegetation and did not have appropriate hydrology to support ULT (Disqualifying Factor 1). These areas were primarily agricultural fields dominated by upland grasses. In addition, some wetlands and canal banks were also disqualified as suitable habitat because they were dominated by dense stands of *Salix exigua* or *Phalaris arundinacea* (Disqualifying Factor 7). Other wetlands had strongly alkaline soils (Disqualifying Factor 3) that exhibited a surface salt crust and supported alkaline and saline-tolerant plant species.

South Boneta Canal

The banks of the South Boneta Canal provide suitable ULT habitat throughout the survey area (Map 3). The habitat along the canal banks is only 1 to 3 feet wide, and is dominated by *Agrostis stolonifera, Juncus balticus, Hordeum jubatum, Equisetum hyemale, Carex rostrata*, and *Carex nebrascensis* (Photo 2). There is moderate grazing of the canal banks on some properties and not on others. There is very little suitable ULT habitat west of the canal within the 300-foot buffer because it is a steep dry hillside. There are several areas of wet meadow habitat east of the canal in the 300-foot buffer that provide suitable ULT habitat (Photo 3). These wet meadows are dominated by similar wetland species as the canal banks. Six ULT individuals were identified in these wet meadow areas in 2021 (Map 10) (Photo 4). No ULT was identified in these wet meadows in 2020. The 300-foot buffer also includes the Lake Fork River at the northern end of the survey area. The banks of the Lake Fork River provide high-quality ULT habitat (Photo 5), and a known reference population is located less than two miles downstream. Nineteen ULT individuals were identified along the banks of the Lake Fork River within the 300-buffer in 2021 (Map 9) (Photo 6). Only four ULT individuals were identified along the river in 2020. Associated species growing with the ULT individuals along the river included *Eleocharis palustris, Carex nebrascensis,* and *Agrostis stolonifera.*

DGIC Class B Canal

The banks of the DGIC Class B Canal provide suitable ULT habitat in some areas and not in others (Map 5). Where there is suitable ULT habitat along the canal banks it is typically only 1 to 3 feet wide, and is dominated by *Agrostis stolonifera, Juncus balticus, Juncus torreyi, Hordeum jubatum, Eleocharis palustris, Alopecurus pratensis,* and *Carex nebrascensis* (Photo 7). Other sections of the canal support dense stands of *Phalaris arundinacea* on the banks or a dense overstory of *Elaeagnus angustifolia* and *Salix exigua,* and were not considered suitable ULT habitat (Photo 8). There is moderate grazing of the canal banks on some properties and not on others. A population of 32 ULT individuals was identified along the canal banks in the northwest portion of the project area that was not included in the 2020 surveys (Map 11) (Photos 9 and 10). There are several areas of wet meadow habitat within the 300-foot buffer that provide suitable ULT habitat. Some of these wet meadow habitats appear to be hydrologically supported by seepage from the canal, while others appear to be supported by natural groundwater discharge zones. These wet meadows are dominated by similar wetland species as the canal banks. The vegetation in some of the adjacent wet meadows is too dense for ULT habitat, but some areas are not as densely vegetated and provide suitable habitat. A population of 342 plants was identified in one of these wet meadows in the northwest portion of the project area that was not included in the 2020 surveys (Map 12) (Photos 11 and 12). This wet meadow supports *Carex nebrascensis, Agrostis stolonifera, Juncus balticus, Castilleja minor* and *Muhlenbergia asperifolia.* The two small populations found in 2020 (5 plants and 1 plant) did not have any blooming ULT present in 2021. Both of these sites were visited three times throughout August 2021 and no flowers were found. Both of these sites were much drier and more heavily grazed than in 2020. The Class B Canal had been shut off for several weeks prior to the 2021 survey, while in 2020 the canal was still flowing.

Coyote Canal

The Coyote Canal does not contain any suitable ULT habitat along its banks, or within the 300' buffer (Map 4). This canal has very steep banks comprised of cobble and sand (Photo 13). There are very few benches along the canal that support wetland vegetation, and those that do have a dense overstory of *Salix exigua* and *Juniperus osteosperma* and do not provide any suitable ULT habitat (Photos 14 and 15). The natural drainage on the south side of the canal within the 300-buffer is dry and supports an extremely dense stand of *Salix exigua*. There is a headgate at the top end of this drainage where it splits from the Coyote Canal that has been filled in and is no longer operational.

DGIC Class C Canal

This canal provides suitable ULT habitat only at the far western end of the survey area (Map 6). Most of the length of the canal is comprised of very steep banks that are regularly maintained (Photo 16 and 17). There are no benches along most of the canal, just steep banks dominated by dense stands of *Phalaris arundinacea* and *Salix exigua*. The pond at the east end of the canal is an irrigation water holding pond with variable water levels, and does not support any ULT habitat. The suitable ULT habitat occurs on the canal banks (Photo 18) and on adjacent wet meadows below a groundwater discharge zone (Photo 19). The canal banks and the slope are both moderately grazed and are dominated by *Carex nebrascensis, Carex rostrata, Agrostis stolonifera, Eleocharis palustris, Juncus balticus, Juncus torreyi,* and *Trifolium fragiferum.* No ULT individuals were found within the survey area.

Gray Mountain Canal

There is no suitable ULT habitat along the Gray Mountain Canal or within the associated 300-buffer (Map 8). This canal has very steep banks that are regularly maintained. Much of the length of this canal is built on the side of an arid rocky slope, which does not provide suitable soil conditions for ULT along the canal banks (Photo 20). The edges of the canal support wetland vegetation, but it is dense (Photo 21) and inundated by the canal, which is too wet of conditions for ULT (Photo 22). The edges of the canal are dominated by *Phalaris arundinacea, Alopecurus pratense,* and *Salix exigua.*

Yellowstone Feeder Canal

This canal provides suitable ULT habitat only where it crosses a natural drainage (Map 2). Most of the length of the canal is comprised of very steep banks that do not provide suitable ULT habitat (Photo 23). The suitable ULT habitat occurs on benches on both sides of the canal where it crosses a natural drainage (Photo 24), and a small area below the canal (Photo 25). The suitable ULT habitat is dominated by *Carex nebrascensis, Agrostis stolonifera,* and *Juncus balticus.* No ULT individuals were found within the survey area.

Arcadia Farms Irrigation System

The Arcadia Farms irrigation system is comprised of numerous canals and ditches, including the Duchesne Feeder Canal, the Red Cap Canal, and the Midview Ditch. The banks of these canals and ditches provide suitable ULT habitat in some areas and not in others (Map 7). Where there is suitable ULT habitat along the banks it is typically only 1 to 3 feet wide, and is dominated by *Agrostis stolonifera, Juncus balticus, Eleocharis palustris, Castilleja minor, Equisetum hyemale Alopecurus pratensis, Carex aquatilis,* and *Carex nebrascensis* (Photo 26). Other sections of canal support dense stands of *Phalaris arundinacea, Glyceria striata,* or *Typha latifolia* or a dense overstory of *Elaeagnus angustifolia* and *Salix exigua*, and were not considered suitable ULT habitat (Photo 27). There is moderate to heavy grazing of the canal banks on some properties and not on others. There are several areas of wet meadow habitat within the 300-foot buffer that provide suitable ULT habitat (Photos 28 and 29). Some of these wet meadow habitats appear to be hydrologically supported by seepage from the canal, while others appear to be supported by natural groundwater discharge zones. These wet meadows are dominated by similar wetland species as the canal banks. There are many wet meadow wetlands within the project area that have strongly alkaline soils and exhibit surface salt crust and support alkaline and saline-tolerant plant species (Photo 30). These strongly alkaline wetland areas were not considered suitable ULT habitat.

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APPENDIX A: MAPS

Maps not available for public due to sensitive nature of species location data

APPENDIX B: PHOTOS

Photos not included due to sensitive location information

APPENDIX C: SURVEYOR QUALIFICATIONS

TODD SHERMAN - WETLAND ECOLOGIST

Todd received his Masters from Utah State University's Department of Landscape Architecture and Environmental Planning in 1996 where his research focused on wetland ecosystems of the Intermountain West, and the planning issues associated with these unique environments. Todd is a certified Senior Professional Wetland Scientist (SPWS #1345) whose experience includes ULT surveys, jurisdictional wetland delineation, wetland functional assessment, vegetation analysis and plant community mapping, Section 404 permitting, wetland restoration design, construction supervision and long-term monitoring of wetland mitigation sites, and stream revegetation design. Todd has been conducting ULT surveys since 2001 on over 100 projects throughout the Intermountain West and has found numerous new populations of ULT.

Spiranthes diluvialis Survey

Duchesne County Water Conservancy District
Duchesne County, Utah

September 2022
Wetland Resources

Spiranthes diluvialis
Survey

Duchesne County Water Conservancy District
Canal Piping Project

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September 2022

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Appendix A: Maps

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Appendix C: Surveyor Qualifications

A. Introduction

Wetland Resources conducted a survey for Ute ladies'-tresses (*Spiranthes diluvialis*) (ULT) for a for an irrigation water piping project in Duchesne County, Utah. The survey area consists of seven separate irrigation systems located in Duchesne County, and a 300-foot buffer around each of the proposed pipeline corridors (Appendix A: Map 1). The survey was conducted for Jones and DeMille Engineering, who is providing engineering and environmental services to the Duchesne County Water Conservancy District for this project. The survey was conducted August 2 through 26, 2022 during the ULT blooming season.

The survey area is situated in the Uinta Basin on the south side of the Uinta Mountains. Elevations in the survey area range from 5300 feet above mean sea level to 6500 feet above mean sea level. A majority of the survey area is currently used for agriculture, including livestock grazing and cultivated fields.

B. Methodology

The assessment of ULT suitable habitat criteria and disqualifiers were conducted in accordance with the U.S. Fish and Wildlife Service (USFWS) protocol (USFWS 1992, 2007, and 2011) and supplemental publications and studies (Arft 1995; Fertig 2005). It was determined that ULT was blooming in the region by a visit on July 26, 2022 to a known ULT site near the South Boneta Canal (Photo 1).

Spiranthes diluvialis is typically found associated with alluvial deposits of silty, sandy, gravelly, or cobbly soil (USFWS 1992). The species may occasionally also be found in highly organic soils or peat. The species seems to prefer well drained soils with fairly high moisture content. Soils may exhibit some gleying or mottling but are generally not strongly anaerobic. Spiranthes diluvialis is found in some heavily disturbed sites, for example, old gravel mines that have since been developed into wetlands, and along well traveled footpaths built on old berms. The species is also found in grazed pastures with introduced pasture grasses. Spiranthes diluvialis is found with grasses, sedges, and rushes, in shrubs, and riparian trees such as willow species. It rarely occurs in deeply shaded sites and prefers partially shaded open glades or pastures and meadows in full sunlight. Specifically, the following criteria was used to determine suitable ULT habitat (USFWS 1992):

1. Seasonally high water table (within 18 inches of the soil surface for at least one week sometime during the growing season, growing season defined as when soil temperatures are above 41 degrees Fahrenheit).
2. In or near wet meadows, stream channels, or flood plains.
3. Vegetation falling into the Facultative Wet or Obligate Wet classification, including introduced pasture grasses.
4. Jurisdictional wetlands as specified under the Clean Water Act.

The following criteria was used to disqualify certain habitats within the survey area that do not support potential ULT habitat (USFWS 2007):

1. Appropriate hydrology not present, typically indicated by:
    - area is comprised of mostly upland vegetation
    - area dries up by mid-July, with water table lower than 12 - 18 inches below the soil surface

2. Heavy clay soils present
3. Soils strongly alkaline
4. Site heavily disturbed, such as, for example:
   - stream banks channelized and stabilized by heavy rip-rap
   - highway rights-of-way built on filled or compacted soil or rock material
   - construction sites where construction has either stripped the topsoil or where construction has been completed within the last 5 years but the area has not been revegetated
5. Stream banks steep, transition from stream margin to upland areas abrupt
6. Site characterized by standing water with cattails, bulrushes, and other emergent aquatic vegetation (note that margins of such areas may be suitable habitat).
7. Riparian areas, stream banks, or wetlands vegetated with dense rhizomatous species such as reed canary grass (*Phalaris arundinacea*), tamarisk or salt cedar (*Tamarix ramosissima*), teasel (*Dipsacus sylvestris*), common reed (*Phragmites australis*), or saltgrass (*Distichlis spicata*)
8. Riparian areas overgrazed or otherwise managed such that the vegetation community is comprised of upland native or weedy species or is unvegetated. (note that the orchid can tolerate rather extreme overgrazing as long as it has not resulted in a drop in the water table as indicated by conversion of the riparian or wet meadow pasture vegetation community to mostly upland species).
9. Potential habitat is no longer in a natural condition, for example, has been converted to agricultural uses and is now plowed and cropped, or has been converted to lawns or golf courses (note that wet meadow pastures with a mix of native and non-native pasture grasses, including pastures that are regularly hayed, are suitable potential habitat).
10. Wetland is a brackish playa or pothole not fed by springs or not in the floodplain of or hydrologically connected with a riparian system or other source of fresh water (note that fens and wetlands associated fresh water springs are suitable potential habitat).

Areas that were determined to contain suitable ULT habitat were surveyed using a 100% coverage pedestrian survey with transect widths of 6 feet. ULT locations were mapped with a sub-meter GPS.

C. Results and Discussion

The survey area includes many palustrine emergent (PEM) wetlands that provide varying degrees of suitability for ULT habitat. Some of the canal banks also provide suitable ULT habitat. A detailed description of each of the seven irrigation systems is provided below. The areas of suitable ULT habitat were mapped, and can be found on Maps 2 through 13 in Appendix A. Photos of the survey area are provided in Appendix B.

The areas that were not surveyed for ULT met the criteria provided by the USFWS for disqualified habitat (USFWS 2007). Primarily these areas were dominated by upland vegetation and did not have appropriate hydrology to support ULT (Disqualifying Factor 1). These areas were primarily agricultural fields dominated by upland grasses. In addition, some wetlands and canal banks were also disqualified as suitable habitat because they were dominated by dense stands of *Salix exigua* or *Phalaris arundinacea* (Disqualifying Factor 7). Other wetlands had strongly alkaline soils (Disqualifying Factor 3) that exhibited a surface salt crust and supported alkaline and saline-tolerant plant species.

South Boneta Canal

The banks of the South Boneta Canal provide suitable ULT habitat throughout the survey area (Map 3). The habitat along the canal banks is only a few feet wide on each side of the canal, and is dominated by *Agrostis stolonifera, Juncus balticus, Hordeum jubatum, Equisetum hyemale, Carex rostrata*, and *Carex nebrascensis* (Photo 2). There was very little grazing of the canal banks north of Highway 87 in 2022, compared to moderate grazing the past two years. Three ULT individuals were identified along the banks of the South Boneta Canal in 2022 (Map 9). No individuals were identified along the canal banks in 2020 or 2021, potentially due to heavier grazing those years, or just the unpredictable nature of ULT flowers not blooming every year. There is very little suitable ULT habitat west of the canal within the 300-foot buffer because most of it is a steep dry hillside.

There are several areas of wet meadow habitat east of the canal in the 300-foot buffer that provide suitable ULT habitat (Photo 3). These wet meadows are dominated by similar wetland species as the canal banks plus *Symphyotrichum chilense, Sonchus arvensis*, and *Castilleja minor*. 50 ULT individuals were identified in these wet meadow areas in 2022 (Map 9) (Photos 4 and 5). No ULT individuals were identified in these wet meadows in 2020, and only six were identified in 2021.

The 300-foot buffer also includes the Lake Fork River at the northern end of the survey area. The banks of the Lake Fork River provide high-quality ULT habitat (Photo 6), and a known reference population is located less than two miles downstream. Species growing along the river include *Eleocharis palustris, Carex nebrascensis*, and *Agrostis stolonifera*. Four ULT individuals were identified along the banks of the river in 2020, nineteen were identified in 2021, but none were found in 2022 despite two intensive surveys two weeks apart during the blooming window.

DGIC Class B Canal

The banks of the DGIC Class B Canal provide suitable ULT habitat in some areas and not in others (Map 5). Where there is suitable ULT habitat along the canal banks it is typically only 1 to 3 feet wide, and is dominated by *Agrostis stolonifera, Juncus balticus, Juncus torreyi, Hordeum jubatum, Eleocharis palustris, Alopecurus pratensis*, and *Carex nebrascensis* (Photo 7). Other sections of the canal support dense stands of *Phalaris arundinacea* on the banks or a dense overstory of *Elaeagnus angustifolia* and *Salix exigua*, and were not considered suitable ULT habitat (Photo 8). There is moderate grazing of the canal banks on some properties and not on others. A population of 8 ULT individuals were identified along the canal banks in the northwest portion of the project area (Map 10) (Photos 9 and 10). 32 individuals were identified at this location in 2021, and the area was not part of the 2020 surveys.

There are several areas of wet meadow habitat throughout the 300-foot buffer that provide suitable ULT habitat. Some of these wet meadow habitats appear to be hydrologically supported by seepage from the canal, while others appear to be supported by natural groundwater discharge zones. These wet meadows are dominated by similar wetland species as the canal banks. The vegetation in some of the adjacent wet meadows is too dense for ULT habitat, but some areas are not as densely vegetated and provide suitable habitat. A population of 858 plants was identified in one of these wet meadows in the northwest portion of the project area along 7000 North (Map 12) (Photos 11 and 12). Only 342 individuals were identified in this area in 2021, and the area was not included in the 2020 surveys. This wet meadow supports *Carex nebrascensis, Agrostis stolonifera, Juncus balticus, Castilleja minor*, and *Muhlenbergia asperifolia*. Two ULT individuals were identified in 2022 approximately 0.25 miles south of this large population (Map 12) (Photo 13). This area was not part of the 2020 survey, and was more heavily grazed in 2021 than in 2022.

A total of 41 ULT individuals were identified in 2022 at the population just north of Bluebell (Map 13) (Photo 14). This population only had 5 individuals in 2020, and did not have any blooming ULT present in 2021, likely due to very heavy grazing that year. The other population near the south end of the Class B Canal project area where one individual was identified in 2020, but none in 2021, did not have any individuals again in 2022. The Class B Canal was not flowing during the 2021 and 2022 surveys, while in 2020 the canal was still flowing.

In addition to the proposed pipeline corridors that have been surveyed in past years, several segments of irrigation canals that would be dewatered by the project were added to the survey area in 2022. Since there would be no ground disturbance in these areas, the USFWS guidance for the dewatered canals was that only the banks of the canal needed to be surveyed unless there was suitable ULT habitat adjacent to the canal that was being hydrologically supported by water from the canal. The standard 300' buffer was surveyed in these areas. Some segments of the dewatered canals supported dense stands of reed canary grass or willows, and did not provide suitable ULT habitat (Photo 15). Other segments supported many associated species and did provide suitable ULT habitat (Photo 16). A new population of 49 ULT individuals was identified along one of these dewatered canal segments in the northern portion of the project area in the vicinity of the large ULT population along 7000 North (Map 11) (Photos 17 and 18). The occupied habitat supports *Agrostis stolonifera, Juncus balticus,* and *Castilleja minor.*

Coyote Canal

The Coyote Canal does not contain any suitable ULT habitat along its banks, or within the 300' buffer (Map 4). This canal has very steep banks comprised of cobble and sand (Photo 19). There are very few benches along the canal that support wetland vegetation, and those that do have a dense overstory of *Salix exigua* and *Juniperus osteosperma* and do not provide any suitable ULT habitat (Photos 20 and 21). The natural drainage on the south side of the canal within the 300-buffer is dry and supports an extremely dense stand of *Salix exigua*. There is a headgate at the top end of this drainage where it splits from the Coyote Canal that has been filled in and is no longer operational.

DGIC Class C Canal

This canal provides suitable ULT habitat only at the far western end of the survey area (Map 6). Most of the length of the canal is comprised of very steep banks that are regularly maintained (Photo 22 and 23). There are no benches along most of the canal, just steep banks dominated by dense stands of *Phalaris arundinacea* and *Salix exigua*. The pond at the east end of the canal is an irrigation water holding pond with variable water levels, and does not support any ULT habitat. The suitable ULT habitat occurs on the canal banks (Photo 24) and on adjacent wet meadows below a groundwater discharge zone (Photo 25). The canal banks and the slope are both moderately grazed and are dominated by *Carex nebrascensis, Carex rostrata, Agrostis stolonifera, Eleocharis palustris, Juncus balticus, Juncus torreyi,* and *Trifolium fragiferum.* No ULT individuals were found within the survey area.

Gray Mountain Canal

There is no suitable ULT habitat along the Gray Mountain Canal or within the associated 300-buffer (Map 8). This canal has very steep banks that are regularly maintained. Much of the length of this canal is built on the side of an arid rocky slope, which does not provide suitable soil conditions for ULT along the canal banks (Photo 26). The edges of the canal support wetland vegetation, but it is dense (Photo 27) and inundated by the canal, which is too wet of conditions for ULT (Photo 28). The edges of the canal are dominated by *Phalaris arundinacea, Alopecurus pratense*, and *Salix exigua.*

Yellowstone Feeder Canal

This canal provides suitable ULT habitat only where it crosses a natural drainage (Map 2). Most of the length of the canal is comprised of very steep banks that do not provide suitable ULT habitat (Photo 29). The suitable ULT habitat occurs on benches on both sides of the canal where it crosses a natural drainage (Photo 30), and a small area below the canal (Photo 31). The suitable ULT habitat is dominated by *Carex nebrascensis, Agrostis stolonifera,* and *Juncus balticus.* No ULT individuals were found within the survey area.

Arcadia Farms Irrigation System

The Arcadia Farms irrigation system is comprised of numerous canals and ditches, including the Duchesne Feeder Canal, the Red Cap Canal, and the Midview Ditch. The banks of these canals and ditches provide suitable ULT habitat in some areas and not in others (Map 7). Where there is suitable ULT habitat along the banks it is typically only 1 to 3 feet wide, and is dominated by *Agrostis stolonifera, Juncus balticus, Eleocharis palustris, Castilleja minor, Equisetum hyemale Alopecurus pratensis, Carex aquatilis,* and *Carex nebrascensis* (Photo 32). Other sections of canal support dense stands of *Phalaris arundinacea, Glyceria striata,* or *Typha latifolia* or a dense overstory of *Elaeagnus angustifolia* and *Salix exigua,* and were not considered suitable ULT habitat (Photo 33). There is moderate to heavy grazing of the canal banks on some properties and not on others. There are several areas of wet meadow habitat within the 300-foot buffer that provide suitable ULT habitat (Photos 34 and 35). Some of these wet meadow habitats appear to be hydrologically supported by seepage from the canal, while others appear to be supported by natural groundwater discharge zones. These wet meadows are dominated by similar wetland species as the canal banks. There are many wet meadow wetlands within the project area that have strongly alkaline soils and exhibit surface salt crust and support alkaline and saline-tolerant plant species (Photo 36). These strongly alkaline wetland areas were not considered suitable ULT habitat.

In addition to the proposed pipeline corridors that have been surveyed in past years, several segments of irrigation canals that would be dewatered by the project were added to the survey area in 2022. Since there would be no ground disturbance in these areas, the USFWS guidance for the dewatered canals was that only the banks of the canal needed to be surveyed unless there was suitable ULT habitat adjacent to the canal that was being hydrologically supported by water from the canal. The standard 300’ buffer was surveyed in these areas. No ULT individuals were found along the dewatered canals.

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APPENDIX A: MAPS

Maps not available for public due to sensitive nature of species location data

APPENDIX B: PHOTOS

Photos not included due to sensitive location information

APPENDIX C: SURVEYOR QUALIFICATIONS

TODD SHERMAN - WETLAND ECOLOGIST

Todd received his Masters from Utah State University's Department of Landscape Architecture and Environmental Planning in 1996 where his research focused on wetland ecosystems of the Intermountain West, and the planning issues associated with these unique environments. Todd is a certified Senior Professional Wetland Scientist (SPWS #1345) whose experience includes ULT surveys, jurisdictional wetland delineation, wetland functional assessment, vegetation analysis and plant community mapping, Section 404 permitting, wetland restoration design, construction supervision and long-term monitoring of wetland mitigation sites, and stream revegetation design. Todd has been conducting ULT surveys since 2001 on over 100 projects throughout the Intermountain West and has found numerous new populations of ULT totaling thousands of plants.

Spiranthes diluvialis Survey

Duchesne County Water Conservancy District
Duchesne County, Utah

September 2023
Wetland Resources

Spiranthes diluvialis
Survey

Duchesne County Water Conservancy District
Canal Piping Project

Prepared for:

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September 2023

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Appendix A: Maps

Appendix B: Photos

Appendix C: Surveyor Qualifications

A. Introduction

Wetland Resources conducted a survey for Ute ladies'-tresses (*Spiranthes diluvialis*) (ULT) for a for an irrigation water piping project in Duchesne County, Utah. The survey area consists of six separate irrigation systems located in Duchesne County, and a 300-foot buffer around each of the proposed pipeline corridors (Appendix A: Map 1). The survey was conducted for Jones and DeMille Engineering, who is providing engineering and environmental services to the Duchesne County Water Conservancy District for this project. The survey was conducted August 7 through 30, 2023 during the ULT blooming season.

The survey area is situated in the Uinta Basin on the south side of the Uinta Mountains. Elevations in the survey area range from 5300 feet above mean sea level to 6500 feet above mean sea level. A majority of the survey area is currently used for agriculture, including livestock grazing and cultivated fields.

B. Methodology

The assessment of ULT suitable habitat criteria and disqualifiers were conducted in accordance with the U.S. Fish and Wildlife Service (USFWS) protocol (USFWS 1992, 2007, and 2011) and supplemental publications and studies (Arft 1995; Fertig 2005). It was determined that ULT was blooming in the region by a visit on August 7, 2023 to a known ULT site near Altamont, Utah (Photos 1 and 2).

Spiranthes diluvialis is typically found associated with alluvial deposits of silty, sandy, gravelly, or cobbly soil (USFWS 1992). The species may occasionally also be found in highly organic soils or peat. The species seems to prefer well drained soils with fairly high moisture content. Soils may exhibit some gleying or mottling but are generally not strongly anaerobic. Spiranthes diluvialis is found in some heavily disturbed sites, for example, old gravel mines that have since been developed into wetlands, and along well traveled footpaths built on old berms. The species is also found in grazed pastures with introduced pasture grasses. Spiranthes diluvialis is found with grasses, sedges, and rushes, in shrubs, and riparian trees such as willow species. It rarely occurs in deeply shaded sites and prefers partially shaded open glades or pastures and meadows in full sunlight. Specifically, the following criteria was used to determine suitable ULT habitat (USFWS 1992):

1. Seasonally high water table (within 18 inches of the soil surface for at least one week sometime during the growing season, growing season defined as when soil temperatures are above 41 degrees Fahrenheit).
2. In or near wet meadows, stream channels, or flood plains.
3. Vegetation falling into the Facultative Wet or Obligate Wet classification, including introduced pasture grasses.
4. Jurisdictional wetlands as specified under the Clean Water Act.

The following criteria was used to disqualify certain habitats within the survey area that do not support suitable ULT habitat (USFWS 2007):

1. Appropriate hydrology not present, typically indicated by:
   - area is comprised of mostly upland vegetation
   - area dries up by mid-July, with water table lower than 12 - 18 inches below the soil surface

2. Heavy clay soils present
3. Soils strongly alkaline
4. Site heavily disturbed, such as, for example:
    - stream banks channelized and stabilized by heavy rip-rap
    - highway rights-of-way built on filled or compacted soil or rock material
    - construction sites where construction has either stripped the topsoil or where construction has been completed within the last 5 years but the area has not been revegetated
5. Stream banks steep, transition from stream margin to upland areas abrupt
6. Site characterized by standing water with cattails, bulrushes, and other emergent aquatic vegetation (note that margins of such areas may be suitable habitat).
7. Riparian areas, stream banks, or wetlands vegetated with dense rhizomatous species such as reed canary grass (*Phalaris arundinacea*), tamarisk or salt cedar (*Tamarix ramosissima*), teasel (*Dipsacus sylvestris*), common reed (*Phragmites australis*), or saltgrass (*Distichlis spicata*)
8. Riparian areas overgrazed or otherwise managed such that the vegetation community is comprised of upland native or weedy species or is unvegetated (note that the orchid can tolerate rather extreme overgrazing as long as it has not resulted in a drop in the water table as indicated by conversion of the riparian or wet meadow pasture vegetation community to mostly upland species).
9. Potential habitat is no longer in a natural condition, for example, has been converted to agricultural uses and is now plowed and cropped, or has been converted to lawns or golf courses (note that wet meadow pastures with a mix of native and non-native pasture grasses, including pastures that are regularly hayed, are suitable potential habitat).
10. Wetland is a brackish playa or pothole not fed by springs or not in the floodplain of or hydrologically connected with a riparian system or other source of fresh water (note that fens and wetlands associated fresh water springs are suitable potential habitat).

Areas that were determined to contain suitable ULT habitat were surveyed using a 100% coverage pedestrian survey with transect widths of 6 feet. ULT locations were mapped with a sub-meter GPS.

C. RESULTS AND DISCUSSION

The survey area includes many palustrine emergent (PEM) wetlands that provide varying degrees of suitability for ULT habitat. Some of the canal banks also provide suitable ULT habitat. A detailed description of each of the six irrigation systems is provided below. The areas of suitable ULT habitat were mapped, and can be found on Maps 2 through 10 in Appendix A. Photos of the survey area are provided in Appendix B.

The areas that were not surveyed for ULT met the criteria provided by the USFWS for disqualified habitat (USFWS 2007). Primarily these areas were dominated by upland vegetation and did not have appropriate hydrology to support ULT (Disqualifying Factor 1). These areas were primarily agricultural fields dominated by upland grasses. In addition, some wetlands and canal banks were also disqualified as suitable habitat because they were dominated by dense stands of *Salix exigua* or *Phalaris arundinacea* (Disqualifying Factor 7). Other wetlands had strongly alkaline soils (Disqualifying Factor 3) that exhibited a surface salt crust and supported alkaline and saline-tolerant plant species.

DGIC Class B Canal

The banks of the DGIC Class B Canal provide suitable ULT habitat in some areas and not in others (Map 4). Where there is suitable ULT habitat along the canal banks it is typically only 1 to 3 feet wide, and is dominated by *Agrostis stolonifera, Juncus balticus, Juncus torreyi, Hordeum jubatum, Eleocharis palustris, Alopecurus pratensis,* and *Carex nebrascensis* (Photo 3). Other sections of the canal support dense stands of *Phalaris arundinacea* on the banks or a dense overstory of *Elaeagnus angustifolia* and *Salix exigua,* and were not considered suitable ULT habitat (Photo 4). There is moderate grazing of the canal banks on some properties and not on others. A population of 10 ULT individuals were identified along the canal banks in the northwest portion of the project area (Map 9) (Photos 5 and 6). 8 individuals were identified at this location in 2022, and 32 individuals were identified in 2021.

There are several areas of wet meadow habitat throughout the 300-foot buffer that provide suitable ULT habitat. Some of these wet meadow habitats appear to be hydrologically supported by seepage from the canal, while others appear to be supported by natural groundwater discharge zones. These wet meadows are dominated by similar wetland species as the canal banks. The vegetation in some of the adjacent wet meadows is too dense for ULT habitat, but some areas are not as densely vegetated and provide suitable habitat. A population of 416 plants was identified in 2023 in one of these wet meadows in the northwest portion of the project area along 7000 North (Map 10) (Photos 7 and 8). 858 individuals were identified in this area in 2022, and 342 individuals were identified in 2021. This wet meadow supports *Carex nebrascensis, Agrostis stolonifera, Juncus balticus, Castilleja minor,* and *Muhlenbergia asperifolia.* No ULT individuals were identified in 2023 at the location where 2 individuals were identified in 2022 approximately 0.25 miles south of this large population. No individuals were found at this location in 2021.

In addition to the proposed pipeline corridors that have been surveyed for three years now, several segments of irrigation canals that would be dewatered by the project were added to the survey area in 2022, so this is just the second year of survey of these areas. Since there would be no ground disturbance in these areas, the USFWS guidance for the dewatered canals was that only the banks of the canal needed to be surveyed unless there was suitable ULT habitat adjacent to the canal that was being hydrologically supported by water from the canal. The standard 300’ buffer was surveyed in these areas. Some segments of the dewatered canals supported dense stands of reed canary grass or willows, and did not provide suitable ULT habitat (Photo 9). Other segments supported many associated species and did provide suitable ULT habitat (Photo 10). A new population of 49 ULT individuals was identified in 2022 along one of these dewatered canal segments in the northern portion of the project area in the vicinity of the large ULT population along 7000 North (Map 4) (Photos 11 and 12). The occupied habitat supports *Agrostis stolonifera, Juncus balticus,* and *Castilleja minor*. The landowner did not grant permission to access his property in 2023, so this population was not resurveyed this year.

Coyote Canal

The Coyote Canal does not contain any suitable ULT habitat along its banks, or within the 300’ buffer (Map 3). This canal has very steep banks comprised of cobble and sand (Photo 13). There are very few benches along the canal that support wetland vegetation, and those that do have a dense overstory of *Salix exigua* and *Juniperus osteosperma* and do not provide any suitable ULT habitat (Photos 14 and 15). The privately-owned lands along this alignment have already been surveyed three years, but this was the third year of surveys for the Tribal-owned lands.

DGIC Class C Canal

This canal provides suitable ULT habitat only at the far western end of the survey area (Map 6). Most of the length of the canal is comprised of very steep banks that are regularly maintained (Photo 16 and 17). There are no benches along most of the canal, just steep banks dominated by dense stands of *Phalaris arundinacea* and *Salix exigua*. The suitable ULT habitat occurs in a wet meadow in a hay field (Photo 18). The wet meadow is dominated by *Carex nebrascensis*, *Carex rostrata*, *Agrostis stolonifera*, *Eleocharis palustris*, *Juncus balticus*, *Juncus torreyi*, and *Trifolium fragiferum*. No ULT individuals were found in the last three years of survey. The privately-owned lands along this alignment have already been surveyed three years, but this was the third year of surveys for the Tribal-owned lands.

Gray Mountain Canal

There is no suitable ULT habitat along the Gray Mountain Canal or within the associated 300-buffer (Map 8). This canal has very steep banks that are regularly maintained. The edges of the canal support wetland vegetation, but it is dense (Photo 19) and inundated by the canal, which is too wet of conditions for ULT (Photo 20). The edges of the canal are dominated by *Phalaris arundinacea*, *Alopecurus pratense*, and *Salix exigua*. The privately-owned lands along this alignment have already been surveyed three years, but this was the third year of surveys for the Tribal-owned lands.

Yellowstone Feeder Canal

This canal provides suitable ULT habitat only where it crosses a natural drainage (Map 2). Most of the length of the canal is comprised of very steep banks that do not provide suitable ULT habitat (Photo 21). The suitable ULT habitat occurs on benches on both sides of the canal where it crosses a natural drainage (Photo 22), and a small area below the canal (Photo 23). The suitable ULT habitat is dominated by *Carex nebrascensis*, *Agrostis stolonifera*, and *Juncus balticus*. No ULT individuals were found in the last three years of survey.

Arcadia Farms Irrigation System

The Arcadia Farms irrigation system is comprised of numerous canals and ditches, including the Duchesne Feeder Canal, the Red Cap Canal, and the Midview Ditch. The banks of these canals and ditches provide suitable ULT habitat in some areas and not in others (Map 7). Where there is suitable ULT habitat along the banks it is typically only 1 to 3 feet wide, and is dominated by *Agrostis stolonifera*, *Juncus balticus*, *Eleocharis palustris*, *Castilleja minor*, *Equisetum hyemale* *Alopecurus pratensis*, *Carex aquatilis*, and *Carex nebrascensis* (Photo 24). Other sections of canal support dense stands of *Phalaris arundinacea*, *Glyceria striata*, or *Typha latifolia* or a dense overstory of *Elaeagnus angustifolia* and *Salix exigua*, and were not considered suitable ULT habitat (Photo 25). There is moderate to heavy grazing of the canal banks on some properties. There are several areas of wet meadow habitat within the 300-foot buffer that provide suitable ULT habitat (Photos 26 and 27). Some of these wet meadow habitats appear to be hydrologically supported by seepage from the canal, while others appear to be supported by natural groundwater discharge zones. These wet meadows are dominated by similar wetland species as the canal banks. There are many wet meadow wetlands within the project area that have strongly alkaline soils and exhibit surface salt crust and support alkaline and saline-tolerant plant species (Photo 28). These strongly alkaline wetland areas were not considered suitable ULT habitat.

In addition to the proposed pipeline corridors that have now been surveyed three years, several segments of irrigation canals that would be dewatered by the project were added to the survey area in 2022. Since there would be no ground disturbance in these areas, the USFWS guidance for the dewatered canals was that only the banks of the canal needed to be surveyed unless there was suitable ULT habitat adjacent to the canal that was being hydrologically supported by water from the canal. The standard 300’ buffer was surveyed in these areas.

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APPENDIX A: MAPS

Maps not available for public due to sensitive nature of species location data

APPENDIX B: PHOTOS

Photos not included due to sensitive location information

APPENDIX C: SURVEYOR QUALIFICATIONS

TODD SHERMAN - WETLAND ECOLOGIST

Todd received his Masters from Utah State University's Department of Landscape Architecture and Environmental Planning in 1996 where his research focused on wetland ecosystems of the Intermountain West, and the planning issues associated with these unique environments. Todd is a certified Senior Professional Wetland Scientist (SPWS #1345) whose experience includes ULT surveys, jurisdictional wetland delineation, wetland functional assessment, vegetation analysis and plant community mapping, Section 404 permitting, wetland restoration design, construction supervision and long-term monitoring of wetland mitigation sites, and stream revegetation design. Todd has been conducting ULT surveys since 2001 on over 100 projects throughout the Intermountain West and has found numerous new populations of ULT totaling thousands of plants.

CODY MITTANCK - WETLAND ECOLOGIST/SPATIAL ANALYST

Cody Mittanck has two decades of experience studying and working within ecosystems of the West. He obtained his Master of Science in Ecology from Utah State University in 2012, and is also a certified Professional Wetland Scientist (PWS #3687). He has completed graduate level courses in wetland science, soils, plant physiology, and botany. As a botanist he has 10 years of experience leading surveys for threatened & endangered species in the Uintah Basin and throughout Utah. He specializes in wetland ecosystems, wetland delineations, biological assessments, Section 404 permitting, and wetland mitigation. As a spatial analyst Cody specializes in plant species distribution modeling using GIS and Remote Sensing. He has extensive experience within ESRI, Erdas, R and Python for applications from field data collection, data analysis, to web and report maps.

Engineering Technical Memorandums

TM005 – Yellowstone Feeder Canal

1.0 Introduction

The Moon Lake Water Users Association (MLWUA) operates and maintains the Yellowstone Feeder Canal, which is an open channel transmission canal extending from the diversion located on the Yellowstone River and follows the natural contours around the base of the Uinta Mountains (reference map in App A). Portions of the canal have been identified by (MLWUA) board members as areas of high water loss due to seepage. Reference Appendix A for the project overview map.

1.1 Design Criteria

- NRCS Irrigation Ditch Lining (Code 428, with noted exceptions)
- NRCS Pond Sealing or Lining (Code 522)
- NRCS Utah Supplement NEM-UT-511 Design

2.0 Background

The MLWUA operates and maintains the Yellowstone Feeder Canal in Duchesne County, Utah. The canal was constructed between 1938 and 1940 and is a transmission canal that delivers critical irrigation water for agricultural production from the Yellowstone River to the west branch of Cottonwood Creek. The water is delivered to reservoirs and distribution canals and serves water users in eastern Duchesne and western Uintah counties.

The western section of the canal is about 10.6 miles long. Sections of the canal are becoming increasingly difficult to maintain, resulting in high water loss from seepage. Prior to Phase I canal lining, losses were estimated to be 30 to 40 percent (over 6,000 acre-feet per year). In May 2017, approximately 4,222 linear feet of the canal, identified as high seepage areas, were lined with a geosynthetic membrane covered with 3 inches of concrete. Additional areas of the canal have now been identified as high seepage areas having higher than normal water losses, and the same treatment is proposed for this project.

3.0 System Conditions

Water from the Yellowstone River supports agricultural uses within the Uinta Basin, primarily for the towns of Neola, Monarch, Cedar View, and unincorporated areas in western Uintah County. The MLWUA is comprised of representatives with irrigation districts served by the Moon Lake Project and multiple rivers and reservoirs, with approximately 75,000 acres of irrigated lands in the Uinta Basin. Primary production includes alfalfa, grass hay, cattle and sheep livestock production, and various grains. Agricultural development in the area is limited by the amount of available water to irrigate crops.

Water in the Yellowstone Feeder Canal is diverted from the Yellowstone River at the diversion structure north of the town of Altonah. Storage deliveries are also provided through Coyote Canal to Browns Draw Reservoir. The Yellowstone Feeder Canal historical flows, obtained from www.duchesneriver.org, indicate that the average daily flows typically run around 58.2 cfs during the irrigation season, with some average daily flows reaching up to 88.4 cfs.

There are currently 10 sections of the canal that have been identified by MLWUA board members as areas where most of the water losses are originating from, due to being high seepage areas. Addressing these 10 areas in the next phase of lining the canal will greatly reduce the seepage, with virtually no water loss from seepage in the areas where the canal is lined. Based on site observations, areas with high seepage correspond to cobble stone material along hillsides and draws, while some areas along benches have more clay in the existing soils and less seepage and vegetation growth downhill from the canal.

MLWUA decided to pursue lining the existing open transmission canal instead of piping the canal in order to reduce maintenance costs and risks associated with multiple pipe inlet structures if portions of the canal were enclosed. Additionally, leaving the canal an open transmission canal would allow for stock watering capabilities for existing grazing operations on Ute Tribal lands. The previous project was presented originally as enclosed pipeline segments to the Ute Tribe Business Committee during scoping and they were opposed to the idea and would have likely not approved access permits to do the work if segments of pipeline had been proposed.

3.1 Data Sources

The analysis used GIS and Google Earth to provide information on the project's location and total length. Real-time and historical water data was obtained from the Duchesne River and Tributaries of Utah website at www.duchesneriver.org (accessed 6/29/2020). Soil information was acquired from the U.S. Geological Survey (USGS) website at https://water.usgs.gov/GIS/metadata/usgswrd/XML/ussoils.xml#stdorder (accessed 8/20/2020).

3.2 Water Supply and Demand Analysis

3.2.1 System Water Supply

The water rights involved include the following listed in **Error! Reference source not found.** below:

Table 3-1. MLWUA Yellowstone Feeder Canal Water Rights

Water Right	Company	Flow (cfs)	Type	Priority Date
43-3027 (A416b1)	Lake Fork Irrigation Company	13.5	Certificated	07/31/1905
43-3028 (A416C)	Lake Fork Irrigation Company	1.57	Certificated	07/31/1905
43-3031 (A416a)	Lake Fork Irrigation Company	7.5	Certificated	8/29/1905
43-3117 (A4203)	Lake Fork Irrigation Company	12.0	Certificated	8/26/1911

The above water rights are all in the name of Lake Fork Irrigation Company and were modified in 2013 by Change Application No. a39182. With this approved change, these water rights can divert 34.57 cfs from the Lake Fork, Uinta, and Yellowstone Rivers and can store in Moon Lake, Big Sand Wash, Browns Draw, and Twin Potts Reservoirs. Additionally, the water can be used for irrigation of 2,801.14 acres. In addition to the listed water rights, there are other water rights that are associated with the Uinta Basin Replacement Project, the Equalization Agreement, and MLWUA exchanges that could be benefited by this proposed action.

3.2.2 Water Demand

The Yellowstone Feeder Canal is a transmission canal that conveys water to irrigation companies on the east side of Duchesne County and west side of Uintah County. Over 75,000 acres and approximately a farming population of 1,825 are served by the MLWUA. Additionally, project water serves municipalities such as Roosevelt City with secondary water, supplementing culinary water supplies in the area.

3.3 Water Loss Analysis

A water loss analysis was conducted to determine the range of water loss experienced in the canal during average flow conditions. This analysis evaluated water loss due to seepage; other types of water loss such as overwatering issues, or operational losses were not evaluated due to insufficient flow information within the system. Losses associated with evaporation on open canal systems are typically on the order of 1-2 percent; this loss is considered insignificant and has not been included in the analysis. The analysis looked at the portion of the open canal system that is proposed to be treated.

3.3.1 Data and Assumptions

The daily average flows for the Yellowstone Feeder Canal were obtained from www.duchesneriver.org for a period from January 1, 2015, through June 29, 2020. The data indicated that the average daily flows when the canal is in use is 58.2 cfs, and range from 0 to 88.4 cfs.

The USGS soils seepage information was obtained from the USGS website in an ESRI shapefile (.shp) for Region 14 of the Upper Colorado Basin. This information contains generalized seepage rates for the soils at and around the project area. This information provides a general seepage rate for the area and may be conservative, as the seepage rate within canals along a rocky hillside is expected to be higher due to the soils being more coarse. This information also assumes seepage rates that generalize large areas and are averages of the soils in those areas. Figure 3-1 below shows the typical seepage information overlay on a map of the area around the project. Green and blue are areas of relatively low infiltration/seepage rates, tan and orange areas had relatively average seepage rates, while areas of red are areas where the seepage is higher than average. The seepage/infiltration rate for the area around the project is moderate, with a range from 0 in/hr on rock and ponds, to nearly 7.1 in/hr on coarse gravels or organic soils capable of absorbing this amount of water.

The methodology used to calculate loss assumes that the water demand on the canal is evenly distributed along the length of the canal. This generalization is treated as the canal system conveying water from the head to the end and having a uniform demand along its length.

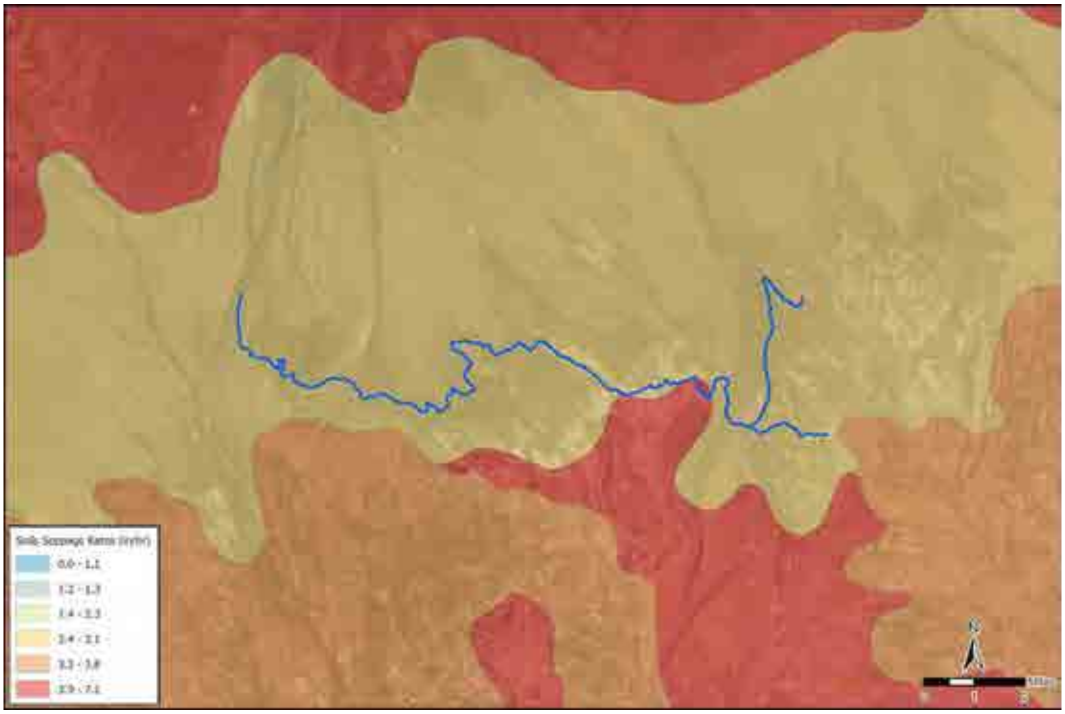


Figure 3-1. Typical Seepage in Project Area

The Yellowstone Feeder Canal has two gauges along the length of the canal. One gauge provides the flows near the diversion from the Yellowstone River, and the Dry Gulch Flume provides the flows near the diversion for Coyote Canal to Browns Draw Reservoir. The Yellowstone Feeder Canal is primarily a transmission canal that does not have any turnouts that are normally used between the two measurement devices along the canal. The difference in flows between the two measurement devices would then indicate the losses experienced in the canal. The flows for the same dates were obtained from www.duchesneriver.org for both of the measurement devices, and the flows for each were averaged. The average flow for the Yellowstone Feeder Canal was 58.2 cfs, and the average flow for the Dry Gulch Flume was 48.3 cfs.

It is important to note that the average flows were determined by removing any days within the data where the Yellowstone Feeder Canal was not in use, including low flow situations and no flow situations. Additionally, the data between the Yellowstone Feeder Canal and the Dry Gulch Flume were compared, and the days when the Yellowstone Feeder Canal was lower than that of the Dry Gulch Flume were also eliminated from the data prior to the average flow calculations. Over the past five years, the average number of days the Yellowstone Feeder Canal was in use was 136 days.

It is important to note that the USGS soil seepage information obtained from the USGS website in an ESRI shapefile (.shp) for Region 14 of the Upper Colorado Basin showed the canal to be in an area where seepage rates ranged from 2.4 to 3.1 in/hr. The seepage rate used in the areas identified as high seepage by MLWUA board members was 2.4 in/hr, while the rest of the canal's seepage rate was set as 0.25 in/hr, except the previously lined areas which had a seepage rate of 0 in/hr.

3.3.2 Methods

The water loss due to seepage is estimated using a seepage rate method for soils. The method requires a seepage rate to be provided and an area measurement where water is subject to seep into the ground. The seepage rates for the project area were determined using information from the USGS and used to estimate the seepage rate for the canal.

The flow velocity in the canal is estimated to vary between 2.1 feet per second (fps) and 6.8 fps, with an estimated average flow velocity of 4 fps. With a known flow rate of the canal, we can calculate the equivalent cross-sectional area of the water in the canal.

The area measurement used in the seepage rate calculation can then be used to estimate the wetted perimeter using the hydraulic radius of an equivalent-sized radial section of pipe. Using this area, the equivalent pipe size needed to convey the same amount of water at the same velocity can be estimated. The area of the pipe is set to be only half the circle because the canal does not enclose the water. Thus, the size of pipe needed to convey the same amount of water as if the pipe were half full is estimated. The equation of a circle is used to determine the arc length, or the wetted perimeter, of the canal that water can seep into. This is shown as the black lines in Figure 3-2 below. Using the wetted perimeter of a circle in the seepage calculation is a conservative choice since the wetted perimeter of the circle will be less than the actual wetted perimeter of the canal channel in the field.

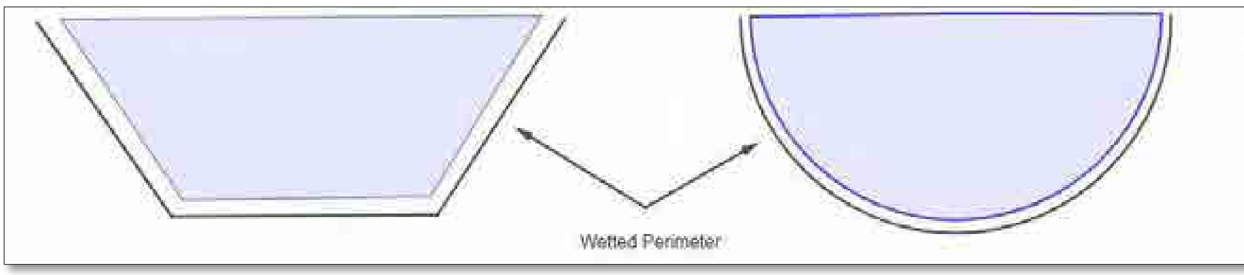


Figure 3-2. Wetted Perimeter

Using the wetted perimeter length, the area where seepage is taking place within the canal can be estimated. The length of the canal is multiplied by the wetted perimeter to calculate the seepage area. This area assumes that there is a constant flow throughout the length of the canal. To account for this assumption, the seepage area is halved if there is no flow at the end of the canal. The average of the wetted perimeter at the start and end of the canal is used to calculate the seepage area when there is a given flow at the end of the canal. The seepage area multiplied by the seepage rate gives the seepage volume per unit of time.

Analyzing the seepage volume per day gives a good basis for analysis because the volume changes over time. The seepage volume is then divided by the amount of water diverted into the canal. This gives the seepage loss as a percentage of the total water diverted. The seepage loss per day can then be multiplied by the number of days in the typical irrigation season to determine the total annual loss due to seepage.

3.3.3 Results

The seepage analysis indicates that the canal has significant seepage losses, especially in areas identified by MLWUA board members as areas of high seepage. The following table summarizes the losses for the length of the Yellowstone Feeder Canal as well as the losses within each individual section identified as areas of high seepage by MLWUA board members.

Table 3-2. Yellowstone Feeder Canal Seepage Analysis Results

Segment	Q Start (cfs)	Q End (cfs)	Length (ft)	Seepage Rate (in/hr)	Q (af/day)	Wetted Perimeter (ft)	Estimated Water Loss (af/day)	Estimated Water Loss (% of total)	Annual Water Loss (af/yr)
River to Liner 1	58.2	58.0	4,541	0.25	115.4	9.5	0.5	0.4%	67

Liner 1	58.0	57.5	774	2.40	114.9	9.5	0.8	0.7%	110
Liner 1 to Liner 2	57.5	57.3	4,897	0.25	114.1	9.5	0.5	0.5%	72
Liner 2	57.3	55.2	4,083	2.40	113.6	9.4	4.2	3.7%	573
Liner 2 to Liner 3	55.2	54.4	14,305	0.25	109.4	9.3	1.5	1.4%	206
Liner 3	54.4	52.8	3,063	2.40	107.9	9.2	3.1	2.9%	420
Existing Liner 1	52.8	52.8	3,000	0.0	104.8	9.1	0.0	0.0%	0
Liner 4	52.8	52.7	330	2.40	104.8	9.1	0.3	0.3%	45
Liner 4 to Existing Liner 2	52.7	52.5	3,071	0.25	104.5	9.1	0.3	0.3%	43
Existing Liner 2	52.5	52.5	2,103	0.0	104.1	9.1	0.0	0.0%	0
Existing Liner 2 to Liner 5	52.5	52.4	1,529	0.25	104.1	9.1	0.2	0.2%	22
Liner 5	52.4	52.0	877	2.40	104.0	9.1	0.9	0.8%	119
Liner 5 to Liner 6	52.0	51.9	1,687	0.25	103.1	9.0	0.2	0.2%	24
Liner 6	51.9	51.5	826	2.40	102.9	9.0	0.8	0.8%	111
Liner 6 to Liner 7	51.5	51.4	2,232	0.25	102.1	9.0	0.2	0.2%	31
Liner 7	51.4	50.9	879	2.40	101.9	9.0	0.9	0.8%	118
Liner 7 to Liner 8	50.9	50.8	2,246	0.25	101.0	8.9	0.2	0.2%	31
Liner 8	50.8	50.6	350	2.40	100.8	8.9	0.3	0.3%	47
Liner 8 to Liner 9	50.6	50.6	791	0.25	100.5	8.9	0.1	0.1%	11
Liner 9	50.6	50.3	650	2.40	100.4	8.9	0.6	0.6%	86
Liner 9 to Dry Gulch Flume	50.3	48.2	41,003	0.25	99.7	8.8	4.1	4.1%	559
Dry Gulch Flume to Liner 10	48.2	34.6	3,005	0.25	95.6	8.0	0.3	0.3%	37
Liner 10	34.6	33.7	2,092	2.40	74.9	7.3	1.7	2.5%	229

Using the average daily flow of 58.2 cfs, the canal experiences approximately 18.9% losses, which translates to approximately 2,960 ac-ft/yr. The losses experienced in the high seepage areas were calculated to be 1,858 ac-ft/yr or approximately 62.8% of the losses experienced in the entire canal.

3.4 Hydraulic Analysis

To perform the hydraulic analysis for the proposed project, an alignment was created in Google Earth that outlined the length of the canal and areas of high seepage. Google Earth and Mannings equation for open channel flow within Hydraulic Toolbox 4.4 was used for the hydraulic analysis.

3.4.1 Data and Assumptions

The model relies on the Google Earth imagery system for an approximate canal alignment, elevation information, and facility locations. The canal alignment is measured using straight lines and does not reflect all of the canal twists and turns. The model provides an approximate alignment and typically within 100 feet of the canal centerline alignment. Elevation information was used from the Google Earth Digital Elevation Model (DEM). The Google Earth DEM is an interpolated model using several different DEM sources. The resulting Google Earth DEM is comparable to a standard SRTM DEM, which has a resolution of approximately 30 meters for the area of interest. The elevation information from the DEM is rough but is sufficient to approximate field conditions for this application.

For the proposed project, a Manning's roughness (n) value of .023 was chosen to represent the shotcrete or concrete used for the liner. Using the data obtained and the Manning roughness coefficient, Manning's equation for open channel flow was used to determine the dimensions needed to convey the design flow safely within the canal. Each lined section length and slope were used to determine the canal dimensions, and the canal dimensions with the deepest flow were chosen to be the dimensions used throughout the project. The freeboard requirements used were the same freeboard requirements as determined in Phase I of the canal lining project.

3.4.2 Methods

The data needed for the hydraulic analysis, including the historic flows of the Yellowstone Feeder Canal, was obtained from previous information gathered during the design of Phase I of the canal lining project, as well as from irrigation company personnel. Google Earth was used to obtain the canal alignment, lengths of proposed lining area, and slopes of the existing canal. Using the information obtained from Google Earth, the water depth at the design flow of the canal was determined using the channel analysis calculator within Hydraulic Toolbox 4.4, which uses Manning's equation for open channel flow.

3.4.3 Model Verification

Phase I of the YFC lining project consisted of lining approximately 4,222 linear feet, and during design of Phase I, the hydraulic design criteria was established for future phases.

3.4.4 Hydraulic Modeling Results

The existing canal uses gravity to transport irrigation water to the water users. The canal system is planned to continue using open channel flow. The existing canal must be checked to ensure adequate capacity to convey the required flows, accounting for seepage losses, flooding, and freeboard.

A calculation spreadsheet was obtained from Mike O'Shea, NRCS, that calculates open channel flow using Manning's Open Channel Flow Equation. The spreadsheet required some initial dimensions to calculate the flow within the canal. The existing canal bottom width was measured to be approximately 4 feet near the proposed treatment segments. The side slopes of the canal liner are generally 2:1 and the slope of the canal was estimated in each lining segment. This information was used to provide a normal flow depth in each of the canal lining segments for the design flow of 90 cfs as summarized in Table 3-3. The additional 1 foot of freeboard is a standard freeboard dimension used in open channel design for the area. The calculation spreadsheet can be seen in Figure 3-3.

Table 3-3. Yellowstone Feeder Canal Water Depth Calculation Results

Segment	Slope (ft/ft)	Water Depth (ft.)
Segment 1	0.0065	1.94
Segment 2	0.0017	2.68
Segment 3	0.0013	2.85
Segment 4	0.0121	1.66
Segment 5	0.0023	2.49
Segment 6	0.0012	2.91
Segment 7	0.0034	2.27
Segment 8	0.0028	2.38
Segment 9	0.0015	2.76
Segment 10	0.0029	2.36

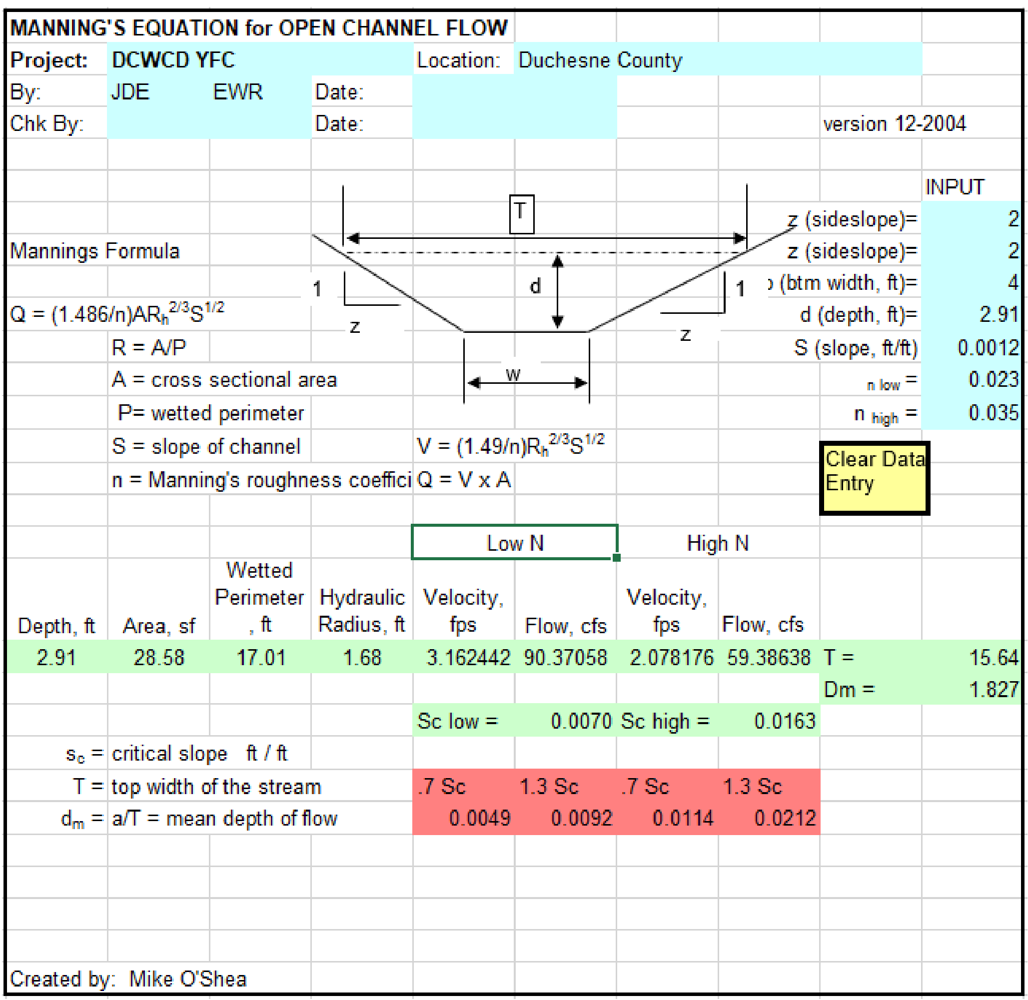


Figure 3-3. Hydraulic Analysis Calculations

The proposed liner sections have been preliminarily designed based on the existing canal alignment and some minor alignment modifications that would remain within the right-of-way and would not require new easement or other relocation requirements to provide the required irrigation flow requirements.

4.0 Description of the Proposed Action

Alternatives were previously developed which were in alignment with the procedures outlined in the NRCS National Watershed Program Manual (NWPM) (NRCS 2014) Parts 501 through 506, NRCS National Watershed Program Handbook (NWPH) (NRCS 2014) Parts 600 through 606, Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies (P&G) (USWRC 1983), and other NRCS watershed planning policy. The alternatives were analyzed for this study based on four criteria outlined in the P&G (USWRC 1983): completeness, effectiveness, efficiency, and acceptability. The proposed alternative was selected based on the ability to address the purpose and need.

The following relevant alternatives and expected consequences must be evaluated, according to the NWPM:

- No Action Alternative – Most likeley future condition if no action alternative is selected.
- Proposed Alternative – This is the federally assisted alternative with the greatest economic benefits, which is one of the alternatives, or a combination of them.

4.1 Alternatives Eliminated from Detailed Study

The following alternatives and options were considered during the planning process but were eliminated from detailed study due to exorbitant costs, environmental impacts, considered infeasible, or other critical factors. A description of the alternatives eliminated from detailed study is included below. Alternatives were eliminated based on the following criteria from the canal company:

- Stop excessive seepage in selected section of the Yellowstone Feeder Canal.
- Flow requirements in the section of the canal is up to 90 cfs maximum.
- Prevent root intrusion from shrubs and trees along canal banks and reduce vegetation growth along canal profile.
- Eliminate canal bank erosion at canal alignment bends and reduce liability with canal bank blowouts and flooding.
- Must be a long-term solution, 50+ years, 75-100 preferable.
- Must be able to withstand livestock and wildlife traffic, no punctures or exposed liners/pipes.
- Provide water to wildlife and livestock in the area per Ut Tribe request.
- Must be able to withstand routine maintenance and canal cleaning with current operating equipment.
- Meets the above criteria and makes financial sense. (Cost)

4.1.1 Membrane Liner with Ballast

This alternative would involve remodeling the canal cross section, installing a plastic liner, and installing cobble and sand over the canal liner. This option would provide approximately 20 years of service.

This option would address most of the irrigation company's requirements and evaluation criteria for flow, seepage control, root intrusion, erosion, liability, and vegetation growth. This alternative does not meet the evaluation criteria for alternative life span, wildlife traffic, or maintenance operations.

4.1.2 HDPE Pipeline – Segments of Canal

This alternative would involve remodeling the canal cross section and installing 60-inch HDPE pipe in the existing canal alignment within the sections that were identified as high seepage, which is approximately 16,900 feet. This option would provide 50+ years of service based on the life span of HDPE. Based off pricing from 2015 when Phase 1 of the Yellowstone Feeder Canal was being evaluated, the cost of this option was determined to be approximately $3,700,000.

This option would address most of the irrigation company's requirements and evaluation criteria for flow, seepage control, root intrusion, erosion, liability, vegetation growth, wildlife traffic, life span, and cost. This alternative does not meet the evaluation criteria for providing water to wildlife in the piped segments or maintenance operations. There are 10 segments identified as high seepage, and each segment would need an inlet and outlet for the pipeline. These inlets and outlets would need to be routinely cleaned and maintained, and with the remoteness of the YFC, this increases maintenances operations as it would require personnel to more frequently travel to the canal for maintenance.

4.1.3 HDPE Pipeline

This alternative would involve remodeling the canal cross section and installing a 60-inch HDPE pipe in the existing canal alignment for the first 10.6 miles of the YFC. This option would provide 50+ years of service based on the life span of HDPE. Based off pricing from 2015 when Phase 1 of the Yellowstone Feeder Canal was being evaluated, the cost of this option was determined to be approximately $14,000,000.

This option would address most of the irrigation company's requirements and evaluation criteria for flow, seepage control, root intrusion, erosion, liability, vegetation growth, wildlife traffic, maintenance operations, and life span. This alternative does not meet the evaluation criteria for providing water to wildlife or cost.

4.2 Alternatives Considered for Detailed Study

Feasible alternatives that can meet the purpose and need for the Yellowstone Feeder Canal project were studied in detail. Two alternatives were evaluated in detail which include 1) the No Action, and 2) the Proposed Alternative.

Preliminary cost estimates were developed for the alternatives using the following procedures:

- Based on (month), 2021 U.S. dollars
- Estimated quantities of construction materials and labor
- Cost associated with mitigation of potential environmental and cultural/historical impacts were not included.

The alternatives considered for detailed study are described below.

4.2.1 No Action Alternative

The No Action Alternative considers the project and resource concerns in the future if no federally funded action were taken. It is also known as the Future-Without-Project plan. With the implementation of the No Action alternative, the canal would remain the same and no improvements authorized. The existing environmental conditions would remain the same. The implementation of this alternative would have no direct costs, with financial opportunities being forfeited.

The estimated operations and maintenance (O&M) costs are approximately $17,600 per year. This includes costs associated with canal cleaning, vegetation removal, beaver maintenance, washout repairs, vegetation control, spraying, mowing, direct labor costs, fuel, equipment, and non-routine maintenance required for continued operation.

4.2.2 Proposed Alternative

Implementation of the Proposed Alternative would authorize the lining of approximately 2.6 miles of the canal in 10 sections using a concrete canal liner. The liners range in length from approximately 300 feet long to 4,000 feet long. The construction of the canal liner would be completed after the irrigation season when the canal was not in use. They could be completed all at once or in phases as funding becomes available, with the more critical sections to be lined first.

The existing canal alignment would be utilized with minor adjustments to the canal alignment being performed only within the existing right-of-way to minimize the bends within the liner. The proposed canal improvements include shaping the existing earthen channel to provide a consistent cross section, installing and compacting sufficient base material for stabilization, installing a composite geomembrane liner, installing shotcrete at 3-inch thickness, and making any grading improvements necessary for freeboard and the access roadway. The proposed lining would be installed using a hydraulically efficient design and would transition naturally into the existing canal banks to minimize erosion and seepage issues.

The lands used for the proposed project are within the canal right-of-way and would use existing prescriptive easements.

5.0 References

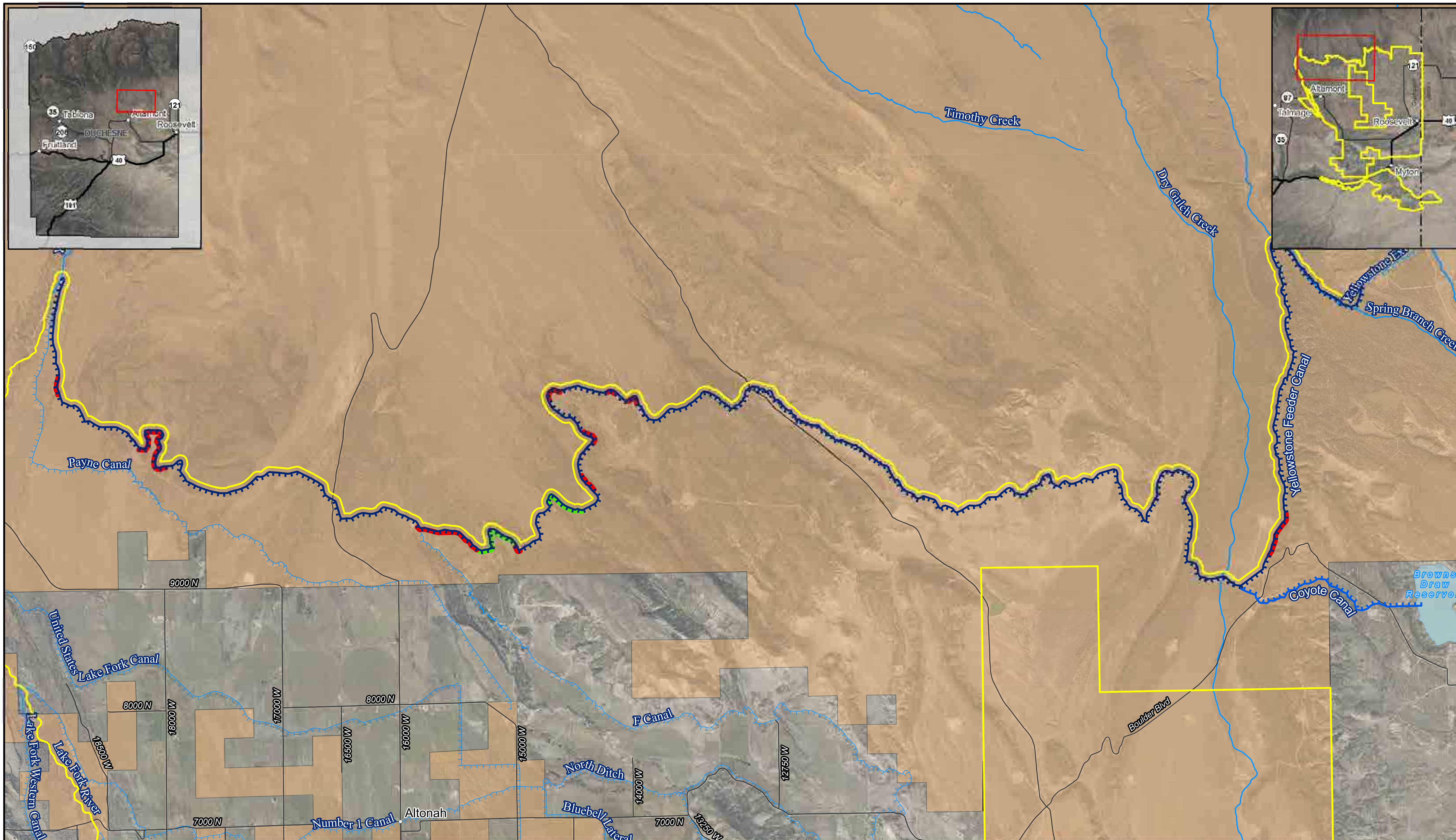
Utah Supplement NEM-UT-511 Subpart A Design.

Utah Irrigation Zone Map, https://deq.utah.gov/public-interest/irrigation-zone-map

Duchesne River Data, http://www.duchesneriver.org/rivers/lake-fork/

USDA Cropland, https://nassgeodata.gmu.edu/CropScape/

Appendix A. Project Overview Map



Completed Liner - Ph. 1

Proposed Lined Section - Ph. 2

Yellowstone Feeder Canal

Coyote Canal

Watershed Boundary

Land Ownership

Tribal Lands

N

Feet

0 2,000 4,000

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Watershed Plan EA

Yellowstone Feeder Canal Proposed Lining Overview

Map Name: H:\JD\Proj\1907-354\Design\GIS\Projects\Environmental\1907-354_Env.aprx - Exh DCWD Watershed EA Yellowstone Feeder Canal Proposed Lining 11x17L

Project Number: 1907-354 | Drawn by: JEM 07-20 | Last Edit: 04/21/2022

Duchesne County

Scale: 1" = 4,000'

1

TM007 – Coyote Canal

1.0 Introduction

The Coyote Canal Project has been identified as an opportunity to address erosion and sediment deposition into Brown's Draw Reservoir by enclosing a portion of the canal in a pipeline to carry irrigation water and storage flows to a stabilized area of the earthen canal. The Coyote Canal is located approximately 6.5 miles west of Neola, Utah, where it runs between the Yellowstone Feeder Canal and Browns Draw Reservoir, as shown in the map in Appendix A.

1.1 Design Criteria

- NRCS Irrigation Pipeline (Code 430)
- NRCS Utah Supplement NEM-UT-511 Design
- NRCS Utah Engineering Technical Notes - Flexible Conduits (TN UT210-15-01)

2.0 Background

The Coyote Canal is a lateral that delivers water from the Yellowstone Feeder Canal and drops it down a series of steep chutes to Brown's Draw Reservoir. Recent erosion nearly failed a county road and required emergency repairs to the roadway and culvert. Additionally, the sediment from the erosion ended up in Brown's Draw Reservoir.

MLWUA proposes to enclose a section of the canal to prevent erosion and sediment deposition into Brown's Draw Reservoir. The pipeline, which would have a screened inlet structure and an outlet structure with energy dissipation, would extend from the takeoff point at the Yellowstone Feeder Canal and carry irrigation water and storage flows down the first steep drop to a location further downstream that has become stabilized without erosion.

3.0 System Conditions

The Coyote Canal conveys water from the Yellowstone Feeder Canal to Brown's Draw Reservoir. Flows typically run at about 38.6 cfs to fill the reservoir between October and December, depending on the water year.

3.1 Data Sources

The analysis used topographic survey data obtained using GPS equipment in order to design the proposed pipeline. Historical water flows within Coyote Canal were obtained from www.duchesneriver.org (accessed 8-20-2020).

3.2 Water Supply and Demand Analysis

3.2.1 System Water Supply

The water rights involved include the following listed in **Error! Reference source not found.** below:

Table 3-1. MLWUA Yellowstone Feeder Canal Water Rights

Water Right	Company	Flow (cfs)	Type	Priority Date
43-3027 (A416b1)	Lake Fork Irrigation Company	13.5	Certificated	07/31/1905
43-3028 (A416C)	Lake Fork Irrigation Company	1.57	Certificated	07/31/1905
43-3031 (A416a)	Lake Fork Irrigation Company	7.5	Certificated	8/29/1905
43-3117 (A4203)	Lake Fork Irrigation Company	12.0	Certificated	8/26/1911

The above water rights are all in the name of Lake Fork Irrigation Company and were modified in 2013 by Change Application No. a39182. With this approved change, these water rights can divert 34.57 cfs from the Lake Fork, Uinta, and Yellowstone Rivers and can store in Moon Lake, Big Sand Wash, Browns Draw, and Twin Potts Reservoirs. Additionally, the water can be used for irrigation of 2,801.14 acres. In addition to the listed water rights, there are other water rights that are associated with the Uinta Basin Replacement Project, the Equalization Agreement, and MLWUA exchanges that could be benefited by this proposed action.

3.2.2 Water Demand

The Coyote Canal is a transmission canal to convey storage water to Brown's Draw Reservoir; there is no specific demand associated with the canal. The daily average flows (approximately 28.4 cfs) in the canal are highest in the month of October, with maximum flows at 106 cfs.

3.3 Water Loss Analysis

A water loss analysis was conducted to determine the range of water loss experienced in the canal during average flow conditions. This analysis evaluated water loss due to seepage; other types of water loss such as overwatering issues, or operational losses were not evaluated due to insufficient flow information within the system to evaluate these losses. Losses associated with evaporation are typically on the order of 1%-2% on open canal systems. This small water loss in the canal system is considered insignificant and has not been included in this loss analysis. The water loss analysis looked at the portion of the open canal system which is proposed to be replaced by the proposed project.

3.3.1 Data and Assumptions

The daily average flows for the Coyote Canal were obtained from www.duchesneriver.org for a period from January 1, 2015 thru June 29, 2020. The data obtained indicated that the average daily flows when Browns Draw Reservoir is being filled were around 38.6 cfs, and typically ranged from 0 to 50 cfs.

The USGS soils seepage information was obtained from the USGS website for Region 14 of the Upper Colorado Basin. This information contained generalized seepage rates for the soils at and around the project area. This information provides a general seepage rate for the area and may be conservative as the seepage rate within canals at the base of a hill is expected to leak more water due to the soils being more coarse at the foot of a hill. This information also assumes seepage rates that generalize large areas and are averages of the soils in those areas. The figure below shows the typical seepage information overlay on a map of the area around the project. Green and blue are areas of relatively low infiltration/seepage rates, while areas of orange to red are areas where the seepage is higher than average. The seepage/infiltration rate varies in this area anywhere from 0 in./hr. on rock and ponds, to nearly 7.1 in./hr. on coarse gravels or organic soils capable of absorbing this amount of water.

The methodology used to calculate loss assumes that the water demand on the canal is evenly distributed along the length of the canal. This canal system conveys water from the head to the end and has a uniform demand along its length.

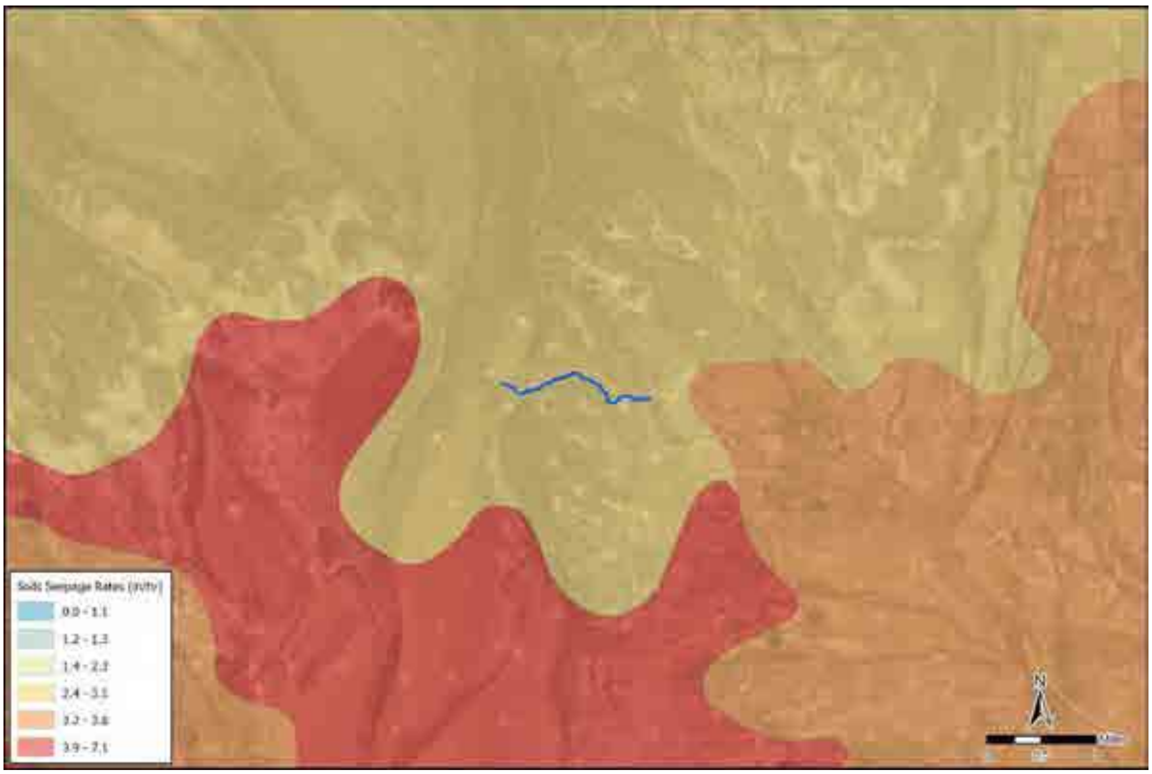


Figure 3-1. Typical Seepage in Project Area

3.3.2 Methods

The water loss due to seepage is estimated using a seepage rate method for soils. The method requires a seepage rate to be provided and an area measurement where water is subject to seep into the ground. The seepage rates for the project area were determined using information from the U.S. Geological Survey (USGS) and used to estimate the seepage rate for the canal.

The flow velocity in the canal is estimated to be vary between 2.0 feet per second (fps) and 7.5 fps, with an estimated average flow velocity of 4 fps. Knowing the flow rate of the canal in cfs, you can get the equivalent cross-sectional area of the water in the canal.

The area measurement used in the seepage rate calculation can then be used to estimate the wetted perimeter using the hydraulic radius of an equivalent sized radial section of pipe. Using this area, the equivalent pipe size needed to convey the same amount of water at the same velocity can be estimated.

The area of the pipe however is set to be only half the circle because the canal does not enclose the water. Thus, the size of pipe needed to convey the same amount of water as if the pipe were half full is estimated. The equation of a circle is used to get the arc length, or the wetted perimeter of the canal that the water can seep into. This is shown as the black lines in Figure 3-3 below. Using the wetted perimeter of a circle in the seepage calculation is a conservative choice since the wetted perimeter of the circle will be less than the actual wetted perimeter of the canal channel in the field.

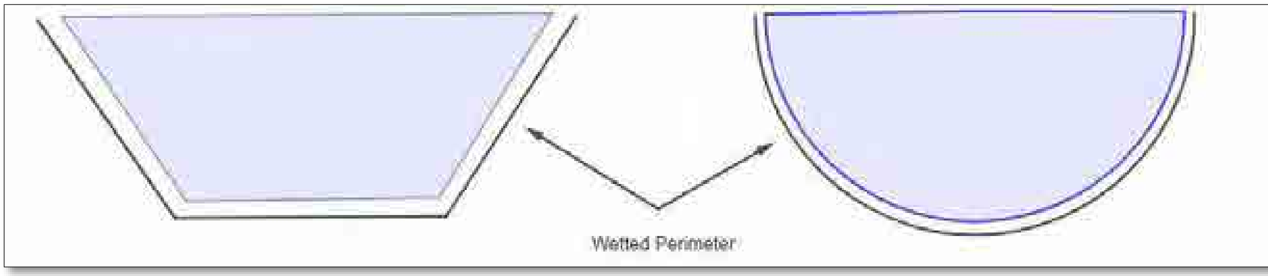


Figure 3-2. Wetted Perimeter

Using the wetted perimeter length, the area where seepage is taking place within the canal can be estimated. The length of the canal is multiplied by the wetted perimeter to get the seepage area. This area assumes that there is a constant flow throughout the length of the canal. To account for this assumption, the seepage area is cut in half if there is zero flow at the end of the canal. The average of the wetted perimeter at the start and end of the canal is used to calculate the seepage area when there is a given flow at the end of the canal. Taking the seepage area and multiplying it by the seepage rate gives the seepage volume per unit of time.

Analyzing the seepage volume per day gives a good basis for analysis because the volume changes over time. The seepage volume is then divided by the amount of water diverted into the canal. This gives the seepage loss as a percentage of the total water diverted. The seepage loss per day can then be multiplied by the number of days in the typical irrigation season to determine the total annual loss due to seepage.

3.3.3 Results

The seepage analysis results for the Coyote Canal are summarized in the table below.

Table 3-2. Coyote Canal Seepage Analysis Results

Segment	Q Start (cfs)	Q End (cfs)	Length (ft)	Seepage Rate (in/hr)	Q (af/day)	Wetted Perimeter (ft)	Estimated Water Loss (af/day)	Estimated Water Loss (% of total)	Annual Water Loss (af/yr)
Entire Canal	28.4	24.8	8,774	2.92	56.3	56.3	7.6	13.5	591
Proposed Pipeline Segment	28.4	26.4	4,413	2.92	56.3	56.3	3.9	6.9	303

Using the average daily flow of 28.4 cfs, the Coyote Canal experiences an estimated water loss of 13.5 percent over the entire length of the canal. This translates into approximately 7.6 ac-ft/day when the canal flows are averaged. Using this average daily loss along with the average days the Coyote Canal was used during the past 5 years, the water loss experienced in the canal is approximately 591 ac-ft/year. The portion of the canal that is proposed to be piped experiences water losses at approximately 3.9 ac-ft/day or a 6.9% loss. With the average number of days the Coyote Canal was in use over the last 5 years, the water loss experienced is approximately 303 ac-ft/year. Enclosing the proposed segment of the Coyote Canal would reduce losses by over 51%.

3.4 Sediment and Erosion Analysis

A sediment analysis was conducted to determine the amount of erosion that has occurred causing sedimentation to deposit into Brown's Draw Reservoir below Coyote Canal as well as sediment and erosion that could occur if the proposed project was not completed.

3.4.1 Data and Assumptions

Knowledge of the area prior to erosion occurring, photographs, and historical imagery were all used during analysis. Additionally, a topographic survey was performed of the area to provide elevation data for the current existing ground of the canal. Using this information, the current channel width and depth could be determined.

The prior depth of the channel was estimated knowing that the original elevation of the channel was at the bottom of the existing culvert. Additionally, the possible future deposition into Brown's Draw Reservoir was determined by estimating the possible future channel bottom by finding a downstream equilibrium slope and projecting it upstream.

3.4.2 Methods

The estimated depth of the channel before erosion was estimated. The area between the existing ground profile and the estimated ground before erosion occurred was determined and multiplied by the average channel width over the same length. This provided the volume of erosion and sediment that travels downstream to Brown's Draw Reservoir.

Additionally, the downstream stable channel equilibrium slope was estimated and projected upstream to determine the amount of potential erosion that could occur if the proposed project were not completed. The area between the existing ground and potential erosion was determined and multiplied by the average channel width over the same length. This provided the volume of erosion and sediment that could potentially travel downstream to Brown's Draw Reservoir.

3.4.3 Results

The analysis showed that there was approximately 15,200 cubic yards of sediment that had eroded from the channel in previous years. Additionally, if the proposed project were not completed, approximately 10,900 additional cubic yards or 6.76 acre-feet could continue to erode and make its way to Brown's Draw Reservoir.

3.5 Hydraulic Analysis

In order to perform the hydraulic analysis of the proposed pipeline, system information was obtained from MLWUA board members, and a topographic survey was performed of the area using GPS equipment. Using the gathered information, an alignment and profile were created in AutoCAD Civil 3D.

3.5.1 Data and Assumptions

The data needed for the hydraulic analysis included the historical flows of the Coyote Canal and topographic survey information. This information was gathered from MLWUA board members, publicly available sources, as well as field collection.

The design flow for the canal was chosen as 90 cfs due to historical flows and potential future flows. It was assumed during design of this pipeline that the pipeline would be open channel flow as the end would be open to the atmosphere with an energy dissipation structure. A Manning's roughness coefficient of 0.012 was chosen for the HDPE pipe.

3.5.2 Methods

Using the topographic survey information that was collected, an alignment and profile were created in AutoCAD Civil 3D. Using the station information as well as the elevations from Civil 3D, a calculation spreadsheet was created to determine pipeline size and velocities within the pipeline.

3.5.3 Model Verification

The model was not verified by field measurements.

3.5.4 Hydraulic Modeling Results

Using the design flow of 90 cfs, in order to keep the proposed pipeline within open channel flow, the first 885 feet of the pipeline would be 63-inch HDPE with the remainder of the pipeline being 54-inch HDPE. Project details are described in Section 4.0.

4.0 Alternatives Evaluation

Alternatives were previously developed which were in alignment with the procedures outlined in the NRCS National Watershed Program Manual (NWPM) (NRCS 2014) Parts 501 through 506, NRCS National Watershed Program Handbook (NWPH) (NRCS 2014) Parts 600 through 606, Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies (P&G) (USWRC 1983), and other NRCS watershed planning policy. The alternatives were analyzed for this study based on four criteria outlined in the P&G (USWRC 1983): completeness, effectiveness, efficiency, and acceptability. The proposed alternative was selected based on the ability to address the purpose and need.

The following relevant alternatives and expected consequences must be evaluated, according to the NWPM:

- No Action Alternative – Most likely future condition if no action alternative is selected
- Proposed Alternative – This is the federally assisted alternative with the greatest economic benefits, which is one of the alternatives, or a combination of them.

4.1 Alternatives Eliminated from Detailed Study

The following alternatives and options were considered during the planning process but were eliminated from detailed study due to exorbitant costs, environmental impacts, considered infeasible, or other critical factors. A description of the alternatives eliminated from detailed study is included below. Alternatives were eliminated based on the following criteria from the canal company:

- Reduce water losses in Coyote Canal.
- Flow requirements in this section of the canal is up to 90 CFS maximum.
- Reduce sediment being deposited into Brown's Draw Reservoir.
- Eliminate canal erosion and reduce liability with canal bank blowouts.

- Reduce or eliminate difficult access areas for maintenance.
- Must be a long-term solution, 50+ years, 75-100 preferable.
- Meets the above criteria and makes financial sense (Cost).

4.1.1 Riprap and Erosion Control

This alternative would involve remodeling the canal cross section, installing geotextile material, and installing riprap for streambank protection in areas where the canal has experienced erosion.

This option would address most of the irrigation company's requirements and evaluation criteria for flow, reduction of sediment, eliminating canal erosion, and liability. This alternative does not meet the evaluation criteria for life span, difficult access, and reducing water losses.

4.1.2 Dual Pipeline

This alternative would involve remodeling the canal cross section, installing two HDPE pipelines, and constructing a dissipation structure at the end of the pipelines. These pipes would be 42" and 48" pipes and would run parallel to each other in the existing canal alignment. This option would provide 50+ years of service based on the life span of the HDPE. This option was evaluated to cost approximately $1,623,000.

This option would address most of the irrigation company's requirements and evaluation criteria for flow, reduction of sediment, eliminating canal erosion, liability, and life span. This alternative does not meet the evaluation criteria for project cost.

4.2 Alternatives Considered for Detailed Study

Feasible alternatives that can meet the purpose and need for the Grey Mountain Canal project were studied in detail. Two alternatives were evaluated in detail which include 1) the No Action, and 2) the Proposed Alternative. Conceptual design drawings for the Proposed Alternative are included in Appendix B.

Preliminary cost estimates were developed for the alternatives using the following procedures:

- Based on July 2021 U.S. dollars.
- Estimated quantities of construction materials and labor
- Costs associated with mitigation of potential environmental and cultural/historical impacts were not included.

The alternatives considered for detailed study are described below.

4.2.1 No Action Alternative

The No Action Alternative considers the project and resource concerns in the future if no federally funded action were taken. It is also known as the Future-Without-Project Plan. With the implementation of the NO Action Alternative, the canal would remain the same and no improvements authorized. The existing environmental conditions would remain the same. The implementation of this alternative would have no direct costs, with financial opportunities being forfeited.

The estimated operations and maintenance (O&M) costs are approximately $16,600 per year. This includes costs associated with canal cleaning, vegetation removal, beaver maintenance, washout repairs, vegetation control, spraying, mowing, direct labor costs, fuel, equipment, and non-routine maintenance required for continued operation.

4.2.2 Proposed Alternative

The goals of the Coyote Canal proposed project were to reduce water losses as well as reduce erosion occurring within the earthen channel. Currently, the Coyote Canal is an earthen channel that has been eroding and depositing sediment into Brown's Draw Reservoir over many years.

The proposed project includes constructing a pipe inlet screen structure, enclosing approximately 4.415 linear feet of the existing earthen channel using approximately 885 linear feet of 63-inch and 3,530 linear feet of 54-inch HDPE pipe, and constructing a dissipation structure at the end of the pipeline. The pressure rating of the pipeline would be DR 32.5 (63 psi), and the pipeline would be able to convey 90 cfs while remaining in open channel flow. Additionally, areas of the canal after the dissipation structure would be shaped and stabilized using riprap to reduce erosion and further sediment deposition into Brown's Draw Reservoir. See Appendix B for the plan sheets of the proposed action.

5.0 References

Natural Resources Conservation Service (NRCS). 2014c. Irrigation Pipeline Code 430.

Utah Supplement NEM-UT-511 Subpart A Design.

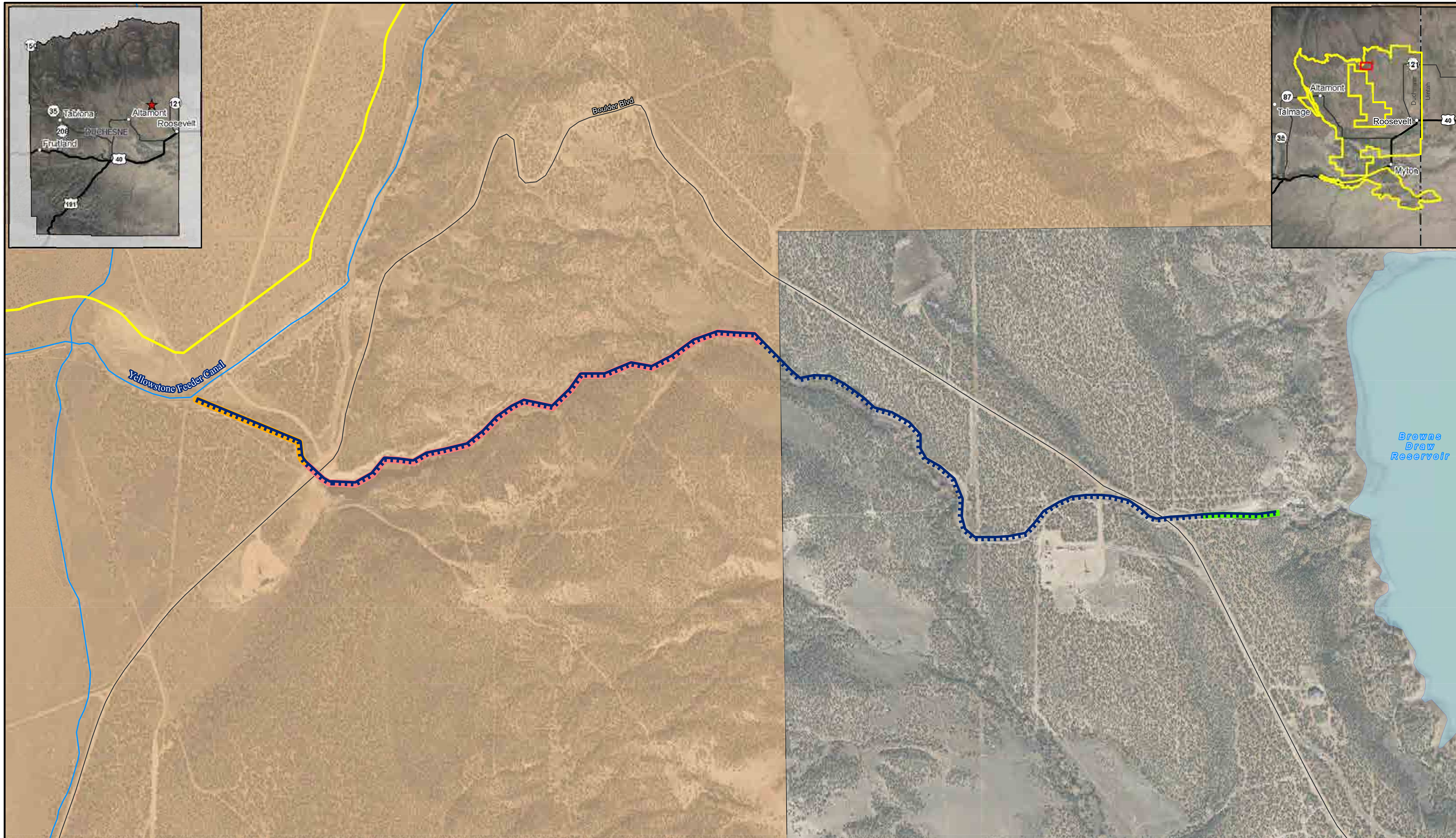
Utah Engineering Technical Notes - Flexible Conduits (TN UT210-15-01)

Utah Irrigation Zone Map, https://deq.utah.gov/public-interest/irrigation-zone-map

Duchesne River Data, http://www.duchesneriver.org/rivers/lake-fork/

USDA Cropland, https://nassgeodata.gmu.edu/CropScape/

Appendix A. Project Overview Map



Stabilization of Channel

Proposed Pipeline

63" HDPE

54" HDPE

Coyote Canal

Watershed Boundary

Tribal Lands

N

0 300 600 Feet

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Watershed Plan EA
Coyote Canal Project Location

Map Name: H:\JD\Proj\1907-354\Design\GIS\Projects\Environmental\1907-354_Env.aprx - Exh DCWD Watershed EA Coyote Canal Project Overview 11x17L

Project Number: 1907-354	Drawn by: JEM 07-20	Last Edit: 04/21/2022

Duchesne County

Scale: 1" = 600'

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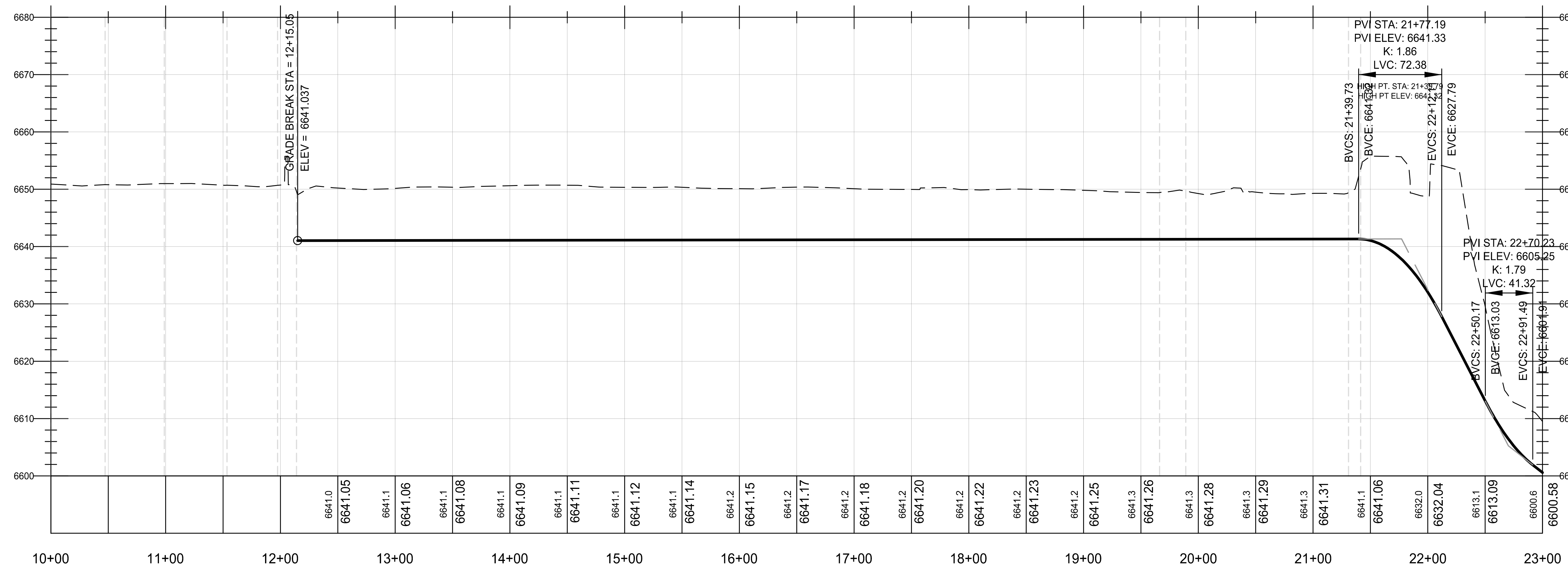
Appendix B. Conceptual Design Drawings



NO.	DATE	REMARKS
		REVISIONS

UPDATED: 1/8/2020
PLOTTED: 1/15/2020

DWG NAME: H:\JD\Proj\1908-226\dwg\PP_1908-226.dwg

SCALE: 1" = 100'

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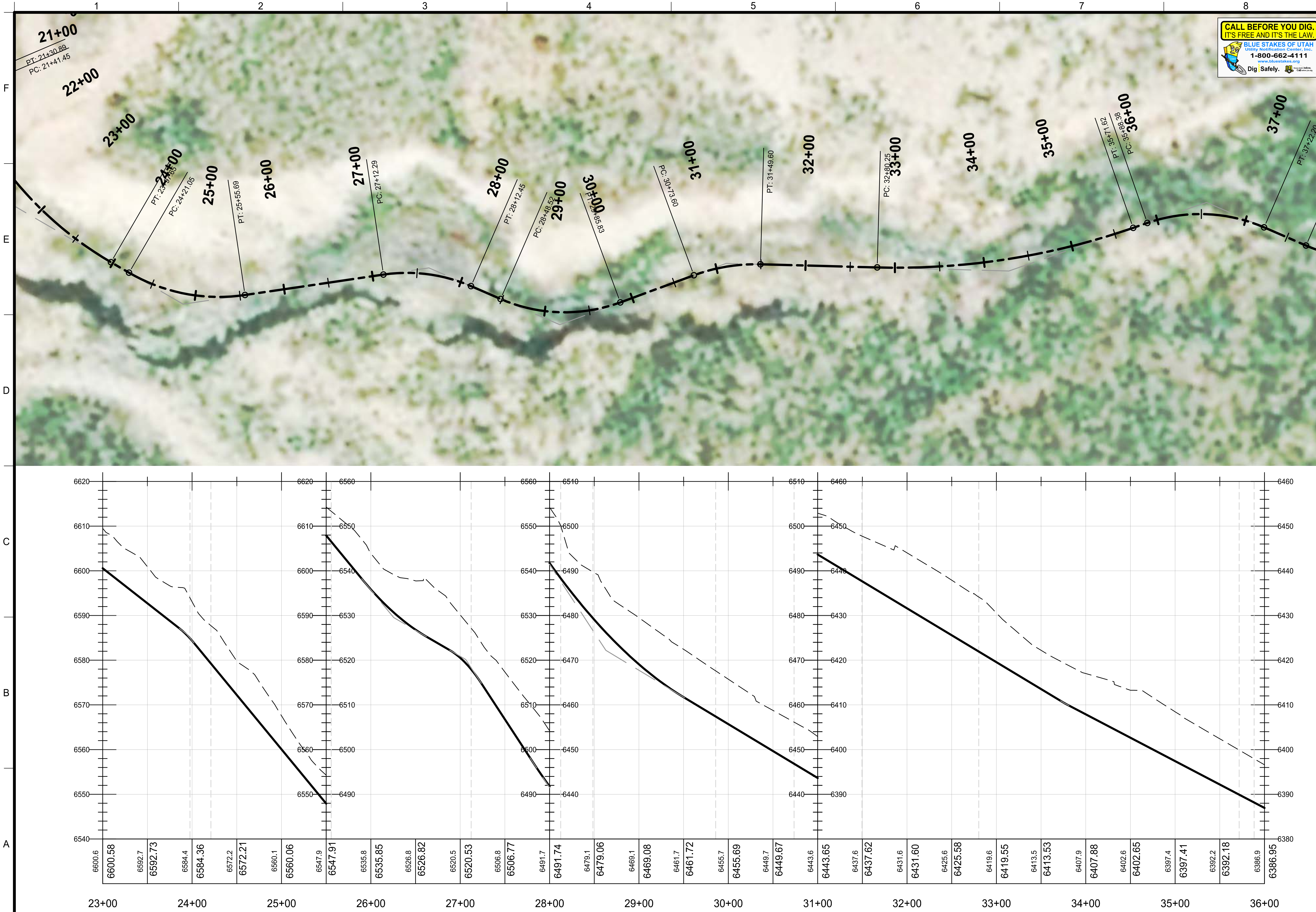
APPROVAL RECOMM: PROJECT DESIGN ENGINEER — DATE
APPROVED: QUALITY MANAGEMENT REVIEW — DATE

MOON LAKE WATER USERS ASSOCIATION
COYOTE CANAL PIPELINE
PLAN AND PROFILE

PROJECT NUMBER: 1908-226

DUCHESNE
COUNTY

SHEET NO. PP-01



MOON LAKE WATER USERS ASSOCIATION

COYOTE CANAL PIPELINE

PLAN AND PROFILE

PROJECT NUMBER: 1908-226

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NO.	DATE	REMARKS

SCALE: 1" = 100'

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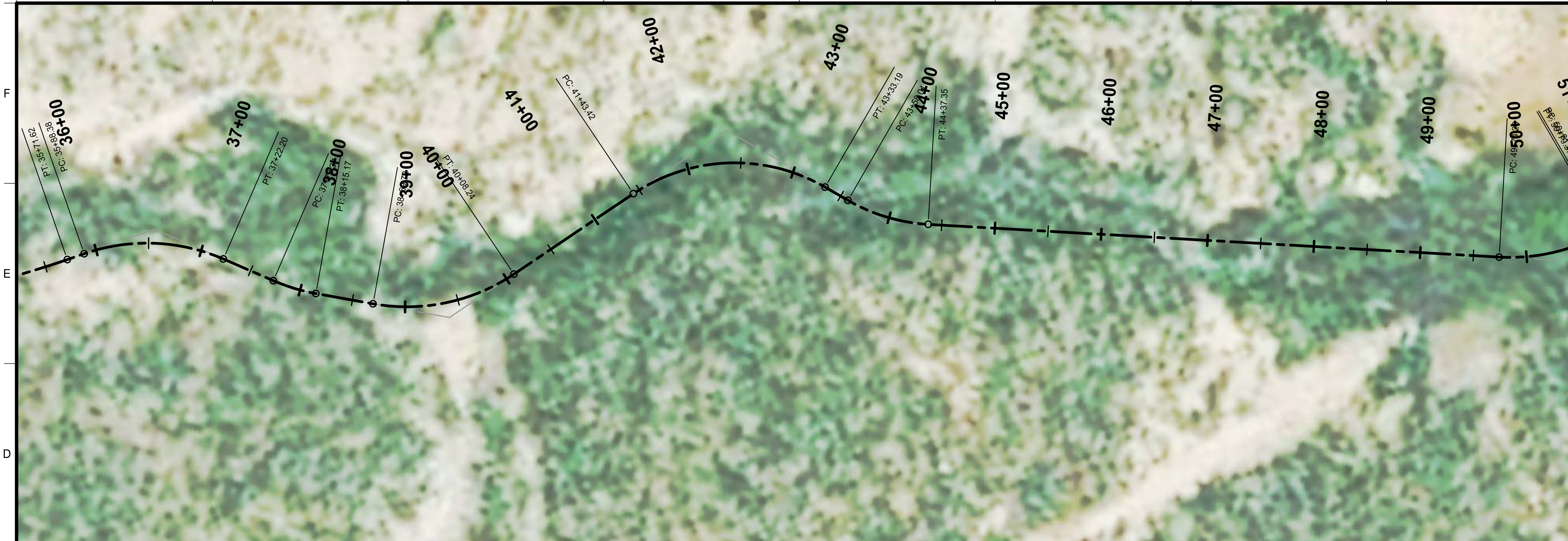
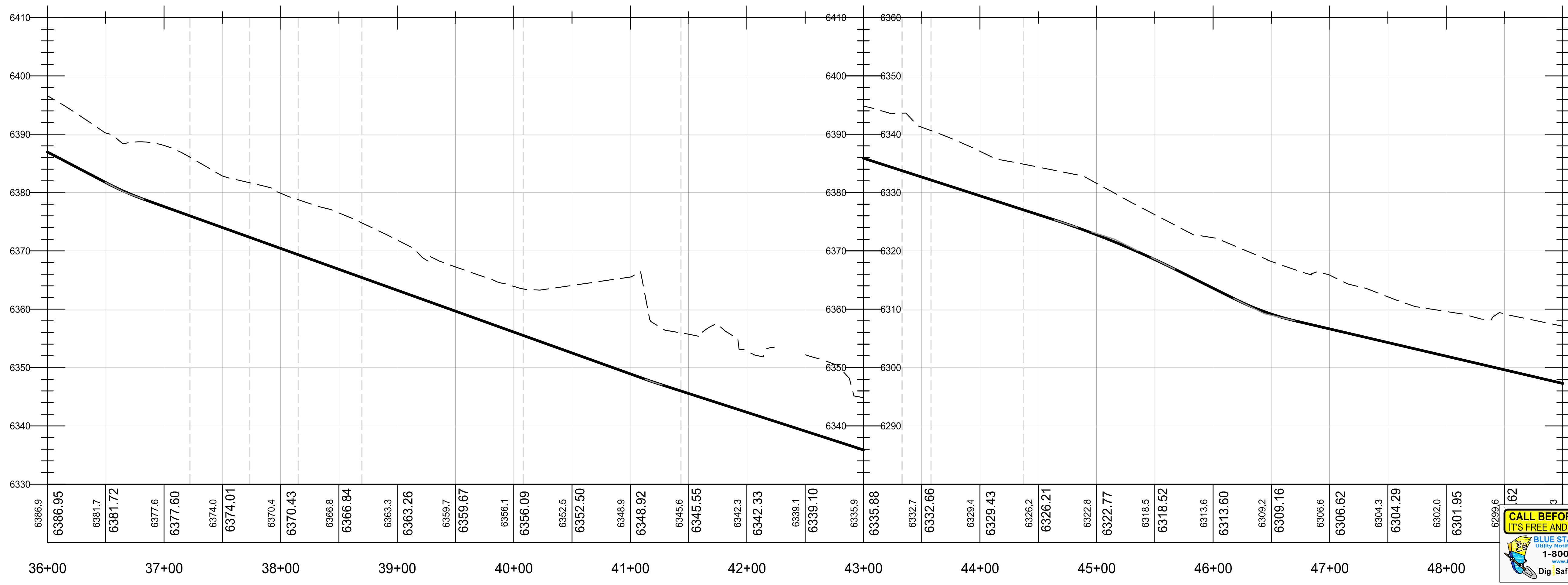
UPDATED: 1/8/2020

PLOTTED: 1/15/2020

DUCHESNE
COUNTY

SHEET NO. PP-02





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PLAN AND PROFILE

PROJECT NUMBER: 1908-226

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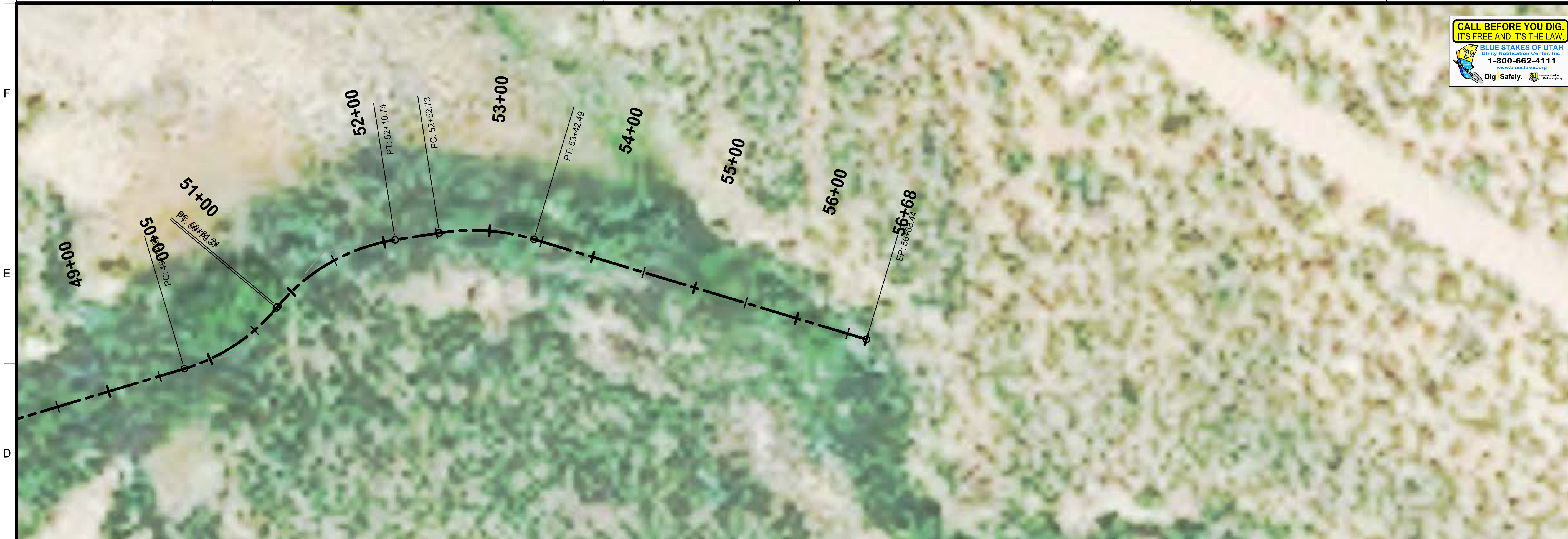

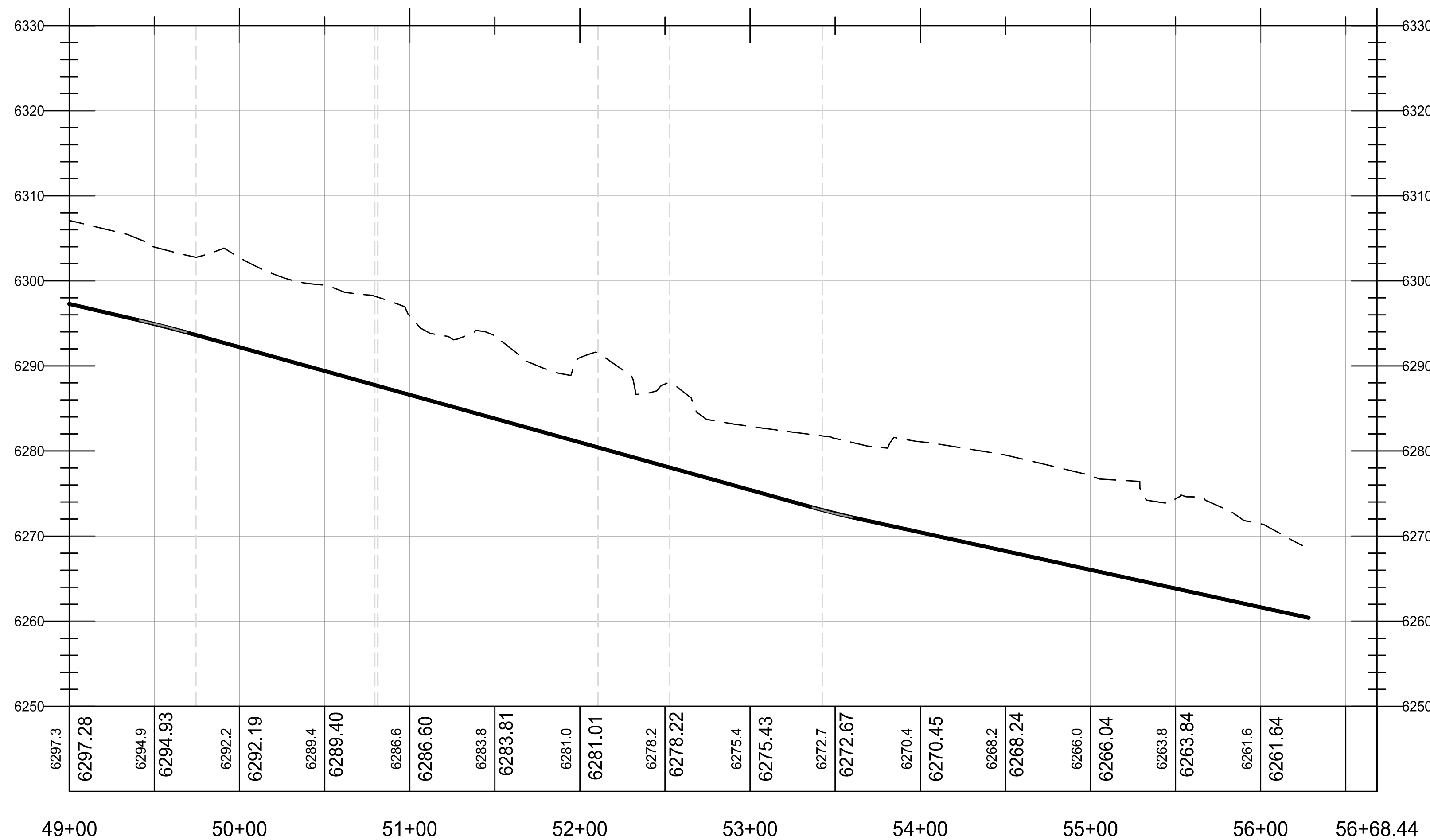

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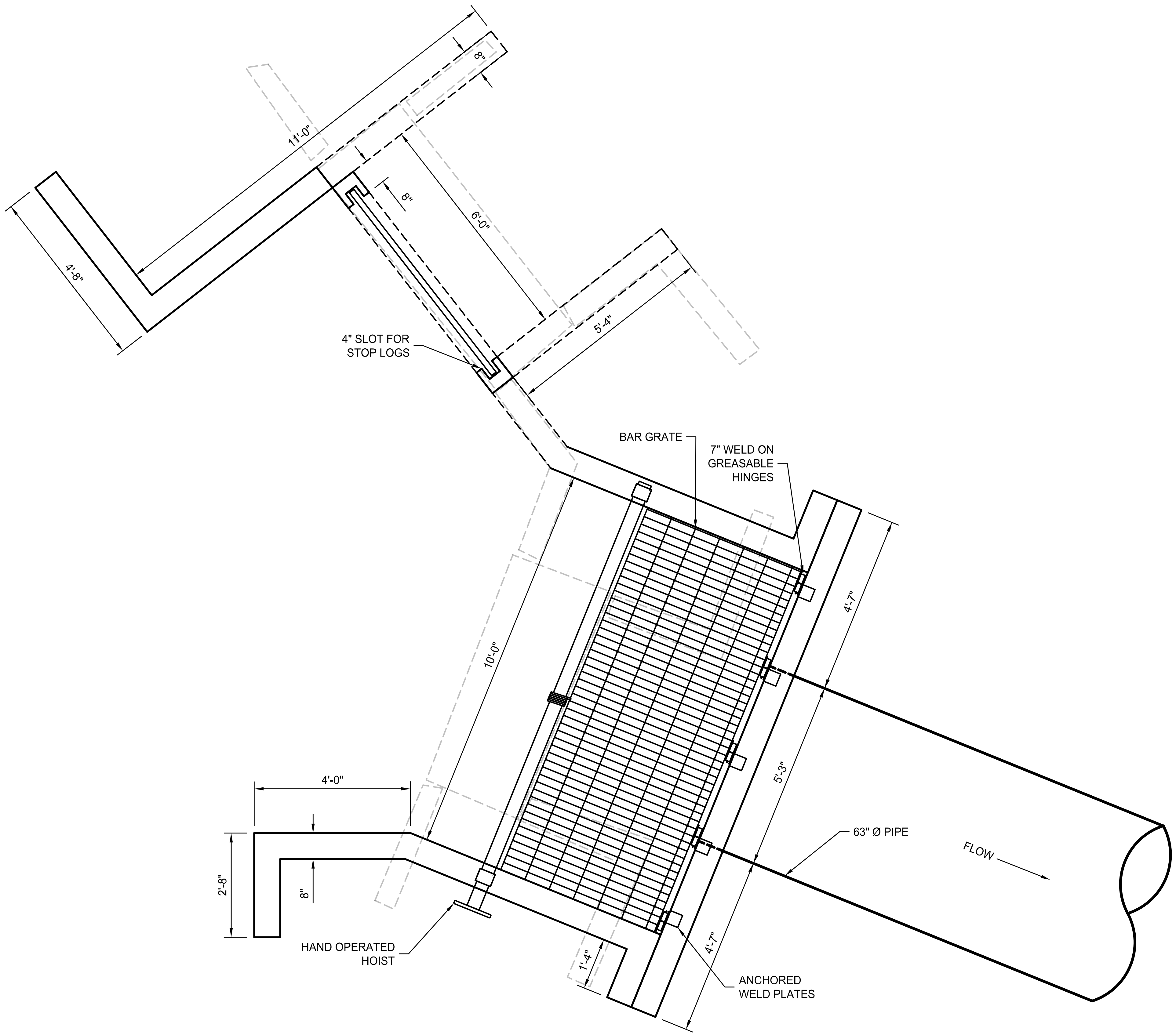

A1	DIVERSION STRUCTURE PLAN DETAIL
SCALE	1" = 3'

MOON LAKE WATER USERS ASSOCIATION

COYOTE CANAL REHABILITATION

DETAILS

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REVISIONS

NO.	DATE	REMARKS

SCALE: 1" = 3'

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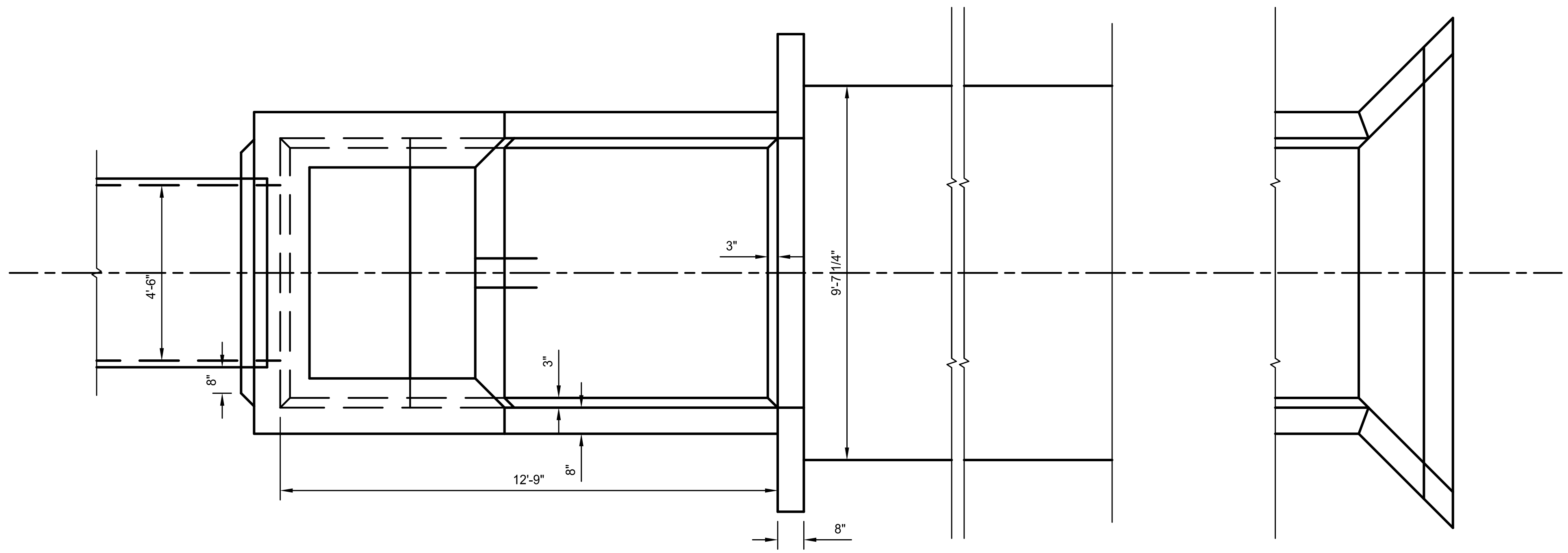
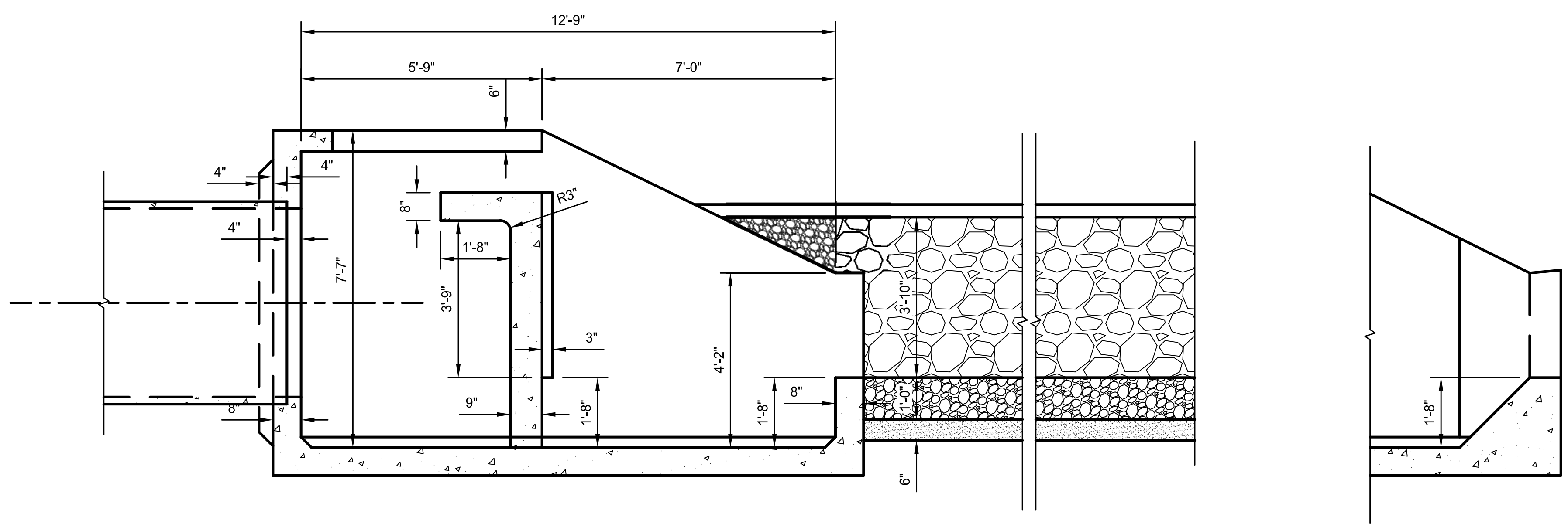
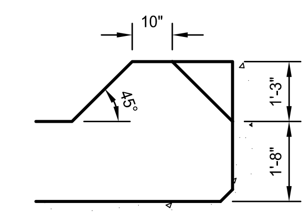
UPDATED: 4/19/2022
PLOTTED: 4/27/2022

DUCHESNE
COUNTY

SHEET NO. DT-01







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UPDATED: 4/19/2022

PLOTTED: 4/27/2022

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MOON LAKE WATER USERS ASSOCIATION

COYOTE CANAL REHABILITATION

DETAILS

PROJECT NUMBER: 1908-226

DUCHESNE COUNTY

SHEET NO. DT-02

TM006 – South Boneta Project

1.0 Introduction

The South Boneta Project has been identified for improvements to address water conservation and irrigation water delivery efficiency through reducing seepage and evaporation losses and providing pressures for sprinkler irrigation. The site is located approximately 2.3 miles west of the town of Altamont and 0.5 mile south of Hwy 87 (see map in 0).

1.1 Design Criteria

- NRCS Irrigation Pipeline (Code 430)
- NRCS Utah Supplement NEM-UT-511 Design
- NRCS Utah Engineering Technical Notes - Flexible Conduits (TN UT210-15-01)

2.0 Background

The South Boneta Irrigation Company has owned and operated the South Boneta Canal for over 100 years. The gravity flow delivery system includes approximately 2.4 miles of open channel canal.

The canal is unlined and has no turnouts as it travels south to the company's existing 18-inch pipeline. When the canal is full, the water master estimates that the canal loses 5 cfs due to seepage and evaporation.

3.0 System Conditions

The South Boneta Canal provides water to its shareholders south of the canal who irrigate about 615 acres. Crops irrigated include high mountain pasture crops including grass/pasture and other hay crops. At the end of the canal, water flows into an existing 18-inch pipeline, which currently does not have enough pressure to provide for sprinkler irrigation on the upper portion of the current irrigation system.

The ditch master has observed water losses in the canal. The ditch master says that with approximately 8 cfs diverted at the head, only about 4 cfs enters into the pipeline, which is a loss of about 50 percent.

3.1 Data Sources

The analysis used GIS and Google Earth to provide information on the project's location and total length. Real-time and historical water data was obtained from the website www.duchesneriver.org (accessed August 20, 2020). Soil information was acquired from the U.S. Geological Survey (USGS) website at https://water.usgs.gov/GIS/metadata/usgswrd/XML/ussoils.xml#stdorder (accessed August 20, 2020.

3.2 Water Supply and Demand Analysis

3.2.1 System Water Supply

South Boneta Irrigation Company has one water right, 43-3103, which has a priority date of 10/6/1910. The right allows for diversion of 8.8 cfs from Lake Fork River between April 1 thru October 31 for use on 616.73 acres. It also allows for diversion from Big Sand Wash, Browns Draw, Moon Lake, and Twin Potts Reservoirs. The right allows for direct flow rights by diverting and storing during the irrigation period or diverting directly through the original points of diversion. The average daily flow during the 2015-2020 irrigation seasons was 3.3 cfs, with a maximum flow of 9.9 cfs.

3.2.2 Water Demand

Utah's Irrigated Crop Consumptive Use Zones are shown in Figure 3-2. The project area is in the moderate zone, with a general irrigation diversion duty of 3.0 acre-feet per acre. With 616.73 irrigated acres, the annual maximum allowable diversion is 1,850.195 acre-feet.

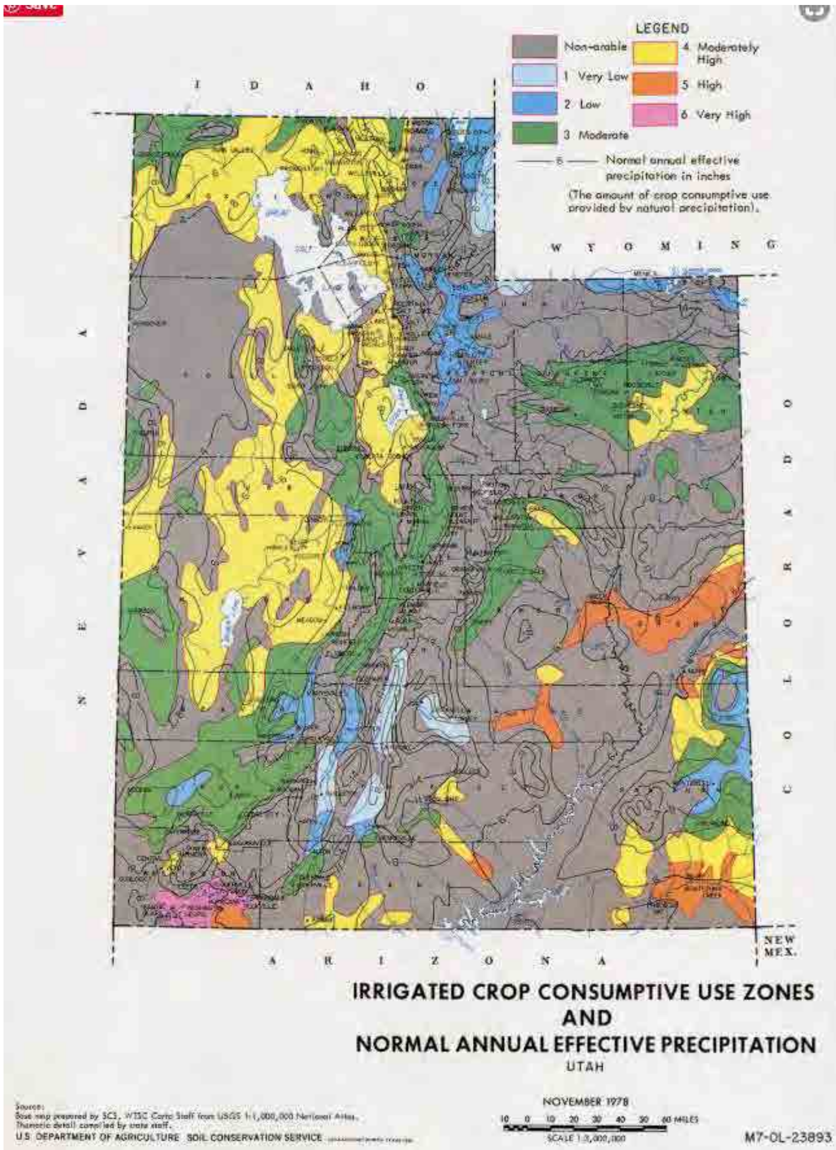


Figure 0-1. Crop Consumptive Use Zones[1]

3.3 Water Loss Analysis

The estimated water loss for the South Boneta Canal was obtained from the irrigation company president, who estimates that the water loss was about 50 percent during summer months. A water loss analysis was conducted to confirm the company's estimate and determine the range of water loss experienced in the canal during average flow conditions. This analysis evaluated water loss in a portion of the open canal system due to seepage; other types of water loss such as overwatering issues or operational losses were

[1] https://deq.utah.gov/public-interest/irrigation-zone-map (accessed 8-20-2020)

not evaluated due to insufficient flow information within the system to evaluate these losses. Losses associated with evaporation are typically on the order of 1-2 percent on open canal systems. This small water loss in the canal system is considered insignificant and has not been included in this loss analysis.

3.3.1 Data and Assumptions

The daily average flows for the South Boneta Canal were obtained from www.duchesneriver.org for a period from April 1, 2015 thru October 31, 2020. The data obtained indicated that the average daily flows during the irrigation season of April 1 to October 31 in the South Boneta Canal was 3.3 cfs, and ranged from 0 to 9.9 cfs. The average flow during the irrigation season between the dates available was 3.3 cfs.

The USGS soils seepage information was obtained from the USGS website for Region 14 of the Upper Colorado Basin. This information contained generalized seepage rates for the soils at and around the project area. This information provides a general seepage rate for the area and may be conservative as the seepage rate within canals at the base of a hill is expected to leak more water due to the soils being more coarse at the foot of a hill. This information also assumes seepage rates that generalize large areas and are averages of the soils in those areas. The figure below shows the typical seepage information overlay on a map of the area around the project. Green and blue are areas of relatively low infiltration/seepage rates, while areas of orange to red are areas where the seepage is higher than average. The seepage/infiltration rate varies in this area anywhere from 0 in./hr. on rock and ponds, to nearly 7.1 in./hr. on coarse gravels or organic soils capable of absorbing this amount of water.

The methodology used to calculate loss assumes that the water demand on the canal is evenly distributed along the length of the canal. This canal system conveys water from the head to the end and has a uniform demand along its length.

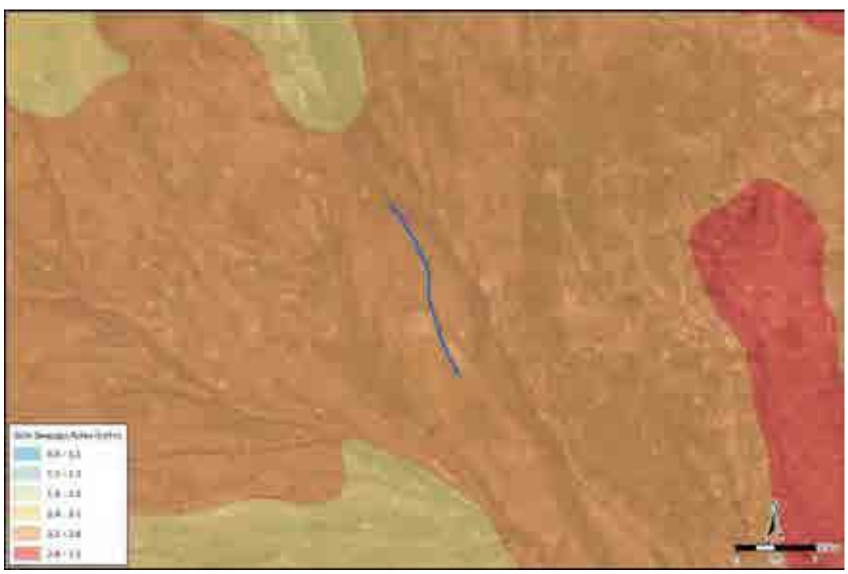


Figure 0-2. Typical Seepage in Project Area

3.3.2 Methods

The water loss due to seepage is estimated using a seepage rate method for soils. The method requires a seepage rate to be provided and an area measurement where water is subject to seep into the ground. The seepage rates for the project area were determined using information from the U.S. Geological Survey (USGS) and used to estimate the seepage rate for the canal.

The flow velocity in the canal is estimated to be vary between 2.0 feet per second (fps) and 7.5 fps, with an estimated average flow velocity of 4 fps. Knowing the flow rate of the canal in cfs, you can get the equivalent cross-sectional area of the water in the canal.

The area measurement used in the seepage rate calculation can then be used to estimate the wetted perimeter using the hydraulic radius of an equivalent sized radial section of pipe. Using this area, the equivalent pipe size needed to convey the same amount of water at the same velocity can be estimated. The area of the pipe however is set to be only half the circle because the canal does not enclose the water. Thus, the size of pipe needed to convey the same amount of water as if the pipe were half full is estimated. The equation of a circle is used to get the arc length, or the wetted perimeter of the canal that the water can seep into. This is shown as the black lines in Figure 3-3 below. Using the wetted perimeter of a circle in the seepage calculation is a conservative choice since the wetted perimeter of the circle will be less than the actual wetted perimeter of the canal channel in the field.

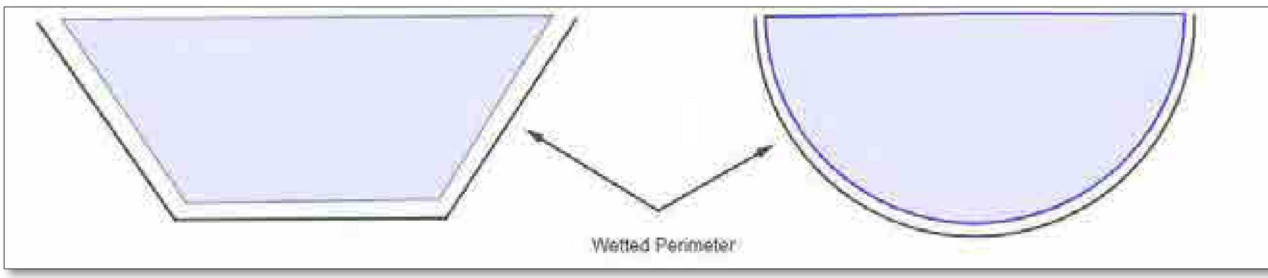


Figure 0-3. Wetted Perimeter

Using the wetted perimeter length, the area where seepage is taking place within the canal can be estimated. The length of the canal is multiplied by the wetted perimeter to get the seepage area. This area assumes that there is a constant flow throughout the length of the canal. To account for this, the seepage area is cut in half if there is zero flow at the end of the canal. The average of the wetted perimeter at the start and end of the canal is used to calculate the seepage area when there is a given flow at the end of the canal. Taking the seepage area and multiplying it by the seepage rate gives the seepage volume per unit of time.

Analyzing the seepage volume per day gives a good basis for analysis. The seepage volume is then divided by the amount of water diverted into the canal. This gives the seepage loss as a percentage of the total water diverted. The seepage loss per day can then be multiplied by the number of days in the typical irrigation season to determine the total annual loss due to seepage.

3.3.3 Results

The seepage analysis indicates that the canal has significant seepage losses along the South Boneta Canal. The following table summarizes the losses.

Table 0-1. Calculated Losses on South Boneta Canal

Q Start (cfs)	Q End (cfs)	Length (ft)	Seepage Rate (in/hr)	Q (af/day)	Wetted Perimeter (ft)	Loss (af/day)	Loss %
3.3	1.3	12,896	3.45	6.5	1.9	3.79	**58.7**

Using the average daily flow of 3.3 cfs and the estimated water loss of 58.7 percent from the canal, the South Boneta Canal experiences water loss as high as 3.8 ac-ft/day when the canal flows are averaged. The seepage rate is nearly 7.2 ac-ft/day when the canal is at a maximum flow of 9.9 cfs. Using this average daily flow, the water loss in the canal is 812 ac-ft/year. This method confirms the estimate from the irrigation company personnel that losses are around 50 percent.

3.4 Hydraulic Analysis

To evaluate the hydraulic performance of the existing canal system and proposed pipeline, a GIS alignment and operation model was developed. This model consisted of a Google Earth alignment drawn using satellite imagery of the current canal system. System information was gathered from discussions with the irrigation company personnel, who are familiar with the area and the irrigation systems operation and history.

3.4.1 Data and Assumptions

The model was developed and prepared in collaboration with the irrigation company personnel. Information was transmitted verbally over phone calls or via email. This information was used to evaluate the existing system and provide design information for alternative analysis.

The model relies on the Google Earth imagery system for an approximate canal alignment, elevation information, and facility locations. The canal alignment is measured using straight lines and does not reflect all of the canal twists and turns. The model provides an approximate alignment and is typically within 100 feet of the canal centerline alignment. Elevation information was used from the Google Earth Digital Elevation Model (DEM). The Google Earth DEM is an interpolated model using several different DEM sources. The resulting Google Earth DEM is comparable to a standard SRTM DEM which has a resolution of approximately 30 meters for the area of interest. The elevation information used from the DEM is rough but is sufficient to approximate field conditions for this application. A starting elevation of 6590 was used to begin the design.

All facility locations marked using Google Earth were located using references to visual landmarks or features, such as approximate distances from roads, bridges, driveways, houses, fences, and other visible features on the Google Earth imagery. Many features were visible in varying dates of the Google Earth imagery.

For the proposed project, a Hazen-Williams coefficient of 150 was used to determine the HDPE pipe size and class required to convey 10 cfs in the pipeline with no turnouts. Pressures were evaluated to determine if a PRV was needed to maintain allowable pressures. The NRCS standard of 72 percent of maximum pressure rating was maintained throughout the design.

3.4.2 Methods

This information was gathered using a local engineering professional in communication with the irrigation company personnel. The local engineering professional was able to coordinate, organize, and consolidate the collected information. The principal method of modeling the existing and proposed systems was using Google Earth and a calculation spreadsheet. Google Earth was used to measure and approximate system elevations, canal lengths, observe system operational control locations, and evaluate alternative options. The calculation spreadsheet was used to compare existing system lengths, quantities to future alternative material quantities, and quantify operational differences between the existing and future system.

3.4.3 Model Verification

The verification consisted of a system overview map that showed the entire system. The model was not verified by field measurements.

3.4.4 Hydraulic Modeling Results

The existing canal uses gravity to transport irrigation water to the irrigation company's existing 18-inch pipeline. The canal system does not provide enough pressure for the shareholders to use sprinkler irrigation. The existing canal has adequate capacity to convey the available flows, accounting for seepage losses.

The proposed pipeline was preliminarily designed based on using the existing canal alignment conveying the maximum diversion of 10 cfs. Project details are described in Section 4.0.

4.0 Alternatives Evaluation

Alternatives were previously developed which were in alignment with the procedures outlined in the NRCS National Watershed Program Manual (NWPM) (NRCS 2014) Parts 501 through 506, NRCS National Watershed Program Handbook (NWPH) (NRCS 2014) Parts 600 through 606, Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies (P&G) (USWRC 1983), and other NRCS watershed planning policy. The alternatives were analyzed for this study based on four criteria outlined in the P&G (USWRC 1983): completeness, effectiveness, efficiency, and acceptability. The proposed alternative was selected based on the ability to address the purpose and need.

The following relevant alternatives and expected consequences must be evaluated, according to the NWPM:

- No Action Alternative – Most likely future condition if no action alternative is selected
- Proposed Alternative – This is the federally assisted alternative with the greatest economic benefits, which is one of the alternatives, or a combination of them.

4.1 Alternatives Eliminated from Detailed Study

The following alternatives were considered during the planning process but were eliminated from detailed study due to exorbitant costs, environmental impacts, considered infeasible, or other critical factors. A description of the alternatives eliminated from detailed study is included below. The following items were evaluated and proposed to the irrigation company. Alternatives were eliminated based on the following criteria from the canal company:

- Stop excessive seepage in canal above current regulating pond.
- Flow requirement of 10 cfs at the existing system connection.
- Prevent or greatly reduce root intrusion from shrubs and trees along canal banks and reduce vegetation growth along canal profile.
- Provide up to an additional 10 psi of irrigation pressures to the existing irrigation system connection
- Reduce water loss from canal bank blowouts, flooding, operational errors, storm surges, and sedimentation.
- Must be a long-term solution, 50+ years, 75-100 preferable.
- Must be able to withstand livestock and wildlife traffic, no punctures or exposed liners/pipes.
- Must be able to withstand routine maintenance and canal cleaning with current operating equipment.

- Meets the above criteria and makes financial sense (Cost).

4.1.1 Canal Lining

This alternative would involve rehabilitating the canal cross section, installing a plastic canal liner, and installing either a partial or full ballast of cobble and sand in the bottom of the canal liner. With the partial ballast over the liner, the banks of the canal liner would remain exposed. This alternative would provide approximately 25-40 years of service based on the lifespan of the liner evaluated.

This alternative would address most of the irrigation company's requirements and evaluation criteria for flow, seepage control, root intrusion, erosion, liability, vegetation growth, and cost. This alternative does not meet the evaluation criteria for alternative life span, wildlife traffic, pressurized irrigation, or maintenance operations.

4.1.2 Piping Segments of the Canal

This alternative would involve rehabilitating the canal cross section, installing a PVC or HDPE pipeline along portions of the canal. This option would provide approximately 50+ years of service based on the lifespan of the pipe material evaluated. The cost of this alternative would largely depend on the proposed segments of the canal to be piped.

This alternative would address most of the irrigation company's requirements and evaluation criteria for flow, seepage control, root intrusion, erosion, liability, vegetation growth, wildlife traffic, life span, pressurized irrigation, cost and maintenance operations.

4.1.3 Pipe Canal and Move Alignment

This alternative would involve rehabilitating the canal cross section, installing an HDPE pipeline along existing and new alignments, and installing irrigation control structures. This alternative would provide approximately 50+ years of service based on the lifespan of the construction materials evaluated.

There were several revisions and alignment modifications made to straighten the alignment of the pipeline. Attention was given to optimizing the project price based on pipeline length, flow demands, pipe size requirements, pressure requirements, and minimize control structures required for operation.

This alternative would address most of the irrigation company's requirements and evaluation criteria for flow, seepage control, root intrusion, erosion, liability, vegetation growth, wildlife traffic, life span, pressurized irrigation, and maintenance operations. This alternative does not meet the evaluation criteria for cost.

4.2 Alternatives Considered for Detailed Study

Feasible alternatives that can meet the purpose and need for the South Boneta Canals project were studied in detail. Two alternatives were evaluated in detail which include 1) the No Action, and 2) the Proposed Alternative.

Preliminary cost estimates were developed for the alternatives using the following procedures:

- Based on July 2021 U.S. dollars.
- Estimated quantities of construction materials and labor
- Costs associated with mitigation of potential environmental and cultural/historical impacts were not included.

The alternatives considered for detailed study are described below.

4.2.1 No Action Alternative

The No Action Alternative considers the project and resource concerns in the future if no federally funded action were taken. It is also known as the Future-Without-Project Plan. With the implementation of the No Action Alternative, the canal would remain the same and no improvements authorized. The existing environmental conditions would remain the same. The implementation of this alternative would have no direct costs, with financial opportunities being forfeited.

The estimated operations and maintenance (O&M) costs are approximately $8,700 per year. This includes costs associated with canal cleaning, vegetation removal, beaver maintenance, washout repairs, vegetation control, spraying, mowing, direct labor costs, fuel, equipment, and non-routine maintenance required for continued operation.

4.2.2 Proposed Alternative

The goals of the projects are to provide more water to shareholders, provide additional pressure to the existing system, and to reduce maintenance. Implementation of the Proposed Alternative would authorize the piping of approximately 12,900 feet of the canal using 22-inch diameter DR 32.5 HDPE pipe, which has a typical pressure rating of 63 psi. A hydraulically efficient design would supply an additional 10 psi of irrigation water to the irrigation company's existing 18-inch pipeline. The proposed project measure would also install a diversion which would include a trash rack/screen to reduce any debris from entering the pipeline. One inlet structure and a control structure with pressure reducing valves would be required to maintain safe operating procedures. A PRV (pressure reducing valve) would be needed near the end of the pipeline to reduce the pressure before it connects to the existing pipeline. The PRV would reduce the pressure to 10 psi about ¼ mile before the terminus.

The construction of the canal pipeline would be completed after the irrigation season, when the canal was not in use. This could be completed all at once or in separate phases as funding becomes available. At a minimum, nearly 2,200 feet of pipe would need to be installed upstream of the existing system connection point in order to produce the required additional pressure.

The pipeline alignment would follow within the existing canal right-of-way. The lands used for the proposed project are private and are within the existing canal alignments and prescriptive easements.

5.0 References

Natural Resources Conservation Service (NRCS). 2014c. Irrigation Pipeline Code 430.

Utah Supplement NEM-UT-511 Subpart A Design.

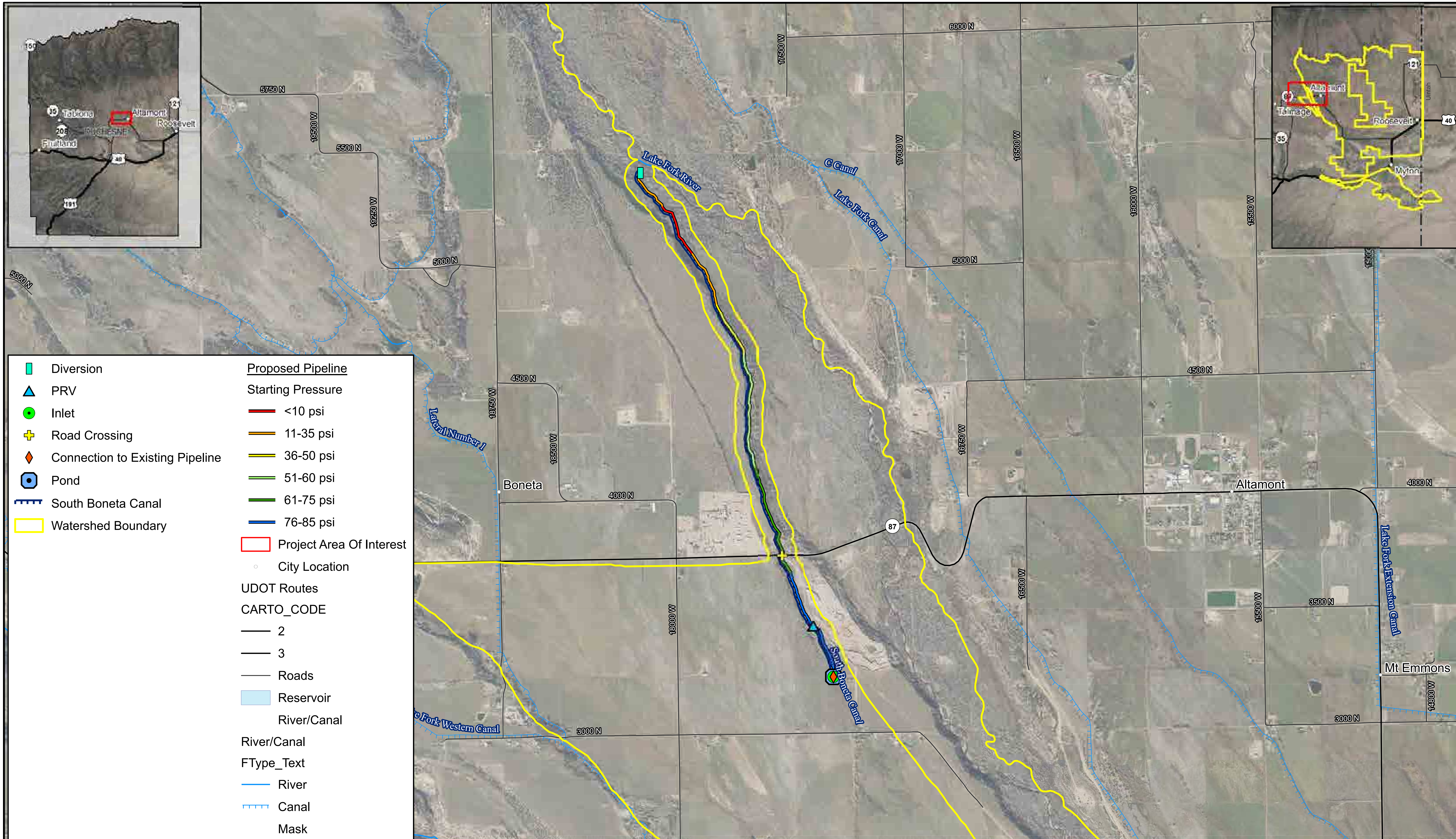
Utah Engineering Technical Notes - Flexible Conduits (TN UT210-15-01)

Utah Irrigation Zone Map, https://deq.utah.gov/public-interest/irrigation-zone-map

Duchesne River Data, http://www.duchesneriver.org/rivers/lake-fork/

USDA Cropland, https://nassgeodata.gmu.edu/CropScape/

Appendix A: Project Overview Map



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Duchesne County Water Conservancy District

Watershed Plan EA
South Boneta Canal Piping Project Overview

Map Name: H:\JD\Proj\1907-354\Design\GIS\Projects\Environmental\1907-354_Env.aprx - Exh DCWD Watershed EA South Boneta Canal Project Overview 11x17L

Project Number: 1907-354 | Drawn by: JEM 07-20 | Last Edit: 04/21/2022

Duchesne County

Scale: 1" = 2,000'

1

TM003 – Dry Gulch Irrigation Company Class B Canal System

1.0 Introduction

The Dry Gulch Irrigation Company Class B Project has been identified for improvements to address water conservation and irrigation water delivery efficiency through reducing seepage and evaporation losses and providing pressures for sprinkler irrigation. The site is located approximately 3 miles northeast of the town of Altamont and 14 miles northwest of the City of Roosevelt as shown in Appendix A.

1.1 Design Criteria

NRCS Irrigation Pipeline (Code 430)

NRCS Utah Supplement NEM-UT-511 Design

NRCS Utah Engineering Technical Notes - Flexible Conduits (TN UT210-15-01)

2.0 Background

The Dry Gulch Irrigation Company (DGIC) has owned and operated the Class B canal system, which includes the Class B Main, F Lateral, I Lateral, and Bluebell Lateral, for over 100 years. The gravity flow delivery system, shown in Appendix A, includes approximately 31 miles of open channel canal.

The canal system is unlined and has six main line segments as it delivers water to the DGIC Class B's water users around the town of Bluebell. When the canal is operating at capacity, the water master estimates that the overall canal system loses 30-40 percent of the water due to seepage and evaporation during the irrigation season.

3.0 System Conditions

The Class B canal system provides water for 170 shareholders along the canal who irrigate about 39,000 acres. Crops irrigated include high mountain pasture crops such as grass/pasture, alfalfa, and other hay crops. Water at the end of these canals flows into existing ponds and other natural water ways used to take tailwater from the system.

The Class B canal system typically diverts an average of approximately 52 cfs during the irrigation season. The highest flow the system has received is about 100 cfs. The ditch master has observed water losses in all segments of the canal system.

This project includes the F, I, and Bluebell Laterals, which irrigate approximately 6,132 acres. It is estimated that approximately 30-40 percent of the water diverted to the Class B canal system is lost due to seepage and evaporation. The F Lateral is believed to have more than 60 percent water loss. The I and Bluebell Lateral are believed to lose about 30 percent.

3.1 Data Sources

The analysis used GIS and Google Earth to provide information on the project's location and total length. Real-time and historical water data was obtained from the website www.duchesneriver.org. Soil information was acquired from the U.S. Geological Survey (USGS) website at https://water.usgs.gov/GIS/metadata/usgswrd/XML/ussoils.xml#stdorder.

3.2 Water Supply and Demand Analysis

3.2.1 System Water Supply

The DGIC has numerous water rights to supply water to its various Classes. Water rights have priority dates dating as far back as 1905. The rights allow for diversion from many sources, including but not limited to, Lake Fork River, Uinta River, Yellowstone River, Motes Creek, Dry Gulch Creek, Sand Wash, Cow Canyon Spring, Spring Stream, Atwood, Chain, Crescent, and Fox Lakes, and regulating ponds. The rights allow for direct flow rights by diverting and storing during the irrigation period or diverting directly through the original points of diversion. The average daily diversion flow recorded for the Class B canal system during the irrigation season since January 1, 2015, is 52.4 cfs and a maximum of 100.0 cfs.

3.2.2 Water Demand

Utah's Irrigated Crop Consumptive Use Zones are shown in Figure 3-1. The project area is in the moderate zone, with a general irrigation diversion duty of 3.0 acre-feet per acre. With 6,132 irrigated acres; their annual maximum allowable diversion is 18,396 acre-feet.

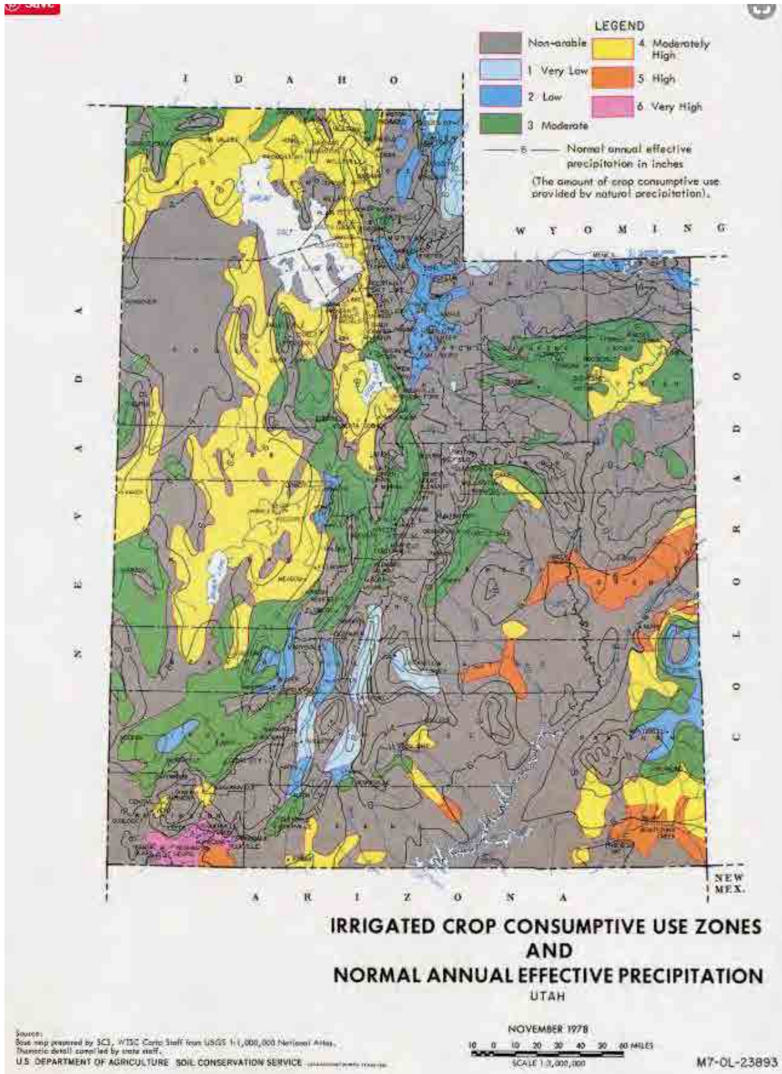


Figure 3-1. Crop Consumptive Use Zones

3.3 Water Loss Analysis

The estimated water loss for the Class B canal system obtained from the DGIC Class B was estimated to be about 40 percent during summer months based on observable landmarks.

A water loss analysis was conducted to confirm the DGIC Class B's estimate and determine the range of water loss experienced in the canal during average flow conditions. This analysis evaluated water loss due to seepage; other types of water loss such as overwatering issues or operational losses were not evaluated due to insufficient flow information within the system to evaluate these losses. Losses associated with evaporation are typically on the order of 1-2 percent on open canal systems. This small water loss in the canal system is considered insignificant and has not been included in this analysis. The water loss analysis looked at the portion of the Class B canal system which is proposed to be replaced by the proposed project.

3.3.1 Data and Assumptions

The daily average flows for the Class B canal system were obtained from duchesneriver.org for a period from January 1, 2015 thru June 23, 2020. Average flows within the system were obtained from DGIC Class B. The data obtained indicated that the average daily flows during the irrigation season of April 1 to October 31 ranged from 0 to 100 cubic feet per second (cfs). The average flow during the irrigation season between the dates available was 52.4 cfs.

The USGS soils seepage information was obtained from the USGS website in an ESRI Shape File (.shp) for Region 14 of the Upper Colorado Basin. This information contained generalized seepage rates for the soils at and around the project area. This information provides a general seepage rate for the area and may be conservative as the seepage rate within canals at the base of a hill is expected to leak more water due to the soils being coarser at the foot of a hill. This information also assumes seepage rates that generalize large areas and are averages of the soils in those areas. Figure 3-2 shows the typical seepage information overlay on a map of the area around the project. Green and blue are areas of relatively low infiltration/seepage rates, while areas of orange to red are areas where the seepage is higher than average. The seepage/infiltration rate varies in this area anywhere from 0 in./hr. on rock and ponds, to nearly 7.1 in./hr. on coarse gravels or organic soils capable of absorbing this amount of water.

The methodology used to calculate loss assumes that the water demand on the canal is evenly distributed along the length of the canal. This canal system conveys water from the head to the end and has a uniform demand along its length.

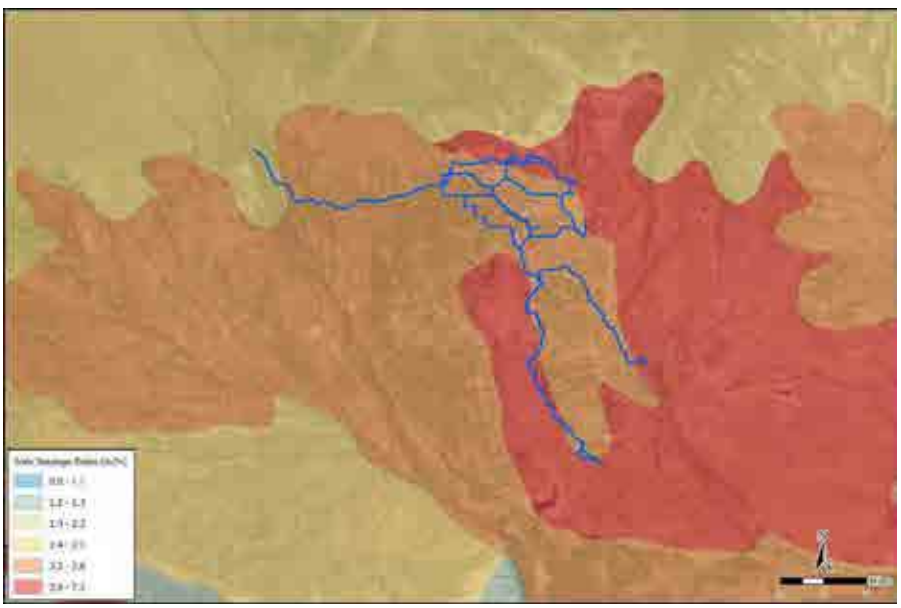


Figure 3-2. Typical Seepage in Project Area

3.3.2 Methods

The water loss due to seepage is estimated using a seepage rate method for soils. The method requires a seepage rate to be provided and an area measurement where water is subject to seep into the ground. The seepage rates for the project area were determined using information from the U.S. Geological Survey (USGS) and used to estimate the seepage rate for the canal.

The flow velocity in the canal system is estimated to be vary between 2.0 feet per second (fps) and 7.5 fps, with an estimated average flow velocity of 4 fps. Knowing the flow rate of the canal in cfs, you can get the equivalent cross-sectional area of the water in the canal.

The area measurement used in the seepage rate calculation can then be used to estimate the wetted perimeter using the hydraulic radius of an equivalent sized radial section of pipe. Using this area, the equivalent pipe size needed to convey the same amount of water at the same velocity can be estimated. The area of the pipe however is set to be only half the circle because the canal does not enclose the water. Thus, the size of pipe needed to convey the same amount of water as if the pipe were half full is estimated. The equation of a circle is used to get the arc length, or the wetted perimeter of the canal that the water can seep into. This is shown as the black lines in Figure 3-3. Using the wetted perimeter of a circle in the seepage calculation is a conservative choice since the wetted perimeter of the circle will be less than the actual wetted perimeter of the canal channel in the field.

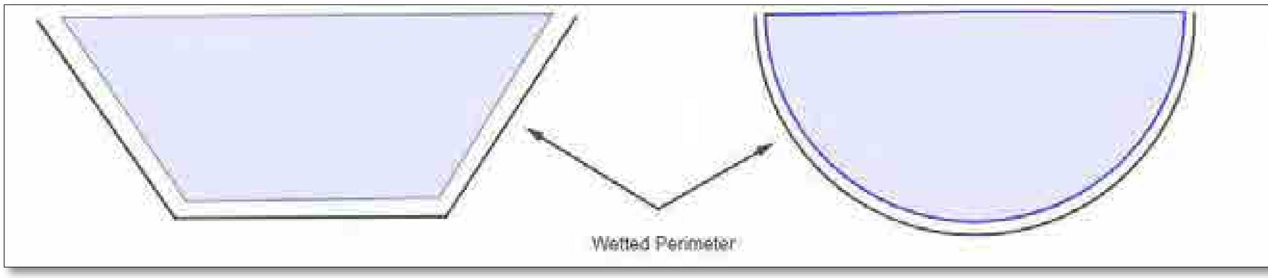


Figure 3-3. Wetted Perimeter

Using the wetted perimeter length, the area where seepage is taking place within the canal can be estimated. The length of the canal is multiplied by the wetted perimeter to get the seepage area. This area assumes that there is a constant flow throughout the length of the canal. To account for this, the seepage area is cut in half if there is zero flow at the end of the canal. The average of the wetted perimeter at the start and end of the canal is used to calculate the seepage area when there is a given flow at the end of the canal. Taking the seepage area and multiplying it by the seepage rate gives the seepage volume per unit of time.

Analyzing the seepage volume per day gives a good basis for analysis. The seepage volume is then divided by the amount of water diverted into the canal. This gives the seepage loss as a percentage of the total water diverted. The seepage loss per day can then be multiplied by the number of days in the typical irrigation season to determine the total annual loss due to seepage.

3.3.3 Results

The seepage analysis indicates that there are significant seepage losses along the selected segments of the Class B canal system. The following table summarizes the losses.

Table 3-1. Class B Canals

Lateral	Q Start (cfs)	Q End (cfs)	Length (ft)	Seepage Rate (in/hr)	Q (af/day)	Wetted Perimeter (ft)
Class B Main	41	39.0	3,179	3.45	81.3	7.9
Lateral F	14	2	32,097	4.93	27.8	3.2
Lateral I	25	3	25,274	3.45	49.6	4.2
Bluebell Lateral	37	5	35,336	4.48	73.4	5.2

Table 3-2 shows the average flow, estimated water loss, percentage lost, and average daily flow lost in each segment.

Table 3-2. Class B Canals

Lateral	Average Flow (cfs)	Estimated Water Loss (af/day)	Estimated Water Loss (%)	Annual Water Loss (af/yr)
Class B Main System	41	4.0	4.9	854
Lateral F	14	23.5	84.5	5,021
Lateral I	25	16.9	34.0	3,612
Bluebell Lateral	37	37.9	51.6	10,685

Using a weighted average, the average loss for the canal system is 35.4 percent. This method confirms the estimate from DGIC Class B's personnel that losses are averaging around 30-40 percent along the entire canal. Operators believe that the three segments lose more water than the analysis shows.

3.4 Hydraulic Analysis

To evaluate the hydraulic performance of the existing canal system and proposed pipeline, a GIS alignment and operation model was developed. This model consisted of a Google Earth alignment drawn using satellite imagery of the current canal system. System information was gathered from discussions with DGIC Class B's personnel, who are familiar with the area and the irrigation systems operation and history.

3.4.1 Data and Assumptions

The model was developed and prepared in collaboration with DGIC Class B's personnel. Information was transmitted verbally over phone calls or via email. This information was used to evaluate the existing system and provide design information for alternative analysis.

The model relies on the Google Earth imagery system for an approximate canal alignment, elevation information, and facility locations. The canal alignment is measured using straight lines and does not reflect all of the canal twists and turns. The model provides an approximate alignment and is typically within 100 feet of the canal centerline alignment. Elevation information was used from the Google Earth Digital Elevation Model (DEM). The Google Earth DEM is an interpolated model using several different DEM sources. The resulting Google Earth DEM is comparable to a standard SRTM DEM which has a resolution of approximately 30 meters for the area of interest. The elevation information used from the DEM is rough but is sufficient to approximate field conditions for this application.

All facility locations marked using Google Earth were located using references to visual landmarks or features, such as approximate distances from roads, bridges, driveways, houses, fences, and other visible features on the Google Earth imagery. Many features were visible in varying historical dates of the Google Earth imagery.

For the proposed project, a Hazen-Williams coefficient of 150 was used to determine the HDPE pipe size and class required to convey the required flow in the pipeline with turnouts located at specified locations along the pipeline segment. Pressures were evaluated to determine if a PRV was needed to maintain allowable pressures. The NRCS standard of 72 percent of maximum pressure rating was maintained throughout the design.

3.4.2 Methods

This information was gathered using a local engineering professional in communication with DGIC Class B's personnel. The local engineering professional was able to coordinate, organize, and consolidate the collected information. The principal method of modeling the existing and proposed systems was using Google Earth and a calculation spreadsheet. Google Earth was used to measure and approximate system elevations, canal lengths, observe system operational control locations, and evaluate alternative options. The calculation spreadsheet was used to compare existing system lengths, quantities to future alternative material quantities, and quantify operational differences between the existing and future system.

3.4.3 Model Verification

The verification consisted of a system overview map that showed the entire system. The model was not verified by field measurements.

3.4.4 Hydraulic Modeling Results

The existing canal system uses gravity to transport irrigation water to DGIC Class B's water users. The canal system planned to provide enough pressure for the majority of the shareholders to use sprinkler irrigation. The existing canal system has adequate capacity to convey the available flows, accounting for seepage losses.

The proposed pipeline system uses portions of the existing canal alignment with new alignments through agricultural fields to optimize the system to provide the required irrigation flow demands and pressure requirements most efficiently. Project details are described in Section 4.0.

4.0 Alternatives Evaluation

Alternatives were previously developed which were in alignment with the procedures outlined in the NRCS National Watershed Program Manual (NWPM) (NRCS 2014) Parts 501 through 506, NRCS National Watershed Program Handbook (NWPH) (NRCS 2014) Parts 600 through 606, Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies (P&G) (USWRC 1983), and other NRCS watershed planning policy. The alternatives were analyzed for this study based on four criteria outlined in the P&G (USWRC 1983): completeness, effectiveness, efficiency, and acceptability. The proposed alternative was selected based on the ability to address the purpose and need.

The following relevant alternatives and expected consequences must be evaluated, according to the NWPM:

- No Action Alternative – Most likely future condition if no action alternative is selected.
- Proposed Alternative – This is the federally assisted alternative with the greatest economic benefits, which is one of the alternatives, or a combination of them.

4.1 <u>Alternatives Eliminated from Detailed Study</u>

The following alternatives were considered during the planning process but were eliminated from detailed study due to exorbitant costs, environmental impacts, considered infeasible, or other critical factors. A description of the alternatives eliminated from detailed study is included below. The following items were evaluated and proposed to DGIC Class B. Alternatives were eliminated based on the following criteria:

- Stop excessive seepage in selected sections of the canal system.

- Flow requirements at the service connections.
- Prevent or greatly reduce root intrusion from shrubs and trees along canal banks and reduce vegetation growth along canal profile.
- Provide irrigation operational pressures to the water users where possible
- Reduce liability with canal bank blowouts, flooding, operational errors, and storm surges.
- Must be a long-term solution, 50+ years, 75-100 preferable.
- Must be able to withstand livestock and wildlife traffic, no punctures or exposed liners/pipes.
- Must be able to withstand routine maintenance and canal cleaning with current operating equipment.
- Meets the above criteria and makes financial sense. (Cost)

4.1.1 Canal Lining

This alternative would involve rehabilitating the canal cross section, installing a plastic canal liner, and installing either a partial or full ballast of cobble and sand in the bottom of the canal liner. With the partial ballast over the liner, the banks of the canal liner would remain exposed. This alternative would provide approximately 25-30 years of service based on the lifespan of the liner evaluated.

This alternative would address most of DGIC Class B's requirements and evaluation criteria for flow, seepage control, root intrusion, erosion, liability, vegetation growth, and cost. This alternative does not meet the evaluation criteria for alternative life span, wildlife traffic, pressurized irrigation, or maintenance operations.

4.1.2 Piping Segments of the Canals

This alternative would involve rehabilitating the canal cross section, installing a PVC or HDPE pipeline along the selected segments. This alternative would provide approximately 50+ years of service based on the lifespan of the pipe material evaluated. The cost of this alternative would largely depend on the proposed segments of the canal to be piped.

This alternative would address most of the irrigation company's requirements and evaluation criteria for flow, seepage control, root intrusion, erosion, liability, vegetation growth, wildlife traffic, life span, and maintenance operations. This alternative does not meet the evaluation criteria for the pressurized irrigation, or cost.

4.2 Alternatives Considered for Detailed Study

Feasible alternatives that can meet the purpose and need for the Class B Canals project were studied in detail. Two alternatives were evaluated in detail which include 1) the No Action, and 2) the Proposed Alternative.

Preliminary cost estimates were developed for the alternatives using the following procedures:

- Based on July 2021 U.S. dollars.
- Estimated quantities of construction materials and labor
- Costs associated with mitigation of potential environmental and cultural/historical impacts were not included.

The alternatives considered for detailed study are described below.

4.2.1 No Action Alternative

The No Action Alternative considers the project and resource concerns in the future if no federally funded action were taken. It is also known as the Future-Without-Project Plan. With the implementation of the No Action Alternative, the canal would remain the same and no improvements authorized. The existing environmental conditions would remain the same. The implementation of this alternative would have no direct costs, with financial opportunities being forfeited.

The estimated operations and maintenance (O&M) costs are approximately $22,800 per year. This includes costs associated with canal cleaning, vegetation removal, beaver maintenance, washout repairs, vegetation control, spraying, mowing, direct labor costs, fuel, equipment, and non-routine maintenance required for continued operation.

4.2.2 Proposed Alternative

The goals of this project are to conserve water and thereby provide conserved water to shareholders, provide additional pressure to the water users, and to reduce maintenance efforts. Implementation of the Proposed Alternative would authorize the piping of approximately 91,400 feet of the canal in three sections using various sizes of HDPE Pipe. The Proposed Alternative would install a pipeline inlet structure at the head of the proposed pipeline segments, which would replace existing canals, using HDPE pipe as determined by the hydraulic analysis described above. The pipeline inlet structures would include a trash rack/screen to reduce any sediment and debris from entering the pipeline.

To optimize the system, Laterals F and I would be coupled together; the 9.0-mile pipeline would convey up to 33 cfs to the DGIC's existing Lateral F and I water users. Lateral F and I (north side) would replace approximately 57,200 feet of the existing canal with nearly 47,300 feet of pipe, and Bluebell Pipeline (southern section) would replace approximately 35,300 feet of canal with nearly 32,100 feet of irrigation pipe. The construction of the pipelines would be completed after the irrigation season, when the canal is not in use. They could be completed all at once or in two separate phases as funding becomes available. The F and I Lateral portions of the project would need to be completed together as the project would alter the open canals and delivery to water users would not be feasible. It is possible that the Bluebell Pipeline itself could be separated into additional phases, depending on funding, with some additional planning.

The proposed pipeline would be installed using HDPE pipe and a hydraulically efficient design would supply all water users along the pipeline with pressurized irrigation water. The HDPE pipe would range in size from 8 to 36 inches in diameter based on flow requirements. The typical pressure rating of the HDPE pipe is DR 32.5 (63 psi), with some locations requiring localized areas of higher-pressure classes like DR 17 (125 psi) pipe. Two pressure reducing valves (PRV) would be needed at strategic locations along the pipeline alignment to reduce the operating pressure before turnouts and to remain within the NRCS design guidelines. Installing localized areas of higher-pressure class pipe is significantly more cost-efficient than installing additional PRVs. Some other control structures and pressure reducing valves would be required to maintain safe operating procedures.

The pipeline alignment would be adjusted to follow within the existing canal right-of-way to where possible, but most of the pipeline would be realigned to minimize the length of pipe needed for the project. Easements would be required across private lands. Where the pipeline alignment follows the existing canal, prescriptive easements would be used.

The Bluebell Lateral is the proposed 6.0-mile pipeline that would convey up to 37 cfs to DGIC's existing Bluebell Lateral water users. Two PRV's would be needed at strategic locations along the pipeline alignment to reduce the operating pressure before turnouts and to remain under the NRCS's 72 percent pressure rating design guidelines. The HDPE pipe would range in size from 42-inches at the north end of the pipeline to 18-inches in diameter at the south end based on flow requirements. The pressure rating of the HDPE pipe is DR 32.5 (63 psi).

5.0 References

Natural Resources Conservation Service (NRCS). 2014c. Irrigation Pipeline Code 430.

Utah Supplement NEM-UT-511 Subpart A Design.

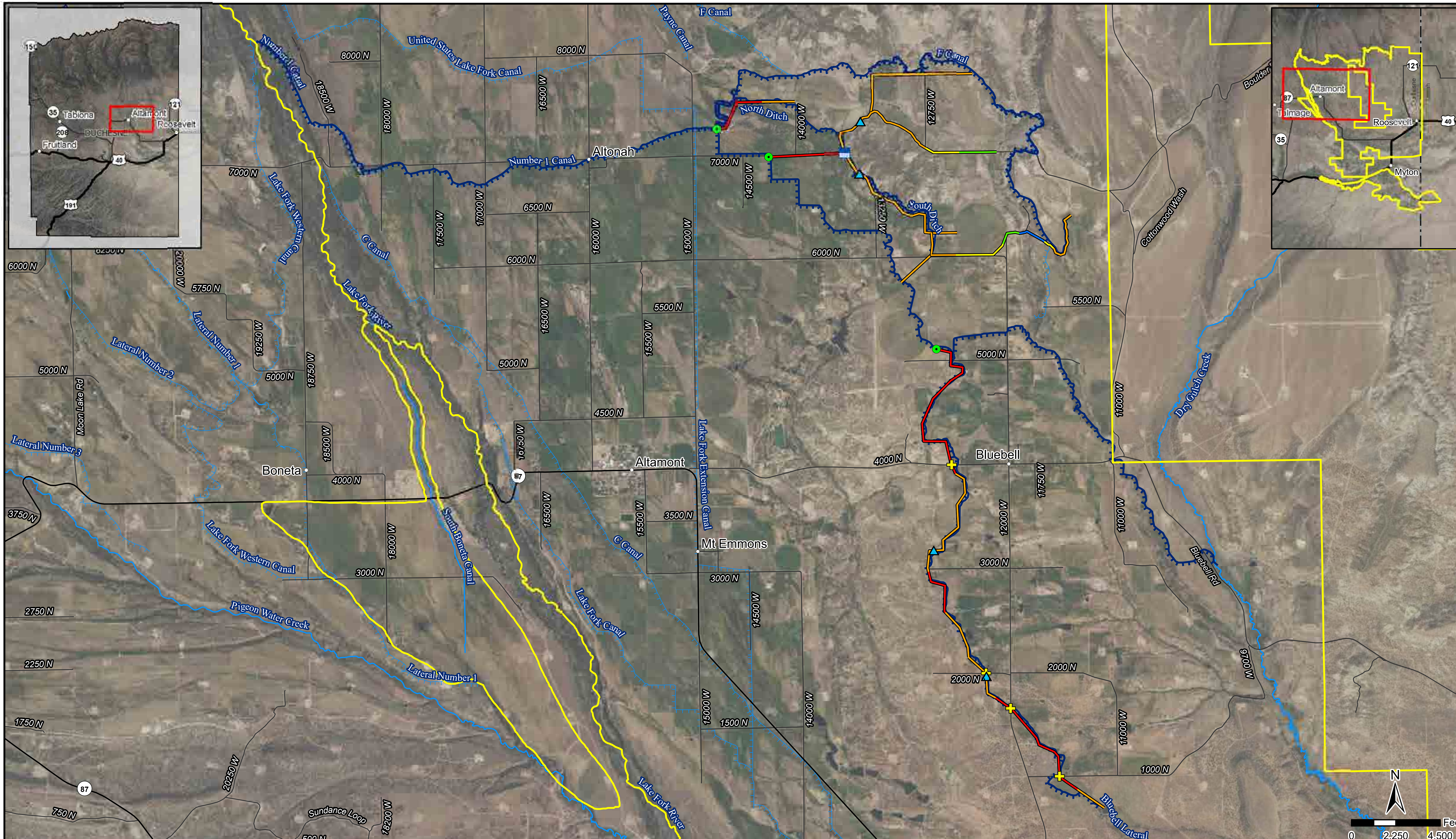
Utah Engineering Technical Notes - Flexible Conduits (TN UT210-15-01)

Utah Irrigation Zone Map, https://deq.utah.gov/public-interest/irrigation-zone-map

Duchesne River Data, http://www.duchesneriver.org/rivers/lake-fork/

USDA Cropland, https://nassgeodata.gmu.edu/CropScape/

Appendix A. Project Overview Map



PRV
Inlet
Control Structure
Road Crossing

Proposed Pipeline
Starting Pressure
≤50 psi
51-100 psi
101-150 psi
151-200 psi
>200 psi

Class B Canal
Watershed Boundary

Jones & DeMille Engineering
- Shaping the Quality of Life -
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Duchesne County Water Conservancy District

Watershed Plan EA
Dry Gulch Irrigation Company Class B Canal Project Overview

Map Name: H:\JD\Proj\1907-354\Design\GIS\Projects\Environmental\1907-354_Env.aprx - Exh DCWD Watershed EA DGIC Class B Canal Proposed Pipeline 11x17L

Project Number: 1907-354 | Drawn by: JEM 07-20 | Last Edit: 04/27/2022

Duchesne County

Scale: 1" = 4,500'

1

TM001 – Dry Gulch Irrigation Company Class C Canal System

1.0 Introduction

The Dry Gulch Irrigation Company Class C Project has been identified for improvements to provide economic benefits to the area by providing water conservation, improving irrigation water delivery efficiency through reducing seepage and evaporation losses, providing pressures for sprinkler irrigation, and reducing pumping costs. Additionally, it will stabilize the canal length along the hillside that is prone to failure and requires constant maintenance. Class C diverts water from Big Sand Wash Reservoir, just northwest of Upalco. The site is located approximately 13 miles southwest of the City of Roosevelt, starting at the reservoir north of Highway 87 and crossing it heading straight south, then traversing east along the ridge towards Highway 191 as shown in Appendix A.

1.1 Design Criteria

- NRCS Irrigation Pipeline (Code 430)
- NRCS Utah Supplement NEM-UT-511 Design
- NRCS Utah Engineering Technical Notes - Flexible Conduits (TN UT210-15-01)

2.0 Background

The Dry Gulch Irrigation Company (DGIC) has owned and operated the Class C canal system for over 100 years. The gravity flow delivery system, shown in Appendix A, includes approximately 8.3 miles of open channel.

3.0 System Conditions

The Class C canal system provides water for shareholders who irrigate about 7,400 acres. Crops irrigated include high mountain pasture crops including: grass/pasture, alfalfa, and other hay crops. The large canal is mostly unlined except in sections along the hillside that have been protected against sliding by lining with cement. There are a three larger turnouts at the head of the system and a few smaller turnouts along the canal's length but the majority of the water is conveyed to the end where it goes into Class C's existing pond and pipeline system. Changes to the diversion rate at the reservoir can take up to 24 hours before reaching the pond at the end of the canal. This has caused issues with the pond overflowing or being drained.

This technical memo provides an analysis of the section of the Class C canal that is the subject of the Proposed Action, which begins approximately 2.9 miles downstream of Big Sand Wash Reservoir at a parshall flume. This location is also downstream of three larger turnouts that divert a combined 65 cfs. The remainder of the document will refer to this section as the Class C conveyance system.

The Class C conveyance system typically diverts a consistent 115-120 cfs during the irrigation season. At the end of the canal, water flows into an existing pond. Diverting more water will cause the pond to overflow and less will cause the pond to dry up. The soil along the hillside is well draining, which results in large seepage losses. It takes a long time for diverted water to reach the existing pond. It is estimated that approximately 25 percent of the water diverted to the Class C canal system is lost due to seepage and evaporation.

3.1 Data Sources

The analysis used GIS and Google Earth to provide information on the project's location and total length. Real-time and historical water data was obtained from the website www.duchesneriver.org. Soil information was acquired from the U.S. Geological Survey (USGS) website at https://water.usgs.gov/GIS/metadata/usgswrd/XML/ussoils.xml#stdorder.

3.2 Water Supply and Demand Analysis

3.2.1 System Water Supply

The DGIC has numerous water rights to supply water to its various Classes. Water rights have priority dates dating as far back as 1905. The rights allow for diversion from many sources including but not limited to Lake Fork River, Uinta River, Yellowstone River, Montes Creek, Dry Gulch Creek, Sand Wash, Cow Canyon Spring, Spring Stream, Atwood, Chain, Cresent, and Fox Lakes, and regulating ponds. Water right 43-2503 is associated with the diversion from Big Sand Wash Reservoir, which allows for 484.38 cfs. The right allows for direct flow rights by diverting and storing during the irrigation period or diverting directly through the original points of diversion.

3.2.2 Water Demand

Utah's Irrigated Crop Consumptive Use Zones are shown in Figure 3-1. The project area is in the moderate zone, with a general irrigation diversion duty of 3.0 acre-feet per acre. With 7,400 irrigated acres; their annual maximum allowable diversion is 22,200 acre-feet.

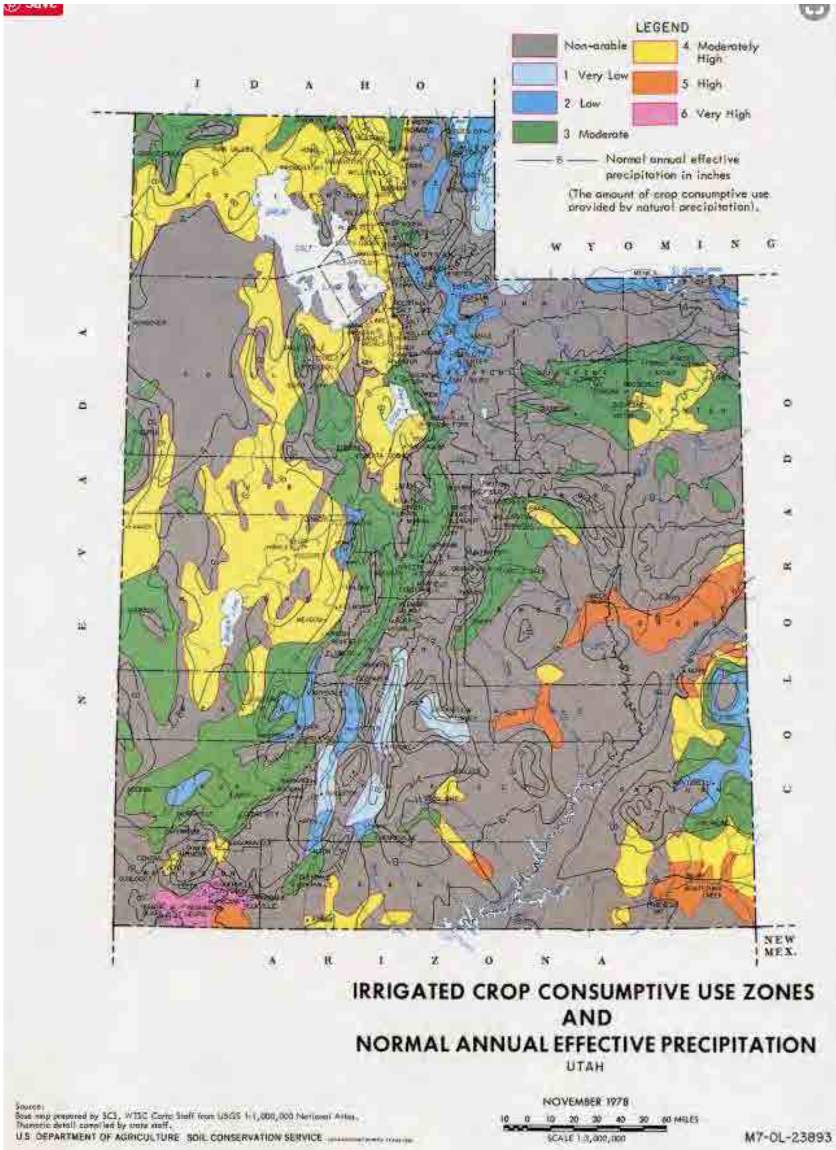


Figure 3-1. Crop Consumptive Use Zones

3.3 Water Loss Analysis

The estimated water loss for the Class C conveyance system, obtained from the Class C Director, is estimated to be about 25 percent during the irrigation season. However it is noted that despite the amount of flow in the canal, the losses never go below 15 cfs due to the porous soil.

A water loss analysis was conducted to determine the range of water loss experienced in the canal during average flow conditions. This analysis evaluated water loss due to seepage; other types of water loss such as overwatering issues or operational losses were not evaluated due to insufficient flow information within the system. Losses associated with evaporation on open canal systems are typically on the order of 1-2 percent. This loss is considered insignificant and has not been included in the loss analysis. The analysis looked at the portion of the Class C system that is proposed to be replaced.

3.3.1 Data and Assumptions

The daily average flows for the Class C conveyance system were obtained from Class C. The information indicated that a consistent flow at the parshall flume during the irrigation season was 115 to 120 cubic feet per second (cfs).

The USGS soils seepage information was obtained from the USGS website in an ESRI shapefile (.shp) for Region 14 of the Upper Colorado Basin. This information contains generalized seepage rates for the soils at and around the project area. This information provides a general seepage rate for the area and may be conservative, as the seepage rate within canals at the base of a hill is expected to be higher due to the soils being more coarse at the foot of a hill. This information also assumes seepage rates that generalize large areas and are averages of the soils in those areas. Figure 3-2 below shows the typical seepage information overlay on a map of the area around the project. Green and blue are areas of relatively low infiltration/seepage rates, tan and orange areas had relatively average seepage rates, while areas of red are areas where the seepage is higher than average. The seepage/infiltration rate for the area around the project is moderate, with a range from 0 in/hr on rock and ponds, to nearly 7.1 in/hr on coarse gravels or organic soils capable of absorbing this amount of water.

The methodology used to calculate loss assumes that the water demand on the canal is evenly distributed along the length of the canal. This generalization is treated as the canal system conveying water from the head to the end and having a uniform demand along its length.

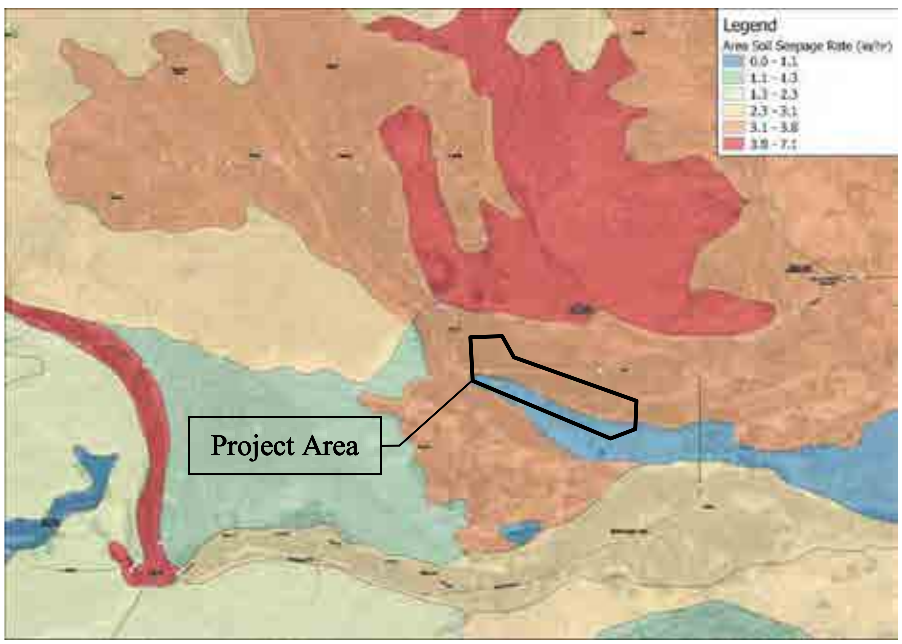


Figure 3-2. Typical Seepage in Project Area

3.3.2 Methods

The water loss due to seepage is estimated using a seepage rate method for soils. The method requires a seepage rate to be provided and an area measurement where water is subject to seep into the ground. The seepage rates for the project area were determined using information from the USGS and used to estimate the seepage rate for the canal.

The flow velocity in the canal system is estimated to be vary between 2.0 feet per second (fps) and 7.5 fps, with an estimated average flow velocity of 4 fps. With a known flow rate of the canal, we can calculate the equivalent cross-sectional area of the water in the canal.

The area measurement used in the seepage rate calculation can then be used to estimate the wetted perimeter using the hydraulic radius of an equivalent-sized radial section of pipe. Using this area, the equivalent pipe size needed to convey the same amount of water at the same velocity can be estimated. The area of the pipe is set to be only half the circle because the canal does not enclose the water. Thus, the size of pipe needed to convey the same amount of water as if the pipe were half full is estimated. The equation of a circle is used to determine the arc length, or the wetted perimeter, of the canal that water can seep into. This is shown as the black lines in Figure 3-3 below. Using the wetted perimeter of a circle in the seepage calculation is a conservative choice since the wetted perimeter of the circle will be less than the actual wetted perimeter of the canal channel in the field.

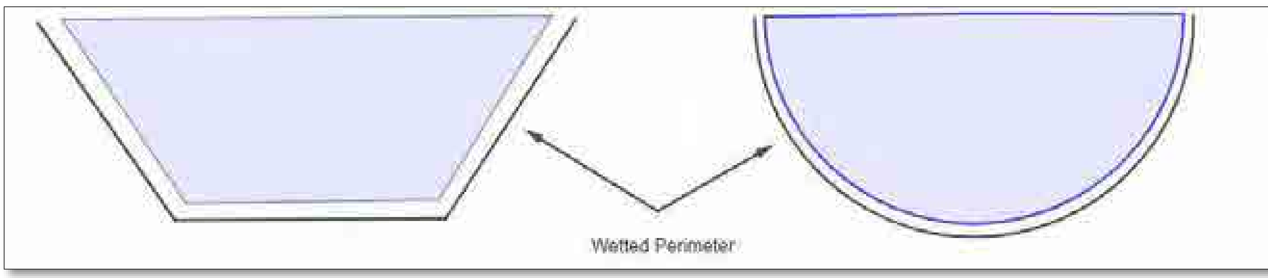


Figure 3-3. Wetted Perimter

Using the wetted perimeter length, the area where seepage is taking place within the canal can be estimated. The length of the canal is multiplied by the wetted perimeter to calculate the seepage area. This area assumes that there is a constant flow throughout the length of the canal. To account for this assumption, the seepage area is halved if there is no flow at the end of the canal. The average of the wetted perimeter at the start and end of the canal is used to calculate the seepage area when there is a given flow at the end of the canal. The seepage area multiplied by the seepage rate gives the seepage volume per unit of time.

Analyzing the seepage volume per day gives a good basis for analysis because the flow rate in the canal changes over the irrigation season and this affects the seepage rate over the course of the irrigation season. The seepage volume is then divided by the amount of water diverted into the canal. This gives the seepage loss as a percentage of the total water diverted. The seepage loss per day can then be multiplied by the number of days in the typical irrigation season to determine the total annual loss due to seepage.

3.3.3 Results

Using the average daily flow, the seepage analysis indicates that there are significant seepage losses along the Class C conveyance system. The following table summarizes the loss.

Table 3-1 Class C Conveyance System

Q Start (cfs)	Q End (cfs)	Length (ft)	Seepage Rate (in/hr)	Q (af/day)	Wetted Perimeter (ft)	Loss (af/day)	Loss %
115	85	28,637	3.04	228.1	12.5	49.9	**21.9**

The consistent flow is 115 cfs with an estimated water loss of 21.9 percent. Using this daily flow, the water loss in the canal is approximately 4,662 ac-ft/year.

This method confirms the estimate from Class C personnel that losses are averaging around 25 percent.

3.4 Hydraulic Analysis

To evaluate the hydraulic performance of the existing canal system and proposed pipeline, a GIS alignment and operation model was developed. This model consisted of a Google Earth alignment drawn using satellite imagery of the current canal system. System information was gathered from discussions with Class C personnel, who are intimately familiar with the area, irrigation system, its operation, and history.

3.4.1 Data and Assumptions

The model relies on the Google Earth imagery system for an approximate canal alignment, elevation information, and facility locations. The canal alignment is measured using straight lines and does not reflect all of the canal twists and turns. The model provides an approximate alignment and is typically within 100 feet of the canal centerline alignment. Elevation information was used from the Google Earth Digital Elevation Model (DEM). The Google Earth DEM is an interpolated model using several different DEM sources. The resulting Google Earth DEM is comparable to a standard SRTM DEM, which has a resolution of approximately 30 meters for the area of interest. The elevation information from the DEM is rough but is sufficient to approximate field conditions for this application.

All facility locations marked using Google Earth were located using references to visual landmarks or features, such as approximate distances from roads, bridges, driveways, houses, fences, and other visible features on the Google Earth imagery. Many features were visible in varying historical dates of the Google Earth imagery.

For the proposed project; Hazen-Williams coefficient of 150 was used to determine the HDPE pipe size and class required to convey the required flow in the pipeline with turnouts located at specified locations along the pipeline segment. Pressures were evaluated to determine if a PRV was needed to maintain allowable pressures. The NRCS standard of 72% of maximum pressure rating was maintained throughout the design.

3.4.2 Methods

The principle method of modeling the existing and proposed systems was using Google Earth and a calculation spreadsheet. Google Earth was used to measure and approximate system elevations and canal lengths, observe system operational control locations, and evaluate alternative options. The calculation spreadsheet was used to compare existing system lengths, quantities to future alternative material quantities, and quantify operational differences between the existing and future system.

3.4.3 Model Verification

The verification consisted of a system overview map that showed the entire system. The model was not verified by field measurements.

3.4.4 Hydraulic Modeling Results

The existing canal system uses gravity to transport irrigation water to Class C's water users. It has adequate capacity to convey the available flows, accounting for seepage losses. The proposed action plans to provide enough pressure for the shareholders on the lower system to use sprinkler irrigation.

The proposed pipeline system uses the existing canal alignment to provide the required irrigation flow demands and pressure requirements most efficiently. Project details are described in Section 4.0.

4.0 Alternatives Evaluation

Alternatives were previously developed which were in alignment with the procedures outlined in the NRCS National Watershed Program Manual (NWPM) (NRCS 2014) Parts 501 through 506, NRCS National Watershed Program Handbook (NWPH) (NRCS 2014) Parts 600 through 606, Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies (P&G) (USWRC 1983), and other NRCS watershed planning policy. The alternatives were analyzed for this study based on four criteria outlined in the P&G (USWRC 1983): completeness, effectiveness, efficiency, and acceptability. The proposed alternative was selected based on the ability to address the purpose and need.

The following relevant alternatives and expected consequences must be evaluated, according to the NWPM:

- No Action Alternative – Most likely future condition if no action alternative is selected
- Proposed Alternative – This is the federally assisted alternative with the greatest economic benefits, which is one of the alternatives, or a combination of them.

4.1 Alternatives Eliminated from Detailed Study

The following alternatives and options were considered during the planning process but were eliminated from detailed study due to exorbitant costs, environmental impacts, considered infeasible, or other critical factors. A description of the alternatives eliminated from detailed study is included below. The following items were evaluated and proposed to DGIC Class C. Alternatives were eliminated based on the following criteria from the canal company:

- Stop excessive seepage in canal along multiple stretches of canal.
- Flow requirement of 110 cfs at the regulating pond.
- Prevent or greatly reduce root intrusion from shrubs and trees along canal banks and reduce vegetation growth along canal profile.
- Reduce water loss from seepage, canal bank blowouts, flooding, operational errors, storm surges, and sedimentation.
- Must be a long-term solution, 50+ years, 75-100 preferable.
- Must be able to withstand livestock and wildlife traffic, no punctures or exposed liners/pipes.
- Enclosed system preferred to deter unauthorized water use.
- Must follow existing canal alignment to prevent additional legal ramifications of local land owners.

- Must be able to withstand routine maintenance and canal cleaning with current operating equipment.
- Possibly provide pressurized water to water users above regulating pond and west of 9000 West.
- Meets the above criteria and makes financial sense (Cost).

4.1.1 Canal Lining

This alternative would involve updating, replacing, or remodeling the canal cross section, installing a plastic canal liner, and installing either a partial or full ballast of cobble and sand in the bottom of the canal liner or a concrete canal liner. With the partial ballast over the liner, the banks of the canal liner would remain exposed. This option would provide approximately 25-35 years of service based on the lifespan of the liner evaluated.

This alternative would address most of DGIC Class C's requirements and evaluation criteria for flow, seepage control, root intrusion, vegetation growth, and cost. Continued lining of troublesome sections has been reviewed, but this option will not prevent the hillside from sliding, which is a major risk for shareholders and landowners below the canal. This alternative does not meet the evaluation criteria for alternative life span, erosion, liability, wildlife traffic, pressurized irrigation or maintenance operations.

4.1.2 Piping Segments of the Canal

This alternative would involve remodeling the canal cross section, installing a large diameter steel or HDPE pipeline along portions of the canal. This option would provide approximately 50+ years of service based on the lifespan of the pipe material evaluated. The cost for this alternative would largely depend on the proposed segments of the canal to be piped.

This alternative would address most of DGIC Class C's requirements and evaluation criteria for flow, seepage control, root intrusion, erosion, liability, vegetation growth, alternative life span, and cost. This alternative does not meet the evaluation criteria for, pressurized irrigation or unauthorized water use.

4.2 <u>Alternatives Considered for Detailed Study</u>

Feasible alternatives that can meet the purpose and need for the Class C Canal project were studied in detail. Two alternatives were evaluated in detail which include 1) the No Action, and 2) the Proposed Alternative.

Preliminary cost estimates were developed for the alternatives using the following procedures:

- Based on July 2021 U.S. dollars.
- Estimated quantities of construction materials and labor
- Costs associated with mitigation of potential environmental and cultural/historical impacts were not included.

The alternatives considered for detailed study are described below.

4.2.1 No Action Alternative

The No Action Alternative considers the project and resource concerns in the future if no federally funded action were taken. It is also known as the Future-Without-Project Plan. With the implementation of the

No Action Alternative, the canal would remain the same and no improvements authorized. The existing environmental conditions would remain the same. The implementation of this alternative would have no direct costs, with financial opportunities being forfeited.

The estimated operations and maintenance (O&M) costs are approximately $63,700 per year. This includes costs associated with canal cleaning, vegetation removal, beaver maintenance, washout repairs, vegetation control, spraying, mowing, direct labor costs, fuel, equipment, and non-routine maintenance required for continued operation.

4.2.2 Proposed Alternative

The goals of this project are to provide economic benefits to the area by providing water conservation, improving irrigation water delivery efficiency through reducing seepage and evaporation losses, providing pressures for sprinkler irrigation, reducing sediment entering the canal, and reducing pumping costs. Additionally, the canal length along the hillside that is prone to failure and requires constant maintenance needs to be stabilized. Implementation of the Proposed Alternative would authorize the piping of approximately 28,500 feet of the existing canal with a 72-inch HDPE pipe and approximately 4,775 feet of the existing canal with HDPE pipe ranging in size from 8-16 inch. A hydraulically efficient design and would supply all water users along the pipeline with pressurized irrigation water. The large pipeline would begin near the Neilson property, shown on Appendix A at the location of a future pond. This starting location provides adequate pressure for shareholders downstream. The large pipeline would convey approximately 115 cfs. Beginning near the Leon property, 5 cfs would be diverted into the smaller pipeline, to provide pressurized water to local shareholders. The remaining 110 cfs would be conveyed to the existing pond at the pipeline's outlet. Two PRV stations (pressure reducing valve) would be needed to reduce the pressure to provide acceptable working pressures along the pipeline alignment and control the canal velocities before entering the existing pond at the end of the canal.

The construction of the canal pipeline would be completed after the irrigation season, when the canal was not in use. The pipeline alignment would follow within the existing canal right-of-way where possible, but the majority of the pipeline would be realigned to minimize the length of pipe needed for the project. The lands used for the proposed project would largely be new alignments and would require new dedicated easements for the pipeline. Where the pipeline alignment follows the existing canal, prescriptive easements would be used.

5.0 References

Natural Resources Conservation Service (NRCS). 2014c. Irrigation Pipeline Code 430.

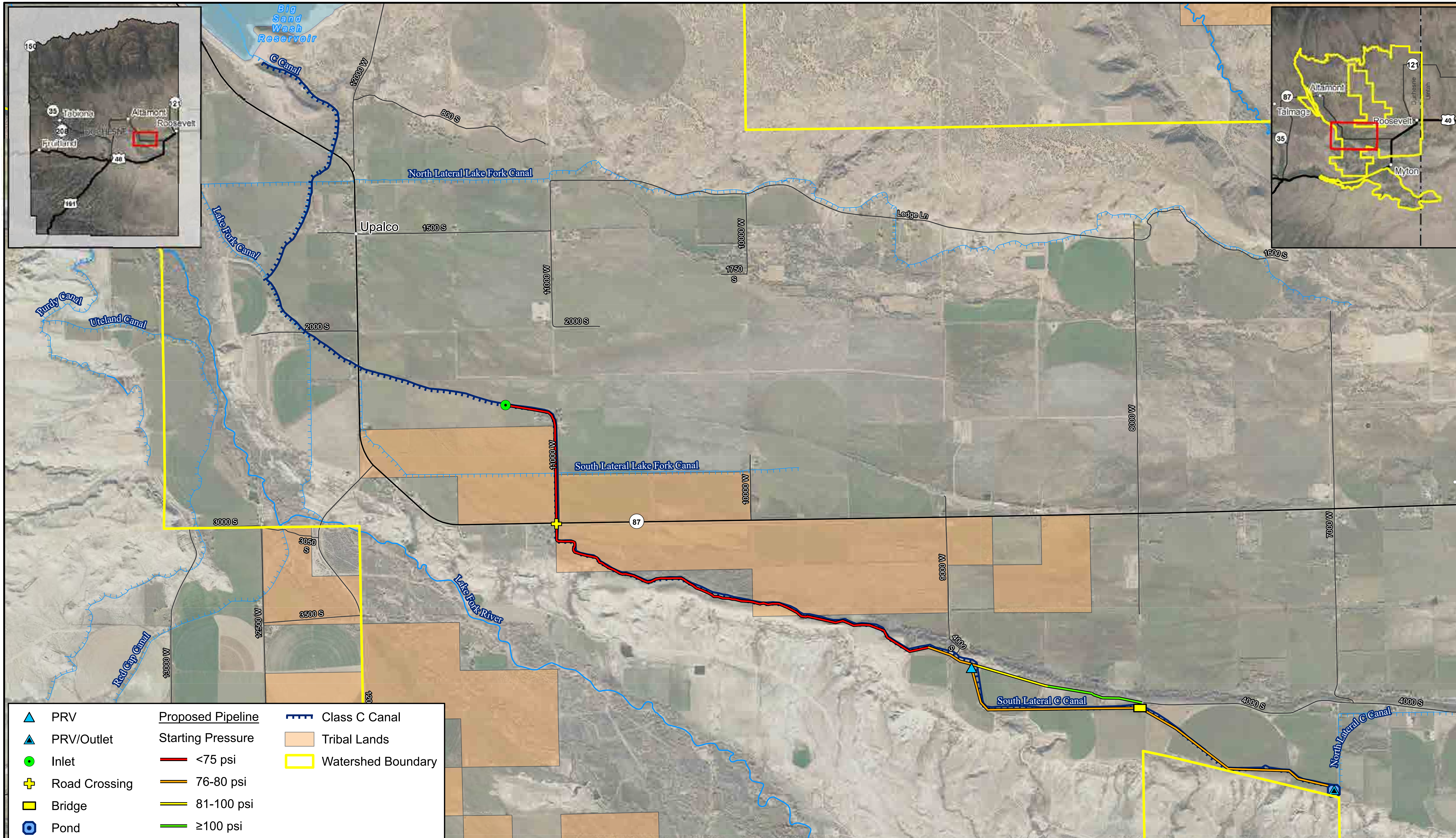
Utah Supplement NEM-UT-511 Subpart A Design.

Utah Engineering Technical Notes - Flexible Conduits (TN UT210-15-01)

Utah Irrigation Zone Map, https://deq.utah.gov/public-interest/irrigation-zone-map

USDA Cropland, https://nassgeodata.gmu.edu/CropScape/

Appendix A: Project Overview Map



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Duchesne County Water Conservancy District

Watershed Plan EA
Dry Gulch Irrigation Company Class C Canal Project Overview

Map Name: H:\JD\Proj\1907-354\Design\GIS\Projects\Environmental\1907-354_Env.aprx - Exh DCWD Watershed EA DGIC Class C Canal Proposed Pipeline 11x17L

Project Number: 1907-354 | Drawn by: JEM 07-20 | Last Edit: 04/21/2022

Duchesne County

Scale: 1" = 2,400'

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TM004 – Arcadia Farms Pipeline

1.0 Introduction

The Arcadia Farms Pipeline project has been identified as a potential project to enclose the existing Red Cap Extension Canal to reduce water losses and more efficiently deliver water. Additionally, a pipeline would allow for pressurized irrigation, and additional acreage in the area that does not currently have access to water could be farmed. The project site is located north of Bridgeland, UT near Lake Boreham as shown in Appendix A.

1.1 Design Criteria

- NRCS Irrigation Pipeline (Code 430)
- NRCS Utah Supplement NEM-UT-511 Design
- NRCS Utah Engineering Technical Notes - Flexible Conduits (TN UT210-15-01)

2.0 Background

The Uintah Indian Irrigation Project O&M Company (UIIP) operates and maintains the Red Cap Extension Canal in Duchesne County, Utah. The canal is an open channel transmission canal which delivers agricultural irrigation water to Arcadia Farms and tribal farms in the area.

The canal extends from the end of the Duchesne Feeder Canal at the Midview Wasteway for approximately 9 miles. Currently, the Red Cap Extension Canal and laterals deliver water to approximately 3,431 acres, with approximately 5,854 acres in the area having water rights. The canal water losses are estimated to be over 20 percent and the existing wasteway that feeds Midview Reservoir has been undermined over many years. UIIP proposes to enclose the Red Cap Extension Canal and laterals to reduce losses, and the new design would allow for an intake structure of the proposed pipeline to be combined with a new design for the wasteway, preventing the undermining and erosion which currently exists. Additionally, with enclosing the canal and its laterals, all 5,854 acres designated to be served by the Red Cap Extension Canal and its laterals could have access to pressurized irrigation water.

3.0 System Conditions

The Red Cap Extension Canal currently serves approximately 18 shareholders, including the Ute Indian Tribe as well as delivering shares for the Duchesne Irrigation Company. The Red Cap Extension Canal currently delivers water to 2,872 acres that have permanently accessible water rights through UIIP and approximately 559 acres for the Duchesne Irrigation Company.

3.1 Data Sources

The analysis for the Arcadia Farms Pipeline site used GIS and Google Earth for information pertaining to the project location and geographical information. Additionally, www.duchesneriver.org was used for the canals historical flow data. Soil information was acquired from the U.S. Geological Survey (USGS) website at https://water.usgs.gov/GIS/metadata/usgswrd/XML/ussoils.xml#stdorder.

3.2 Water Supply and Demand Analysis

3.2.1 System Water Supply

There are a total of just over 5,854 acres in the Arcadia Farms area with water rights. The maximum duty is one cubic feet per second (cfs) per 70 acres, allowing for a maximum flow of 83.63 cfs. The average daily flow recorded since January 1, 2015 is 31.48 cfs with a maximum flow of 76.7 cfs.

3.2.2 Water Demand

Utah's Irrigated Crop Consumptive Use Zones are shown in Figure 3-2. The project area is located in the moderate zone, with a general irrigation diversion duty of 3.0 acre-feet per acre. With 5,854.12 acres, the annual maximum allowable diversion is 17,562.36 acre-feet.

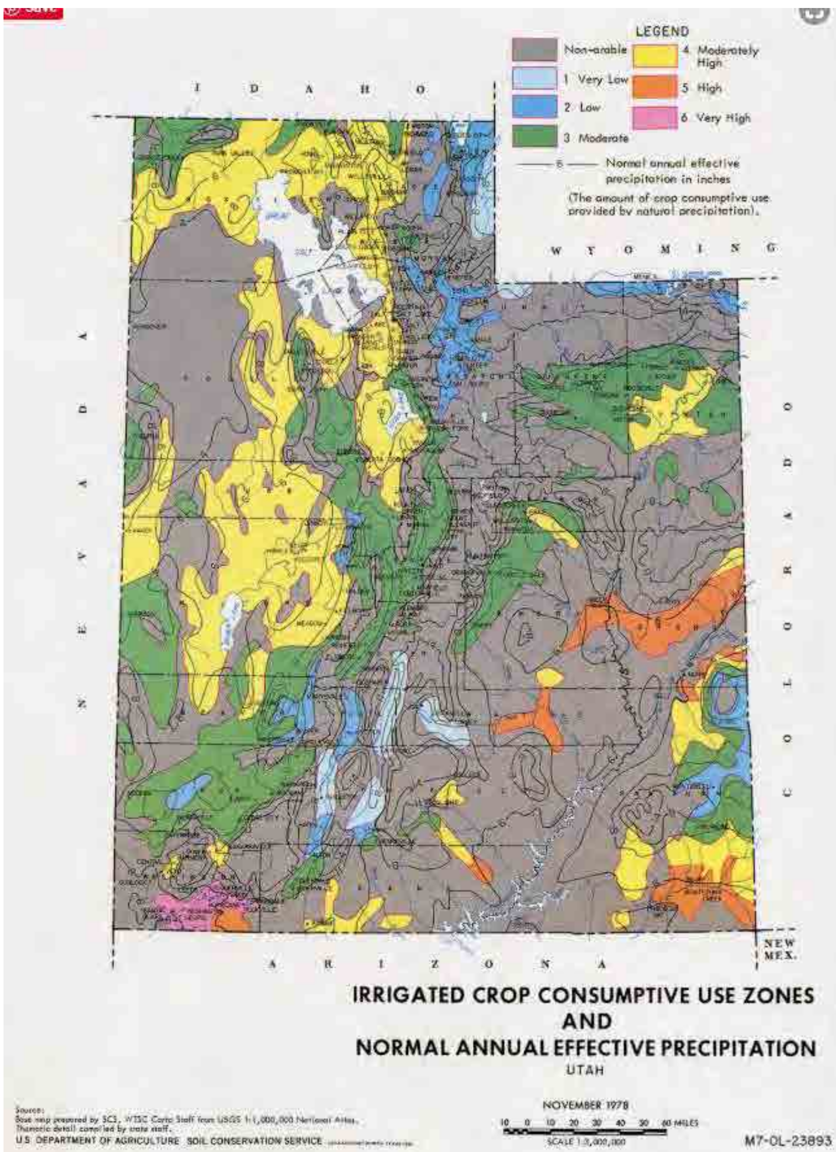


Figure 3-1. Crop Consumptive Use Zones

3.3 Water Loss Analysis

The estimated water loss for the Red Cap Extension Canal was obtained from the UIIP Board, which estimated that the water loss exceeded 20%.

A water loss analysis was conducted to confirm the company's estimate and determine the range of water loss experienced in the canal during average flow conditions. This analysis evaluated water loss due to seepage; other types of water loss such as overwatering issues, or operational losses were not evaluated due to insufficient flow information within the system to evaluate these losses. Losses associated with evaporation are typically on the order of 1%-2% on open canal systems. This small water loss in the canal system is considered insignificant and has not been included in this loss analysis. The water loss analysis looked at the portion of the open canal system which is proposed to be replaced by the proposed project.

3.3.1 Data and Assumptions

The daily average flows for the Red Cap Extension Canal were obtained from duchesneriver.org for a period from January 1, 2015 thru June 29, 2020. The data obtained indicated that the average daily flows during the irrigation season of April 1 to October 31 in the Red Cap Extension Canal was 31.48 cfs, and ranged from 0 to 76.7 cfs.

The USGS soils seepage information was obtained from the USGS website for Region 14 of the Upper Colorado Basin. This information contained generalized seepage rates for the soils at and around the project area. This information provides a general seepage rate for the area and may be conservative as the seepage rate within canals at the base of a hill is expected to leak more water due to the soils being more coarse at the foot of a hill. This information also assumes seepage rates that generalize large areas and are averages of the soils in those areas. The figure below shows the typical seepage information overlay on a map of the area around the project. Green and blue are areas of relatively low infiltration/seepage rates, while areas of orange to red are areas where the seepage is higher than average. The seepage/infiltration rate varies in this area anywhere from 0 in./hr. on rock and ponds, to nearly 7.1 in./hr. on coarse gravels or organic soils capable of absorbing this amount of water.

The methodology used to calculate loss assumes that the water demand on the canal is evenly distributed along the length of the canal. This canal system conveys water from the head to the end and has a uniform demand along its length.

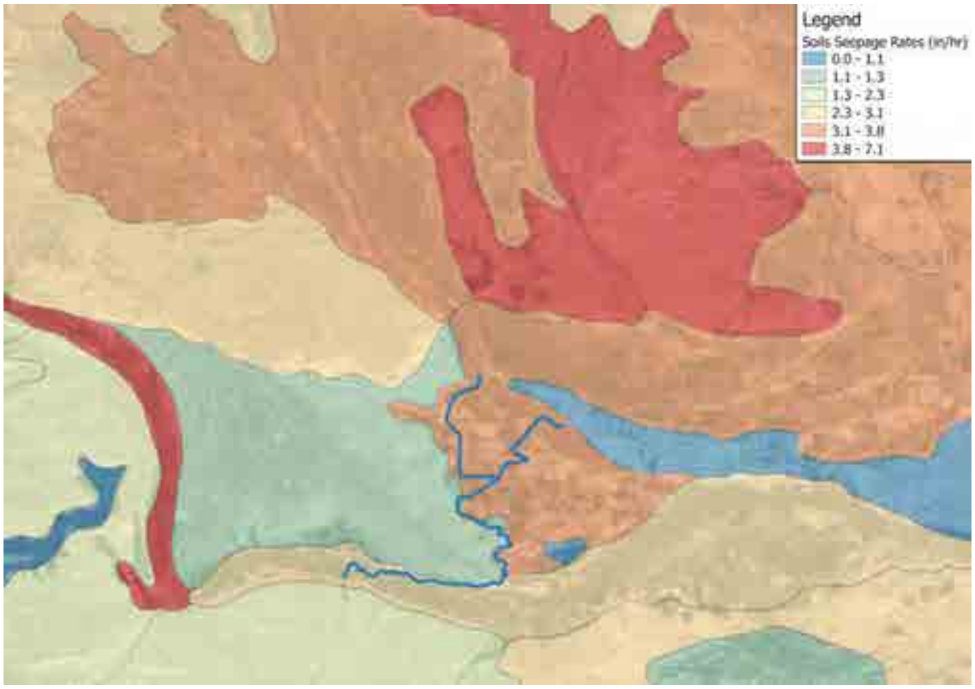


Figure 3-2. Typical Seepage in Project Area

3.3.2 Methods

The water loss due to seepage is estimated using a seepage rate method for soils. The method requires a seepage rate to be provided and an area measurement where water is subject to seep into the ground. The seepage rates for the project area were determined using information from the U.S. Geological Survey (USGS) and used to estimate the seepage rate for the canal.

The flow velocity in the canal is estimated to be vary between 2.0 feet per second (fps) and 7.5 fps, with an estimated average flow velocity of 4.0 fps. Knowing the flow rate of the canal in cfs, an equivalent cross-sectional area of the water in the canal can be calculated.

The area measurement used in the seepage rate calculation can then be used to estimate the wetted perimeter using the hydraulic radius of an equivalent sized radial section of pipe. Using this area, the equivalent pipe size needed to convey the same amount of water at the same velocity can be estimated. The area of the pipe however is set to be only half the circle because the canal does not enclose the water. Thus, the size of pipe needed to convey the same amount of water as if the pipe were half full is estimated. The equation of a circle is used to get the arc length, or the wetted perimeter of the canal that the water can seep into. This is shown as the black lines in Figure 3-3 below. Using the wetted perimeter of a circle in the seepage calculation is a conservative choice since the wetted perimeter of the circle will be less than the actual wetted perimeter of the canal channel in the field.

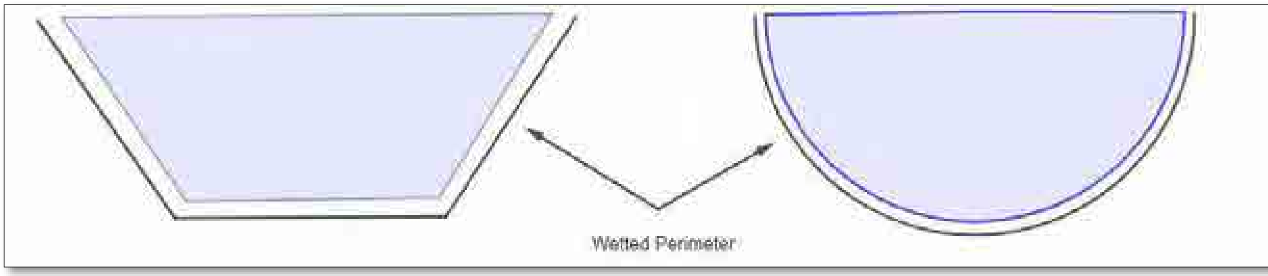


Figure 3-3 Wetted Perimeter

Using the wetted perimeter length, the area where seepage is taking place within the canal can be estimated. The length of the canal is multiplied by the wetted perimeter to get the seepage area. This area assumes that there is a constant flow throughout the length of the canal. To account for this, the seepage area is cut in half if there is zero flow at the end of the canal. The average of the wetted perimeter at the start and end of the canal is used to calculate the seepage area when there is a given flow at the end of the canal. Taking the seepage area and multiplying it by the seepage rate gives the seepage volume per unit of time.

Analyzing the seepage volume per day gives a good basis for analysis. The seepage volume is then divided by the amount of water diverted into the canal. This gives the seepage loss as a percentage of the total water diverted. The seepage loss per day can then be multiplied by the number of days in the typical irrigation season to determine the total annual loss due to seepage.

3.3.3 Results

The seepage analysis results for the Red Cap Extension Canal are summarized in the table below.

Table 3-1 Red Cap Extension Canal Seepage Analysis Results

Q Start (cfs)	Q End (cfs)	Length	Seepage Rate (in/hr)	Q (acre-feet/day)	Wetted Perimeter (ft)	Loss (acre-feet/day)	Loss %	Annual Water Loss (acre-feet/year)
44.07	40.2	7,920	2.61	87.4	8.1	7.7	8.8	1,651
40.2	34.3	7,920	2.05	79.7	7.6	5.7	7.1	1,219
34.3	18.1	7,920	2.76	68.1	6.3	6.4	9.3	1,359
18.1	9.0	7,920	3.69	35.9	4.5	6.1	17.0	1,306
9.0	1.7	7,920	3.69	17.9	2.7	3.6	20.2	775
1.7	0.8	7,870	3.69	3.4	1.4	1.8	54.1	391

Using the average daily flow from a two week period in July 2020 of 44.07 cfs, the Red Cap Extension Canal experiences water loss of 35.8%. Using the water loss percentage obtained and the average flow of 31.48 cfs during the irrigation season, the seepage rate is approximately 4,783.7 ac-ft/year. The seepage rate is nearly 11,655 ac-ft/year when the canal is at a maximum flow of 76.7 cfs. This method confirms the estimate from the irrigation company personnel that losses are well exceeding 20% within the canal.

3.4 Hydraulic Analysis

In order to perform the hydraulic analysis of the proposed pipeline, a GIS alignment was created and InfoWater Pro was used to model the pipeline.

3.4.1 Data and Assumptions

The data needed for the hydraulic analysis included the historic flows of the Red Cap Extension canal, current demand of the system, and the water rights information for shareholders in the Arcadia Farms area. This information was gathered from UIIP irrigation personnel and Bureau of Indian Affairs personnel who were familiar with the system.

The InfoWater model uses the GIS alignment which was created, and the approximate elevations of each junction, along with the approximate lengths of each pipe, were obtained from Google Earth. The Google Earth DEM is an interpolated model using several different DEM sources. The resulting Google Earth DEM is comparable to a standard SRTM DEM which has a resolution of approximately 30 meters for the area of interest. The elevation information used from the DEM is rough but is sufficient to approximate field conditions for this application.

In order to maintain conservatism for dynamic pressures within the pipeline, the pipeline was modeled as if all users were to irrigate at the same time. Currently, the shareholders are on turns for irrigation, but using this conservative assumption, it would model the lowest dynamic pressure that could be experienced at each junction. Additionally, the maximum diversion of 83.63 cfs was used for modeling purposes, distributed between the two respective pipelines within the proposed alignment.

For the model, a Hazen-Williams coefficient of 130 was used in order to determine the HDPE pipe size and pressure rating to convey the required flow in the pipeline with turnouts located at specified locations along the pipeline. The pressures within the pipeline were evaluated to ensure that the NRCS standard of 72% of maximum pressure rating was maintained throughout the design.

3.4.2 Methods

Using the GIS alignment that was created in InfoWater Pro, the junctions were placed in the locations of the turnouts along the pipeline. The pipeline properties including diameter, length, roughness, and flow were entered into the model. The length of the pipeline and elevations of the junctions were approximated from Google Earth. The model was ran once all of the applicable information was entered, and the pipeline attributes were optimized to ensure that the velocities and pressures met the NRCS standards.

3.4.3 Model Verification

This model was not verified by field measurements.

3.4.4 Hydraulic Modeling Results

In the west pipeline, the dynamic pressures range from approximately 3 psi to 26 psi due to the terrain and characteristics of the pipeline. The east pipeline dynamic pressures range from approximately 2 psi to 57 psi. More detailed results of the model can be viewed in Appendix A exhibit.

4.0 Alternatives Evaluation

Alternatives were previously developed which were in alignment with the procedures outlined in the NRCS National Watershed Program Manual (NWPM) (NRCS 2014) Parts 501 through 506, NRCS National Watershed Program Handbook (NWPH) (NRCS 2014) Parts 600 through 606, Economic and

Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies (P&G) (USWRC 1983), and other NRCS watershed planning policy. The alternatives were analyzed for this study based on four criteria outlined in the P&G (USWRC 1983): completeness, effectiveness, efficiency, and acceptability. The proposed alternative was selected based on the ability to address the purpose and need.

The following relevant alternatives and expected consequences must be evaluated, according to the NWPM:

- No Action Alternative – Most likely future condition if no action alternative is selected
- Proposed Alternative – This is the federally assisted alternative with the greatest economic benefits, which is one of the alternatives, or a combination of them.

4.1 Alternatives Eliminated from Detailed Study

The following alternatives and options were considered during the planning process but were eliminated from detailed study due to exorbitant costs, environmental impacts, considered infeasible, or other critical factors. A description of the alternatives eliminated from detailed study is included below. Alternatives were eliminated based on the following criteria from the canal company:

- Reduce water losses in the Red Cap Extension Canal and its laterals.
- Flow requirement in the canal is up to 85 CFS maximum.
- Serve all acreage associated with Arcadia Farms including where water can not currently be delivered.
- Must be a long-term solution, 50+ years, 75-100 preferable.
- Meets the above criteria and makes financial sense (Cost).
- Operationally Feasible with UIIP with minimal Operation and Maintenance Costs and fitting dynamic of Tribal and non-Tribal lands and water users.

4.1.1 Pipeline with Central Pump Station

This alternative would involve installing HDPE pipelines with the pipe ranging in size from 8” to 48”. Starting at Midview Wasteway, this alternative would extend north in two parallel, High Density Polyethelyne (HDPE) pipes. One of the pipelines would be for the shareholders located to the west and one pipeline for the shareholders located to the east.

In the majority of the east pipeline there is sufficient pressure to reduce on-farm pumping for sprinkler irrigation. A centralized pump station was proposed in this alternative for the west side pipeline where pressures would require on-farm pumping in order to use sprinkler irrigation. This option was evaluated to cost approximately $9,486,000.

This option would address most of the irrigation company’s requirements and evaluation criteria for flow, reducing water losses, serving all acreage, and life span. This alternative does not meet the evaluation criteria for project cost. Additionally, adding a central pump station on one side of the pipeline would introduce additional fees for some shareholders, managing the pump station across several different agencies, and additional O&M costs, which the UIIP is unable to manage.

4.1.2 Concrete Canal Liner

This alternative would involve shaping the existing earthen channel to provide a consistent cross section, installing and compacting sufficient base material for stabilization, installing a composite geomembrane liner, installing shotcrete at 3-inch thickness, and making any grading improvements necessary for freeboard and the access roadway.

This option would address most of the irrigation company's requirements and evaluation criteria for flow, reducing water losses, and life span. This alternative does not meet the evaluation criteria to serve all the acreage of Arcadia Farms.

4.2 Alternatives Considered for Detailed Study

Feasible alternatives that can meet the purpose and need for the Arcadia Farms project were studied in detail. Two alternatives were evaluated in detail which include 1) the No Action, and 2) the Proposed Alternative.

Preliminary cost estimates were developed for the alternatives using the following procedures:

- Based on July 2021 U.S. dollars.
- Estimated quantities of construction materials and labor
- Costs associated with mitigation of potential environmental and cultural/historical impacts were not included.

The alternatives considered for detailed study are described below.

4.2.1 No Action Alternative

The No Action Alternative considers the project and resource concerns in the future if no federally funded action were taken. It is also known as the Future-Without-Project Plan. With the implementation of the NO Action Alternative, the canal would remain the same and no improvements authorized. The existing environmental conditions would remain the same. The implementation of this alternative would have no direct costs, with financial opportunities being forfeited.

The estimated operations and maintenance (O&M) costs are approximately $41,750 per year. This includes costs associated with canal cleaning, vegetation removal, beaver maintenance, washout repairs, vegetation control, spraying, mowing, direct labor costs, fuel, equipment, and non-routine maintenance required for continued operation.

4.2.2 Proposed Alternative

The Arcadia Farms Pipeline project would enclose the Red Cap Extension Canal, which is currently an open transmission channel, along with its associated laterals. In doing this, the water losses that the canal experiences would be reduced and almost eliminated, additional water could be delivered to shareholders having non-accessible water rights, and pressure in the system could reduce costs of on-farm pumping for some shareholders. The proposed pipeline's intake structure would be combined with a new design for the wasteway which feeds Midview Reservoir, preventing undermining and erosion which has been occurring at the wasteway for many years.

Starting at Midview Wasteway, the Arcadia Farms pipeline would extend north in two parallel, High Density Polyethelyne (HDPE) pipes. One of the pipelines would be for the shareholders located to the west and one pipeline for the shareholders located to the east. The proposed alignment of the pipeline would follow existing canal right-of-ways where possible, but easements would be required where private and tribal land will be crossed.

The total length of pipeline is approximately 21 miles, and the size of HDPE ranges from 8 inches to 48 inches in diameter. Throughout the project, the pressure rating of the HDPE pipe is primarily DR 32.5 (63 psi); however, there are some areas that require DR 26 (80 psi) and DR 21 (100 psi). The increase in the pressure rating of the pipe is a safety factor required by the NRCS to not exceed 72% of the pressure rating of the pipe.

5.0 References

Natural Resources Conservation Service (NRCS). 2014c. Irrigation Pipeline Code 430.

Utah Supplement NEM-UT-511 Subpart A Design.

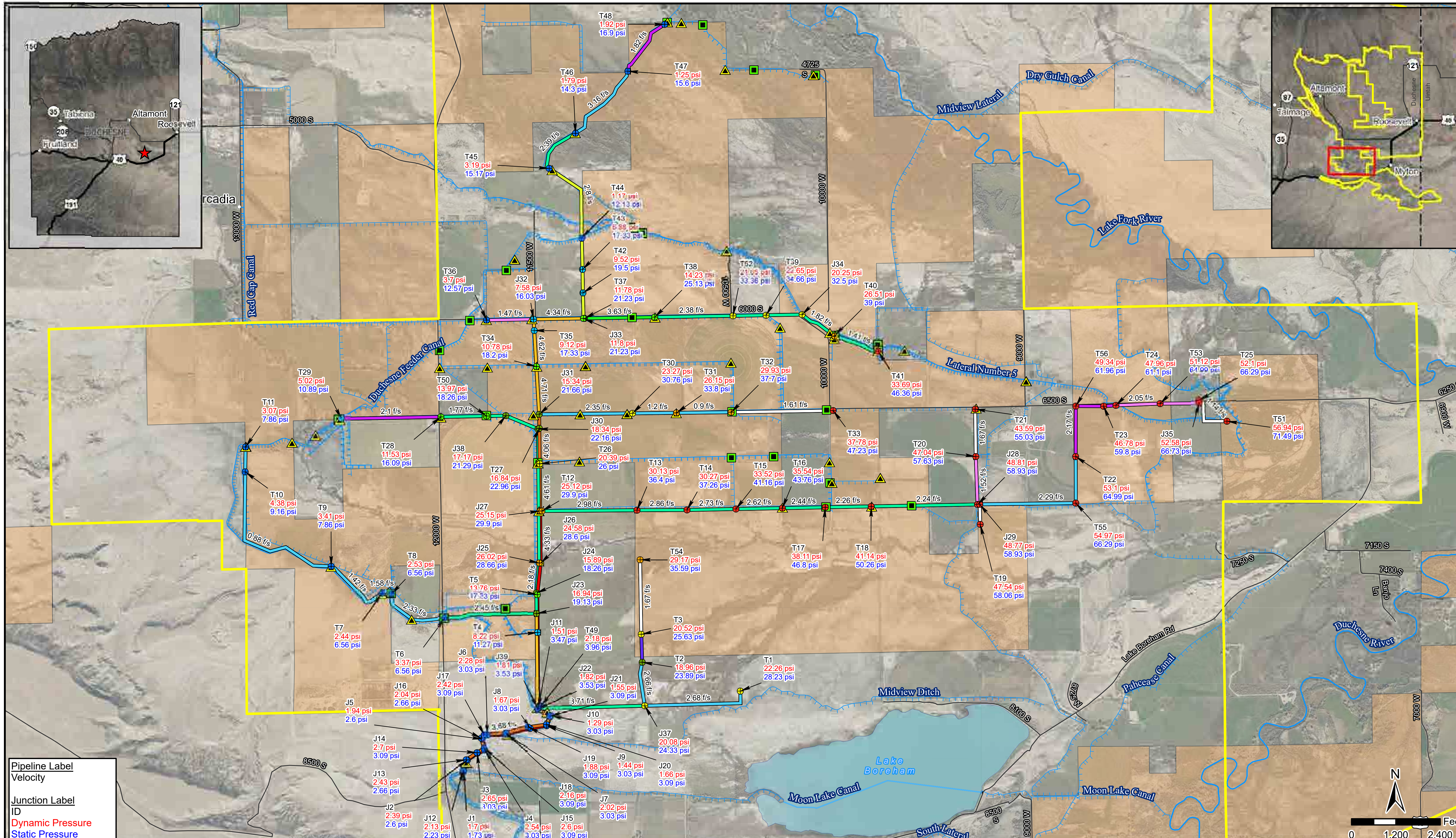
Utah Engineering Technical Notes - Flexible Conduits (TN UT210-15-01)

Utah Irrigation Zone Map, https://deq.utah.gov/public-interest/irrigation-zone-map

Duchesne River Data, http://www.duchesneriver.org/rivers

USDA Cropland, https://nassgeodata.gmu.edu/CropScape/

Appendix A. Project Overview Map



Proposed Pipeline
- 8"
- 12"
- 16"
- 18"
- 20"
- 24"
- 26"
- 28"
- 36"
- 42"
- 48"

Proposed Junction
- 0 - 4 psi
- 5 - 9 psi
- 10 - 14 psi
- 15 - 19 psi
- 20 - 24 psi
- 25 - 29 psi
- ≥ 30 psi

- Existing Turnouts
- Existing Headgates
- Watershed Boundary
- Tribal Lands

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Duchesne County Water Conservancy District

Watershed Plan EA
Arcadia Farms Pipeline Project Overview

Duchesne County

Scale: 1" = 2,400'

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Map Name: H:\JD\Proj\1907-354\Design\GIS\Projects\Environmental\1907-354_Env.aprx - Exh DCWD Watershed EA Arcadia Farms Pipeline Project Overview 11x17L

Project Number: 1907-354 | Drawn by: JEM 07-20 | Last Edit: 04/21/2022

TM002 – Gray Mountain Canal

1.0 Introduction

The Gray Mountain Canal is owned by the Bureau of Indian Affairs (BIA). The canal is located between the towns of Duchesne and Myton, roughly paralleling U.S. Highway 191, less than a mile south (see map in Appendix A). The water users are concerned about water loss. The goals of this project are to provide more water to shareholders, improve system reliability, improve system safety, and to reduce maintenance efforts.

1.1 Design Criteria

- NRCS Irrigation Ditch Lining (Code 428, with noted exceptions)
- NRCS Pond Sealing or Lining (Code 522)
- NRCS Utah Supplement NEM-UT-511 Design

2.0 Background

The Gray Mountain Canal system is comprised of a 7.9-mile long open channel segment, mostly unlined, that run along the foothills south of Bridgeland. At the end of the canal, water flows into existing large diameter pipeline that delivers water to users of the Pleasant Valley Irrigation Company (PVIC).

In 1976, a seepage study on the Gray Mountain Canal was performed by the State of Utah Department of Natural Resources (Technical Publication No. 50) that looked into the seepage rates along different reaches of the Gray Mountain Canal. The study found that the first 7.5 miles of the canal lost nearly 19.5 cubic feet per second (cfs) during irrigation season flow conditions. This would equate to nearly a 15 percent seepage loss in the first 7.5 miles of the canal.

In 2013, a feasibility study was performed on the canal to determine possible solutions to conserve water. Several options of modifying the canal were analyzed, including lining the canal with a submerged and exposed geomembrane liner, combination of pipe and concrete liner of the canal, and completely lining the canal with a concrete liner. The analysis provided cost estimates and concept drawings for the options evaluated. The relevant pages from the study are attached as Appendix B.

3.0 System Conditions

The Gray Mountain Canal system provides water for Uintah Basin Irrigation Company (UBIC) and the Ute Indian Tribe (Tribe). UBIC serves approximately 10,300 acres of agricultural land via 82 shareholders. The Tribe's water serves approximately 3,500 acres via 103 shareholders. Crops irrigated include high mountain pasture crops including grass/pasture, alfalfa, grass, and other hay crops[1].

Water is diverted from the Duchesne River into the large mostly unlined Gray Mountain Canal, which has a 16 foot channel bottom width, 36 foot total channel width, and is approximately 7 feet deep. The canal has a capacity of 200 cfs; approximately 28 percent of the water is used by the Tribe through 17 turnouts, and the remaining 72 percent of the water is used by the UBIC. The canal also conveys water to the PVIC, which has an existing 72-inch pipeline.

When the canal is full, the water master estimates that the canal loses 30-35 cfs from seepage and evaporation along several specific points along the canal. The Gray Mountain Canal typically diverts an average of approximately 128 cfs during the irrigation season. The highest flow the system has received is about 222 cfs. The ditch master has observed water losses in all segments of the canal system. It is

[1] USDA Cropland, https://nassgeodata.gmu.edu/CropScape/ (accessed 8-20-2020)

estimated that approximately 25 percent of the water diverted to the system is lost due to seepage and evaporation.

There are specific points along the canal that have water visibly seeping out of the canal banks. These seeps are generally due to poor soil conditions and root infiltration into the canal banks. Trees, shrubs, and other plants thrive on the banks of the canal due to the water levels in the canal. There have been multiple canal bank breaches within the last 10 years caused by roots growing into the banks of the canal. To date, there has not been much property damage as a result of the breaches, but the irrigators receiving water from the canal must go without water while the breach is repaired.

3.1 Data Sources

The analysis used GIS and Google Earth to provide information on the project's location and total length. Real-time and historical water data was obtained from http://www.duchesneriver.org/rivers/lake-fork/ (accessed 8-20-2020). Soil information was acquired from the U.S. Geological Survey (USGS) website at https://water.usgs.gov/GIS/metadata/usgswrd/XML/ussoils.xml#stdorder (accessed 8-20-2020).

3.2 Water Supply and Demand Analysis

3.2.1 System Water Supply

UBIC has four water rights and the USA Indian Irrigation Service has three water rights for the water conveyed in the Gray Mountain Canal (Table 3-1). During water shortages, supplemental flows from Starvation Reservoir are used to meet water demand. The average daily flow recorded during the irrigation season since January 1, 2015, is 128 cfs, with a maximum of 222 cfs. The total annual water supply in the canal is approximately 55,200 acre-feet, which includes 14,000 acre-feet of the Tribe's water supply.

Table 3-1. Water Rights for Gray Mountain Canal

Water Right	Company	Flow (cfs)	Volume (ac-ft)	Type	Priority
43-462	UBIC	136.97	40,786.44	Water User's Claim	06/16/1910
43-1698	UBIC	25	-	Water User's Claim	06/20/1911
43-11687	UBIC	-	33	Water User's Claim	06/16/1910
43-11713	UBIC	1		Water User's Claim	06/16/1910
43-460	USA Indian Irrigation Service	8.38		Water User's Claim	09/06/1921
43-459	USA Indian Irrigation Service	52		Water User's Claim	07/10/1905
43-1204	USA Indian Irrigation Service	15		Water User's Claim	07/10/1905

3.2.2 Water Demand

Utah's Irrigated Crop Consumptive Use Zones are shown in Figure 3-1. The project area is in the moderate zone, with a general irrigation diversion duty of 3.0 acre-feet per acre. With 13,800 irrigated acres, the annual maximum allowable diversion is 41,400 acre-feet for UBIC and the Tribe. The remaining water is diverted for the PVIC.

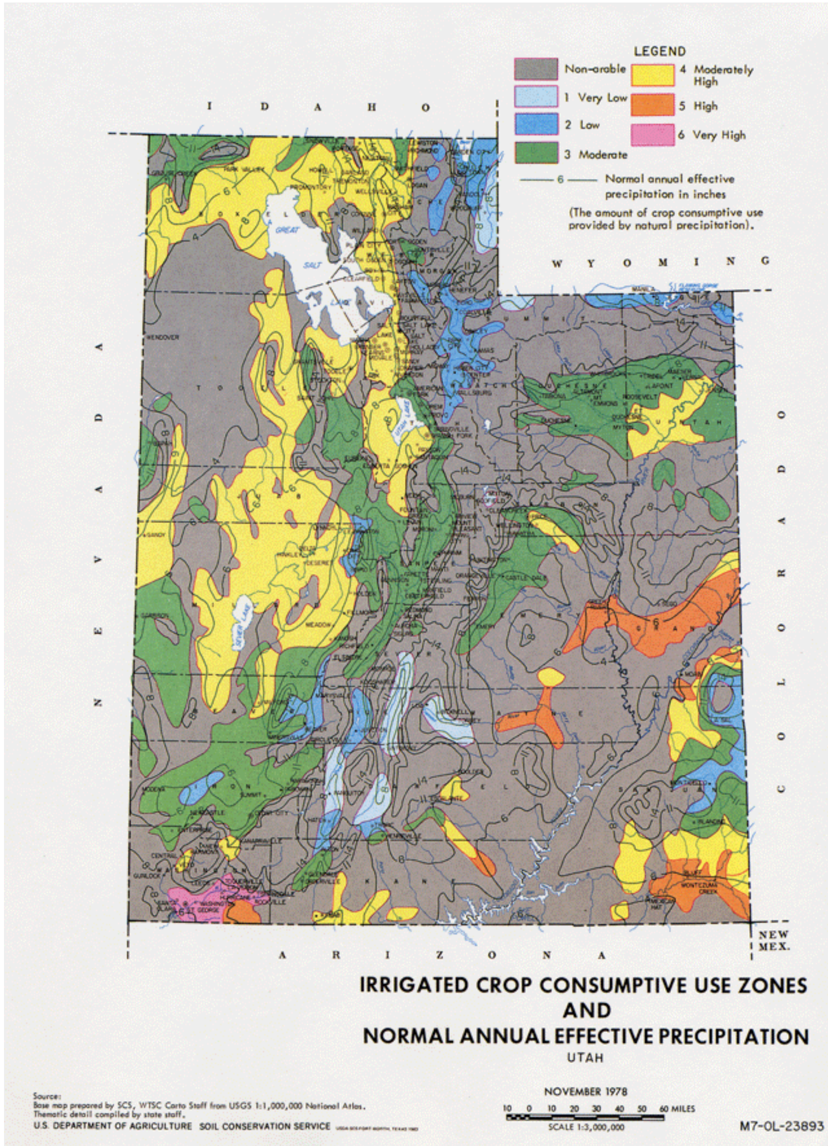


Figure 3-1. Crop Consumptive Use Zones[2]

3.3 Water Loss Analysis

A water loss analysis was conducted to determine the range of water loss experienced in the canal during average flow conditions. This analysis evaluated water loss due to seepage; other types of water loss such as overwatering issues or operational losses were not evaluated due to insufficient flow information within the system. Losses associated with evaporation on open canal systems are typically on the order of 1-2 percent; this loss is considered insignificant and has not been included in the analysis. The analysis looked at the length of the open canal system that is proposed to be treated.

[2] https://deq.utah.gov/public-interest/irrigation-zone-map (accessed 8-20-2020)

3.3.1 Data and Assumptions

The daily average flows for the Gray Mountain Canal were obtained from duchesneriver.org for a period from January 1, 2015, through June 23, 2020. Average flows within the system were obtained from the irrigation company. The data obtained indicate that the average daily flows during the irrigation season of April 1 to October 31 range from 0 to 222 cfs. The average recorded flow during the irrigation season between the dates available is 128 cfs.

The USGS soils seepage information was obtained from the USGS website in an ESRI shapefile (.shp) for Region 14 of the Upper Colorado Basin. This information contains generalized seepage rates for the soils at and around the project area. This information provides a general seepage rate for the area and may be conservative, as the seepage rate within canals at the base of a hill is expected to be higher due to the soils being more coarse at the foot of a hill. This information also assumes seepage rates that generalize large areas and are averages of the soils in those areas. Figure 3-1 below shows the typical seepage information overlay on a map of the area around the project. Green and blue are areas of relatively low infiltration/seepage rates, tan and orange areas had relatively average seepage rates, while areas of red are areas where the seepage is higher than average. The seepage/infiltration rate for the area around the project is moderate, with a range from 0 in/hr on rock and ponds, to nearly 7.1 in/hr on coarse gravels or organic soils capable of absorbing this amount of water.

The methodology used to calculate loss assumes that the water demand on the canal is evenly distributed along the length of the canal. This generalization is treated as the canal system conveying water from the head to the end and having a uniform demand along its length.

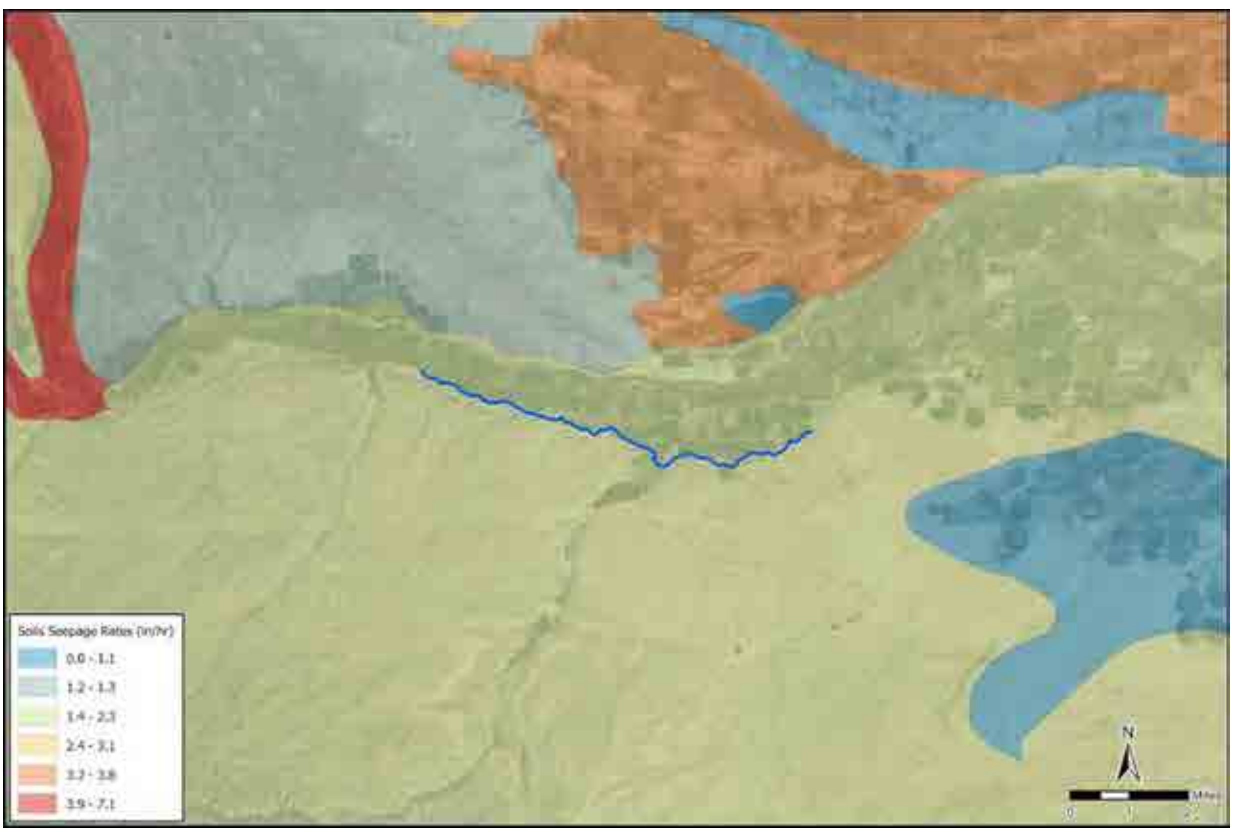


Figure 3-1. Typical Seepage in Project Area

3.3.2 Methods

The water loss due to seepage is estimated using a seepage rate method for soils. The method requires a seepage rate to be provided and an area measurement where water is subject to seep into the ground. The seepage rates for the project area were determined using information from the USGS and used to estimate the seepage rate for the canal.

The flow velocity in the canal is estimated to vary between 2.1 feet per second (fps) and 6.8 fps, with an estimated average flow velocity of 4 fps. With a known flow rate of the canal, we can calculate the equivalent cross-sectional area of the water in the canal.

The area measurement used in the seepage rate calculation can then be used to estimate the wetted perimeter using the hydraulic radius of an equivalent-sized radial section of pipe. Using this area, the equivalent pipe size needed to convey the same amount of water at the same velocity can be estimated. The area of the pipe is set to be only half the circle because the canal does not enclose the water. Thus, the size of pipe needed to convey the same amount of water as if the pipe were half full is estimated. The equation of a circle is used to determine the arc length, or the wetted perimeter, of the canal that water can seep into. This is shown as the black lines in Figure 3-2 below. Using the wetted perimeter of a circle in the seepage calculation is a conservative choice since the wetted perimeter of the circle will be less than the actual wetted perimeter of the canal channel in the field.

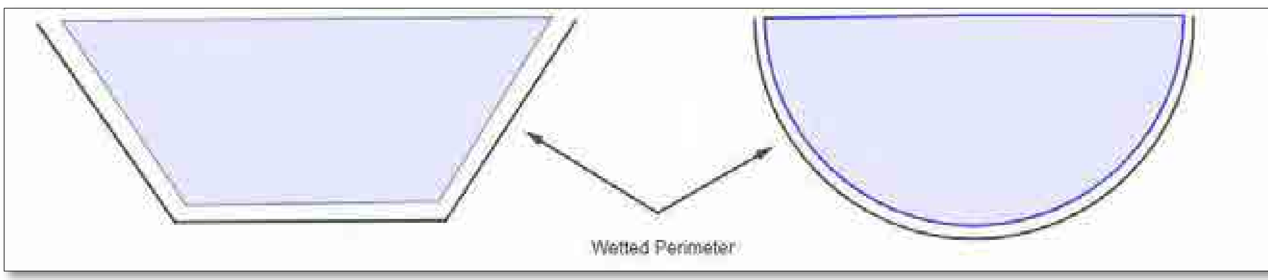


Figure 3-2. Wetted Perimeter

Using the wetted perimeter length, the area where seepage is taking place within the canal can be estimated. The length of the canal is multiplied by the wetted perimeter to calculate the seepage area. This area assumes that there is a constant flow throughout the length of the canal. To account for this assumption, the seepage area is halved if there is no flow at the end of the canal. The average of the wetted perimeter at the start and end of the canal is used to calculate the seepage area when there is a given flow at the end of the canal. The seepage area multiplied by the seepage rate gives the seepage volume per unit of time.

Analyzing the seepage volume per day gives a good basis for analysis because the volume changes over time. The seepage volume is then divided by the amount of water diverted into the canal. This gives the seepage loss as a percentage of the total water diverted. The seepage loss per day can then be multiplied by the number of days in the typical irrigation season to determine the total annual loss due to seepage.

3.3.3 Results

Using the average daily flow, the seepage analysis indicated that the estimated water loss for the entire 7.9-mile canal is 23.4 percent, which is consistent with the irrigation company's estimates. A total length of approximately 10,475 feet (1.98 miles) is proposed to be lined in three separate sections (see map in Appendix A). These three sections account for a total water loss of approximately 6.4 percent, or nearly one-third (28 percent) of the total water loss (see Table 3-2).

Table 3-2. Calculated Losses on Gray Mountain Canal

Segment	Q Start (cfs)	Q End (cfs)	Length (ft)	Seepage Rate (in/hr)	Q (af/day)	Wetted Perimeter (ft)	Estimated Water Loss (af/day)	Estimated Water Loss (% of total)	Annual Water Loss (af/yr)
Gray Mountain Canal	128	98	41,818	2.33	253.9	13.3	59.4	23.4	12,721
Liner 1	128	126.4	2,138	2.31	253.9	14.1	3.2	1.3	686
Liner 2	122	117.9	5,545	2.31	242.0	13.7	8.1	3.3	1,727
Liner 3	115	113	2,792	2.33	228.1	13.4	4.0	1.8	855

3.4 Hydraulic Analysis

To evaluate the hydraulic performance of the existing canal system and canal lining, a GIS alignment and operation model were developed. The model consisted of a Google Earth alignment drawn using satellite imagery of the current canal system. System information was gathered from discussions with the BIA, the Gray Mountain Canal ditch master, and the PVIC.

3.4.1 Data and Assumptions

The model relies on the Google Earth imagery system for an approximate canal alignment, elevation information, and facility locations. The canal alignment is measured using straight lines and does not reflect all of the canal twists and turns. The model provides an approximate alignment and is typically within 100 feet of the canal centerline alignment. Elevation information was used from the Google Earth Digital Elevation Model (DEM). The Google Earth DEM is an interpolated model using several different DEM sources. The resulting Google Earth DEM is comparable to a standard SRTM DEM, which has a resolution of approximately 30 meters for the area of interest. The elevation information from the DEM is rough but is sufficient to approximate field conditions for this application.

All facility locations marked using Google Earth were located using references to visual landmarks or features, such as approximate distances from roads, bridges, driveways, houses, fences, and other visible features on the Google Earth imagery. Many features were visible in varying historical dates of the Google Earth imagery.

For the proposed project, a Mannings roughness (n) value of 0.013 for concrete liner was used to determine the canal liner dimensions required to convey the required flow. Hydraulic gradelines were evaluated to determine freeboard requirements along the banks of the canal to supply adequate flow during high flows and storm events.

3.4.2 Methods

The principal method of modeling the existing and proposed systems was using Google Earth and a calculation spreadsheet. Google Earth was used to measure and approximate system elevations and canal lengths, observe system operational control locations, and evaluate alternative options. The NRCS Open Channel Flow calculation spreadsheet using Manning's Flow Equation was used to verify that the liner dimension would provide adequate flow. Additional calculation spreadsheets were used to compare existing system lengths, quantities to future alternative material quantities, and quantify operational differences between the existing and future system.

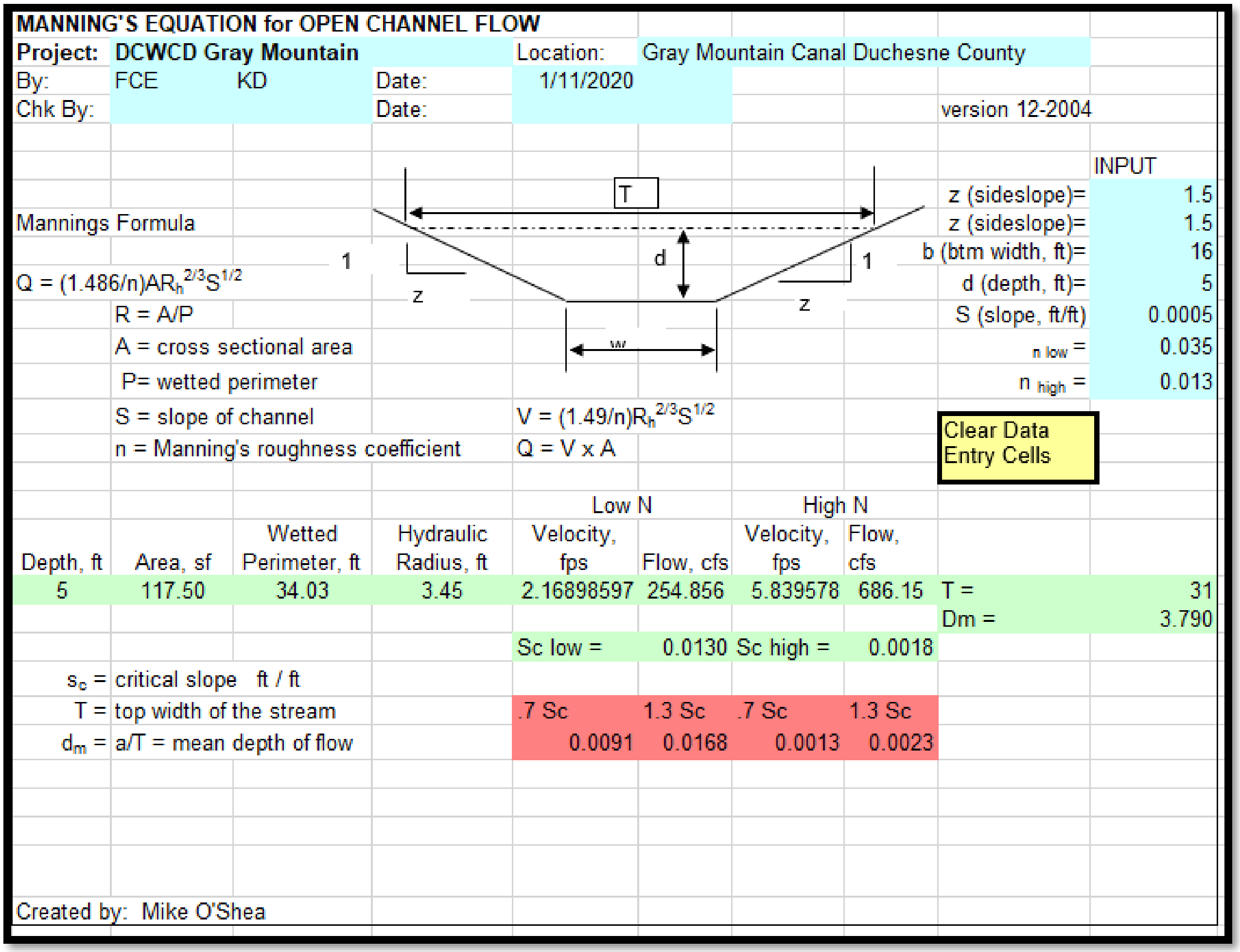
3.4.3 Model Verification

The verification consisted of a system overview map that showed the entire system. The model was not verified by field measurements.

3.4.4 Hydraulic Modeling Results

The existing canal uses gravity to transport irrigation water to the water users. The canal system is planned to continue using open channel flow. The existing canal must be checked to ensure adequate capacity to convey the required flows, accounting for seepage losses, flooding, and freeboard.

A calculation spreadsheet was obtained from Mike O'Shea, NRCS, that calculates open channel flow using Manning's Open Channel Flow Equation. The spreadsheet required some initial dimensions to calculate the flow within the canal. The existing canal bottom width was measured to be approximately 16 feet near the proposed treatment segments. The side slopes of the canal liner are generally 1.5:1 and the slope of the canal was estimated to be 0.05%. This information was used to provide a normal flow depth of 5 feet for 250 cfs. 220 cfs + 10% = 242 cfs. The additional 1 foot of freeboard is a standard freeboard dimension used in open channel design for the area. The calculation spreadsheet can be seen in Figure 3-3.



MANNING'S EQUATION for OPEN CHANNEL FLOW

Project: **DCWCD Gray Mountain** | Location: Gray Mountain Canal Duchesne County
By: FCE KD | Date: 1/11/2020
Chk By: | Date: | version 12-2004

Mannings Formula

$Q = (1.486/n)AR_h^{2/3}S^{1/2}$

R = A/P
A = cross sectional area
P= wetted perimeter
S = slope of channel
n = Manning's roughness coefficient

$V = (1.49/n)R_h^{2/3}S^{1/2}$
Q = V x A

INPUT	
z (sideslope)=	1.5
z (sideslope)=	1.5
b (btm width, ft)=	16
d (depth, ft)=	5
S (slope, ft/ft)	0.0005
n_{low} =	0.035
n_{high} =	0.013

Clear Data Entry Cells

Depth, ft	Area, sf	Wetted Perimeter, ft	Hydraulic Radius, ft	Low N Velocity, fps	Low N Flow, cfs	High N Velocity, fps	High N Flow, cfs		
5	117.50	34.03	3.45	2.16898597	254.856	5.839578	686.15	T =	31
								Dm =	3.790
				Sc low =	0.0130	Sc high =	0.0018		
				.7 Sc	1.3 Sc	.7 Sc	1.3 Sc		
				0.0091	0.0168	0.0013	0.0023		

s_c = critical slope ft / ft
T = top width of the stream
d_m = a/T = mean depth of flow

Created by: Mike O'Shea

Figure 3-3. Hydraulic Analysis Calculations

The proposed liner sections have been preliminarily designed based on the existing canal alignment and some minor alignment modifications that would remain within the right-of-way and would not require new easement or other relocation requirements to provide the required irrigation flow requirements.

4.0 Alternatives Evaluation

Alternatives were previously developed which were in alignment with the procedures outlined in the NRCS National Watershed Program Manual (NWPM) (NRCS 2014) Parts 501 through 506, NRCS National Watershed Program Handbook (NWPH) (NRCS 2014) Parts 600 through 606, Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies (P&G) (USWRC 1983), and other NRCS watershed planning policy. The alternatives were analyzed for this study based on four criteria outlined in the P&G (USWRC 1983): completeness, effectiveness, efficiency, and acceptability. The proposed alternative was selected based on the ability to address the purpose and need.

The following relevant alternatives and expected consequences must be evaluated, according to the NWPM:

- No Action Alternative – Most likely future condition if no action alternative is selected

- Proposed Alternative – This is the federally assisted alternative with the greatest economic benefits, which is one of the alternatives, or a combination of them.

4.1 Alternatives Eliminated from Detailed Study

The following alternatives and options were considered during the planning process but were eliminated from detailed study due to exorbitant costs, environmental impacts, considered infeasible, or other critical factors. A description of the alternatives eliminated from detailed study is included below. The following items were partially evaluated and proposed in a 2013 "Planning Cost Estimates for Alternatives" by Horrocks Engineers. These alternatives were prepared based on 2013 costs for a 35,000 foot section of the Gray Mountain Canal. Portions of this document are included in Appendix B. Alternatives were eliminated based on the following criteria from the canal company:

- Stop excessive seepage in selected sections of the Gray Mountain Canal.
- Flow requirements in the sections of the canal is up to 220 CFS maximum.
- Prevent root intrusion from shrubs and trees along canal banks and reduce vegetation growth along canal profile.
- Eliminate canal bank erosion at canal alignment bends and reduce liability with canal bank blowouts and flooding.
- Must be a long-term solution, 50+ years, 75-100 preferable.
- Must be able to withstand livestock and wildlife traffic, no punctures or exposed liners/pipes.
- Must be able to withstand routine maintenance and canal cleaning with current operating equipment.
- Meets the above criteria and makes financial sense. (Cost)

4.1.1 Membrane Liner with Bottom Ballast

This alternative would involve remodeling the canal cross section, installing a plastic canal liner, and installing cobble and sand in the bottom of the canal liner. The banks of the canal liner would remain exposed. This option would provide approximately 25-30 years of service based on the lifespan of the liner evaluated. This option was evaluated to cost approximately $13,755,000.

This option would address most of the irrigation company's requirements and evaluation criteria for flow, seepage control, root intrusion, erosion, liability, vegetation growth, and cost. This alternative does not meet the evaluation criteria for alternative life span, wildlife traffic, or maintenance operations.

4.1.2 Membrane Liner with Full Ballast

This alternative would involve remodeling the canal cross section, installing a PVC canal liner, and installing cobble and sand over the canal liner. This option would provide approximately 20 years of service based on the lifespan of the liner evaluated. This option was evaluated to cost approximately $16,890,000.

This option would address most of the irrigation company's requirements and evaluation criteria for flow, seepage control, root intrusion, erosion, liability, vegetation growth, wildlife traffic, and cost. This alternative does not meet the evaluation criteria for the life span, or maintenance operations.

4.1.3 Slip Lined Concrete

This alternative would involve remodeling the canal cross section and installing a slip lined concrete canal liner. This option would provide approximately 20-50 years of service based on the soil conditions and base preparation. This option was evaluated to cost approximately $19,010,000.

This option would address most of the irrigation company's requirements and evaluation criteria for flow, seepage control, root intrusion, erosion, liability, vegetation growth, wildlife traffic, maintenance operations, and cost. This alternative does not meet the evaluation criteria for the life span.

4.1.4 Membrane Liner with Shotcrete on Bottom and Sides

This alternative would involve remodeling the canal cross section, installing a PVC liner and using fiber-reinforced shotcrete canal liner. This option would provide approximately 40-50 years of service based on similar projects that have used this alternative. This option was evaluated to cost approximately $22,100,000.

This option would address most of the irrigation company requirements and evaluation criteria for flow, seepage control, root intrusion, erosion, liability, vegetation growth, wildlife traffic, maintenance operations, and cost. This alternative does not meet the evaluation criteria for the life span.

4.1.5 Steel Pipeline – 63" and 84"

This alternative would involve remodeling the canal cross section, installing a 63-inch HDPE pipe, and an 84-inch diameter steel pipe. These pipes would run parallel to each other in the existing canal alignment. This option would provide approximately 50-85 years of service based on similar projects that have used this alternative. This option was evaluated to cost approximately $51,720,000.

This option would address most of the irrigation company's requirements and evaluation criteria for flow, seepage control, root intrusion, erosion, liability, vegetation growth, wildlife traffic, maintenance operations, and life span. This alternative does not meet the evaluation criteria for project cost.

4.1.6 Steel Pipeline - 108"

This alternative would involve remodeling the canal cross section, installing a 108-inch diameter steel pipe in the existing canal alignment. This option would provide approximately 50-85 years of service based on similar projects that have used this alternative. This option was evaluated to cost approximately $52,340,000.

This option would address most of the irrigation company's requirements and evaluation criteria for flow, seepage control, root intrusion, erosion, liability, vegetation growth, wildlife traffic, maintenance operations, and life span. This alternative does not meet the evaluation criteria for project cost.

4.2 Alternatives Considered for Detailed Study

Feasible alternatives that can meet the purpose and need for the Gray Mountain Canal project were studied in detail. Two alternatives were evaluated in detail which include 1) the No Action, and 2) the Proposed Alternative.

Preliminary cost estimates were developed for the alternatives using the following procedures:

- Based on 2021 U.S. dollars.
- Estimated quantities of construction materials and labor

- Costs associated with mitigation of potential environmental and cultural/historical impacts were not included.

The alternatives considered for detailed study are described below.

4.2.1 No Action Alternative

The No Action Alternative considers the project and resource concerns in the future if no federally funded action were taken. It is also known as the Future-Without-Project Plan. With the implementation of the NO Action Alternative, the canal would remain the same and no improvements authorized. The existing environmental conditions would remain the same. The implementation of this alternative would have no direct costs, with financial opportunities being forfeited.

The estimated operations and maintenance (O&M) costs are approximately $51,000 per year, with a present value estimate of $4,006,000 over a 100-year life. This includes costs associated with canal cleaning, vegetation removal, beaver maintenance, washout repairs, vegetation control, spraying, mowing, direct labor costs, fuel, equipment, and non-routine maintenance required for continued operation.

4.2.2 Proposed Alternative

Implementation of the Proposed Alternative would authorize the lining of approximately 10,620 feet of the canal in three sections using a concrete canal liner. Liner 1 (west side) would line approximately 2,138 feet of the existing canal, Liner 2 (center) would line approximately 5,545 feet, and Liner 3 (east side) would line approximately 2,792 feet. The construction of the canal liners would be completed after the irrigation season, when the canal was not in use. They could be completed all at once or in three separate phases as funding becomes available.

The canal alignment would be adjusted within the existing canal right-of-way to minimize the amount of bends needed in the liner. The proposed lining would be installed using a hydraulically efficient design and would transition naturally into the existing canal banks to minimize erosion and seepage issues. The lining would be constructed using a 3-inch thick concrete liner with two layers of geofabric that would extend 16 feet across the bottom of the canal and up the canal banks at 42° on both banks to a height of approximately 6 feet above the canal floor or the top of the existing canal bank. These dimensions include a 10% flow safety factor for flooding and an additional freeboard dimension of 1 foot above the high water line. These dimensions also closely match the current canal dimensions and will minimize the amount of earthwork required to prepare the existing canal to be lined. Matching the existing canal dimensions will also minimize the potential erosion flows associated with transitional changes between the untreated channel and the lined sections of the canal.

Additional improvements to be completed with the canal liners include a seepage collection and monitoring pipe system, as well as canal access road improvements.

The lands used for the proposed project are within the canal right-of-way and would use existing prescriptive easements.

5.0 References

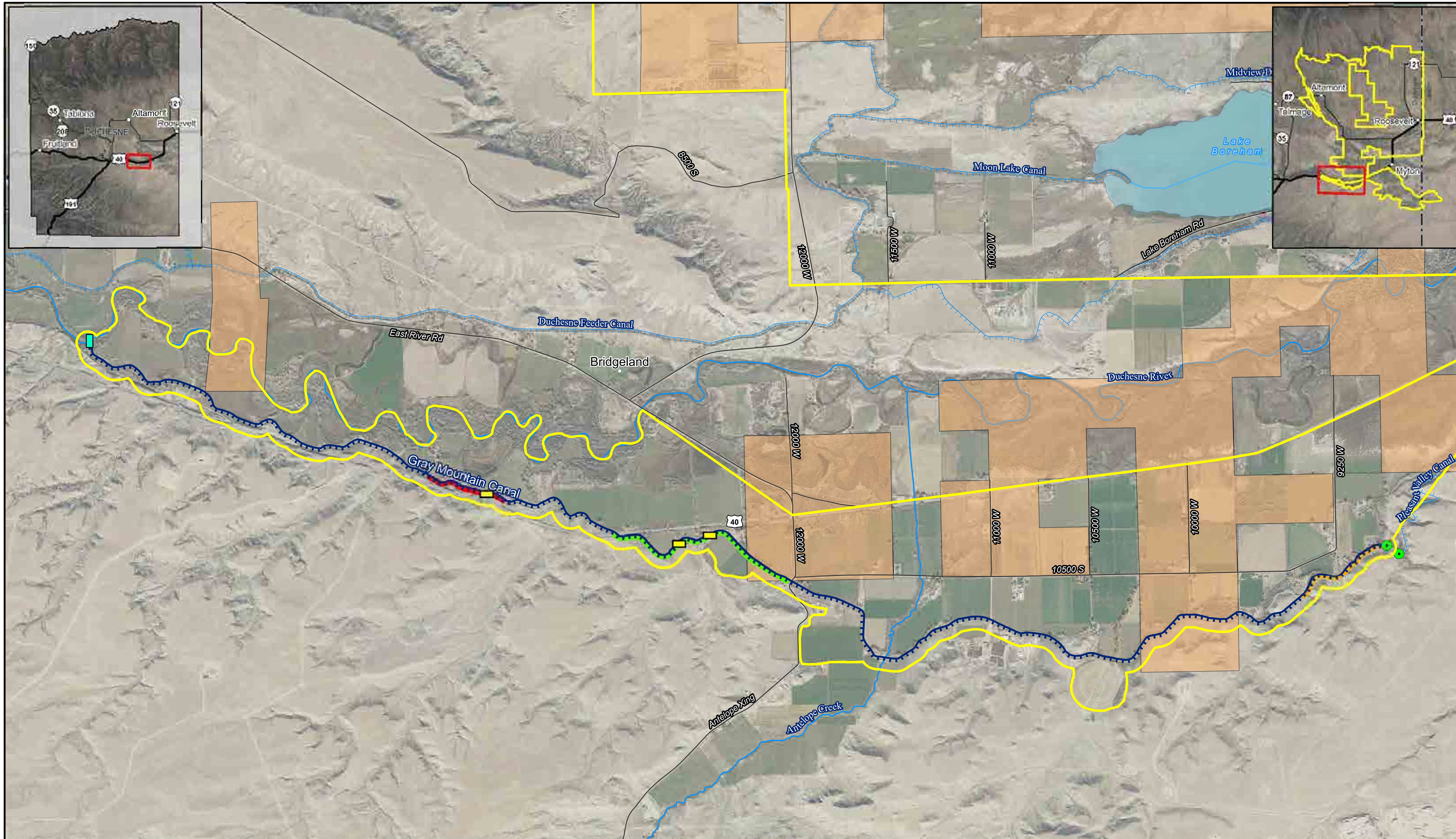
Utah Supplement NEM-UT-511 Subpart A Design.

Utah Irrigation Zone Map, https://deq.utah.gov/public-interest/irrigation-zone-map

Duchesne River Data, http://www.duchesneriver.org/rivers/lake-fork/

USDA Cropland, https://nassgeodata.gmu.edu/CropScape/

Appendix A. Project Overview Map



- Bridge
- Diversion
- Pipeline inlet
- Gray Mountain Canal
- Proposed Liner 1
- Proposed Liner 2
- Proposed Liner 3
- Tribal Lands
- Watershed Boundary

N

0 1,200 2,400 Feet

Jones & DeMille Engineering
- Shaping the Quality of Life -
800.748.5275 www.jonesanddemille.com

FRANSON CIVIL ENGINEERS

Duchesne County Water Conservancy District

Watershed Plan EA
Gray Mountain Canal Proposed Lining Overview

Map Name: H:\JD\Proj\1907-354\Design\GIS\Projects\Environmental\1907-354_Env.aprx - Exh DCWD Watershed EA Grey Mountain Canal Proposed Lining 11x17L

Project Number: 1907-354 | Drawn by: JEM 07-20 | Last Edit: 04/21/2022

Duchesne County

Scale: 1" = 2,400'

1

Appendix B. 2013 Feasibility Study Pages

File Copy

HORROCKS

ENGINEERS

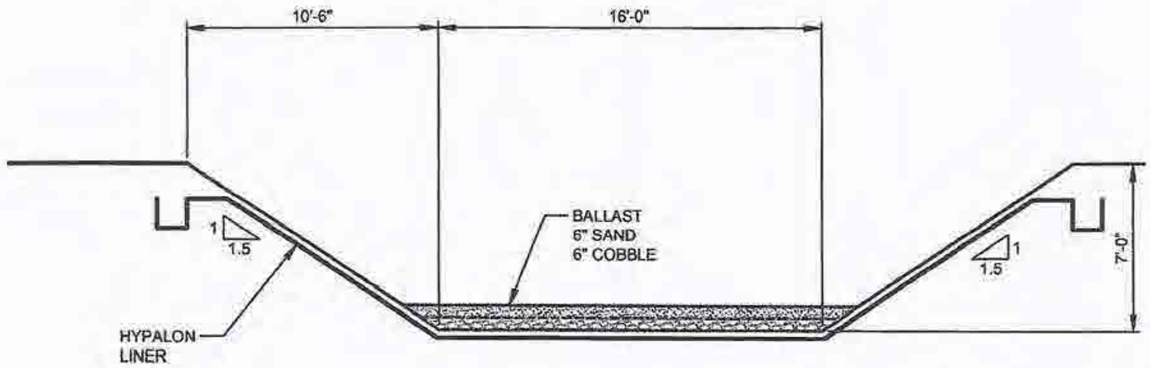
Gray Mountain Canal Rehabilation Project

Planning Cost Estimates for Alternatives

31-Oct-13

ENR CCI = 9689

ALTERNATE		PLANNING COST ESTIMATE	
1	Membrane Liner with Bottom Ballast	$13,755,000	30 yr life 40 mil Thick
2	Membrane Liner with Full Ballast	$16,890,000	PVC Liner 1 to 3 slope covered 20 yr life
3	Slip Lined Concrete	$19,010,000	steeper slope 25 to 50 soil condition
4	Membrane Liner with Shotcrete on bottom & sides	$22,100,000	40m PVC with sprayed on concrete 40 to 50 yr
5	63" HDPE & 84" Steel Pipeline	$51,720,000	
6	Single 108" Steel Pipeline	$52,340,000	



A
E-1
OPTION #1
HYPALON LINER
W/ BOTTOM BALLAST

HORROCKS ENGINEERS

2162 West Grove Parkway
Suite 400
Pleasant Grove, UT 84062
(801) 763-5100

GRAY MT. CANAL REHAB

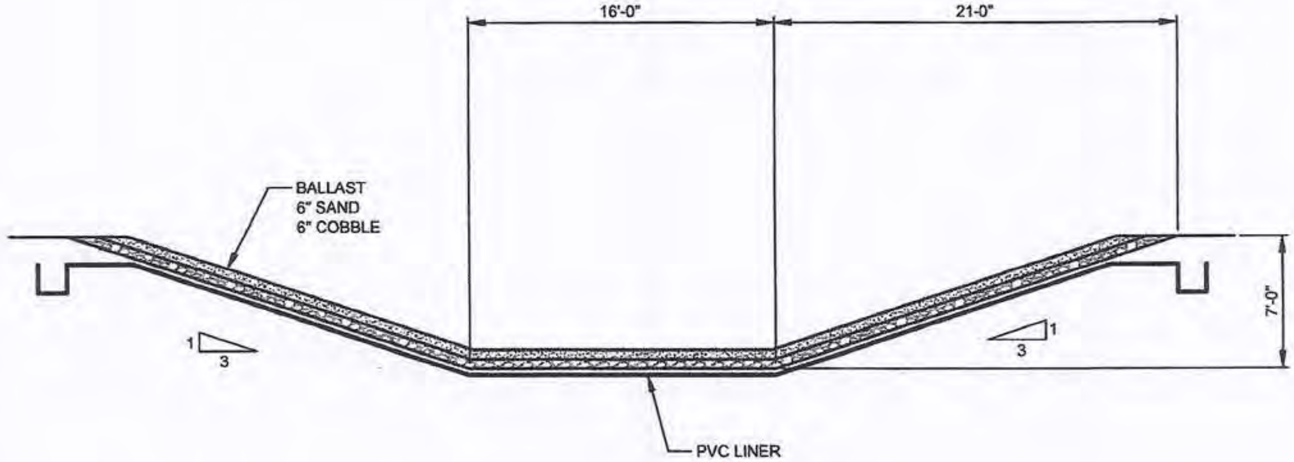
OPTION #1

O:\2013\RT-602-1310 Grey Mt Canal Rehab\Project Data\Sheet_Files\Exhibit\RT-602-1310_CANAL EXHIBITS.dwg, Option 1, 11/1/2013 10:20:50 AM, caseyg

Budgetary Cost Estimate for Gray Mountain Canal Membrane Liner with Bottom Ballast

20-Oct-13

Item #	Description	Quantity	Units	Unit Cost	Total Cost
1	Mobilization	1	L.S.	$ 500,000.00	$ 500,000.00
2	Clear & Grub	22	Ac.	$ 2,000.00	$ 44,000.00
3	Canal Exc.	210,000	C.Y.	$ 12.00	$ 2,520,000.00
4	45 Mil Hypalon Liner	187,000	S.Y.	$ 20.00	$ 3,740,000.00
5	Ballast over liner	23,000	C.Y.	$ 22.00	$ 506,000.00
6	Turnout Structure	8	Ea.	$ 15,000.00	$ 120,000.00
7	Check Structure	5	Ea.	$ 165,000.00	$ 825,000.00
8	Bridge Replacement	5	Ea.	$ 65,000.00	$ 325,000.00
9	Roadway UBC	8,500	C.Y.	$ 22.00	$ 187,000.00
10	Contingency (20%)	1	L.S.	$ 1,753,000.00	$ 1,753,000.00
	Subtotal - Construction				$ 10,520,000.00
	Design Engineering (6%)				$ 630,000.00
	Geotechnical Investigation				$ 100,000.00
	Right-of-ways				$ 150,000.00
	Environmental				$ 750,000.00
	Habitat Replacement & Mitigation				$ 500,000.00
	Construction Management (9%)				$ 945,000.00
	Legal & Administration				$ 160,000.00
	Total Estimated Project Costs				$ 13,755,000.00



B
E-2
OPTION #2
PVC LINER W/ BALLAST

HORROCKS ENGINEERS
2162 West Grove Parkway
Suite 400
Pleasant Grove, UT 84062
(801) 763-5100

GRAY MT. CANAL REHAB

OPTION #2

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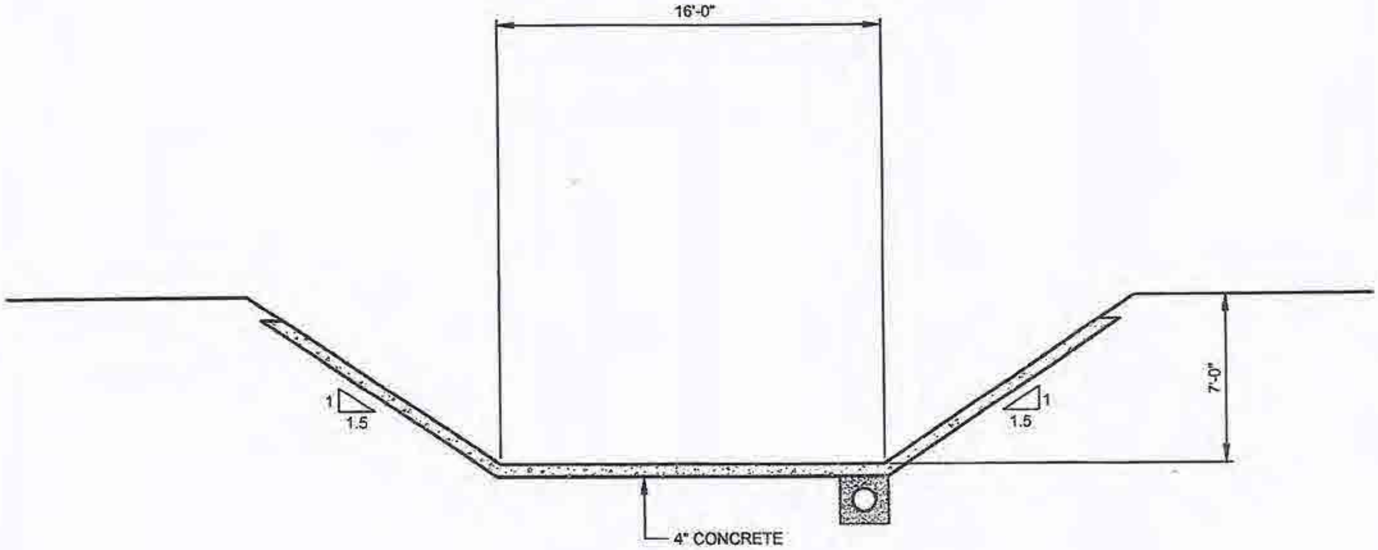
Budgetary Cost Estimate for
Gray Mountain Canal
Membrane Liner with Full Ballast

30-Oct-13

Item #	Description	Quantity	Units	Unit Cost	Total Cost
1	Mobilization	1	L.S.	$ 600,000.00	$ 600,000.00
2	Clear & Grub	40	Ac.	$ 2,000.00	$ 80,000.00
3	Canal Exc.	420,000	C.Y.	$ 12.00	$ 5,040,000.00
4	40 Mil PVC Liner	272,000	S.Y.	$ 9.00	$ 2,448,000.00
5	Ballast over liner	60,000	C.Y.	$ 22.00	$ 1,320,000.00
6	Turnout Structure	8	Ea.	$ 15,000.00	$ 120,000.00
7	Check Structure	5	Ea.	$ 165,000.00	$ 825,000.00
8	Bridge	5	Ea.	$ 65,000.00	$ 325,000.00
9	Roadway UBC	8,500	C.Y.	$ 22.00	$ 187,000.00
10	Contingency (20%)	1	L.S.	$ 2,190,000.00	$ 2,190,000.00
	Subtotal - Construction				$ 13,135,000.00
	Design Engineering (6%)				$ 788,000.00
	Geotechnical Investigations				$ 125,000.00
	Right-of-ways				$ 250,000.00
	Environmental				$ 750,000.00
	Habitat Replacement & Mitigation				$ 500,000.00
	Construction Management (9%)				$ 1,182,000.00
	Legal & Administration				$ 160,000.00
	Total Estimated Project Costs				$ 16,890,000.00



C
E-3
OPTION #3
SLIP LINED CONCRETE

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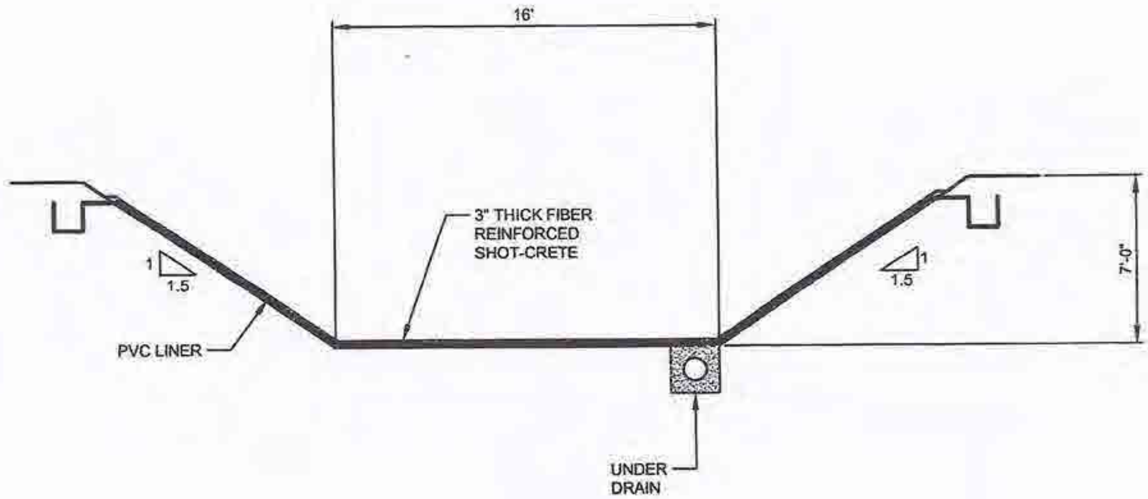
Suite 400
Pleasant Grove, UT 84062
(801) 763-5100

GRAY MT. CANAL REHAB

OPTION #3

Budgetary Cost Estimate for 30-Oct-13
Gray Mountain Canal
Slip Lined Concrete

Item #	Description	Quantity	Units	Unit Cost	Total Cost
1	Mobilization	1	L.S.	$ 500,000.00	$ 700,000.00
2	Clear & Grub	40	Ac.	$ 2,000.00	$ 80,000.00
3	Canal Exc.	420,000	C.Y.	$ 12.00	$ 5,040,000.00
4	Subgrade Prep	161,500	S.Y.	$ 8.00	$ 1,292,000.00
5	Sliplined Concrete	161,500	S.Y.	$ 18.00	$ 2,907,000.00
6	Under-Drains	35,000	ft.	$ 30.00	$ 1,050,000.00
7	Turnout Structure	8	Ea.	$ 11,500.00	$ 92,000.00
8	Check Structure	5	Ea.	$ 165,000.00	$ 825,000.00
9	Bridge Replacement	5	Ea.	$ 65,000.00	$ 325,000.00
10	Roadway UBC	8,500	C.Y.	$ 22.00	$ 187,000.00
11	Contingency (20%)	1	L.S.	$ 2,500,000.00	$ 2,500,000.00
	Subtotal - Construction				$ 14,998,000.00
	Design Engineering (6%)				$ 902,000.00
	Geotechnical Investigation				$ 180,000.00
	Right-of-ways				$ 150,000.00
	Environmental				$ 750,000.00
	Habitat Replacement & Mitigation				$ 500,000.00
	Construction Management (9%)				$ 1,350,000.00
	Legal & Administration				$ 180,000.00
	Total Estimated Project Costs				$ 19,010,000.00



D
E-4
OPTION #4
SHOT CRETE OVER
PVC LINER

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ENGINEERS

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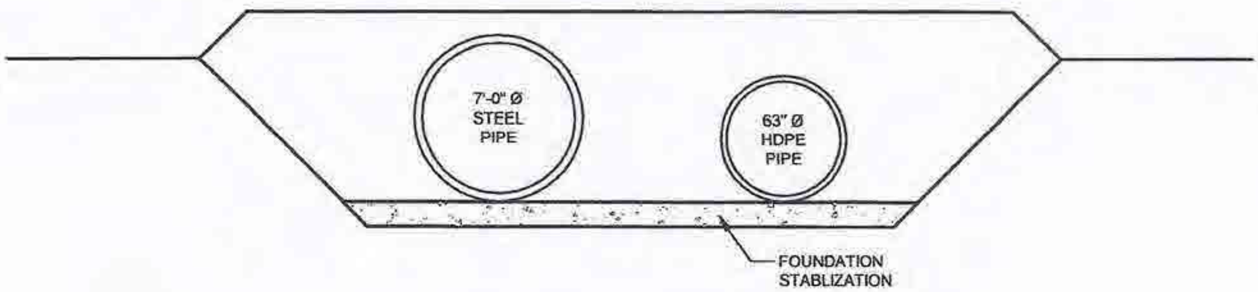
Pleasant Grove, UT 84062
(801) 763-5100

GRAY MT. CANAL REHAB

OPTION #4

Budgetary Cost Estimate for 30-Oct-13
Gray Mountain Canal
Membrane Liner with Shotcrete on bottom & sides

Item #	Description	Quantity	Units	Unit Cost	Total Cost
1	Mobilization	1	L.S.	$ 500,000.00	$ 600,000.00
2	Clear & Grub	40	Ac.	$ 2,000.00	$ 80,000.00
3	Canal Exc.	420,000	C.Y.	$ 12.00	$ 5,040,000.00
4	40 Mil PVC Liner	272,000	S.Y.	$ 9.00	$ 2,448,000.00
5	Shotcrete	247,000	S.Y.	$ 16.50	$ 4,075,500.00
6	Under-Drains	35,000	ft.	$ 30.00	$ 1,050,000.00
7	Turnout Structure	8	Ea.	$ 11,500.00	$ 92,000.00
8	Check Structure	5	Ea.	$ 165,000.00	$ 825,000.00
9	Bridge	5	Ea.	$ 65,000.00	$ 325,000.00
10	Roadway UBC	8,500	C.Y.	$ 22.00	$ 187,000.00
11	Contingency (20%)	1	L.S.	$ 2,945,500.00	$ 2,945,500.00
	Subtotal - Construction				$ 17,668,000.00
	Design Engineering (6%)				$ 1,060,000.00
	Geotechnical Investiugation				$ 180,000.00
	Right-of-ways				$ 150,000.00
	Environmental				$ 750,000.00
	Habitat Replacement & Mitigation				$ 500,000.00
	Construction Management (9%)				$ 1,592,000.00
	Legal & Administration				$ 200,000.00
	Total Estimated Project Costs				$ 22,100,000.00



E
E-5
OPTION #5
DOUBLE PIPE

HORROCKS ENGINEERS

2162 West Grove Parkway
Suite 400
Pleasant Grove, UT 84062
(801) 763-5100

GRAY MT. CANAL REHAB

OPTION #5

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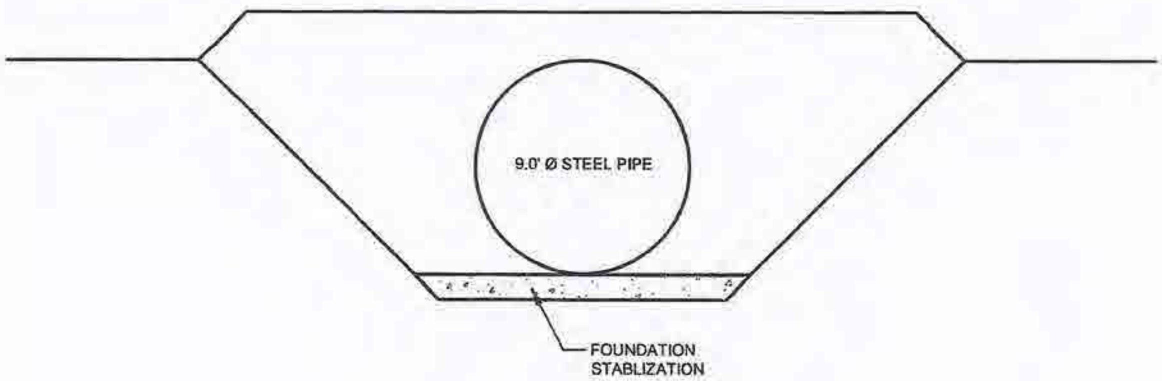
Budgetary Cost Estimate for 30-Oct-13
Gray Mountain Canal
63" HDPE & 84" Steel Pipeline

Item #	Description	Quantity	Units	Unit Cost	Total Cost
1	Mobilization	1	L.S.	$ 2,000,000.00	$ 2,000,000.00
2	84" Steel Pipe	38,230	ft.	$ 650.00	$ 24,849,500.00
3	63" DR 32.5 HDPE Pipe	38,230	ft.	$ 250.00	$ 9,557,500.00
4	Excavation	28,400	C.Y.	w/pipe	
5	Bedding	100,000	C.Y.	w/pipe	
6	Backfill	57,000	C.Y.	w/pipe	
7	HDPE Pipe Installation	38,230	ft.	w/pipe	
8	Steel Pipe Installation	38,230	ft.	w/pipe	
9	Foundation Stabilization Material	28,400	C.Y.	w/pipe	
10	Check Structures	3	Ea.	$ 70,000.00	$ 210,000.00
11	Turnouts	8	Ea.	$ 15,000.00	$ 120,000.00
12	Cathodic Protection	1	L.S	$ 100,000.00	$ 100,000.00
13	Roadway UBC	8,500	C.Y.	$ 22.00	$ 187,000.00
14	Contingency (20%)	1	L.S	$ 7,406,000.00	$ 7,406,000.00
	Subtotal - Construction				$ 44,430,000.00
	Design Engineering (6%)				$ 2,590,000.00
	Geotechnical Investigations				$ 90,000.00
	Right-of-ways				$ 150,000.00
	Environmental				$ 750,000.00
	Habitat Replacement & Mitigation				$ 500,000.00
	Construction Management (8%)				$ 2,960,000.00
	Legal & Administration				$ 250,000.00
	Total Estimated Project Costs				$ 51,720,000.00



E
E-5
OPTION #6
STEEL PIPE 108"Ø

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Suite 400
Pleasant Grove, UT 84062
(801) 763-5100

GRAY MT. CANAL REHAB

OPTION #6

Budgetary Cost Estimate for
Gray Mountain Canal
Single Steel Pipeline

30-Oct-13

Item #	Description	Quantity	Units	Unit Cost	Total Cost
1	Mobilization	1	L.S.	$ 2,000,000.00	$ 2,000,000.00
2	108" Steel Pipe	38,230	ft.	$ 900.00	$ 34,407,000.00
3	Excavation	55,500	C.Y.	w/pipe	
4	Bedding	63,800	C.Y.	w/pipe	
5	Backfill	153,000	C.Y.	w/pipe	
6	Pipe Installation	38,230	ft.	w/pipe	
7	Foundation Stabilization Material	3,000	C.Y.	w/pipe	
8	Check Structures	3	Ea.	$ 85,000.00	$ 255,000.00
9	Turnouts	8	Ea.	$ 15,000.00	$ 120,000.00
10	Cathodic Protection	1	L.S	$ 100,000.00	$ 100,000.00
11	Roadway UBC	8,500	C.Y.	$ 22.00	$ 187,000.00
12	Contingency (20%)	1	L.S	$ 7,401,000.00	$ 7,401,000.00
	Subtotal - Construction				$ 44,470,000.00
	Design Engineering (6%)				$ 2,730,000.00
	Geotechnical Investigation				$ 90,000.00
	Right-of-ways				$ 150,000.00
	Environmental				$ 750,000.00
	Habitat Replacement & Mitigation				$ 500,000.00
	Construction Management (8%)				$ 3,400,000.00
	Legal & Administration				$ 250,000.00
	Total Estimated Project Costs				$ 52,340,000.00

Cultural Resource Survey

CLASS III CULTURAL RESOURCE SURVEY OF THE NATURAL RESOURCES CONSERVATION SERVICE'S DCWCD PL-566 PROJECT CLEANUP IN DUCHESNE COUNTY, UTAH

REDACTED

By:

Jessica Del Bozque
Jody Patterson

Prepared For:

Natural Resources Conservation Service
Salt Lake City, Utah

Ute Indian Tribe
Uintah and Ouray Agency

Prepared Under Contract With:

Jones & DeMille Engineering
1535 South 100 West
Richfield, Utah 84701

Prepared By:

Montgomery Archaeological Consultants, Inc.
322 East 100 South
Moab, Utah 84532

MOAC Report No. 22-029

February 6, 2023

State of Utah Public Lands Policy Archaeological Survey Permit No. 167

State of Utah Antiquities (Survey) Permit No. U22MQ0612

Ute Tribal Permit No. A23-363

For Official Use Only: Disclosure of Site Locations Prohibited (43 C.F.R. § 7.18)

ABSTRACT

In October 2022, Montgomery Archaeological Consultants conducted a Class III cultural resource survey of cleanup areas for the Natural Resources Conservation Service's (NRCS) DCWCD PL-566 project in Duchesne County, Utah. The cleanup survey was conducted under contract with Jones and DeMille Engineering at the request of Jenna Jorgensen. The proposed project will consist of lining segments of the Yellowstone Feeder and Gray Mountain Canals and the piping of the South Boneta Canal, Bluebell Lateral, North I Ditch, South I Ditch, F Canal, C Canal, Duchesne Feeder Canal, Midview Lateral, Lateral No. 5, Red Cap Canal, and few associated lateral ditches to reduce or eliminate water losses. The undertaking is described in detail in the original DCWCD PL-566 Class III report completed in 2021 (Del Bozque and Patterson 2021; SHPO No. U21MQ0113). The cleanup survey compliments this original survey and consists of 27.9 acres along the Yellowstone Feeder Canal, the Coyote Canal (a lateral of the Yellowstone Feeder), the South Boneta Canal, the Bluebell Lateral Canal, the Duchesne Feeder Canal, the Moon Lake Canal, and a pipeline and road alignment near Arcadia.

The Class III cultural resource survey of the NRCS' DCWCD PL-566 project cleanup in Duchesne County, Utah resulted in the identification of 10 previously documented archaeological sites (42DC376, 42DC2013, 42DC2793, 42DC3029, 42DC3081, 42DC3084, 42DC4248, 42DC4249, 42DC4262, and 42DC4263), of which one was updated (42DC2793), within 100 ft of the project area. Of these 10 sites, six (42DC376, 42DC2793, 42DC3029, 42DC3081, 42DC3084, and 42DC4249) are eligible for NRHP listing.

Based on the proposed impacts to four eligible canals including 42DC376, 42DC2793, 42DC3084, and 42DC4249, a determination of *historic properties adversely affected* is proposed for the undertaking pursuant to Section 106 of 36 CFR 800. Adverse effects will be mitigated through the development of a Memorandum of Agreement between the NRCS, the Utah State Historic Preservation Office, and other consulting parties.

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PROJECT INFORMATION

In October 2022, Montgomery Archaeological Consultants conducted a Class III cultural resource survey of cleanup areas for the Natural Resources Conservation Service's (NRCS) DCWCD PL-566 project in Duchesne County, Utah. The cleanup survey was conducted under contract with Jones and DeMille Engineering at the request of Jenna Jorgensen. The proposed project will consist of lining segments of the Yellowstone Feeder and Gray Mountain Canals and the piping of the South Boneta Canal, Bluebell Lateral, North I Ditch, South I Ditch, F Canal, C Canal, Duchesne Feeder Canal, Midview Lateral, Lateral No. 5, Red Cap Canal, and few associated lateral ditches to reduce or eliminate water losses. The undertaking is described in detail in the original DCWCD PL-566 Class III report completed in 2021 (Del Bozque and Patterson 2021; SHPO No. U21MQ0113). The cleanup survey compliments this original survey and consists of 27.9 acres along the Yellowstone Feeder Canal, the Coyote Canal (a lateral of the Yellowstone Feeder), the South Boneta Canal, the Bluebell Lateral Canal, the Duchesne Feeder Canal, the Moon Lake Canal, and a pipeline and road alignment near Arcadia.

The cleanup area totals 27.9 acres that occur on private property (3.9 acres) and Ute Indian tribal land (Uintah and Ouray Agency) (24 acres). The NRCS DCWCD PL-566 cleanup areas are in Township 1 North, Range 3 West, Sections 28 and 29; Township 1 North, Range 4 West, Sections 27, 28, and 36; Township 1 South, Range 2 West, Section 6; Township 1 South, Range 4 West, Section 21; Township 2 South, Range 3 West, Sections 4 and 15; and Township 3 South, Range 3 West, Sections 22, 24, and 34 (Figures 3-10).

The inventory objective was to locate, document, and evaluate any cultural resources within the project area to comply with 36 CFR 800, the National Historic Preservation Act (NHPA) of 1966 (as amended). The inventory was also implemented to attain compliance with several federal and state mandates, including the National Environmental Policy Act of 1969, the Archaeological and Historic Preservation Act of 1974, the Archaeological Resources Protection Act of 1979, the American Indian Religious Freedom Act of 1978, Utah State Antiquities Act of 1973 (amended 1990), and Utah Code, Title 9, Chapter 8, Section 404 (9-8-404).

Jessica Del Bozque (Field Supervisor) conducted the fieldwork on October 6 and 7, 2022 under the direction of Jody J. Patterson (Principal Investigator). The survey was accomplished under the auspices of State of Utah Public Lands Policy Archaeological Survey Permit No. 167, State of Utah Antiquities Permit (Survey) No. U22MQ0612, and Ute Tribal Permit No. A23-363, issued to MOAC, Moab, Utah. Mr. Brad Pinnecoose, Ute Compliance Officer, was notified when MOAC personnel were enroute to and departing tribal land.

Jessica Del Bozque conducted file searches using SEGO on February 26, 2021, and October 3, 2022, which indicated that 33 inventories have been conducted within one half-mile of the cleanup areas since 1977 (Table 1). The record searches also indicated that 34 previously recorded sites occur within the same search area (Table 2). Additionally, Jessica Del Bozque completed searches of cadastral plats, historic aerial photographs, historic maps, and other historic resources for the Class III area over multiple days (Table 3). This search did not identify any additional undocumented canals or structures.

Table 1. Previous inventories within one half-mile of the project area.

State Project Number	Project Title	Consultant
U77UA0241	Archeological and Historical Survey of the Payne Area Near the Yellowstone River and of the Coyote Basin Area West of Neola, Utah	University of Utah
U80NH0410	Archaeological Investigations of Proposed Transmission Line Corridors for the Moon Lake Project, Northwestern Colorado, Northeastern Utah, and Southwestern Wyoming	Nickens & Associates
U83BE0410	Cultural Resources Survey of Portions of Fourteen Uintah Indian irrigation Project Canals, Duchesne and Uintah Counties	Bureau of Reclamation (BOR)
U84AF0372	Cultural Resource Evaluation of Two Proposed Well Locations in the Cottonwood Bench Locality of Duchesne County, Utah	AERC
U84SJ0191	Cultural Resources Survey of Lear Petroleum's Well Broderick-Larsen Fee 3 24-10, Duchesne County, Utah	Sagebrush Archaeological Consultants
U86AK0219	Cultural Resources Survey of Three Borrow Pit Areas in the Blue Bench, South Myton Bench Localities of Duchesne County, Utah	Archaeological Research Consultants
U90AK0059	Arcadia Road Construction & Repaving, Duchesne County, Utah	Archaeological Research Consultants
U91AK0153	Arcadia Road Construction & Repaving, Duchesne County, Utah	Archaeological Research Consultants
U94SJ0741	Uintah Basin Replacement Project (CUP)	Sagebrush Archaeological Consultants
U97JB0465	Ute Tribe Cattle Feeding Project	JBR Environmental Consultants
U99AY0238	A CRI for the Wade Cook #4-6A2 Well's Proposed Access Reroute and Pipeline in Section 6, T1S, R2W, Uintah-Ouray Ute Reservation, Duchesne County, Utah	An Independent Archaeologist
U99AY0338	Quinex Energy Corporation: A CRI for the Wade Cook #4-6A2 Well's Proposed Water Retaining Pond its Access and Pipeline, in Section 6, T1S, R2W, Uintah-Ouray Ute Reservation, Duchesne County, Utah	An Independent Archaeologist
U99MQ0677	CRI of Quinex Energy Corporation's ER #A5-6 and ER #5-6A Well Location on Monarch Ridge, Duchesne County, Utah	MOAC
U02BE0245	A CRI of the Proposed Arcadia Farms Salinity Pipeline Project, Duchesne County, Utah	BOR
U04BE0460	A CRI of the Proposed Duchesne County Water Conservancy District Phase 2 Salinity Pipeline Project - K2	BOR
U09GN0583	Class III, Red Cap Lake Fork, Arcadia, Utah	PEPG Engineering, LLC
U10SH0077	CRI for a Proposed Water Pipeline Near Red Cap Canal, Duchesne County, Utah	NRCS
U10SH0117	CRI of Proposed Sprinkler Irrigation System near Arcadia, Duchesne County, Utah	NRCS
U11MQ0761	Newfield E&P Monument Butte 3D Seismic Project	MOAC
U11MQ1027	CRI of Newfield Exploration's North Myton Bench and South Myton Bench Block Surveys	MOAC
U11MQ1089	CRI of Newfield Exploration's Five Well Locations	MOAC
U12MQ0117	CRI of Newfield Exploration's Proposed Three Wells, Duchesne County	MOAC
U12MQ0290	CRI of Newfield Exploration's Ute Tribal 2-34-3-3WH Well Locations	MOAC
U12MQ0316	CRI of Newfield Exploration's 10 Well Locations in Duchesne and Uintah Counties, Utah	MOAC
U12MQ0401	CRI of Newfield Exploration's Proposed 4-21-3-3WH Well Location, Duchesne County, Utah. (Township 3S, Range 3W, Section 21)	MOAC
U12MQ0492	CRI of Newfield Exploration's Central Basin Tribal Surface Archaeological Block Survey Phase 2	MOAC
U12MQ0573	CRI of Newfield Exploration's Six Well Locations, Duchesne County, Utah	MOAC
U13GR0434	Devon West Roosevelt 3D Seismic	Aros Archaeology, LLC
U13MQ0322	CRI of Newfield Exploration's Proposed Four Central Basin Well Locations	MOAC
U16HO0348	A CRI for the Proposed Yellowstone Feeder Canal Upgrade Project North of Altonah, Duchesne County, Utah	
U16SH0212	CRI of an Environmental Quality Incentives Program (EQIP) Water Management Project near Zimmerman Wash, Duchesne County, Utah	NRCS
U17GR0617	CRS of the Proposed Newfield Exploration Beal UT 13-34-3-3 Well, Access Road and Pipeline in Duchesne County, Utah	Aros Archaeology, LLC
U21MQ0113	Class III Cultural Resource Survey of the Natural Resources Conservation Service's DCWCD PL-566 Project in Duchesne County, Utah	MOAC

Table 2. Previously documented sites within one half-mile of the project area.

Site Number	SHPO Report No.	Site Type	Affiliation	NRHP Status
42DC376	U21MQ0113 U13MQ0322 U11MQ1027 U11MQ0761	Duchesne Feeder Canal	Ute, European-American	Eligible
42DC843	U94SJ0741	Lithic Scatter	Unknown Prehistoric	Not Eligible
42DC844	U94SJ0741	Historic Road Remnant	Unknown Historic	Not Eligible
42DC2013	U21MQ0113	South Boneta Canal	European-American	Not Eligible
42DC2793	U21MQ0113 U16HO0348	Yellowstone Feeder Canal	European-American	Eligible
42DC3029	U12MQ0290 U12MQ0117 U11MQ1074 U11MQ0761	Midview Ditch	Ute, European-American	Eligible
42DC3030	U11MQ1027 U11MQ0761	Midview Lateral Canal	Ute, European-American	Eligible
42DC3059	U11MQ1027	Lateral No. 5 Canal	Ute, European-American	Eligible
42DC3081	U11MQ1027	Red Cap Canal	Ute, European-American	Eligible
42DC3084	U21MQ0113 U11MQ1027	Moon Lake Canal	Ute, European-American	Eligible
42DC3097	U11MQ1027	Abandoned Residence	Ute	Eligible
42DC3099	U11MQ1027	Lithic Scatter	Unknown Prehistoric	Eligible
42DC3100	U11MQ1027	Historic Structure and Trash Scatter	Ute	Eligible
42DC3104	U11MQ1027	Trash Scatter	European-American	Not Eligible
42DC3109	U11MQ1027	Lithic Scatter	Unknown Prehistoric	Eligible
42DC3120	U11MQ1027	Lithic and Ceramic Scatter	Fremont	Eligible
42DC3121	U11MQ1027	Lithic and Ceramic Scatter	Fremont	Eligible
42DC3122	U11MQ1027	Habitation	Fremont	Eligible
42DC3123	U11MQ1027	Trash Scatter	Ute, European-American	Not Eligible
42DC3129	U11MQ1089	Trash Scatter	Ute, European-American	Not Eligible
42DC3130	U11MQ1089	Trash Scatter	Ute, European-American	Not Eligible
42DC3517	U13GR0434	Old Well	European-American	Not Eligible
42DC3533	U13GR0434	Trash Scatter	Unknown Historic	Not Eligible
42DC3555	U13GR0434	Trash Scatter	Unknown Historic	Not Eligible
42DC3556	U13GR0434	Trash Scatter	Unknown Historic	Not Eligible
42DC4248	U21MQ0113	Lateral Canal	Ute, European-American	Not Eligible
42DC4249	U21MQ0113	Bluebell Lateral	Ute, European-American	Eligible
42DC4257	U21MQ0113	Corral	European-American	Not Eligible
42DC4260	U21MQ0113	Abandoned Residence	Ute	Not Eligible
42DC4261	U21MQ0113	Lateral Ditch	Ute, European-American	Not Eligible
42DC4262	U21MQ0113	Lateral Ditch	Ute, European-American	Not Eligible
42DC4263	U21MQ0113	Corral	Ute, European-American	Not Eligible
42DC4264	U21MQ0113	Lateral Ditch	Ute, European-American	Not Eligible
42DC4265	U21MQ0113	Trash Scatter	Unknown Historic	Not Eligible

Table 3. Historic sources examined for Class III area.

Source	Checked?	Reference(s)/Source(s)	Relevant Information with 0.5 miles of Class III Area
SEGO Database	Yes	Sego.utah.gov	See Tables 1 and 2
Historic Contexts	Yes	history.utah.gov/shpo/shpo-compliance/Resources	"Irrigation in the Uinta Basin, 1869 to 1972"
Water Rights	Yes	Maps.waterrights.utah.gov	Canals associated with the project are owned by the Dry Gulch Irrigation Company, Moon Lake Water Users, South Boneta Irrigation Company, the Bureau of Reclamation, Lake Fork Irrigation Company, and Uintah Indian Irrigation Project
Land Patents	Yes	glorecords.blm.gov	Several in/near project area. Those relevant to project are noted in site descriptions.
Mining Records	Yes	archives.utah.gov- Uintah County Mining Notices of Location; mindat.org	N/A
Grazing Records	Yes	databasin.org; gis.blm.gov	None in PA
Sanborn Maps	Yes	Collections.lib.utah.edu	N/A

Source	Checked?	Reference(s)/Source(s)	Relevant Information with 0.5 miles of Class III Area
GLOs	Yes	ut.blm.gov/LandRecords/search_plats.cfm	T1N, R4W, 1883: Uintah & Heber Indians Trail T1N, R3W, 1904: Nothing of note in PA vicinity T1S, R2W, 1904: Nothing of note in PA vicinity T1S, R4W, 1882: Nothing of note in PA vicinity T2S, R3W, 1882: Nothing of note in PA vicinity T3S, R3W, 1882: Wagon Road to Salt Lake City from Ashley; 1923: Misc. canals and roads
MTPs	Yes	ut.blm.gov/LandRecords/search_plats.cfm	Ute Indian Reservation, Indian Allotments, several land patents.
USGS Historic Quadrangle Maps	Yes	Uinta, UT (1:250K), 1885 Duchesne, UT (1:125K), 1939 Salt Lake City, UT (1:250K), 1958 Bluebell, UT (1:24K), 1965 Neola NW, UT (1:24K), 1965 Altonah, UT (1:24K), 1965 Altamont, UT (1:24K), 1965 Bridgeland, UT (1:24K), 1964	Misc. roads and canals
Pertinent Published and Gray Literature	Yes	See Literature Review-Tables 1 & 2; References Cited	See Literature Review-Tables 1 & 2; References Cited
Field Office Class I documents and SLM Model	Yes	dha.lib.utah.edu	N/A
Other: Historic Aerial Photographs, Satellite Imagery	Yes	Source: earthexplorer.usgs.gov ID: ARA001210173099: 1953 1:64000 Aerial ID: AR1VAMR00010070: 1962 1:24000 Aerial ID: AR1VAMR00010106: 1962 1:24000 Aerial ID: AR1VAMR00010107: 1962 1:24000 Aerial ID: AR1VAMR00020102: 1962 1:24000 Aerial ID: AR1VAMR00010065: 1962 1:24000 Aerial ID: AR1VAMR00010066: 1962 1:24000 Aerial ID: AR1VAMR00010086: 1962 1:24000 Aerial ID: AR1VAMR00020013: 1962 1:24000 Aerial ID: AR1VAMR00020031: 1962 1:24000 Aerial ID: AR1VEFM00010046: 1976 1:78000 Aerial ID: AR1VEFM00010048: 1976 1:78000 Aerial Source: https://geodata.geology.utah.gov/imagery/ ID: AD_16: 1936 1:31680 Aerial Photo ID: Source: Google Earth Satellite Imagery Imagery dates reviewed:	Misc. roads and canals

ENVIRONMENTAL BACKGROUND

The project area lies within the Uinta Basin physiographic unit, a distinctly bowl-shaped geologic structure (Stokes 1986). The Uinta Basin, considered the northernmost extension of the Colorado Plateau, is within the Green River Basin. Topographically, this area consists of highly dissected sandstone and mudstone rock formations and broad sandy silt ridges. Recent alluvial deposits, older alluvial-terrace deposits, and rock outcrops of the Upper Eocene Uinta Formation constitute the geology of the area. The Uinta Formation is comprised of eroded outcrops formed by fluvially deposited, interbedded sandstone and mudstone. This formation is known for its fossil vertebrates including turtles, crocodilians, fish, and mammals.

Specifically, the cleanup project area is located near the communities of Bluebell, Boneta, Arcadia, and Monarch. The elevation of the project area ranges from 5,220 to 7,160 ft. Water resources in the area include the Yellowstone River, the Duchesne River, and the Lake Fork River. The area occurs in the Upper Sonoran lifezone dominated by a Big Sagebrush vegetation community with some pinyon-juniper woodland. However, much of the project area has been developed and cultivated. Modern disturbances to the project area include roads, utility lines, residential buildings, oil and gas development, and agriculture (Figures 1-2).

Figure 1. Project Area Overview near Yellowstone Feeder Canal.

Figure 2. Project Area Overview near Arcadia.

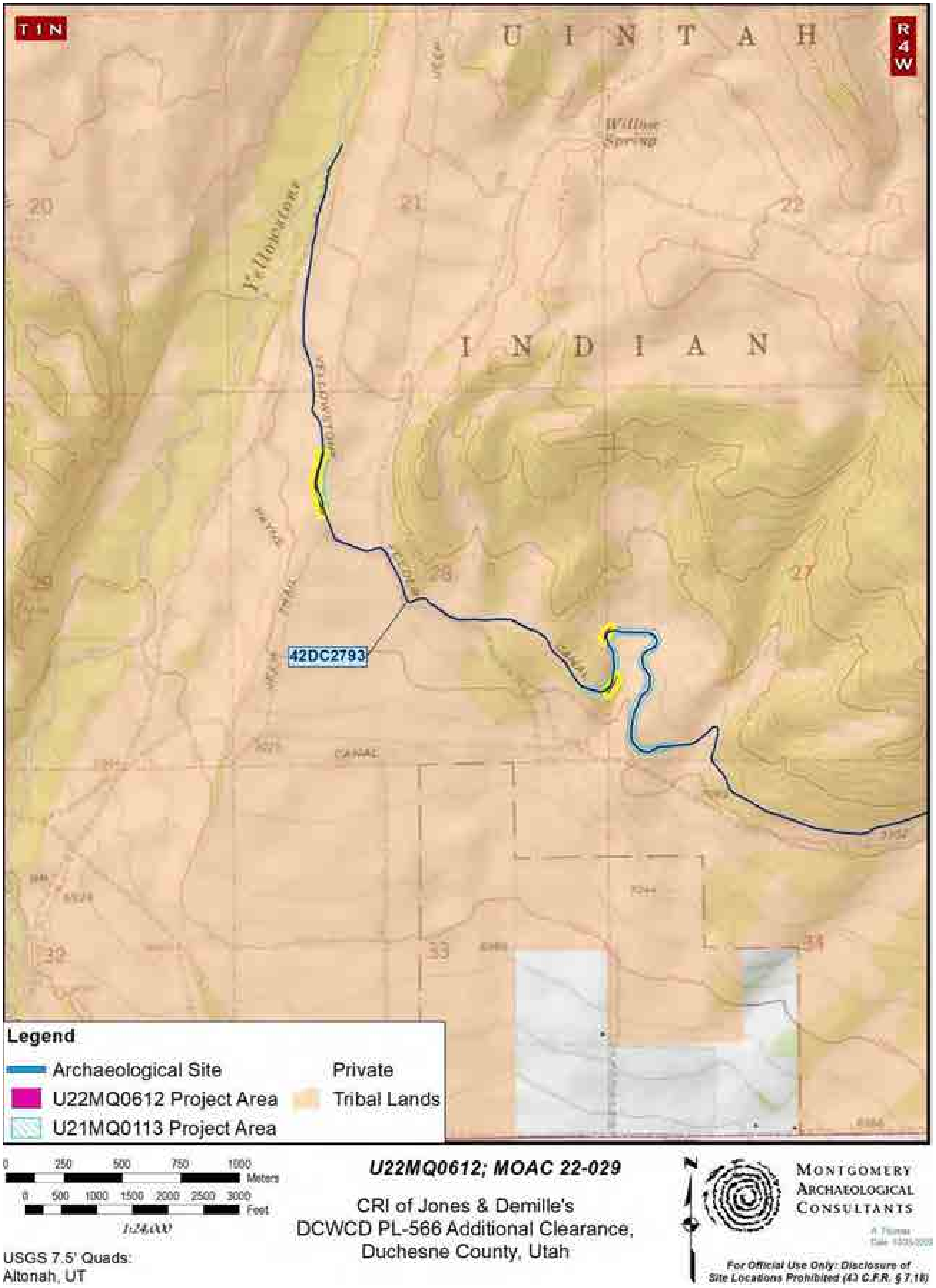

Figure 3. Project Location Map (1 of 8).

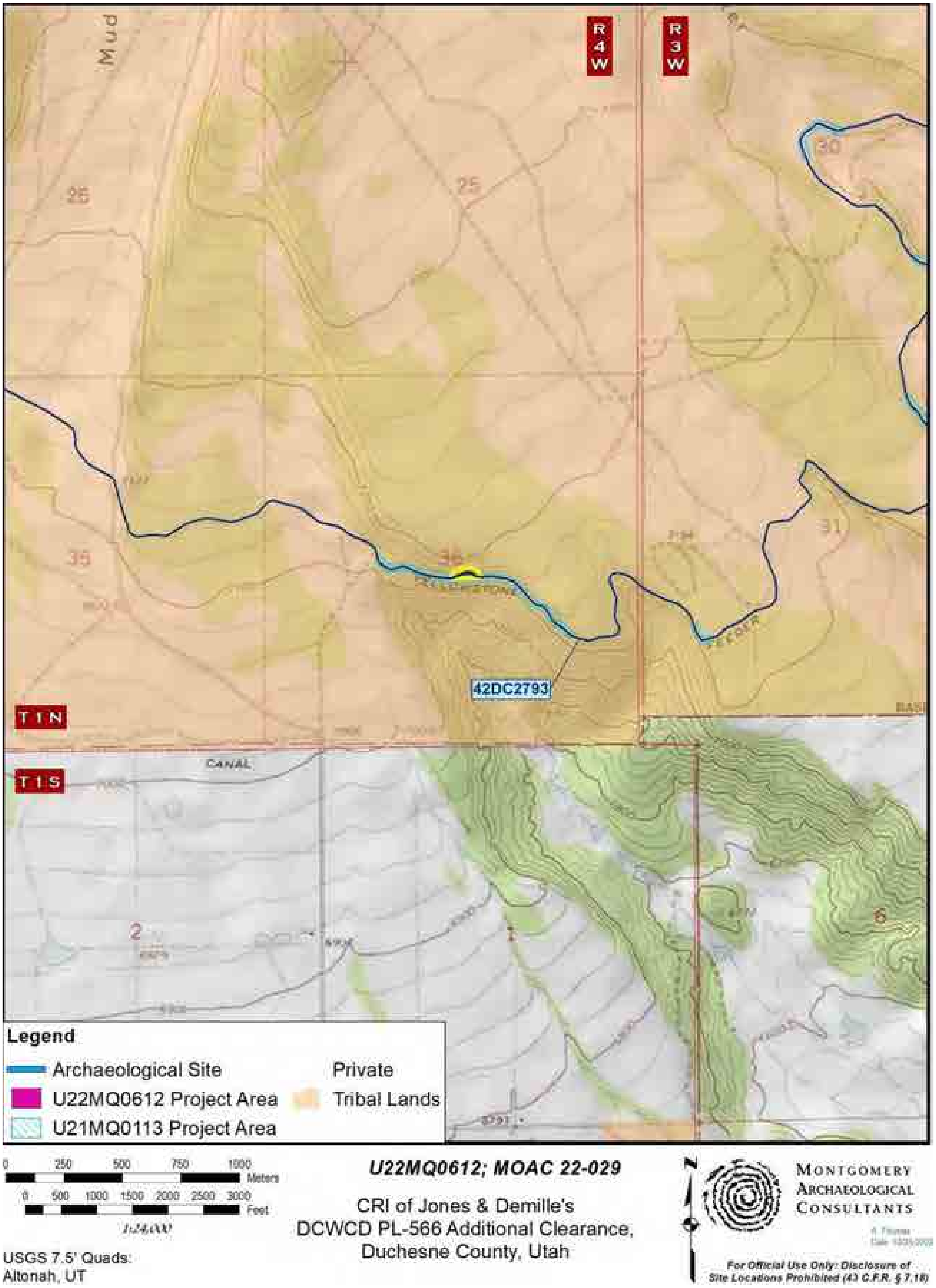

Figure 4. Project Location Map (2 of 8).

Figure 5. Project Location Map (3 of 8).

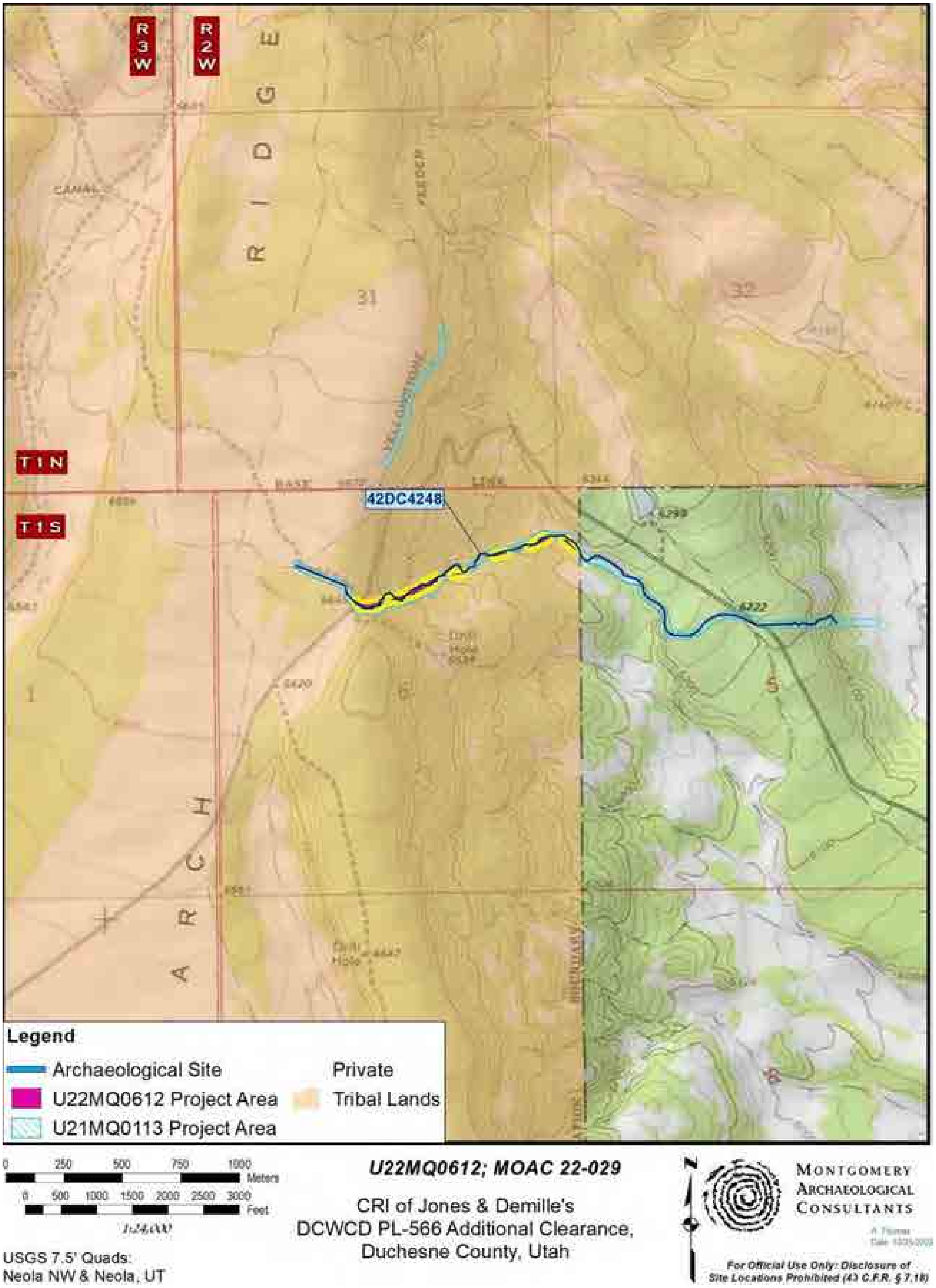

Figure 6. Project Location Map (4 of 8).

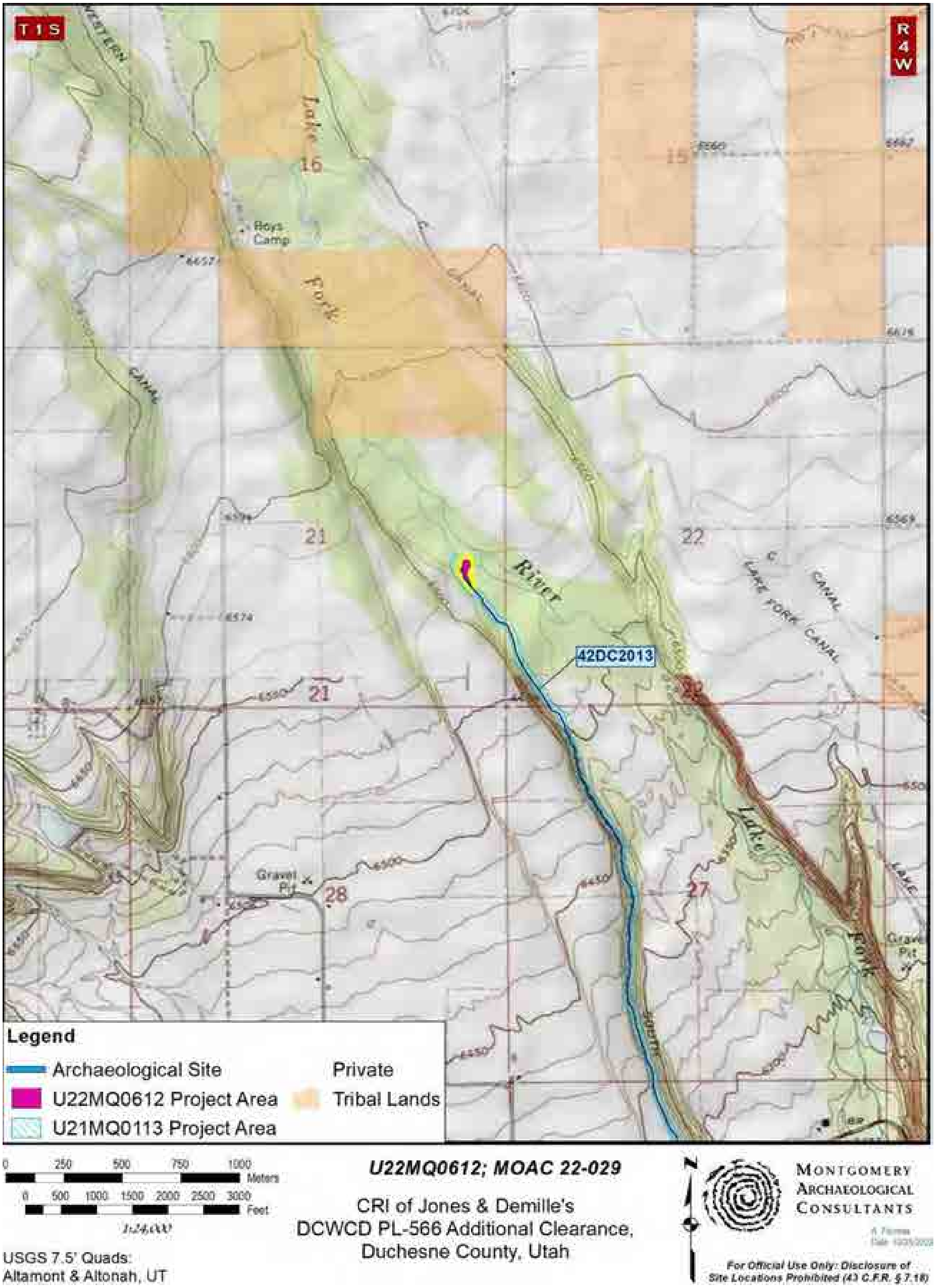

Figure 7. Project Location Map (5 of 8).

Figure 8. Project Location Map (6 of 8).

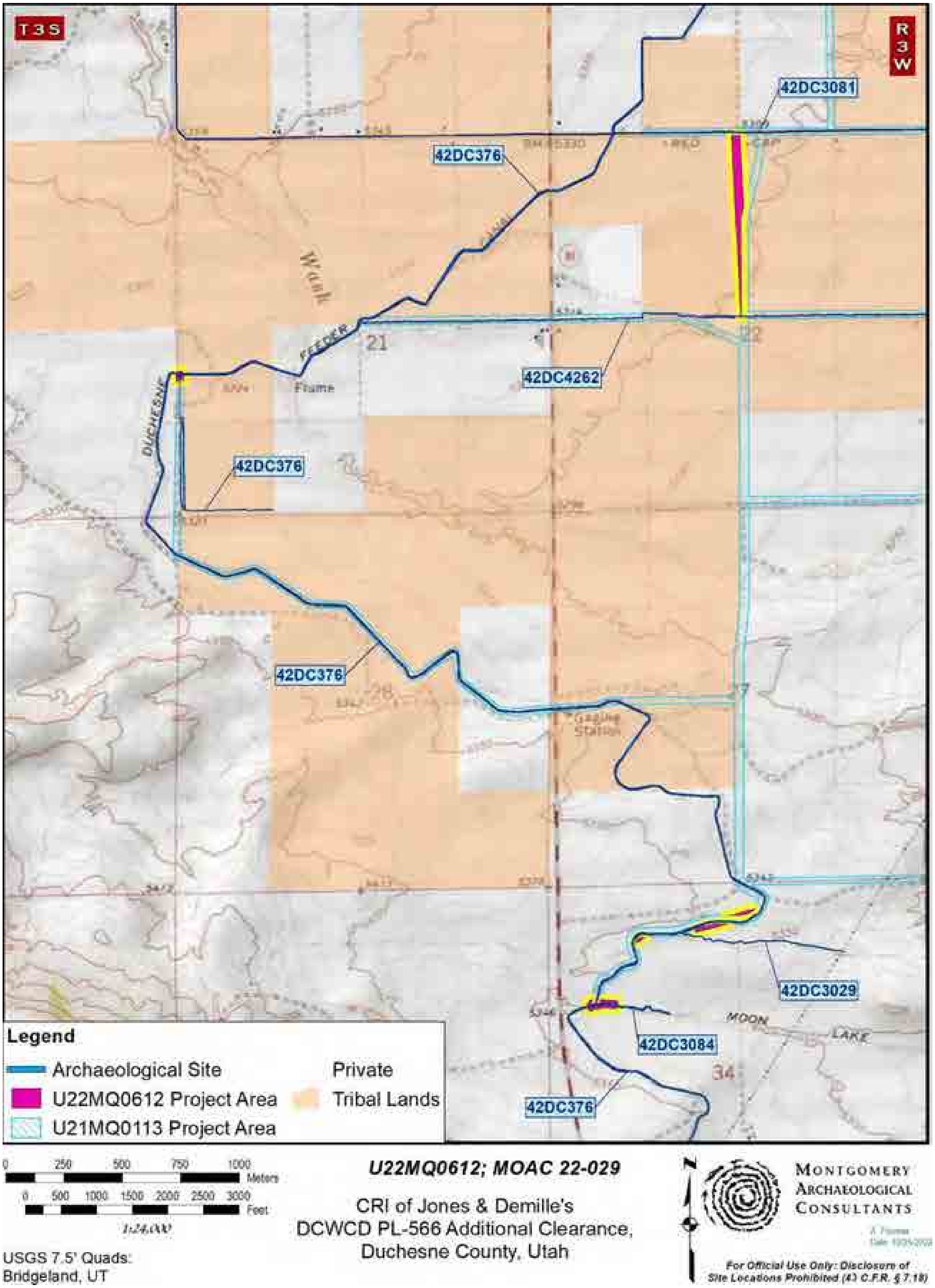

Figure 9. Project Location Map (7 of 8).

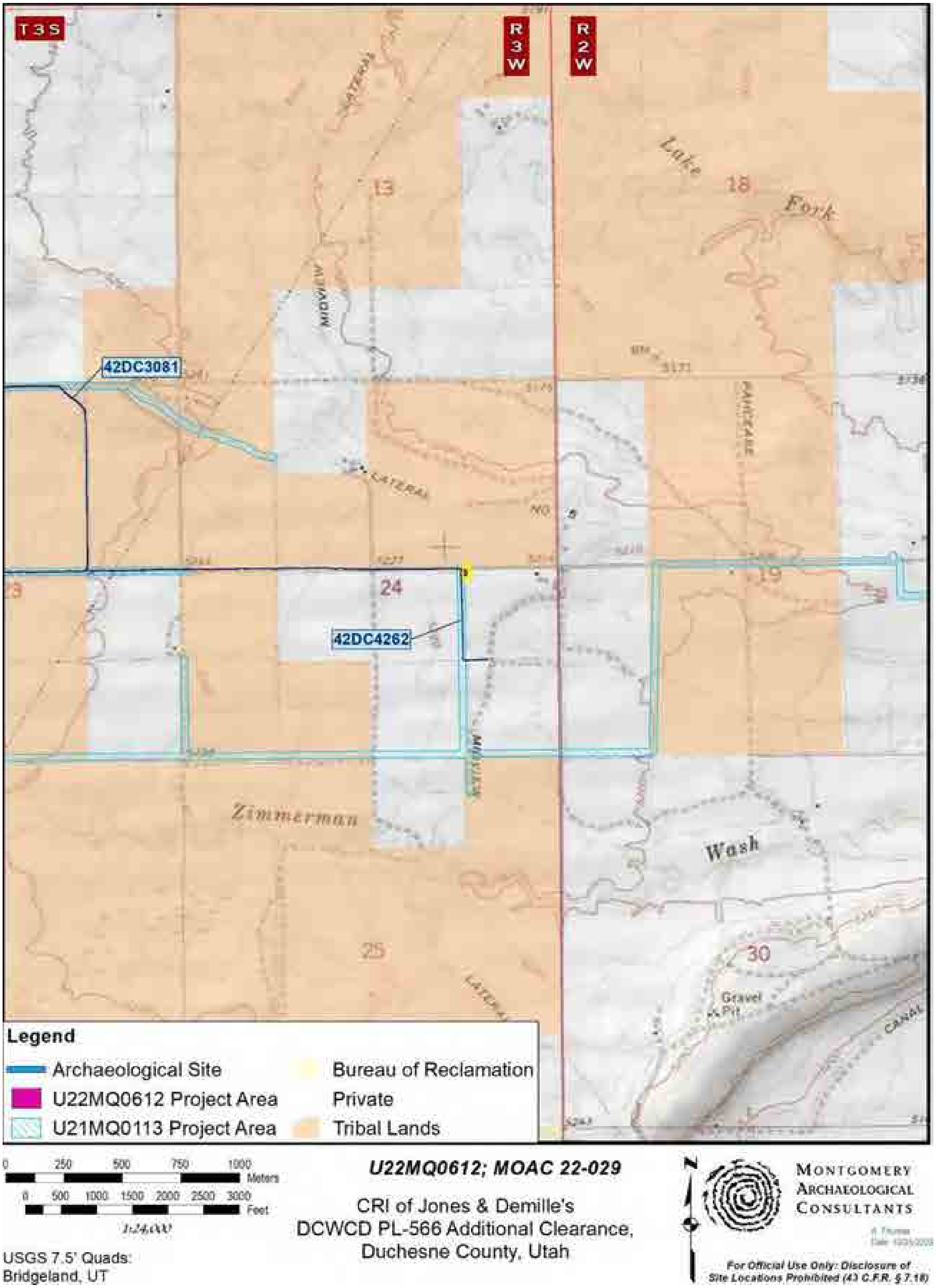

Figure 10. Project Location Map (8 of 8).

HISTORIC OVERVIEW

Human occupation in northeastern Utah spans the last 10,000-12,000 years and is represented by the Paleoindian, Archaic, Formative, Protohistoric, and Historic cultural periods (Table 4). Cultural remains within the project area represent the historic era and are primarily tied to agricultural pursuits.

The earliest recorded visit by Europeans to Utah was the Dominguez-Escalante expedition, of 1776. From the early 1820s to 1845, the Uinta Basin became an important part of the expanding western fur trade. Among several trappers and traders who traversed the Uinta Basin in 1824 were Etienne Provost, Antoine Robidoux, William Becknell, and William Huddard. Robidoux stayed in the Uinta Basin for twenty years and established at least two forts between 1825 and 1847 (Burton 1996:5). After the abandonment of the trading posts, the Uinta Basin was not occupied by whites until the late 1860s, when U.S. agents were assigned to the Uinta Reservation. The agency was located at Whiterocks and remained there for over 40 years, until 1912.

On May 5, 1864, Congress passed a law confirming the 1861 executive order setting up the Uintah Reservation (Burton 1996:24). This treaty provided that the Ute people give up their land in central Utah and move within one year to the Uintah Reservation without compensation for loss of land and independence. The Uinta-ats (later called Tavaputs), PahVant, Tumpanawach, and some Cumumba and Sheberetch of Utah were gathered at the Uintah agency during the late 1860s and early 1870s to form the Uintah Band (Burton 1996:18-19). In the 1880 treaty council the White River Utes, who had participated in the Meeker Massacre, were forced to sell all their land in Colorado and were moved under armed escort to live on the Uintah Reservation (Callaway et al. 1986:339). Shortly thereafter, 361 Uncompahgre Utes were forced to sell their lands, and were relocated to the Ouray Reservation adjacent to the southern boundary of the Uintah Reservation. This area embraced a tract of land to the east and south of the Uintah Reservation below Ouray lying east of the Green River. A separate Indian Agency was established in 1881 with headquarters at Ouray which was located across the river from where the first military post, Fort Thornburgh was located. The Department of War established Fort Thornburgh along the Green River in 1881 to maintain peace between the settlers of Ashley Valley. The infantry who participated in the relocation of the Colorado Indians ensured that the Uncompahgre and White River Utes remained on the two reservations (Burton 1996:28).

The historic settlement of Duchesne County is unique in the state of Utah in that it was not settled by Mormon pioneers, as early scouting parties had deemed the area unfit for settlers. Thus, the earliest permanent European settlements and associated developments within the Uinta Basin were established by the U.S. Army during the 1800s. The two most significant settlements built during this time were Fort Thornburg (in Uintah County) and Fort Duchesne; soldiers were quickly put to work in the construction of freight roads that connected these forts to establish settlements in Wyoming, and to the towns and markets of northern Utah. During the 1880s, the area was gradually opened for settlement with the granting of 160-acre parcels under the Homestead Act. Myton, located east and southeast of the project area, started as a trading post on the Uintah Indian Reservation sometime in the mid-1880s. The trading post served as a small segment of the Native American population until 1886, when the army constructed a bridge of the Duchesne River (Barton 1998:154). Myton, originally known as Bridge, quickly changed from a small bustling waystation and Native American trading post to a town of tents and a few wooden buildings prior to the opening of the Uintah Reservation around 1905. The growth of Myton was facilitated by the completion of the supply route that ran through the natural corridor of Nine Mile Canyon, and the settlement attracted people from various parts of the world including Denmark, England, Switzerland, Sweden, Wales, and Germany as well as many states of the Union (Barton 1998:156).

In many respects, the control, storage, and delivery of water resources have dictated the settlement of the Uintah Basin by European Americans. As early as the 1870s Indian agents assigned to the Uintah Indian Reservation recognized the need for irrigation canals if the land of the reservation was to be transformed into productive agricultural land. Periodically, federal appropriations were made to the Ute people for the construction of canals. Originally intended to help the reservation Indians develop small, self-sufficient farms, most of the irrigation water was eventually appropriated by Mormon settlers who flocked to the area when the Uintah Indian Reservation was opened to European Americans for homesteading in 1905. During the first few years, nearly 1,100 homesteaders had moved onto the newly acquired reservation allotments. The earliest developer of the water resources in the Uinta Basin was the federal government through the United States Indian Irrigation Service (Barton 1998:304). This was followed by the Dry Gulch Irrigation Company which was organized in 1905 by William Smart (Wasatch LDS Stake president), and the Wasatch Development Company. To ensure availability of water to its members, the Dry Gulch Irrigation Company undertook an extensive canal-building project, built by assessed labor. The irrigation company also entered into agreements with the Indian Irrigation Service and the Department of the Interior to utilize some of the existing Indian canals to deliver "white" water to its members (Barton 1998:308). The first survey of a canal from the Uinta River for the Dry Gulch Irrigation Company was made in March 1906, and work began on the canals with the slogan, "Water by May 1906" (Burton 1996:308). The first canals build under Uintah Irrigation Project was the Whiterocks Canal, followed by the Farm Creek, Deep Creek, and Uintah canals.

The irrigation system in Duchesne County was expanded in the 1930s by the Civilian Conservation Corps (CCC). The CCC got underway in Utah in the spring of 1933. In October 1934, the CCC companies were established in the county at Moon Lake and at Bridgeland, with four additional temporary or seasonal camps located in Yellowstone Canyon, near Altonah, at Myton, and in Uintah Canyon (Barton 1998:249). The Bridgeland CCC group worked on a canal from the Duchesne River to Arcadia and construction of the Boreham (Midview) Reservoir, the largest of the CCC projects in the area that was completed in 1938. The Duchesne Feeder Canal was built from 1937-1939 as part of the Moon Lake Project to divert surplus water from the Duchesne River to the Lake Boreham reservoir and to Indian project lands on the Lake Fork River in exchange for Lake Fork waters which were used on the higher lands of the Moon Lake project (Truesdale 2001). This canal and the Midview Reservoir were constructed by the CCC (1968th Brigade) in connection with Depression-era relief and recovery programs.

Since the mid-1950s, the prosperity of the Uinta Basin has hinged on oil and natural gas exploration booms. In April 1925, a 10-million-cubic-foot gas gusher was struck near Ashley Creek between Vernal and Jensen (Burton 1996:140). The Ashley Field was the first major producer of gas in the county and in eastern Utah (Burton 1996:140). By 1929, lines were installed that supplied Vernal and Ashley Valley with natural gas from the Ashley Field; these lines were shut down after 12 years when gas pressure had declined beyond a usable point (Burton 1996:142). Very little activity occurred until the 1940s when big oil-producing wells were drilled in the county, making petroleum one of Vernal's major industries (Burton 1996:141). By 1949, Uintah County had 26 producing oil wells with several in fields in Ashley Valley. Shortly thereafter, oil fields opened in the Uinta Basin including Red Wash in 1951, Walker Hollow in 1953, and Bluebell in 1955 (Barton 1998). Three-hundred families moved to Vernal in 1955 (Burton 1996:141). In 1970, the immensely successful Miles No. 1 well was drilled in the Altamont/Bluebell oil field. The success at Miles No. 1 and the oil crisis overseas fueled a full-blown oil boom in the county (Barton 1998). By the late 1980s, the boom had started to bust, impacting housing prices, employment, and county income from oil and gas taxes. The last oil and gas boom was in 2012 and has slowed since that time. There are several oil and gas fields in the Uinta Basin, though they are concentrated in the southern halves of Duchesne and Uintah Counties. In 2013, a quarter of Utah's total crude oil production came from tribal lands (Utah Oil and Gas 2015).

Table 4. Archaeological Periods and Cultural Traditions of Northeast Utah.

Period	Dates	Diagnostic Characteristics
Paleoindian	11,500-7,500 B.P.	-Exploitation of Megafauna -Large fluted and nonfluted spear points. -Stemmed points uncommon -Highly mobile
Archaic Early Middle Late	9,000-1,500 B.P. 9,000 – 7,000 B.P. 7,000 – 3,000 B.P. 3,000 – 1,500 B.P.	-Atlatl darts (e.g., Pinto, Humboldt, McKean, San Rafael Side-notched, etc.) -Residential/logistical foraging strategy - Reliance on hunting and increased levels of gathering wild plants
Formative	1,500 – 750 B.P.	-Horticulture -Introduction of ceramics -Introduction of the bow and arrow -Increased sedentism -Development of residential hamlets, small villages
Late Prehistoric/Ethnohistoric	750 – 250 B.P.	-Residential/logistic mobility -Very little, if any, horticulture, -Intermountain brown wares -Triangular and small side-notched points (e.g., Cottonwood, Desert Side-notched. -Attributed to the Numic migration from the west and north.
Historic	250 – 50 B.P.	-Early exploration by nonaboriginal people (e.g., Rivera ca. 1765; Dominguez-Escalante expedition ca.1776). -Old Spanish Trail ca. 1830-1848 -US Gov. Expeditions (ca. 1853-1871) -Initial settlement by members of the Church of Jesus Christ of Latter-day Saints and others (ca. 1880) -Primary land use of region was related to agrarian and mineral extraction pursuits.

Sources: Barton 1998; Burton 1996 & 1998; Black and Metcalf 1986; Byers 2012; Callaway et al. 1986; Copeland and Fike 1988; Davis 1985 & 1988; Finken 1977; Greubel 1996; Hafen and Hafen 1954; Holmer and Weder 1980; Horn 1988; Jennings 1978; Lindsay 1986; Madsen 1975; Marwitt 1970; Montgomery 1984; Newsome and Tipps 1993; Schroedl 1976 and 1991; Westfall 1988.

EXPECTATIONS

Based on the results of the literature review, previous projects, historic sources research, and professional experience derived from working in the area, minimal cultural resources were anticipated within the survey areas. Cultural resources anticipated within the project area include prehistoric or historic isolates and irrigation/agricultural related sites.

FIELD METHODS

MOAC archaeologists performed an intensive Class III pedestrian survey for the DCWCD PL-566 project cleanup, which is considered 100 percent coverage. The Class III area was examined for cultural resources by the archaeologist walking parallel transects spaced no more than 15 m (49 ft) apart. Ground visibility was fair to good. A total of 27.9 acres were inventoried for cultural resources on private property (3.9 acres) and Ute tribal land (24 acres).

INVENTORY RESULTS

The inventory resulted in the identification of 10 previously documented archaeological sites (42DC376, 42DC2013, 42DC2793, 42DC3029, 42DC3081, 42DC3084, 42DC4248, 42DC4249, 42DC4262, and 42DC4263) (Table 5). These 10 sites were updated or documented during the original DCWCD PL-566 project (U21MQ0113). However, during the cleanup survey, one additional segment of 42DC2793 (the Yellowstone Feeder Canal) was documented.

Smithsonian Site No.: 42DC376
Site Type: Duchesne Feeder Canal
Eligibility: Eligible, Criteria A and C
Description: Site 42DC376 is the Duchesne Feeder Canal. The Duchesne Feeder Canal was built in 1937-1939 as part of the Moon Lake Project to facilitate a complicated exchange of water rights between various irrigation companies, as well as the Ute tribal water rights (Southworth 1981). This canal and the Midview Reservoir (Lake Boreham) were constructed by the Civilian Conservation Corps (CCC – 1968th Brigade). The Moon Lake Project took 23,000 acre-feet of water from the upper Lake Fork River for delivery to stockholders in the Moon Lake Water Users Association. Two segments of the canal and an unnamed lateral were documented for the U21MQ0113 inventory. In general, the Duchesne Feeder Canal is an earthen channel that ranges from 7-20 ft wide and up to 6 ft deep. The U21MQ0113 documented segments embody these same characteristics. The southern segment (4,921 ft long) extends south from MOAC's U13MQ0322 documentation, from just below the Midview Ditch to the Moon Lake Canal. Two features are along this segment including a concrete diversion structure at the junction of the Duchesne and Moon Lake Canals (F-C) and a metal flume (F-B). The northern segment (1,114 ft) extends north from MOAC's U11MQ1027 documentation near the Lake Fork River. One feature, a wooden bridge (F-A), is associated with this segment. The unnamed lateral is F-N1, diverging from the main canal at a headgate (F-N) documented by MOAC as part of U11MQ0761. This ditch (2,564 ft long) runs south from the main canal before turning east to its terminus in Zimmerman Wash. This earthen ditch ranges from 3-6 ft wide and 1-3 ft deep. It splits into two parallel ditches for 1,888 ft. It has three associated features including a steel culvert (F-N1A), a metal Parshall flume (F-N1B), and a wooden weir/headgate (F-N1C). This unnamed lateral ditch may have been constructed shortly after the Duchesne Feeder Canal was constructed but was in place by 1953 based on aerial imagery. The Duchesne Feeder Canal was running/in-use at the time of documentation. The unnamed lateral ditch, F-N1, was not in use at the time of documentation. Three other previously documented segments are associated with the overall DCWCD PL-566 area, documented under project numbers U11MQ0761, U11MQ1027, and U13MQ0322.

Current Undertaking: The proponent plans to pipe the Duchesne Feeder Canal within the project area. This will be done by burying the pipe in the canal for most of its length (omitting curves) by placing the pipe at the bottom of the canal and pushing in the banks to cover it, resulting in an adverse effect.

Smithsonian Site No.: 42DC2013
Site Type: South Boneta Canal
Eligibility: Not Eligible
Description: Site 42DC2013 is the South Boneta Canal, which is owned by the South Boneta Irrigation Company. The South Boneta Irrigation Company is one of several that formed shortly after the opening of the Uintah Reservation in 1905 (Barton 1998:307). It became a registered business in 1920. It is thought that the South Boneta Canal was constructed around 1910 based on water rights records from the State Engineer's office (Mutaw 2005). The canal begins off the Lake Fork River in Section 21 of T1S, R4W and runs south roughly 3 miles before it appears to terminate into Pigeon Water Creek, which drains into the Lake Fork River. This canal is the only one owned by the South Boneta Irrigation Company and historically

irrigated 617 acres (Roosevelt Standard 1929). In the early 20th century, 1,768 acres of land on the bench surrounding Boneta were under cultivation growing wheat, oats, alfalfa, orchards, potatoes, etc. (Myton Free Press 1915). As Boneta was known for having some of the best wheat in the basin, wheat formed the bulk of this cultivation effort at 554 acres (Myton Free Press 1915). The South Boneta Canal was responsible for irrigating a third of the cultivated land surrounding Boneta. The canal was first documented by URS Corporation in 2005, which consisted of a 100 ft long segment crossing SR-87 (U05UI0502). A total of 12,531 ft of the canal was documented for the U21MQ0113 inventory including the 2005 segment. The South Boneta Canal is an earthen ditch with natural cobbles along the bottom measuring 3 ft wide and less than 1 ft deep. Interestingly, the canal traverses "uphill" from the valley along the Lake Fork River onto the bench above. The documentation begins at the diversion of the canal from the Lake Fork River via a modern headgate and ends at the south at the stock pond where the canal appears to currently end. A likely in-period headgate is in this pond but is displaced. The original alignment extending south from the pond towards Pigeon Water Creek is abandoned or piped after this point. Four associated features were documented including a Parshall flume (F-A) and three culverts (F-B, F-C, and F-D). No associated artifacts were observed. The canal was in use at the time of documentation.

Current Undertaking: The South Boneta Canal will be piped in the project area. This site is considered not eligible for NRHP listing.

Smithsonian Site No.: 42DC2793
Site Type: Yellowstone Feeder Canal
Eligibility: Eligible, Criteria A and C
Description: Site 42DC2793 is the Yellowstone Feeder Canal, which was constructed as part of the Moon Lake Project between 1935 and 1941. The Moon Lake Project was conducted by the Civilian Conservation Corps (CCC) as part of the "New Deal" economic stimulus programs of the Roosevelt administration (Truesdale 2010, Jordan 2016). The Moon Lake Project was one of the largest emergency relief and reclamations projects conducted by the CCC in Duchesne County (Truesdale 2010, Jordan 2016). Numerous portions of the canal have been documented including a 10.6-mile section completed by Bighorn Archaeology in 2016 as part of U16HO0348. MOAC documented 8,716 ft of the canal on Monarch Ridge for the U21MQ0113 project. A total of 3,317 ft of the canal on a ridge between Water Hollow and Cottonwood Wash was documented for the current project. At the east end, the segment runs downslope into Cottonwood Wash. The irrigation waters run down Cottonwood Wash for 1.6 miles until they are diverted into a manufactured ditch again. A modern culvert bridge is located at the east end of the documented segment, allowing irrigation waters to run under Cottonwood Wash Road. A 1976 date is inscribed on the railing of the bridge. No in-period artifacts were observed. In general, the canal is an earthen/clay lined ditch averaging 13-16 ft wide and 6 ft deep

Current undertaking: The proponent plans to line the Yellowstone Feeder Canal in the project area, which will result in an adverse effect. Portions of the associated road along the Yellowstone Feeder Canal will be improved as needed.

Smithsonian Site No.: 42DC3029
Site Type: Midview Ditch
Eligibility: Eligible, Criterion A
Description: This site is the Midview Ditch, which distributes irrigation water from the Duchesne Feeder Canal. The Midview Ditch was built between 1937 and 1939 as part of the Moon Lake Project. This canal and the Midview Reservoir (Lake Boreham) were constructed by the CCC (1968th Brigade). The canal segment associated with the current project was documented by MOAC in 2012 (U12MQ0290 and U12MQ0117). The canal is an earthen ditch ranging 8-16 ft wide and 4-5 ft deep. The canal is eroded and appears to no longer be in use. Features documented include a steel flume, a steel culvert, and a steel headgate. These features occur near the junction with the Duchesne Feeder Canal.

Current Undertaking: The Midview Ditch will not be impacted by the proposed undertaking.

Smithsonian Site No.: 42DC3081
Site Type: Red Cap Canal
Eligibility: Eligible, Criterion A
Description: The Red Cap Canal was constructed under the Uintah Indian Irrigation Project in the 1890s to increase the agricultural productivity of reservation land (Barton 1998). A total of 36,473 ft (6.91 mi) was documented by MOAC in 2011 (U11MQ1027). The canal is an earthen ditch ranging in width from 6 to 20 ft with an average depth of 6 ft. Portions of the canal are overgrown, not well maintained, and dry while other portions of the canal are better maintained and still in use. A 2,538 ft (0.48 mi) portion of the canal was filled in.

Current Undertaking: As part of the overall DCWCD PL-566 project, the proponent plans to pipe the Red Cap Canal by burying the pipe in the canal for most of its length (omitting curves) by placing the pipe at the bottom of the canal and pushing in the banks to cover it, resulting in an adverse effect. The Red Cap Canal is near the DCWCD PL-566 cleanup, but not directly associated with any cleanup areas.

Smithsonian Site No.: 42DC3084
Site Type: Moon Lake Canal
Eligibility: Eligible, Criteria A and C
Description: Site 42DC3084 is the Moon Lake Canal. The Moon Lake Canal is fed by the Duchesne Feeder Canal (42DC376) and empties into Lake Boreham (42DC3082). Both the Duchesne Feeder Canal and Lake Boreham were built by the Civilian Conservation Corps (CCC), between 1937-1939 and 1937-1938 respectively, as part of the Moon Lake Project. The Duchesne Feeder Canal, as part of the Moon Lake Project, facilitated a complicated exchange of water rights between various irrigation companies, as well as the Ute tribal water rights (Southworth 1981). The Moon Lake Project took 23,000 acre-feet of water from the upper Lake Fork River for delivery to stockholders in the Moon Lake Water Users Association. The Moon Lake Canal was constructed by the CCC around the same time as the Duchesne Feeder Canal and Lake Boreham. A short segment of the Moon Lake Canal (1,142 ft) was documented from its diversion from the Duchesne Feeder Canal (42DC376 – Feature C) as part of the U21MQ0113 project. From its diversion with the Duchesne Feeder, the Moon Lake Canal is concrete lined for 66 ft to descend a ~30-degree slope into its earthen channel within a deep erosion cut. The canal utilized two waterfalls to help descend the slope. This segment is 20 ft wide and up to 2 ft deep. No associated artifacts were observed.

Current Undertaking: The concrete drop structure extending from the diversion from the Duchesne Feeder Canal will be replaced with twin pipe spillway, resulted in an adverse effect.

Smithsonian Site No.: 42DC4248
Site Type: Lateral Canal
Eligibility: Not Eligible
Description: This site is a lateral of the Yellowstone Feeder Canal that terminates into Browns Reservoir documented during the U21MQ0113 survey. The Yellowstone Feeder Canal was constructed by the Civilian Conservation Corps (CCC) between 1935 and 1941 as part of the Moon Lake Project. This lateral diverts from the Yellowstone Feeder in Section 6 of T1S, R2W. The historic alignment consists of a short 1,000 ft long earthen ditch averaging 13-16 ft wide and 6 ft deep with natural cobbles along the bottom. The constructed canal then drained into a natural drainage, which carries the water down the ridge and towards the historic townsite of Monarch. The historic alignment is first visible on 1953 aerial imagery. It is thought to have been constructed between this time and 1941. The shape of the ditch is different than the Yellowstone Feeder, basin shaped rather than trapezoidal, indicating they were not constructed at the

same time by the CCC. This lateral was added after the Moon Lake Project. Sometime after 1979, and between 1982 and 1985, Browns Reservoir was created and a 2,860 ft long canal of comparable size was constructed in Section 5 of T1S, R2W to move water from the drainage to the reservoir. This is based on the review of 1979 aerial imagery (extension and reservoir absent), the 1982 Duchesne, UT 1:100000 quad (extension and reservoir absent), and 1985 Google Earth imagery (extension and reservoir visible). There are five associated features including headgates (Features A and E), a diversion structure (Feature B), a flume (Feature C), and a culvert (Feature D). Some of these features are in the natural drainage. No associated artifacts were located. The canal was not in use during at the time of recording.

Current Undertaking: This ineligible ditch will be piped.

Smithsonian Site No.: 42DC4249
Site Type: Bluebell Lateral
Eligibility: Eligible, Criterion A
Description: This site is the Bluebell Lateral canal, which is a lateral of the No. 1 Canal (née Class B Canal). The Bluebell Lateral diverts from the No. 1 Canal just east-northeast of Altonah. It terminates into Dry Gulch Creek roughly four miles east of Big Sand Wash Reservoir. The Bluebell Lateral was constructed by, or at least enlarged, by the Farmers Irrigation Company; a project underway by 1913 (Duchesne Record 1913). Since its initial construction, the Bluebell Lateral was a joint interest of the Farmers Irrigation Company and the Dry Gulch Irrigation Company, both responsible for maintenance and hiring of water masters and ditch riders (Vernal Express 1913, Myton Free Press 1915, Roosevelt Standard 1927 and 1930). The Dry Gulch Irrigation Company acquired Farmers Irrigation Company in 1945 and has been solely responsible for the maintenance of the Bluebell Lateral ever since (Smith 2013). The Bluebell Lateral, in addition to other laterals associated with the No. 1 Canal, were essential to the establishment of the Altonah and Bluebell communities. This system still serves agricultural producers in the area (Smith 2013). A total of 58,100 ft of the Bluebell Lateral was documented for the U21MQ0113 inventory. This was the first recording of this historic canal. The Bluebell Lateral is an earthen ditch ranging 5-10 ft wide and 1-3 ft deep; natural cobbles line the bottom. Thirty-eight features were documented along this segment including two bridges, seven headgates, seven culverts, six weirs, twelve weir/headgate complexes, a Parshall flume, a headgate/flume, wing walls, and a diversion structure. A few sites were documented along the canal including a collapsed cabin (42DC4255) and two corrals (42DC4256 and 42DC4257). Only in-period features were documented.

Current Undertaking: The proponent plans to pipe the Bluebell Lateral through the project area. This will be done by burying the pipe in the canal for most of its length (omitting curves) by placing the pipe at the bottom of the canal and pushing in the banks to cover it, resulting in an adverse effect.

Smithsonian Site No.: 42DC4262
Site Type: Lateral Ditch
Eligibility: Not Eligible
Description: This site consists of a lateral earthen ditch that conveys water between the Duchesne Feeder Canal and the Midview Lateral Canal along 6450 S. It was documented during the U21MQ0113 survey. It ranges from 4 to 6 ft wide and 3 to 7 ft deep. It has seven associated features including two corrugated culverts (Features A and E), a wooden headgate and weir (Feature B), a wooden weir (Feature C), a Parshall flume (Feature D), a metal weir (Feature F), a wooden diversion, headgate, and culvert (Feature G), and a concrete weir (Feature H). No associated artifacts were observed. This ditch runs between two canals constructed by the Civilian Conservation Corps during the Moon Lake Project – the Duchesne Feeder and the Midview Lateral. These canals are visible on 1936 aerial imagery in construction. This ditch is also possibly constructed or at least partially, but it is difficult to discern based on its small size. It was likely in use around 1938 or shortly thereafter when the first irrigation waters were released from the Moon Lake Reservoir (Roosevelt Standard 1938).

Current undertaking. This ineligible site is partially within a cleanup area.

Smithsonian Site No.: 42DC4263
Site Type: Corral
Eligibility: Not Eligible
Description: The site is a large corral documented during the U21MQ0113 survey. It is predominantly post-and-rail construction and contains three main pens, one with an L-shaped covered area, and two chutes. Based on aerial imagery, the site post-dates 1968 but was built by 1976. When reviewing Google Earth imagery, the corral does not appear to have been seriously used since 1997. The corral occurs on land patented to Togarvias Unca Sam as an Indian Allotment. Togarvias Unca Sam was an Uncompahgre Ute man born in Colorado around 1860, later moving to the Arcadia area and settling on his allotment, which he farmed until his death in 1950 (Roosevelt Standard 1950). The corral post-dates Togarvias Unca Sam's use of the farm but is associated with his heirs or leasers of the property. The property is now Uintah-Ouray Ute tribal land.

Current undertaking. This ineligible site is near a cleanup area.

Table 5. Summary of Archaeological Sites.

Site No.	Site Type	NRHP Status	Association to Project Area
42DC376	Duchesne Feeder Canal	Eligible, A & C	Will be replaced by buried pipe in PA
42DC2013	South Boneta Canal	Not Eligible	Will be replaced by buried pipe in PA
42DC2793	Yellowstone Feeder Canal	Eligible, A & C	Will be lined in PA, road improved as needed
42DC3029	Midview Ditch	Eligible, A	Not impacted by undertaking
42DC3081	Red Cap Canal	Eligible, A	Nearby but not in cleanup area
42DC3084	Moon Lake Canal	Eligible A and C	Concrete drop structure will be replaced by twin pipe spillway
42DC4248	Lateral Canal	Not Eligible	Will be replaced by buried pipe in PA
42DC4249	Bluebell Lateral	Eligible, A	Will be replaced by buried pipe in PA
42DC4262	Lateral Ditch	Not Eligible	Partially within PA
42DC4263	Corral	Not Eligible	Partially within PA

NATIONAL REGISTER OF HISTORIC PLACES EVALUATIONS

The National Register Criteria for Evaluation of Significance and procedures for nominating cultural resources to the National Register of Historic Places (NRHP) are outlined in 36 CFR 60.4 as follows:

> The quality of significance in American history, architecture, archaeology, and culture is present in districts, sites, buildings, structures, and objects of State and local importance that possess integrity of location, design, setting, material, workmanship, feeling, and association, and that they:
>
> a)...are associated with events that have made a significant contribution to the broad patterns of our history; or
>
> b)...are associated with the lives of persons significant to our past; or
>
> c)...embody the distinctive characteristics of a type, period, or method of construction; or that represents the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction; or
>
> d)...have yielded or may be likely to yield information important in prehistory or history.

The Class III cultural resource survey of the NRCS' DCWCD PL-566 project cleanup in Duchesne County, Utah resulted in the identification of identification of 10 previously documented archaeological sites (42DC376, 42DC2013, 42DC2793, 42DC3029, 42DC3081, 42DC3084, 42DC4248, 42DC4249, 42DC4262, and 42DC4263). Of these 10 sites, six (42DC376, 42DC2793, 42DC3029, 42DC3081, 42DC3084, and 42DC4249) are eligible for NRHP listing. These sites are canals including the Duchesne Feeder Canal (42DC376), the Yellowstone Feeder Canal (42DC2793), the Midview Ditch (42DC3029), the Red Cap Canal (42DC3081), the Moon Lake Canal (42DC3084), and the Bluebell Lateral (42DC4249) that have been previously determined eligible under Criterion A due to their association with early irrigation practices in the Uinta Basin. The Duchesne Feeder Canal (42DC376), Yellowstone Feeder Canal (42DC2793), and Moon Lake Canal (42DC3084) have also been previously determined eligible under Criterion C due to their embodiment of CCC construction and workmanship.

The remaining four sites are ineligible for NRHP listing. These include the South Boneta Canal (42DC2013), two unnamed lateral canals/ditches (42DC4248 and 42DC4262), and a corral (42DC4263). Sites 42DC2013, 42DC4248, 42DC4262, and 42DC4263 have been previously determined ineligible for NRHP listing as they failed to meet the outlined criteria.

SUMMARY

The Class III cultural resource survey of the NRCS' DCWCD PL-566 project cleanup in Duchesne County, Utah resulted in the identification of 10 previously documented archaeological sites (42DC376, 42DC2013, 42DC2793, 42DC3029, 42DC3081, 42DC3084, 42DC4248, 42DC4249, 42DC4262, and 42DC4263), of which one was updated (42DC2793), within 100 ft of the project area. Of these ten sites, six (42DC376, 42DC2793, 42DC3029, 42DC3081, 42DC3084, and 42DC4249) are eligible for NRHP listing.

All six eligible sites are canals. Two of these canals, the Midview Ditch (42DC3029) and Red Cap Canal (42DC3081) will not be impacted by the project cleanup areas. The Moon Lake Canal (42DC3084) will have its concrete drop structure extending from its diversion from the Duchesne Feeder replaced with a twin pipe spillway, which will be an adverse impact. One of these canals, the Yellowstone Feeder (42DC2793), will be lined in the project area and have its associated access road improved as needed. Two canals including the Duchesne Feeder Canal (42DC376) and the Bluebell Lateral (42DC4249) will be replaced by buried pipelines through the project area, which will be completed by placing the pipe within the canals for most of their length and pushing in the banks to cover up the pipelines.

Based on the proposed impacts to four eligible canals including 42DC376, 42DC2793, 42DC3084, and 42DC4249, a determination of *historic properties adversely affected* is proposed for the undertaking pursuant to Section 106 of 36 CFR 800. Adverse effects will be mitigated through the development of a Memorandum of Agreement between the NRCS, the Utah State Historic Preservation Office, and other consulting parties.

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Public Participation Plan

Public Participation Plan

United States
Department of
Agriculture

Duchesne County Water Conservancy District Watershed Plan

Duchesne County, Utah

Natural Resources
Conservation Service

September 2019

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Purpose of This Strategy

The National Watershed Program Manual (NWPM) sets forth the policy for all watershed plans developed under the Watershed Program. No project will be funded under Public Law (PL) 83-566 authority (Watershed Protection and Flood Prevention Act of 1954, as amended) unless it meets the requirements set forth in the manual. PL 83-566 authorizes the NRCS to provide technical and financial assistance to sponsoring local organizations (SLOs) to prepare and implement watershed plans. The SLO for this effort is the Duchesne County Water Conservancy District (DCWCD).

The NRCS will assist the DCWCD in preparing a watershed project plan and environmental assessment, which will be combined into a single document, called the Plan-EA. The Plan-EA will be prepared to comply with the National Environmental Policy Act (NEPA). The purpose of the Plan-EA is to develop a watershed project plan so that NRCS can decide whether to provide technical and financial assistance to the DCWCD for implementation of the alternative selected by the DCWCD.

The intent of this public participation plan is to outline the outreach methods and timing of public participation throughout the planning and NEPA process in developing the Plan-EA.

This strategy has been designed to assist with communication between the NRCS and the public. This document should be considered a “living document” as it may be updated as information changes (such as contact information or as activities are completed or new ones are identified).

Public Participation Objectives

The term “public” used in this document is a broad term that includes private citizens, local, state, regional, and national government entities, federally recognized Indian Tribes, formal collaborative groups, cooperating agencies, special interest groups, community groups, and others.

The objective is to deliver concise, consistent messages regarding the Plan-EA process and how to engage the public in the process.

In order to keep the public and all associated agencies and organizations fully informed throughout the duration of the project, the strategy will:

- Provide opportunities for members of the public to comment and provide useful data.
- Promote public education and awareness of watershed protection in the area.
- Identify coordination efforts to involve the public in the NEPA process.
- Inform those persons and agencies that may be interested or affected by providing public notice of NEPA-related public meetings and the availability of environmental documents.
- Identify cooperative agencies to be involved in interagency coordination.
- Promote constructive open dialogue, debate, and deliberation among different perspectives.
- Collaborate with local communities to gather information and identify issues to include during the project’s decision-making process.
- Provide a credible and consistent approach.

Participation Opportunities

Public Meetings

Two public meetings will be held to provide information for and solicit feedback on the project. The meetings will be held in Roosevelt, Utah, in the DCWCD Offices.

1. **Scoping Meeting, October 2019**

A public scoping meeting will be held to gain input and feedback from the public concerning the project's purpose and need, potential alternatives, environmental issues to be addressed in the EA, methodologies to be used to evaluate impacts, and other project-related observations. The purpose of scoping and the NEPA process will be explained by Jenna Jorgensen, Environmental Coordinator. Graphical displays, including maps and charts, will be provided as needed. All previously submitted scoping comments submitted by mail, fax, or e-mail will also be considered and discussed.

2. **Draft PLAN-EA Meeting, Approximately August 2020**

A public review meeting will be held following publication of the Draft Plan-EA. Eric Major, Monique Franson, and Greg Allington, will present the proposed alternative and evaluation framework, and discuss the environmental effects of the proposed alternative. The meeting will be open to input and feedback from the public concerning the content and effectiveness of the Draft Plan-EA.

Public Notices and Mailings

There will be four public notices implemented for the following events throughout the duration of the project:

1. **Scoping Meeting**

The notice for the public scoping meeting will be published in the *Uintah Basin Standard* approximately 14 days and 7 days prior to the scheduled meeting (October 8 and 15). Draft notices will be provided to the NRCS for review at least 7 days before publication (no later than October 1).

A copy of the public notice will also be mailed to a pre-determined mailing list approximately 2 weeks prior to the scoping meeting.

2. **Draft PLAN-EA Notice of Availability (NOA) and Public Meeting Notice for Draft PLAN-EA Review Meeting**

Following the completion of the Draft Plan-EA, a Notice of Availability (NOA) and news release will be provided to the NRCS for review at least 7 days before the publication submittal deadline. The NOA will be published locally in the legal section of the *Uintah Basin Standard*; the notice will also provide the date, location, and time of the public meeting for receiving comments on the Draft Plan-EA. The NOA will be published at least 30 days prior to the date of the public meeting (anticipated to be July 2020).

The NOA will also be mailed to the complete mailing list approximately 30 days prior to the scheduled meeting.

3. Filing of the Final PLAN-EA

Following the completion of the Final Plan-EA, an NOA and news release will be provided to the NRCS for review at least 7 days before publication (anticipated September 2020). The NOA will be published locally in the legal section of the *Uintah Basin Standard.*

The NOA will also be mailed to the complete mailing list at the time of publication.

4. Finding of No Significant Impact (FONSI)

The draft FONSI and NOA will be prepared for submittal to the NRCS. The NRCS will prepare the final FONSI and publish the FONSI and NOA locally.

Target Audiences

In providing opportunities for engagement, participation will be encouraged by:

i. Interested individuals and entities, including those interested at the local, regional, and national levels.

ii. Low-income populations, and minority populations.

iii. Private landowners whose lands are in, adjacent to, or otherwise affected by, or whose actions may impact, future management actions in the plan area.

iv. Federal agencies, state agencies, states, counties, and local governments.

v. Interested or affected federally recognized Indian Tribes.

Depending on the level of involvement in the project, outreach will be accomplished by formal letters, e-mail, web publication, the *Uintah Basin Standard*, and word-of-mouth.

Contact List

The contact list will be maintained as an Excel spreadsheet. The list identifies the expected initial stakeholders and contacts, and will be updated to aid in communication with various interested or affected parties.

Tribal Consultation

Consultation letters will also be sent to Tribes identified by the NRCS archaeologist.