Chapter 3: Alternatives

3.1 Introduction

This chapter describes and compares general information about the project alternatives that are studied in detail in this EIS, including a No-Action Alternative and three action alternatives. The chapter also describes all of the initial alternatives that were considered; the alternatives selection process, including alternatives that were considered but eliminated from further study; and NRCS's preferred alternative.

The regulations at 40 CFR 1502.14 require agencies to "rigorously explore and objectively evaluate all reasonable alternatives and, for alternatives which were eliminated from detailed study, briefly discuss the reasons for their having been eliminated." Alternatives studied in detail should meet the purpose of the project, address issues raised during scoping, and avoid, minimize, or mitigate adverse environmental impacts associated with the proposed action.

NRCS is not required to analyze alternatives that are unreasonable or that are inconsistent with the project's purpose. NRCS's NEPA guidance states that the agency does not need to examine every conceivable alternative or speculative alternatives. In addition, NRCS does not need to examine alternatives that won't work, are not reasonable, or are infeasible, unrealistic, impractical, or not economical (National Environmental Compliance Handbook, Section 610.B.28). NEPA also requires NRCS to consider a No-Action Alternative, which discloses the effects of not undertaking the proposed action.

3.2 Alternatives Studied in This EIS

This EIS studies four alternatives:

- No-Action Alternative
- Purple Alternative (preferred alternative) (Figure 3-1)
- Orange Alternative (Figure 3-6)
- Blue Alternative (Figure 3-8)

The Purple, Orange, and Blue Alternatives would meet the project purpose and need and would implement the proposed action. Collectively, these alternatives are called *action alternatives*. This section describes the following aspects of the action alternatives:

- Location and operation
- Structural features
- Costs (both construction costs and operation and maintenance costs)
- Permit and compliance requirements

Cost estimates for the action alternatives are in Appendix C1, Action Alternative Cost Estimates. The impacts of the four alternatives are discussed in Chapter 5, Environmental Consequences.

This Draft EIS identifies the Purple Alternative as the preferred alternative. For a detailed discussion about why NRCS has chosen the Purple Alternative as the preferred alternative, see Section 3.5, Preferred Alternative.

3.2.1 No-Action Alternative

Under the No-Action Alternative, the LN Canal irrigation water delivery system would not be temporarily or permanently modified or reconstructed, and the LN Canal irrigation water would not be delivered to users downstream of the Laub Diversion (a diversion structure along Canyon Road at about 1100 East in Logan) using the LN Canal. The No-Action Alternative would not result in any physical changes to the LN Canal, LN Canal POD, LHPS Canal, or LHPS Canal POD. Under the No-Action Alternative, NRCS would not distribute funding to the SLO to repair the LN Canal system. The No-Action Alternative would not address the existing landslide area along Canyon Road in Logan.

What is the No-Action Alternative?

The No-Action Alternative describes what would happen if NRCS does not supply the project funding and the SLO is unable to implement the proposed action. The No-Action Alternative shows how not restoring water delivery would affect the human and natural environment.

The temporary system used to deliver water to LN Canal shareholders in 2009 and 2010 could be available for limited use, but, as described in Section 2.1.2.2, Operation of the LN and LHPS Canals, the temporary system is not intended for long-term use. Making assumptions about the length of time this system could be used to deliver water to LN Canal shareholders is speculative. The Logan & Northern Irrigation Company; the Logan, Hyde Park and Smithfield Canal Company; the City of Logan; and USU originally agreed to the temporary system under the assumption that the Logan & Northern Irrigation Company would implement a permanent solution and that the temporary system was indeed temporary.

The City of Logan and USU are not in the irrigation water delivery business, and continued use of an unimproved LHPS Canal to deliver water to both LN Canal and LHPS Canal shareholders would continue to adversely affect LHPS Canal shareholders. Because the future, long-term use of the temporary system is not likely, the No-Action Alternative assumes that the temporary system would not be used to deliver LN Canal shares in the future.

Under the No-Action Alternative, LN Canal shareholders between the existing LN Canal POD and the Laub Diversion would continue to receive water using the existing LN Canal. No more than 2 cfs would be diverted from the POD and conveyed in the canal to the Laub Diversion. At the Laub Diversion, unused irrigation water would be routed back to the Logan River. Shareholders downstream of the Laub Diversion would not receive water through the LN Canal. The reach of the LN Canal downstream of the Laub Diversion would be abandoned in place by the Logan & Northern Irrigation Company. Intact sections of the canal could still be used to collect and convey stormwater and water from other sources along the

canal (such as water from seeps and springs). Under this alternative, it is likely that the long-term maintenance and management of the canal sections that are intact would become the responsibility of parties who continue to use the canal for conveying stormwater (that is, the Cities of Logan and North Logan, USU, the Utah Department of Transportation [UDOT], and/or Cache County).

LN Canal shareholders who would not receive their shares under the No-Action Alternative would need to cease irrigating altogether or find alternate water sources in order to continue the activities that were supported using the LN Canal water before the 2009 landslide. For example, shareholders who used the water for agricultural production and who want to continue production would need to either use culinary water or groundwater and/or change the way they farm. If a farmer were to rely on groundwater and the groundwater source could not provide the amount of water he or she needs to support the farming operation or if pumping would cost more, the farmer might choose to reduce the amount of land farmed or switch to dry-farming techniques.

Because estimating how the irrigation practices of affected shareholders might change under a No-Action Alternative is speculative, this EIS assumes that LN Canal shareholders downstream of the Laub Diversion would not irrigate any of the land that was irrigated using LN Canal water before the 2009 landslide.

If the No-Action Alternative were implemented, the SLO and the Logan & Northern Irrigation Company could seek funding from other sources in order to restore safe water delivery to LN Canal shareholders. However, because identifying other sources of funding and the amounts of funding that the SLO and irrigation company might be able to secure is speculative, this EIS assumes that adequate funding to restore safe delivery of irrigation water would not be available under the No-Action Alternative.

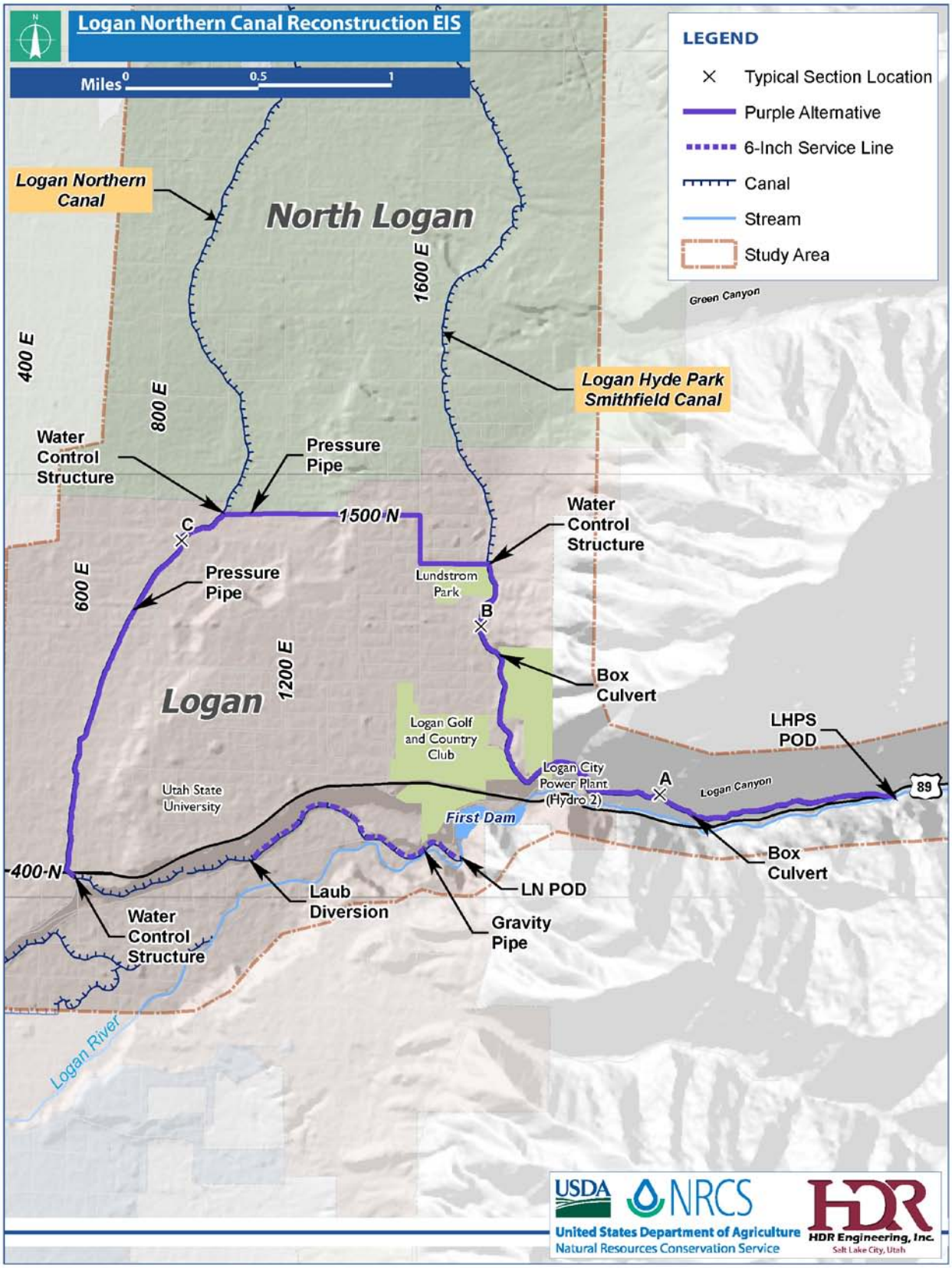
3.2.2 Purple Alternative: LHPS Canal POD to 1500 North

3.2.2.1 Location and Operation

Location

Figure 3-1 shows the route of the Purple Alternative, and Figure 3-2, Figure 3-3, and Figure 3-4 show the typical cross-sections. This alternative would divert LN Canal water using the LHPS Canal POD just below Second Dam. Once the water is diverted, it would be conveyed for about 2.4 miles using a reconstructed LHPS Canal to Lundstrom Park in Logan. At the park, the LN Canal water would be taken from the LHPS Canal and conveyed in a piped system under the park and city streets for about 1.2 miles to the LN Canal at about 1500 North. At 1500 North, most of the water would be discharged directly into the existing LN Canal for delivery to downstream shareholders. The rest of the water would be directed into a 1-mile-long pressure pipe constructed in a canal maintenance road parallel to the existing LN Canal between about 400 North and 1500 North.

Figure 3-1. Purple Alternative



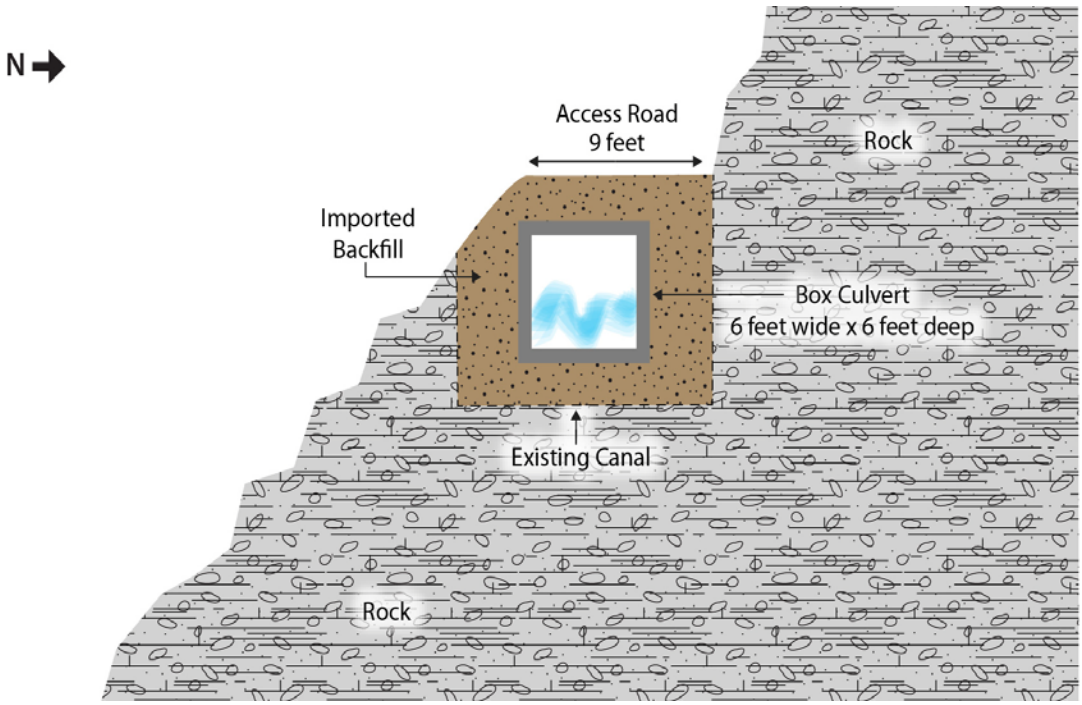


Figure 3-2. Typical Cross-Section A: 6-foot-wide by 6-foot-deep box culvert in Logan Canyon (looking downstream)

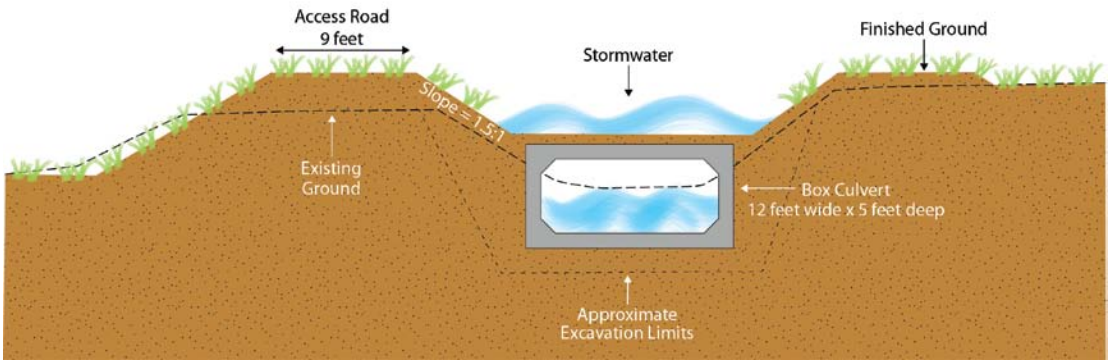


Figure 3-3. Typical Cross-Section B: 12-foot-wide by 5-foot-deep box culvert at about 1200 North in Logan (looking downstream)

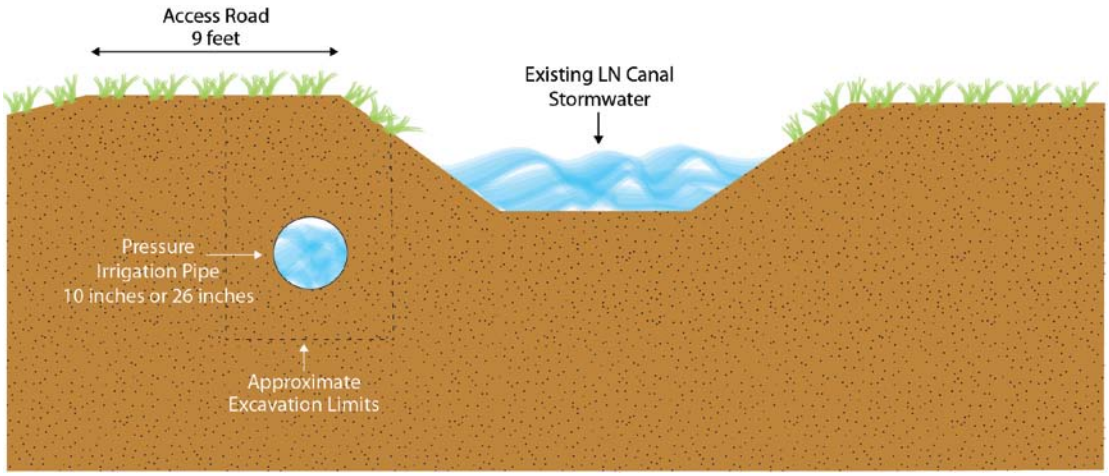


Figure 3-4. Typical Cross-Section C: Pressure pipe in LN Canal (looking downstream)

Shareholders between the existing LN Canal POD and the Laub Diversion (a distance of about 1 mile) would receive water through a new 6-inch-diameter pipeline constructed in the existing LN Canal alignment for water delivery to shareholders in this area.

This alternative includes purchasing and demolishing structures on 14 properties along the north side of Canyon Road in Logan in the area of the 2009 landslide and in the historic landslide zone between about 750 East and 1100 East (Figure 3-5 and Table 3-1). The land in this area is unstable and is at risk of future landslides. The affected structures are along the toe of a steep slope known locally as the Logan Bluff (described in Section 4.4.5.1, Topography).

NRCS has not completed detailed geologic studies to identify the exact limits of the zone but has identified an area that it focuses on for the purpose of this EIS based on topography, landslide history, geology or soil characteristics, and available documentation. NRCS recognizes that further study would be needed to clearly define the limits of the area that would be most susceptible to future landslides.

What is the route of the Purple Alternative?

The Purple Alternative would divert LN Canal water at the LHPS Canal POD and use the LHPS Canal between the POD and Lundstrom Park. At Lundstrom Park, the LN Canal water would be diverted under the park and city streets to the LN Canal at about 1500 North in Logan. The Purple Alternative includes a new pipeline in the LN Canal alignment between 400 North and 1500 North to deliver water to upstream shareholders. It also includes a short pipeline in the LN Canal between the LN Canal POD and the Laub Diversion to provide water to shareholders in that area.

This alternative would not repair the 2009 landslide site or otherwise address the stability of the historic landslide zone, so removing the future risk to life and property can best be achieved by purchasing the structures and relocating the residents. The City of Logan owns six properties in the area; the 14 affected properties are in addition to the six already owned by the City.

Figure 3-5. Parcels From Which Structures Would Be Acquired

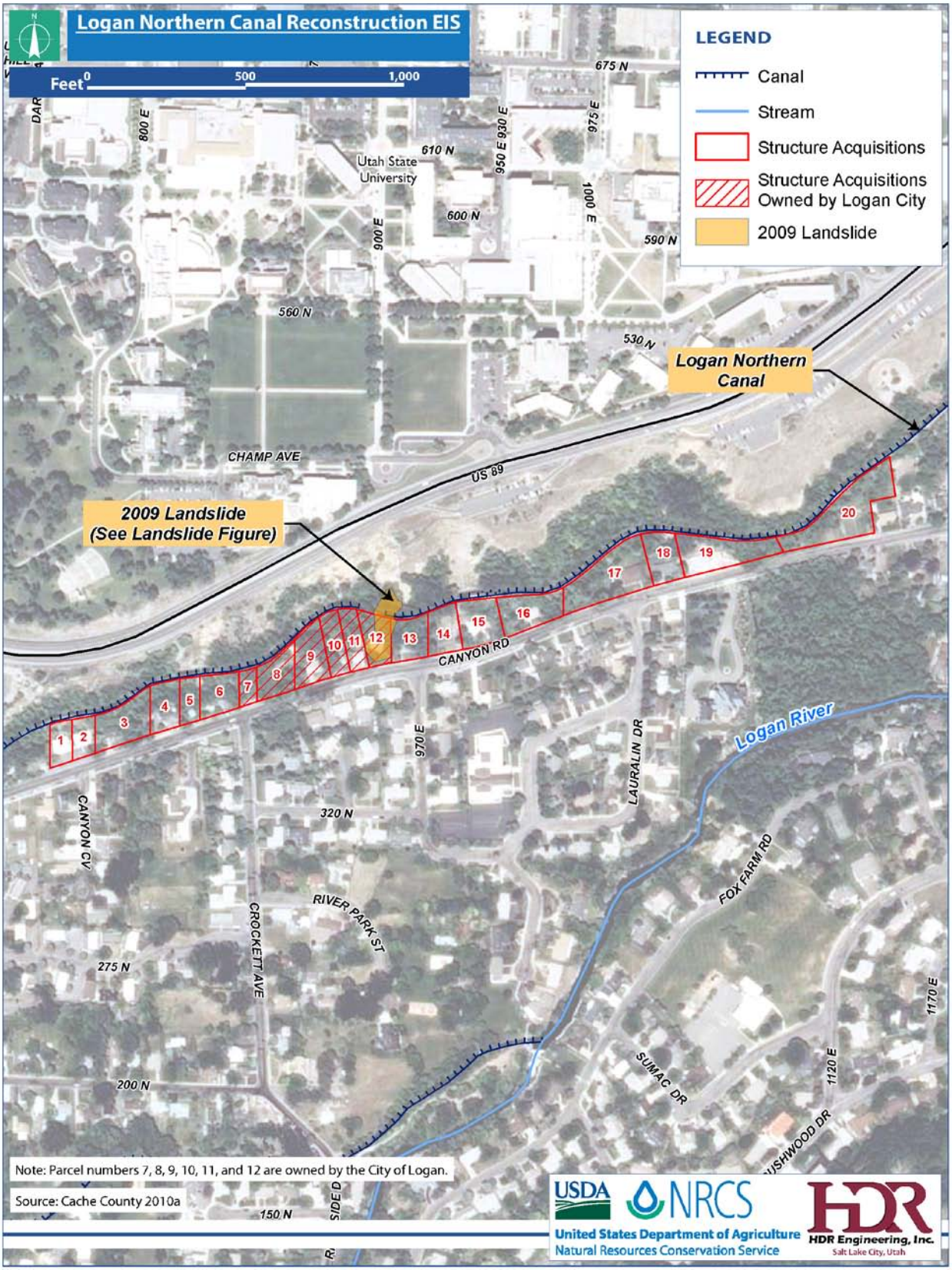


Table 3-1. Proposed Structure Acquisitions along the North Side of Canyon Road in Logan

Identifier[a]	Tax Identifier/ Parcel Number	Address
1	06-048-0013	783 Canyon Road
2	06-048-0014	805 Canyon Road
3	06-048-0015	815 Canyon Road
4	06-091-0001	821 Canyon Road
5	06-091-0002	855 Canyon Road
6	06-091-0003	895 Canyon Road
13	06-091-0009	925 Canyon Road
14	06-091-0031	Not applicable (vacant)
15	06-091-0010	975 Canyon Road
16	06-091-0011	989 Canyon Road
17	06-092-0001	1035 Canyon Road
18	06-092-0002	1055 Canyon Road
19	06-092-0003	1067 Canyon Road
20	06-092-0006	Not applicable (vacant)

Source: Cache County 2010

[a] These identifiers match the numbers shown in Figure 3-5. Parcels 7, 8, 9, 10, 11, and 12 are already owned by the City of Logan; structures might be present, but no one is living in them. Parcels 14 and 20 appear to be undeveloped and without residential structures but could have other structures such as outbuildings for which compensation would be required.

The NRCS EWPP manual allows NRCS to purchase and remove structures when removing that structure is the least costly alternative, the purchase is from a willing seller, and the purchase would not affect a lessee or tenant (EWPP Manual, Title 390, Part 5116[B]). Under the NRCS guidance, the purchase must be based on current value and the purchase can include relocating residents and demolishing structures. Buying and demolishing the structures in this historic landslide area is the least-costly way to protect life and property from hazards associated with future landslides. Purchasing the structures would not completely remove the risks associated with future landslides in this area or along other areas of the Logan Bluff, but it would minimize the potential loss of life and property damage in the area immediately surrounding the 2009 landslide.

Because the purchase of structures would address an area damaged during the event that triggered the need for the proposed action, the purchase does not conflict with the EWPP prohibition against solving watershed or natural problems that existed prior to the natural disaster (Title 390, Part 511.4[v]). This purchase is consistent with the objective of the

EWPP, which requires NRCS to implement recovery measures that "relieve imminent hazards to life and property created by a natural disaster that causes a sudden impairment of a watershed" (7 CFR 624.2).

Once NRCS purchases the structures, the properties on which they are located would be restricted from any future development that would place people or property at risk of landslides. The most likely scenario for future management of the affected properties would be zoning-based or deed-based restrictions on the future use of the properties.

Construction equipment and materials would be staged in existing parking lots and other previously disturbed areas along the LHPS and LN Canals. Because of limited space, construction contractors would probably not stage any equipment or materials in Logan Canyon. Equipment and materials would not be staged in areas that support sensitive resources such as wetlands or other natural water bodies or near sensitive land uses such as churches and medical facilities.

Operation

The Purple Alternative would require moving the POD for some of the Logan & Northern Irrigation Company's water rights from the LN Canal POD just below First Dam to the LHPS Canal POD upstream to a point just below Second Dam. The combined flows to be diverted at the LHPS Canal POD would be a maximum of 130 cfs. The diversions to the canal system would vary based on actual irrigation demands and would be based on seasonal variations in Logan River flow rates. Logan River flow rates during the irrigation season vary but tend to drop as the summer and fall seasons progress. Because of this, the actual diversion at the LHPS Canal POD would be something less than 130 cfs throughout much of the irrigation season.

The few shareholders between the Laub Diversion and 400 North/600 East would not receive LN Canal water. The Logan & Northern Irrigation Company would need to purchase the shares historically delivered to this reach of the canal, and the former shareholders would need to use a different water supply, which would probably be culinary water provided by the City of Logan. The City of Logan has stated that it could provide service to these new users if they no longer receive LN Canal shares (Nielsen 2010).

This alternative includes enclosing reaches of the LHPS Canal. Enclosing the canal would prevent debris from accumulating along the canal alignments, which would help improve water quality and eliminate operational problems such as clogged headgates and local flooding associated with buildup of debris. Enclosing the canal would also enable separation of irrigation water and stormwater, which would also protect the quality of water in the canals.

NRCS's standards for irrigation canals specify construction standards and maximum flow rates that are appropriate for irrigation water delivery systems. If the LHPS Canal were to remain open, the canal alignment would need to be substantially enlarged to safely convey as much as 130 cfs of irrigation water and the stormwater that the LHPS Canal has historically captured between the mouth of Logan Canyon and Lundstrom Park. Enclosing the LHPS

Canal should enable construction to be completed within the existing canal easement and minimize encroachment on adjacent properties.

Finally, open canals pose a safety hazard in areas where they can be accessed by the public. People have historically waded and floated in the canals, even though the canals are generally posted for no trespassing and are not safe or legal recreational features. The amount of increased water proposed for the LHPS Canal could exacerbate the safety hazard if the canal were not enclosed.

The Water Conveyance Facilities Safety Act (2010 Utah Legislature House Bill 60, signed by Governor Gary Herbert on March 23, 2010) requires canal facility owners or operators to develop management plans for water-conveyance facilities such as the LHPS Canal and LN Canal. This plan would identify the cities and counties that the canal passes through, would identify the canal components (such as PODs, bridges, and stormwater entry points), and would include a maintenance and improvement plan, information about insurance coverage, a slope stability assessment, a stormwater assessment, and an emergency response plan. Canal owners or operators must adopt management plans prepared in support of the Water Conveyance Facilities Safety Act no later than May 1, 2013.

3.2.2.2 Structural Features

The Purple Alternative would require constructing, operating, and maintaining new features in the existing LHPS Canal and LN Canal alignments. The structural features would include the following:

- Modified LHPS Canal POD structure on the Logan River just below Second Dam. This would be needed to accommodate diversion and design flow rates as high as 130 cfs. Modifications would include reconstructing the canal flow gage along US 89.
- About 2.4 miles of new box culvert to convey irrigation water from the LHPS Canal POD to Lundstrom Park in the existing LHPS Canal alignment. Preliminary calculations show that about 1.6 miles of 6-foot-wide by 6-foot-deep box culvert would be needed between the LHPS Canal POD and the mouth of Logan Canyon (called the Logan Canyon section), and about 0.8 mile of 12-foot-wide by 5-foot-deep box culvert would be needed from the Logan Golf & Country Club (golf course) to Lundstrom Park.
- A new stormwater channel for about 0.8 mile in the LHPS Canal alignment to convey stormwater.
- Modify Cedar Heights Drive where it crosses the LHPS Canal to accommodate the new box culvert. Also modify several private driveways and pedestrian crossings that cross the LHPS Canal and LN Canal.
- Restore landscaping removed along the LHPS Canal during project construction.

- A water-control structure at Lundstrom Park to transition water from the box culvert to the existing open channel. The new structure combines irrigation water and stormwater for conveyance downstream.
- A new headgate structure at Lundstrom Park to allow LN Canal water to be diverted into a new pressurized pipeline system running west to the LN Canal.
- About 1.2 miles of new 42-inch-diameter pressure pipe to convey 40 cfs of LN Canal water from the LHPS Canal to the LN Canal. The pipeline, which would require air vents and a flow meter, would be routed under city streets and through and under a field to connect to the LN Canal at 1500 North.
- A new water-control structure at the LN Canal to discharge water from the pipe system to the LN Canal system. The structure would include pressure-reducing valves, flow control, and energy-dissipation measures. Water would be divided at the structure into the existing LN Canal open channel to serve shareholders to the north (downstream of 1500 North) and into a pressurized pipeline system traveling to the south (upstream of about 1500 North).
- About 1 mile of 10-inch-diameter pressure pipe from 1500 North to 400 North installed in the existing canal maintenance road. The pressure pipe, which would not affect the existing LN Canal, would convey about 2 cfs for use by shareholders in this reach. These shareholders could access water from the pressure pipe or from the LN Canal. Access from the canal would be available for water not taken from the pressure pipe and that is discharged from the pipe into the LN Canal at about 400 North.
- A new water-control structure to discharge water not taken directly from the pressure pipe into the existing LN Canal at 400 North. This water would supply the Temple Ditch (a LN Canal shareholder) and would provide water in the canal to the north (downstream) to prevent stagnant pools between 400 North and 1500 North.
- About 1 mile of 6-inch-diameter pipe in the current LN Canal alignment between the LN Canal POD and the Laub Diversion at about 1100 East. This pipeline would carry up to 2 cfs for delivery to shareholders in this area. The POD would not need to be modified to accommodate the 6-inch pipeline.

3.2.2.3 Purple Alternative Costs

Table 3-2 summarizes the cost of the Purple Alternative. Detailed cost information is presented in Appendix C1, Action Alternative Cost Estimates.

Table 3-2. Cost Summary for the Purple Alternative
in millions

Item	Cost	Subtotal
Construction materials and installation costs		
Logan Canyon conveyance segment	$7.1	
Valley conveyance segment	$4.2	
Pressurized pipeline systems	$1.6	
Property acquisition and easements[a]	$2.7	**$15.6**
Additional construction items[b]	$3.5	
Engineering and construction management[c]	$1.2	
Total cost estimate		**$20.3**
Total cost range (0% to +10%, rounded)		**$20.4 – $22.4**

[a] Assumes an average cost of $157,000 per property and $10,000 in relocation assistance for each property owner, $10,000 to demolish structures, and purchase of 10 temporary construction easements.

[b] Additional construction items are based on a percentage of material and installation and property costs subtotal and include contractor mobilization (5%), environmental permits and controls (0.5%), minor utility crossings (2%), and a 15% construction contingency.

[c] Engineering and construction management are also based on a percentage of construction costs and include survey and geotechnical evaluations (1.5%), final engineering analysis and design plan production (5%), bid document production and contractor procurement assistance (0.5%), and construction management (1%).

The reported value of the Logan Canyon conveyance segment in Table 3-2 ($7.1 million) is different than the value reported in the description of the gravity option referenced in Section 3.4.1.3, Step 3: Alternative Similarities and Differences ($9.4 million to $10.3 million). These values differ because additional construction and engineering percentages are applied to the construction materials and installation subtotal, and this subtotal includes costs for other conveyance segments in Table 3-2.

3.2.2.4 Permit and Compliance Requirements

In addition to EWPP requirements and mitigation measures that might be identified as part of this EIS, construction of the Purple Alternative would also require the following permits or authorizations:

- Use permit from USFS for work on land administered by USFS.
- CWA Section 404 authorization for modifying the LHPS Canal POD, the LHPS Canal, and LN Canal. If USACE determines that the activity requires an individual permit, then a separate Section 401 water quality certification would also be required.
- Compliance with the CWA Section 402 National Pollutant Discharge Elimination System (NPDES) general permit for construction-related stormwater discharges (file a Notice of Intent and compile a Storm Water Pollution Prevention Plan [SWPPP]).
- National Historic Preservation Act (NHPA) Section 106 concurrence and memorandum of agreement with the State Historic Preservation Officer (SHPO) for modifying the LHPS Canal POD, LHPS and LN Canals, and possibly the LN Canal POD.
- Stream alteration permit from the Utah Division of Water Rights for modifying the POD.
- Antidegradation review by the Utah Division of Water Quality for potential impacts to a Category 1 water (Logan River in Logan Canyon).
- Approved permanent change for LN Canal water rights to ensure that the LN Canal water can be legally diverted at the LHPS Canal POD.
- Construction easements from UDOT (US 89), the City of Logan (city streets and other city property), USU (at the golf course), and property owners along the LHPS and LN Canals.

In all cases, the SLO or its contractors would be responsible for obtaining the authorizations ensuring compliance with any conditions of permit approval.

3.2.3 Orange Alternative: LHPS Canal POD to 2900 North or 3100 North

3.2.3.1 Location and Operation

Location

Figure 3-6 shows the route of the Orange Alternative, and Figure 3-2, Figure 3-3, Figure 3-4, and Figure 3-7 show the typical cross-sections. This alternative is the same as the Purple Alternative to Lundstrom Park; in this segment, the alternative follows the LHPS Canal alignment for about 2.4 miles from the LHPS Canal POD just below Second Dam. From Lundstrom Park, the Orange Alternative would continue to convey irrigation water in a box culvert to the north in the LHPS Canal alignment for another 2.5 miles to about 2900 North or 2.8 miles to about 3100 North in North Logan.

What is the route of the Orange Alternative?

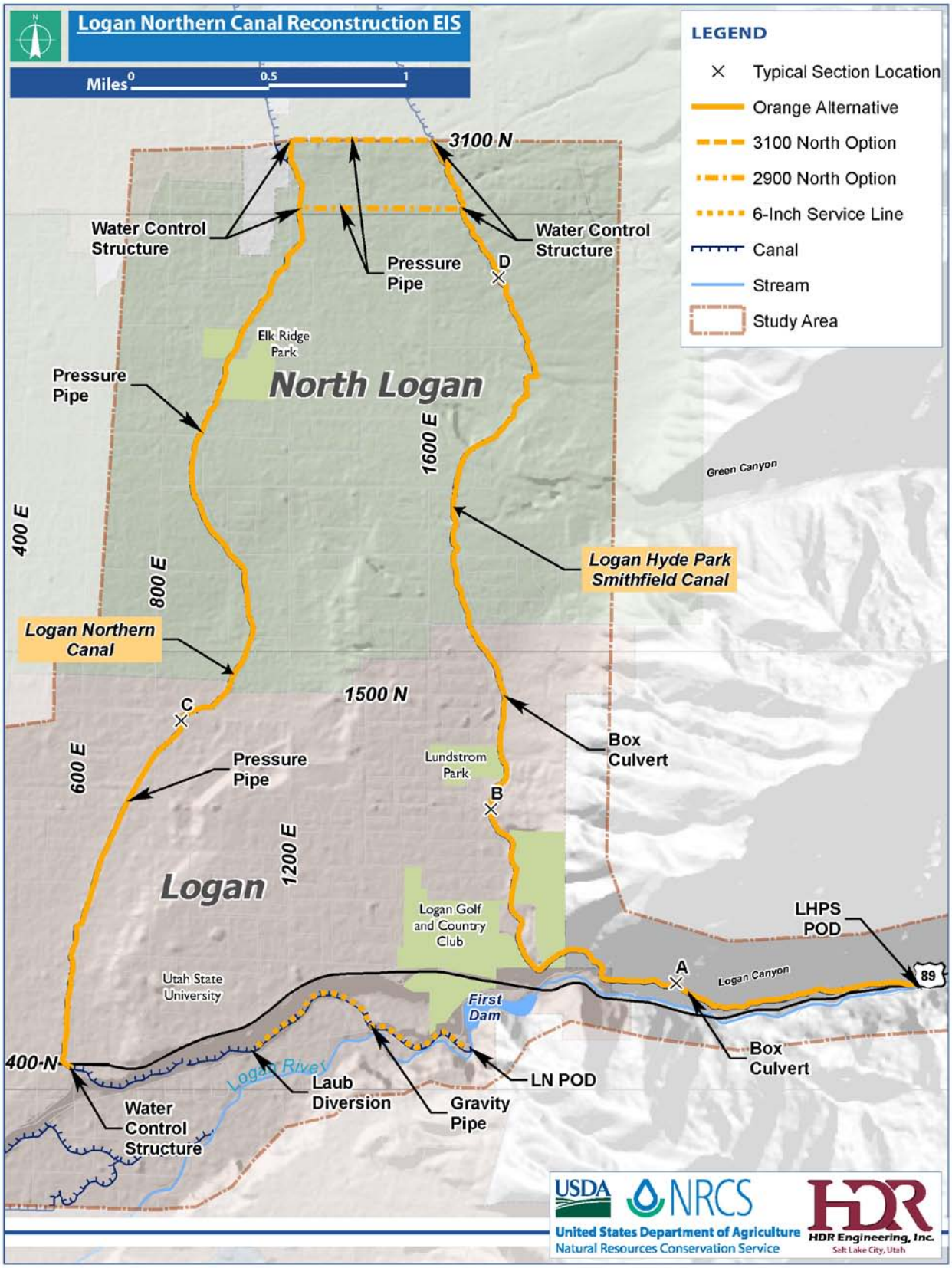
The Orange Alternative would divert LN Canal water at the LHPS Canal POD and use the LHPS Canal between the POD and either 2900 North or 3100 North. The LN Canal water would be diverted under either 2900 North or 3100 North to the LN Canal. The Orange Alternative includes a new pipeline in the LN Canal alignment between 400 North and either 2900 North or 3100 North to deliver water to upstream shareholders. It also includes a short pipeline in the LN Canal between the LN Canal POD and the Laub Diversion to provide water to shareholders in that area.

At either 2900 North or 3100 North, the LN Canal water would be conveyed due west for about 0.5 mile (2900 North) or 0.6 mile (3100 North) in an underground pipe system to the LN Canal. At the LN Canal, some of the water would be discharged into the existing LN Canal and would continue downstream for delivery to shareholders to the north. The remaining LN Canal water would be directed into a pressurized pipeline system constructed in the LN Canal maintenance road for delivery to upstream shareholders. This pressurized pipeline system would measure 3.1 miles from 2900 North to 400 North or 3.4 miles from 3100 North to 400 North.

Like the Purple Alternative, the Orange Alternative includes a 1-mile-long, 6-inch-diameter pipeline from the existing LN Canal POD just below First Dam to the Laub Diversion. The Orange Alternative also includes purchasing structures from 14 properties in the historic landslide zone as described for the Purple Alternative (Figure 3-5 and Table 3-1).

Finally, as described for the Purple Alternative, construction equipment and materials would be staged in existing parking lots and other previously disturbed areas along the LHPS and LN Canals outside of Logan Canyon and sensitive resource areas.

Figure 3-6. Orange Alternative



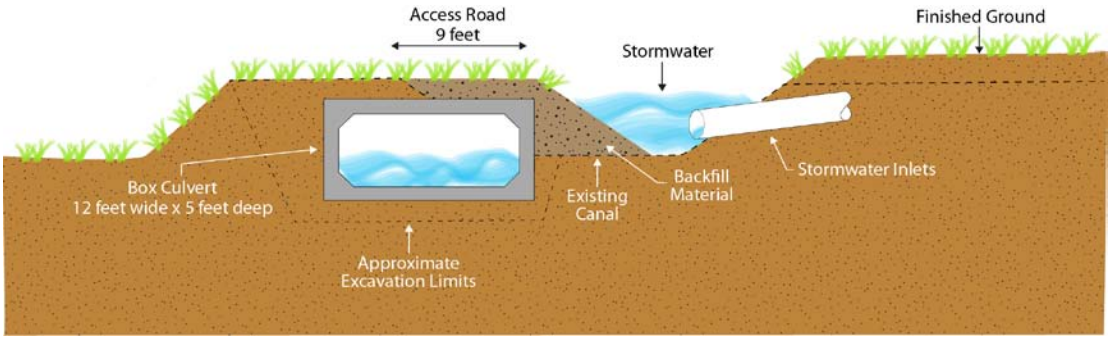


Figure 3-7. Typical Cross-Section D: 12-foot-wide by 5-foot-deep box culvert at about 2700 North in North Logan (looking downstream)

Operation

The Orange Alternative would also require moving the POD of some of the Logan & Northern Irrigation Company's water rights to the LHPS Canal POD, as described for the Purple Alternative. This alternative would also divert a maximum of 130 cfs at the POD.

Also, as described for the Purple Alternative, shareholders between the Laub Diversion and about 400 North/600 East would not receive LN Canal water, and NRCS would purchase structures from 14 properties along the Logan Bluff to reduce the risk to life and property (Figure 3-5 and Table 3-1).

The Orange Alternative would also enclose reaches of the LHPS and LN Canals for the same reasons described for the Purple Alternative. The LN Canal and LHPS Canal would be addressed in a management plan prepared in support of the Water Conveyance Facilities Safety Act as described for the Purple Alternative.

3.2.3.2 Structural Features

The Orange Alternative would require constructing, operating, and maintaining new features in the existing LHPS Canal and LN Canal alignments. The structural features would include the following:

- Modified LHPS Canal POD structure on the Logan River just below Second Dam, as described for the Purple Alternative.
- About 1.6 miles of new 6-foot-wide by 6-foot-deep box culvert, as described for the Purple Alternative. With this alternative, the 12-foot-wide by 5-foot-deep box culvert described for the Purple Alternative would extend for about 3.3 miles from the golf course to 2900 North or about 3.6 miles from the golf course to 3100 North in the LHPS Canal alignment.
- A new stormwater channel for about 3.3 miles to 2900 North or 3.6 miles to 3100 North in the LHPS Canal alignment to convey stormwater.

- Modify Cedar Heights Drive, 1770 East, 1800 East, and Cottonwood Lane where these streets cross the LHPS Canal to accommodate the new box culvert. Also modify several private driveways and pedestrian crossings that cross the LHPS Canal and LN Canal.
- A water-control structure at either 2900 North or 3100 North to transition water from the box culvert to the existing open channel. The new structure would allow stormwater to combine with irrigation water.
- A new headgate structure at either 2900 North or 3100 North to allow LN Canal water to be diverted into a new pressurized pipeline system running west to the LN Canal.
- About 0.5 mile to 0.6 mile of new 36-inch-diameter pressure pipe to convey 30 cfs from the LHPS Canal and the LN Canal along 2900 North or 3100 North, respectively. The new pipeline would require air vents and a flow meter.
- A new water-control structure at the LN Canal to discharge water from the pipe system to the LN Canal system. The structure would include pressure-reducing valves, flow control, and energy-dissipation measures. Water would be divided at the structure into the existing LN Canal flow to serve shareholders to the north (downstream of 2900 North or 3100 North) and into a pressurized pipeline system traveling to the south (upstream of about 2900 North or 3100 North).
- About 2.1 miles of 26-inch-diameter pressure pipe from 2900 North to 1500 North, or 2.5 miles from 3100 North to 1500 North, to convey 15 cfs of irrigation water to upstream shareholders. This pipeline would be installed in the existing canal maintenance road.
- As described for the Purple Alternative, about 1 mile of 10-inch-diameter pressure pipe to deliver water to shareholders between 1500 North and 400 North.
- As described for the Purple Alternative, a new water-control structure to discharge water into the existing LN Canal at 400 North.
- As described for the Purple Alternative, about 1 mile of 6-inch-diameter pipe to deliver water to shareholders between the LN Canal POD and the Laub Diversion.

3.2.3.3 Orange Alternative Costs

Table 3-3 summarizes the cost of the Orange Alternative 3100 North option. Detailed cost information is presented in Appendix C1, Action Alternative Cost Estimates.

Table 3-3. Cost Summary for the Orange Alternative (3100 North Option)

in millions

Item	Cost	Subtotal
Construction materials and installation costs		
Logan Canyon conveyance segment	$7.1	
Valley conveyance segment	$18.2	
Pressurized pipeline systems	$1.9	
Property acquisition and easements[a]	$3.0	**$30.2**
Additional construction items[b]	$6.8	
Engineering and construction management[c]	$2.4	
Total cost estimate		**$39.4**
Total cost range (0% to +10%, rounded)		**$39.5 to $43.4**

[a] Assumes an average cost of $157,000 per property and $10,000 in relocation assistance for each property owner, $10,000 to demolish structures, and purchase of 20 temporary construction easements.

[b] Additional construction items are based on a percentage of material and installation and property costs subtotal and include contractor mobilization (5%), environmental permits and controls (0.5%), minor utility crossings (2%), and a 15% construction contingency.

[c] Engineering and construction management are also based on a percentage of construction costs and include survey and geotechnical evaluations (1.5%), final engineering analysis and design plan production (5%), bid document production and contractor procurement assistance (0.5%), and construction management (1%).

Compared to the 3100 North option, the 2900 North option would require a shorter reach of the box culvert construction in the LHPS Canal (0.3 mile less) and a shorter pressurized pipeline system (also 0.3 mile less). Because the additional construction items and engineering construction-management categories listed in Table 3-3 apply percentages to the construction materials and installation subtotals, the total cost for the 2900 North option would be less, or a total of between $37.0 million and $40.7 million. For conceptual cost estimates of the Orange Alternative options, see Appendix C1.

3.2.3.4 Permit and Compliance Requirements

In addition to EWPP requirements and mitigation measures that might be identified as part of this EIS, constructing the Orange Alternative would require the permits or authorizations listed for the Purple Alternative in Section 3.2.2.4, Permit and Compliance Requirements. The only difference for the Orange Alternative is that construction would also require easements from the City of North Logan and a letter of map revision or map amendment from Cache County and the Federal Emergency Management Agency (FEMA) for effects to the Green Canyon Creek floodplain along the LHPS Canal.

In all cases, the SLO or its contractors would be responsible for obtaining the authorizations ensuring compliance with any conditions of permit approval.

3.2.4 Blue Alternative: Reconstruct LN Canal

3.2.4.1 Location and Operation

Location

Figure 3-8 shows the route of the Blue Alternative. This alternative would divert LN Canal water using the existing LN Canal POD just below First Dam. Once the water is diverted, it would be conveyed for about 1.7 miles along the existing LN Canal alignment in a pipeline. The pipeline would discharge directly into the existing LN Canal for delivering water to downstream shareholders. This alternative would repair the area affected by the 2009 landslide so that the pipeline could be constructed through the landslide area.

What is the route of the Blue Alternative?

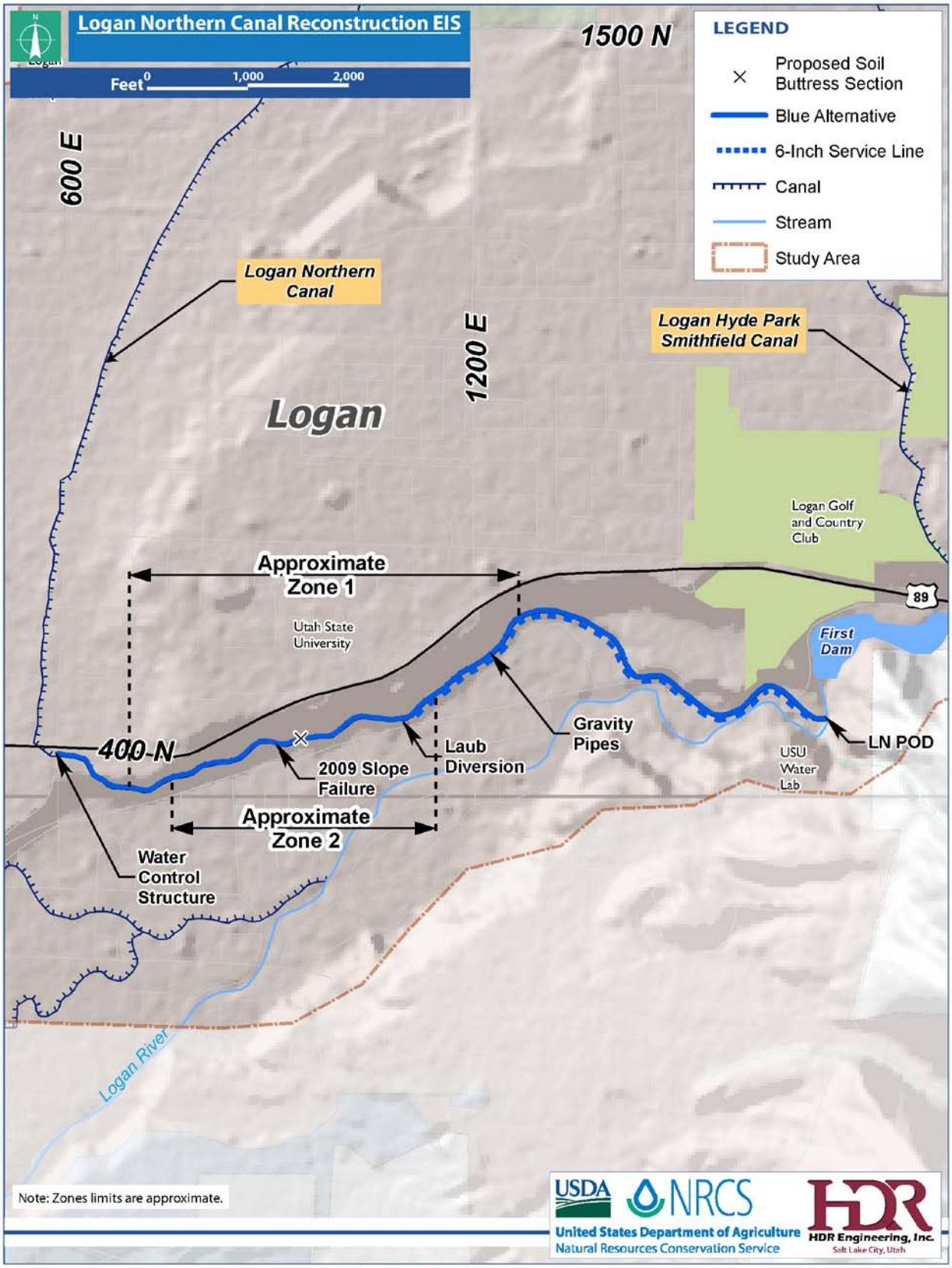
The Blue Alternative would divert LN Canal water at the LN Canal POD and use the existing LN Canal alignment between the POD and about 400 North/600 East. This alternative also includes a short section of pipeline to serve shareholders between the LN Canal POD and the Laub Diversion.

As described for the Purple and Orange Alternatives, shareholders between the existing LN Canal POD and the Laub Diversion (a distance of about 1 mile) would receive water through a new 6-inch-diameter pipeline constructed in the existing LN Canal alignment for delivering water to shareholders in this area.

The Blue Alternative also includes purchasing structures from 14 properties in the 2009 landslide zone as described for the Purple Alternative (Figure 3-5 and Table 3-1). The Blue Alternative differs from the Purple and Orange Alternatives in that the purchase is required not only to remove the future risk to life and property but also to accommodate reconstruction of the LN Canal.

Construction equipment and materials for the Blue Alternative could stage on the acquired properties at the base of the Logan Bluff along Canyon Road outside of sensitive resource areas.

Figure 3-8. Blue Alternative



Operation

The Blue Alternative would not require moving the POD for any of the Logan & Northern Irrigation Company's water rights. The amount of LN Canal water that would be diverted would be the same as the amount diverted before the 2009 landslide. All shareholders would receive water.

The Blue Alternative includes enclosing the reach of the LN Canal between the LN Canal POD and about 400 North. The primary reason for enclosing this reach of the canal would be to ensure that the new structure would operate safely given the geologic history of the Logan Bluff. Enclosing this reach would also have the same types of benefits for water quality and public safety as those described for the Purple Alternative in Section 3.2.2.1, Location and Operation.

Because this alternative would include a flow-monitoring system (which is described in Section 3.2.4.2, Structural Features and Control Measures), the proposed pipeline between the LN Canal POD and 400 North/600 East would be used for conveying irrigation water only. To make it easier for Logan & Northern Irrigation Company to operate the flow-monitoring system, shareholders along this reach would not be able to take water directly from the new pipeline. The new 6-inch-diameter pipeline described in Section 3.2.2.2, Structural Features, for the Purple Alternative would accommodate shareholders between the POD and the Laub Diversion. However, shareholders between the Laub Diversion and 400 North/600 East would not receive LN Canal water. As described for the Purple Alternative, the Logan & Northern Irrigation Company would purchase the shares historically delivered to this reach of the canal, and the City of Logan could provide culinary water.

3.2.4.2 Structural Features and Control Measures

The Blue Alternative would be constructed in the existing LN Canal alignment between the LN Canal POD and 400 North/600 East. This area, known as the Logan Bluff, has a history of slope instability. As stated in Section 1.1.2.1, Emergency Watershed Protection Program, EWPP funds cannot be used to solve watershed or natural problems that existed before the natural disaster. For the Blue Alternative, this means that the funds could not be used to stabilize the hillside beyond what is needed to construct this alternative. Because of this, NRCS and the SLO must assume that future landslides would occur and might damage the new structure, which would be a pipeline. Therefore, this alternative includes management and structural controls to address the risk of future landslides in specific areas of this canal alignment between the POD and 400 North/600 East.

For the purpose of this alternative, NRCS defined two zones along the Logan Bluff to help determine specific management and structural controls. These zones, called Zone 1 and Zone 2, are based on topography, landslide history, geology or soil characteristics, and available documentation. The Blue Alternative focuses on potential management and structural controls in the two zones that would provide engineered structures to ensure that the public would be generally protected against a pipeline failure due to a future landslide.

Zone 2 is the historic landslide area within which structures would be purchased under the Purple and Orange Alternatives.

Zones 1 and 2 are shown in Figure 3-8. Zone 1 spans the area of the Logan Bluff between about 700 East and 1300 East in Logan. Zone 2, which is within Zone 1, spans the area between about 750 East and 1100 East. Zone 2 includes the area that was affected during the 2009 landslide.

If the Blue Alternative is selected, these zones could be modified based on the results of a detailed geotechnical and geological subsurface investigation that would be conducted during the final design phase of the alternative. The subsurface investigation would provide site-specific information (such as soil data, groundwater flow information, and information on the size of the potential sliding mass) to further refine the extents of Zones 1 and 2 and to provide specific criteria for the final design of the structural controls.

The rest of this section describes the general structural features of the Blue Alternative and its management controls and structural control features. The controls identified in this section would establish management activities such as detecting landslide movement, preparing emergency response plans, and purchasing structures and structural elements such as subsurface drainage, drilled shaft foundations, and a soil buttress. These controls would be applied to manage the risk of future landslides that could affect the alternative. These management and structural controls are discussed in detail below.

General Structural Features

The Blue Alternative would require constructing, operating, and maintaining new features in the existing LN Canal alignment. The structural features of the Blue Alternative would include the following:

- Demolish the existing LN Canal conveyance structure between the LN Canal POD and 400 North.
- A modified LN Canal POD structure on the Logan River just below First Dam to accommodate a design flow of up to 80 cfs and a new flow-control gate.
- About 1.7 miles of 60-inch-diameter to 72-inch-diameter steel pipe in the existing LN Canal alignment to convey irrigation water (using gravity flow) from the LN Canal POD to 400 North/600 East.
- About 1.6 miles of a new 4-foot-wide lined drainage channel to convey stormwater and other water (such as water from seeps and springs) from the hillside upslope of the new pipeline. This channel would convey water parallel to the pipeline alignment and would eventually discharge into the existing irrigation canal at 400 North/600 East.
- A top-of-slope runoff-control network consisting of a berm or other system at the top of the bluff to prevent stormwater runoff from traveling down the hillside. This berm

would be about 2 feet high, would be protected from erosion, and would be about 5,000 linear feet long.

- A new water-control structure at about 400 North/600 East to discharge water from the irrigation pipe system and drainage channel to the existing LN Canal. The structure would include flow-control measures and energy-dissipation measures.
- As described for the Purple and Orange Alternatives, about 1 mile of a 6-inch-diameter pipe to deliver water to shareholders between the LN Canal POD and the Laub Diversion.

Management Controls in Zones 1 and 2

As part of the Blue Alternative, the SLO would be responsible for operating or implementing management controls and measures in Zones 1 and 2. The purpose of the management controls would be to monitor the landslide-prone area, monitor pipeline flow, and plan procedures for responding to a future landslide.

As described in the Location section for the Purple Alternative on page 3-3, NRCS recognizes that Zone 2 is unstable and at risk of future landslides. Adding irrigation water delivery to this area as proposed under the Blue Alternative could increase the risk to life and property in this area above that associated with the Purple and Orange Alternatives. As a result of reviewing topographical data, information about historic landslides, and information about how those landslides affected the LN Canal, and taking into account the amount of space required to construct the alternative so that it is safe, NRCS determined that structures located in Zone 2 would need to be acquired to reduce the risk to life and property associated with operating the LN Canal along this area of the Logan Bluff. Purchasing the structures would not completely remove the risk to life and property, but it would reduce the risk associated with future landslides in Zone 2.

Based on the available information, NRCS estimates that structures in Zone 1 but outside Zone 2 are probably outside the area that is most at risk of being inundated with water and debris due to a breach of the canal caused by a landslide. This determination could change based on information gained through a detailed geotechnical and geological study that would need to be conducted during the final design phase of the project, if this alternative is selected. The cost of purchasing structures on 14 privately owned properties that are in Zone 2 is included in the cost of the Blue Alternative described in Section 3.2.4.3, Blue Alternative Costs.

Management controls for both zones would include the following:

- A flow-detection system that would monitor flows along the length of the pipeline. In case of a drop in flow rate, this system could broadcast an alarm or otherwise alert the canal operators and local public safety agencies. The flow-detection system could be coordinated to activate a shutoff gate at the POD.
- A canal management plan as required by the Water Conveyance Facilities Safety Act. This plan would identify the cities and counties that the canal passes through, would identify the canal components (such as PODs, bridges, and stormwater entry points), and would include a maintenance and improvement plan, information about insurance coverage, a slope stability assessment, a stormwater assessment, and an emergency response plan. The emergency response plan would explain how public safety and emergency response agencies would be notified in the event of an emergency, their respective roles in the event of an emergency, how the public would be protected in the event of an emergency, and how the canal would be repaired following an emergency.
- A public outreach and information plan to inform the general public and the adjacent landowners about the presence of the pipeline, instructions on whom to contact and what to do in case of an emergency associated with a future landslide, and how such a landslide might affect the pipeline.
- A visual assessment plan that would identify appropriate intervals for visual inspections of the pipeline and pipeline corridor for evidence of landslides or other problems.
- Benchmarks such as survey monuments installed along the pipeline and along the hillside above and below the pipeline and annual monitoring of these benchmarks to identify land movements. The SLO would be responsible for the recordkeeping associated with annual monitoring.
- Public warning signs along the alignment with emergency phone numbers.

Structural Controls in Zones 1 and 2

The Blue Alternative would also require additional structural controls in Zones 1 and 2. The purpose of these controls is to protect the pipeline against future landslides. These structural controls would include the following:

- About seventy-five 36-inch-diameter drilled shaft foundations placed about every 20 feet. These shaft foundations would be drilled to a depth of about 75 feet to support 1.4 miles of pipe (Zone 1 exclusive of Zone 2). These foundations would protect the pipeline against landslide movement since they would extend through the sliding mass and into stable, undisturbed material. These foundations would include tie-backs, which are steel bars drilled horizontally about 100 feet into the slope. These tie-backs would provide added lateral stability.

- About 90 subsurface sub-horizontal drains placed about every 50 feet. These drains would be drilled horizontally into the uphill slope to collect and control groundwater that is trapped, or perched, on top of an underlying impervious layer. The drains, which would increase the stability of the structural controls in Zones 1 and 2, would extend far enough to reach the point where gravels contact the underlying finer-grained sands and would convey groundwater to the drainage channel described above in the section titled General Structural Features on page 3-22 for the Blue Alternative. An array of five or six horizontal drains would be installed about 50 feet into the bluff in a fan pattern at each of the 90 primary drain locations.
- Assuming that residential structures on the 14 properties would be acquired, a soil buttress below the pipeline would be constructed for about 0.6 mile in Zone 2. This buttress, which would be a large mass of soil, would retain the slope and reduce the potential for slope failure below the pipeline. The buttress would consist of about 130,000 cubic yards of granular fill (gravels) placed about 40 feet from the toe of the existing hillside and sloping upward at a ratio 1.5 to 1 (horizontal to vertical). The proposed buttress is shown in Figure 3-9.

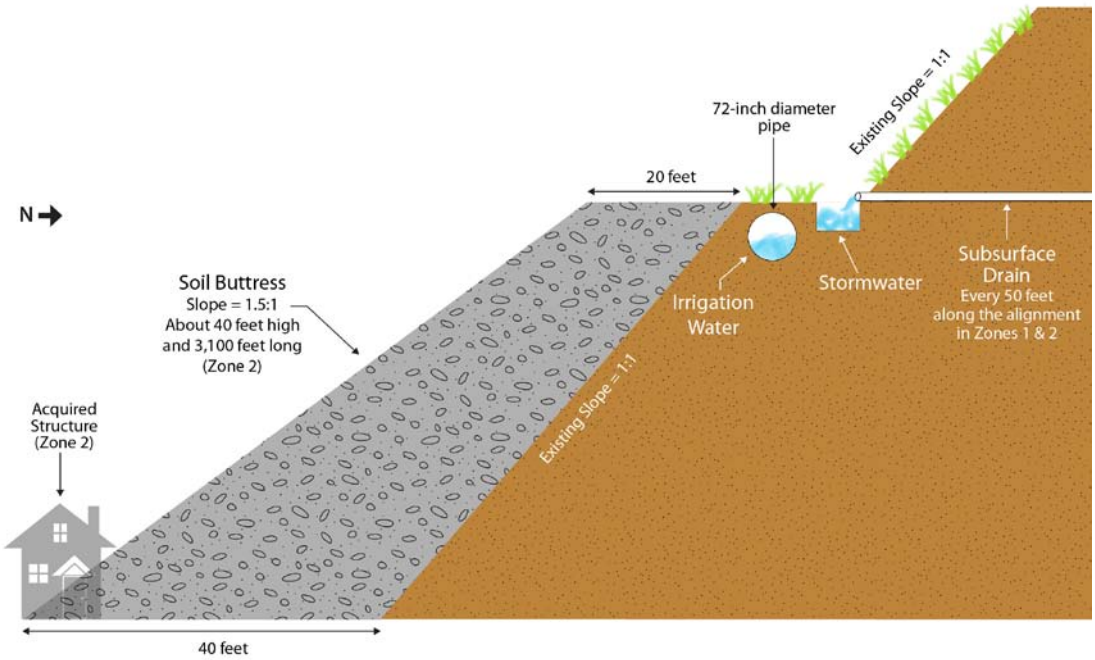


Figure 3-9. Proposed Soil Buttress (looking downstream)

3.2.4.3 Blue Alternative Costs

Table 3-4 summarizes the cost of the Blue Alternative. Detailed cost information is presented in Appendix C1, Action Alternative Cost Estimates.

Table 3-4. Cost Summary for the Blue Alternative
in millions

Item	Cost	Subtotal
Construction materials and installation costs		
Irrigation conveyance system	$7.6	
Slope stabilization systems	$6.6	
Property acquisition and easements[a]	$2.6	**$16.8**
Additional construction items[b]	$5.5	
Engineering and construction management[c]	$1.8	
Total cost estimate		**$24.1**
Total cost range (0% to +10%, rounded)		**$24.1 to $26.5**

[a] Assumes an average cost of $157,000 per property and $10,000 in relocation assistance for each property owner, $10,000 to demolish structures, and purchase of five temporary construction easements.

[b] Additional construction items are based on a percentage of material and installation and property costs subtotal and include contractor mobilization (5%), environmental permits and controls (0.5%), minor utility crossings (2%), and a 25% construction contingency. A higher contingency compared to the other alternatives was assumed because of the uncertainty in the location of specific geologic features.

[c] Engineering and construction management are also based on a percentage of construction costs and include survey and geotechnical evaluations (2.5%), final engineering analysis and design plan production (5%), bid document production and contractor procurement assistance (0.5%), and construction management (1%). This alternative assumes a higher percentage (4%) compared to the other alternatives (1.5%) for the anticipated additional geotechnical evaluation required for the final design of this alternative.

3.2.4.4 Permit and Compliance Requirements

In addition to evaluations conducted and mitigation measures that might be identified as part of this EIS, construction of the Blue Alternative would also require the following permits or authorizations:

- CWA Section 404 authorization for modifying the LN Canal POD and LN Canal. If USACE determines that the activity requires an individual permit, then a separate Section 401 water quality certification would also be required.
- Compliance with the CWA Section 402 NPDES general permit for construction-related stormwater discharges (file a Notice of Intent and compile a SWPPP).
- Antidegradation review by the Utah Division of Water Quality for potential impacts to a Category 3 water (Logan River).
- NHPA Section 106 concurrence and memorandum of agreement with the SHPO for modifying the LN Canal and the LN Canal POD structure.
- Stream alteration permit from the Utah Division of Water Rights for modifying the LN Canal POD.
- Construction easements from UDOT, the City of Logan, USU, and property owners along the LN Canal.
- Letter of map revision or map amendment from Cache County and FEMA for effects to the Logan River floodplain related to modifying the LN Canal POD.

In all cases, the SLO or its contractors would be responsible for obtaining the authorizations ensuring compliance with any conditions of permit approval.

3.3 Alternative Summary

Table 3-5 summarizes the elements of the alternatives carried forward for further study. Items that are common to all of the build alternatives (such as enclosing the canal and affecting the existing use and landscape associated with an open canal, construction-related impacts, and the need for temporary and permanent easements) are not addressed. Instead, the table focuses on how the alternatives are similar or different.

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Table 3-5. Summary of Alternatives Studied in Detail

Alternative	Details of Primary Conveyance Structure	Notable Features	Costs[a]
No-Action	No change to existing conditions. LN Canal is currently used to convey about 2 cfs from LN Canal POD to Laub Diversion.	• Would not address the project purpose and need or solve the problem. • Continued nondelivery of LN Canal water shares would result in long-term adverse effects on activities that depend on the water (such as agriculture, municipal irrigation, and drinking water exchanges), local economic conditions, and the community. • No risk to life and property associated with using the section of the LN Canal between the LN Canal POD and 400 North/600 East for irrigation purposes. • No temporary or permanent easements would be required. • No effect on waters of the U.S. • No impacts to public or private property. • Similar to Purple and Orange Alternatives in that it would not repair the 2009 landslide site on the LN Canal at about 970 East. • No secondary benefits to water conservation, water quality, or stormwater conveyance.	Not applicable
Purple	• Modified LHPS Canal POD and reconstructed flow gage. • 1.6 miles of 6-foot-wide by 6-foot-deep box culvert from LHPS Canal POD to golf course. • 0.8 mile of 12-foot-wide by 5-foot-deep box culvert from golf course to Lundstrom Park. • Structure that transitions LHPS Canal water from box culvert to open canal with headgate to divert 40 cfs into 42-inch-diameter pipe at Lundstrom Park. • 1.2 miles of 42-inch-diameter pipe (under park and city streets); includes air vents and flow meter. • Structure that transitions pipe flow to open canal flow in LN Canal at 1500 North. • 1 mile of 10-inch-diameter pipe from 400 North to 1500 North. • Structure that transitions pipe flow to open canal flow in LN Canal at 400 North. • 1 mile of 6-inch-diameter pipe from LN Canal POD to Laub Diversion.	• Would address the project purpose and need. • Would use the LHPS Canal and LN Canal. • Would require purchasing structures from 14 properties. • Enclosing 2.4 miles of the LHPS Canal would provide secondary benefits related to water conservation, water quality, stormwater conveyance, and public safety in this stretch. There would be additional water conservation and water quality benefits associated with conveying water in about 1 mile of pressure pipe and additional irrigation efficiencies associated with shareholders' ability to change from flood irrigation to sprinkler irrigation. • Similar to the No-Action and Orange Alternatives, would not cause a risk to life and property associated with using the section of the LN Canal along Canyon Road between the LN Canal POD and 400 North/600 East for irrigation purposes. • The 2009 landslide site at about 970 East on the LN Canal would be abandoned and left unrepaired. • The Cities of Logan and North Logan would be able to use the LN Canal alignment to convey stormwater between the LN Canal POD and 1500 North. • Would affect waters of the U.S. at the LHPS Canal POD, along about 2.4 miles of the LHPS Canal, along 1 mile of the LN Canal, and possibly at the LN Canal POD.	Construction: $20.4 million to $22.4 million
Orange (*continued on the next page*)	• Modified LHPS Canal POD and reconstructed flow gage. • 1.6 miles of 6-foot-wide by 6-foot-high box culvert from LHPS Canal POD to golf course. • 3.3 miles of 12-foot-wide by 5-foot-deep box culvert from golf course to 2900 North or 3.6 miles to 3100 North. • Structure that transitions LHPS Canal water from box culvert to open canal with headgate to divert 30 cfs into 36-inch-diameter pipe at 2900 North or 3100 North. • 0.5 mile of 36-inch-diameter pipe under 2900 North or 0.6 mile under 3100 North; includes air vents and flow meter. • Structure that transitions pipe flow to open canal flow in LN Canal at either 2900 North or 3100 North. • 2.1 miles of 26-inch-diameter pipe from 1500 North to 2900 North or 2.4 miles from 1500 North to 3100 North.	• Would address the project's purpose and need. • Would use the LHPS Canal and LN Canal. • Would require purchasing structures from 14 properties. • Offers two options for placing the pipeline from the LHPS Canal to the LN Canal (at either 2900 North or 3100 North). • Would have the greatest secondary benefits of the action alternatives. Enclosing between 4.9 miles and 5.2 miles of the LHPS Canal would provide secondary benefits related to water conservation, water quality, stormwater conveyance, and public safety in this stretch. There would be additional water conservation and water quality benefits associated with conveying water between 3.1 miles and 3.4 miles of pressure pipe and additional irrigation efficiencies associated with shareholders' ability to change from flood irrigation to sprinkler irrigation. • Similar to the No-Action and Purple Alternatives, would not cause a risk to life and property associated with using the section of the LN Canal along Canyon Road between the LN Canal POD and 400 North/600 East for irrigation purposes. • The 2009 landslide site at about 970 East on the LN Canal would be abandoned and left unrepaired. • The Cities of Logan and North Logan would be able to use the LN Canal alignment to convey stormwater between the LN Canal POD and 2900 North or 3100 North.	Construction: $39.5 million to $43.4 million (3100 North option) or $37.0 million to $40.7 million (2900 North option)

Table 3-5. Summary of Alternatives Studied in Detail

Alternative	Details of Primary Conveyance Structure	Notable Features	Costs[a]
	• 1 mile of 10-inch-diameter pipe from 400 North to 1500 North. • Structure that transitions pipe flow to open canal flow in LN Canal at 400 North. • 1 mile of 6-inch-diameter pipe from LN Canal POD to Laub Diversion.	• Would affect waters of the U.S. at the LHPS Canal POD, along about 4.9 to 5.2 miles of the LHPS Canal, along 1 mile of the LN Canal, and possibly at the LN Canal POD.	
Blue	• Modified LN Canal POD. • Demolished existing canal structure from LN Canal POD to 400 North. • 1.7 miles of 60-inch-diameter to 72-inch-diameter gravity steel pipe. • Structure that transitions pipe flow to open canal flow in LN Canal at 400 North. • 1.7 miles of 4-foot-wide concrete drainage channel. • 1 mile of 6-inch-diameter pipe from LN Canal POD to Laub Diversion. • 5,000 linear feet (about 1 mile) of top-of-slope stormwater berm. • 1,500 linear feet (about 0.3 mile) of pipeline supported on pile foundations. • 2,900 linear feet (about 0.6 mile) of pipeline supported by a buttress wall.	• Would address the project purpose and need. • Would convey LN Canal irrigation flow in the historic LN Canal alignment; would not use the LHPS Canal. • Would repair the 2009 landslide site on the LN Canal at about 970 East. • Would require purchasing structures from 14 properties. • Would continue the risk associated with placing irrigation water in a pipe through an area at risk of future landslides. • Would require structural controls to support the pipeline along an active landslide area. • Would require active management of the pipeline and alignment to monitor flow and land movement through management controls. • Would require a detailed geologic and geotechnical investigation to design management and structural controls along the historic alignment. • Would have the least amount of secondary benefits of the action alternatives. Enclosing about 1.7 miles of the LN Canal would provide some secondary benefits related to water conservation, water quality, and public safety in this stretch. This alternative would not provide any stormwater conveyance benefits. • Would affect waters of the U.S. at the LN Canal POD and along about 1.7 miles of the LN Canal.	Construction: $24.1 million to $26.5 million

[a] For more information on alternative cost, see Appendix C1, Action Alternative Cost Estimates.

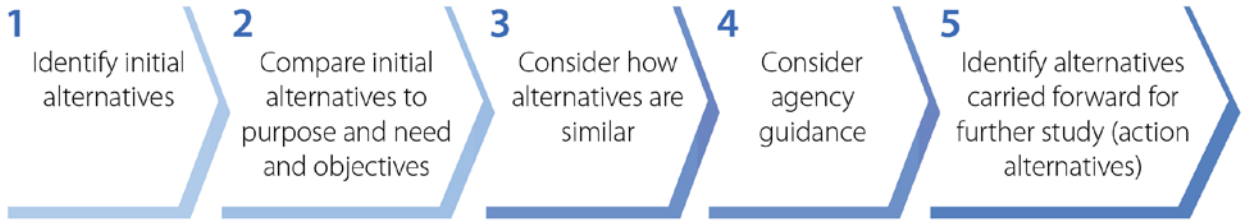
3.4 Alternatives Eliminated from Detailed Study

After the release of the Notice of Intent to complete an EIS, NRCS went through a five-step alternatives screening process and identified the alternatives to be studied in detail in this EIS that are described in Section 3.2, Alternatives Studied in This EIS. This section describes the five-step process and identifies the alternatives that NRCS eliminated from detailed study.

The five-step process consisted of:

1. Identifying the initial alternatives based on existing information and information provided through the scoping process (Section 2.5, Scoping Summary)
2. Evaluating whether the initial alternatives met NRCS's objectives for the proposed action (Section 2.2.2.1, NRCS Objectives)
3. Considering similarities and differences among the initial alternatives
4. Considering agency guidance on identifying project alternatives
5. Eliminating alternatives that would not be studied in detail

Five-step Alternative Screening Process



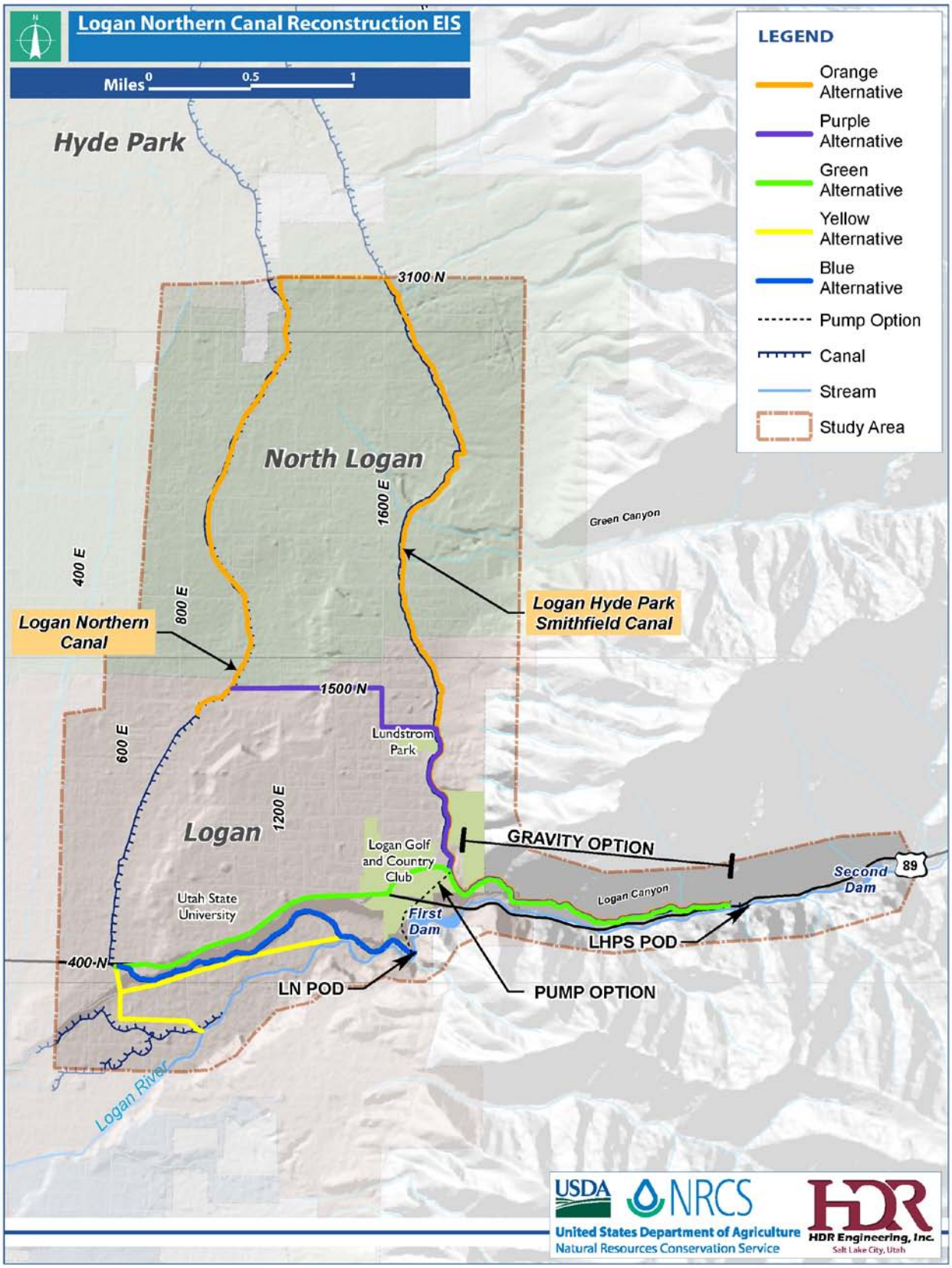
3.4.1.1 Step 1: Initial Alternatives

In Step 1, NRCS identified five initial alternatives. These alternatives, which are shown in Figure 3-10, were as follows:

- Orange Alternative, which is the same as the alternative described in Section 3.2.3, Orange Alternative: LHPS Canal POD to 2900 North or 3100 North.
- Purple Alternative, which is the same as the alternative described in Section 3.2.2, Purple Alternative: LHPS Canal POD to 1500 North.
- Green Alternative: This route would use the LHPS Canal POD below Second Dam and carry LN Canal and LHPS Canal water in a box culvert installed in the LHPS Canal to the golf course. From the golf course, this alternative would carry the LN Canal water west to the existing LN Canal via US 89 in a pipe under the road. LN Canal water would be discharged back into the existing canal at about 400 North/600 East.
- Yellow Alternative: This route would generally follow Canyon Road to 400 North. This option would use a pipeline under the roadway instead of the existing canal and would use the existing LN Canal POD near First Dam. LN Canal water would be discharged back into the existing canal at about 400 North/600 East.
- Blue Alternative, which is the same as the alternative described in Section 3.2.4, Blue Alternative: Reconstruct LN Canal.

NRCS identified the Orange, Purple, Green, and Yellow Alternatives based on consultation with the SLO; the Logan & Northern Irrigation Company; the Logan, Hyde Park and Smithfield Canal Company; and the Cities of Logan and North Logan. NRCS added the Blue Alternative as a result of scoping comments.

Figure 3-10. Initial Alternatives



3.4.1.2 Step 2: NRCS Objectives

In Step 2, NRCS considered how well the five initial action alternatives would meet the NRCS objectives listed in Section 2.2.2.1, NRCS Objectives.

Table 3-6 compares the five initial alternatives and the No-Action Alternative against the objectives to understand the extent to which each option meets the objectives. Items that fully meet the objective are indicated by the letter Y for *yes*. Items that might or might not meet the objective or meet most but not all of the intent of the objective are indicated by the letter M for *maybe*. Items that clearly would not meet the objective are indicated by the letter N for *no*.

Table 3-6. Comparison of Initial Alternatives

Objective	Alternative					
	No-Action	Orange	Purple	Green	Yellow	Blue
More beneficial than adverse in the extent and intensity of its environmental and economic effects	N	Y	Y	M	M	N
In compliance with Federal, State, and local laws	Y	Y	Y	Y	Y	Y
Acceptable to affected individuals and communities	N	M	M	M	M	M
Complete with all necessary components included	N	Y	Y	Y	Y	Y
Efficient in achieving the desired outcome	N	N	M	M	M	M
Emphasizes measures that are the most economical and are to be accomplished using the least-damaging practical construction techniques and equipment that retain as much of the existing characteristics of the landscape and habitat as possible[a]	N	N	M	M	M	N
Could be implemented consistent with USFS standards and guidelines[b]	NA	Y	Y	Y	NA	NA
Avoid and minimize impacts to waters of the U.S.	Y	N	N	N	N	N
Total Y	**2**	**4**	**4**	**3**	**2**	**2**
Total N	**5**	**3**	**1**	**1**	**1**	**3**

NA = not applicable

[a] Assumptions about cost are not based on actual contractor bid costs. Assumptions are based on the expected magnitude of the project elements and the area of land that would be affected by each alternative.

[b] This objective applies only to alternatives that would use National Forest System land.

The following sections explain the conclusions shown in Table 3-6.

More Beneficial than Adverse in the Extent and Intensity of Its Environmental and Economic Effects

In general, the adverse effects of the alternatives are related to how changing the canal system structures would affect the environment and the local economy. The adverse environmental effects would mainly be due to the loss of landscaped and upland vegetation (described in Section 4.4.2.1, Vegetation) and a reduction in groundwater recharge as a result of the change from an open system to a closed system. The general beneficial environmental effects of the alternatives would be related to water quality, water conservation, and safety. The economic effects would be the result of increased irrigation system efficiency and support of the pre-landslide economic activity previously enabled by the LN Canal water.

The No-Action Alternative would not affect the canal system infrastructure. However, because the No-Action Alternative would not address the basic project need, it is more adverse than beneficial.

Detailed information about the environmental and economic effects of the action alternatives is included in Chapter 5, Environmental Consequences. The following discussions focus on the general effects of all of the initial alternatives.

Environmental Effects

All of the initial alternatives would affect the canal system by installing box culverts or pipes in place of an existing open canal feature and changing a POD structure. The Orange Alternative would affect the longest segments of both the LN and LHPS Canals, while the Yellow and Blue Alternatives would affect only a short segment of the LN Canal and would not affect the LHPS Canal.

All of the initial alternatives would require removing riparian vegetation at a POD site on the Logan River. The amount of riparian vegetation removed under any of the alternatives would be the same, would be minor, and would not affect the overall connectivity and nature of vegetation along the river.

The Orange Alternative would disturb the most landscaped and upland vegetation along the LHPS Canal because it would change the open canal to a box culvert for the longest length of the canal. The Orange Alternative would also have the greatest reduction in amount of water lost to seepage and therefore would have the greatest potential to affect groundwater recharge. However, this would also have the most beneficial effect on surface water conservation of the action alternatives.

The Orange Alternative would also provide the most water quality benefits because it would separate stormwater and irrigation water over the longest length of the LHPS and LN Canals. Separating the irrigation and stormwater along long reaches of the LHPS and LN Canals would provide significant stormwater conveyance benefits in Logan and North Logan.

Under the Orange Alternative, the canal capacity and flow velocity would be greater than that in the existing LHPS Canal, so enclosing reaches of the canal would be an important safety

improvement. The Orange Alternative would result in the greatest safety improvement because it would reduce drowning hazards along the greatest length of the LHPS Canal. This alternative would also have the greatest reduction in potential flood hazards related to blockages of an open system. Finally, this alternative would not carry irrigation water over the historically unstable landslide zone along the Logan Bluff. Although the Orange Alternative would have the most extensive environmental impacts, overall its beneficial impacts related to water conservation, water quality, stormwater conveyance, safety, and energy (discussed in the section titled Economic Effects on page 3-37) would outweigh the adverse impacts related to vegetation removal and groundwater recharge.

The Purple Alternative would also require removing some landscaped and upland vegetation along the LHPS Canal, but it would be less than that removed for the Orange Alternative because the affected length of the canal would be shorter. The Purple Alternative would have a smaller effect on groundwater recharge than the Orange Alternative because it would convert shorter reaches of the LHPS and LN Canals, which means that the Purple Alternative would have a smaller beneficial effect on surface water conservation. The Purple Alternative would have moderate water quality and safety benefits as a result of separating stormwater and irrigation water in the LHPS and LN Canals and enclosing the LHPS Canal between the POD and Lundstrom Park. Although these benefits would be less than those for the Orange Alternative, they would be greater than those for the Green, Yellow, and Blue Alternatives.

For the Purple Alternative, separating the irrigation and stormwater along reaches of the LHPS and LN Canals would provide some stormwater conveyance benefit to Logan and a lesser extent to North Logan. The Purple Alternative would have some safety benefit because it would reduce drowning hazards and potential flooding hazards related to blockages of an open system along short reaches of the LHPS and LN Canals. Like the Orange Alternative, this alternative would not carry irrigation water over the historically unstable landslide zone along the Logan Bluff. Although the Purple Alternative would have moderately extensive environmental impacts, its beneficial impacts related to water conservation, water quality, stormwater conveyance, and safety would outweigh its adverse impacts related to vegetation removal and groundwater recharge.

The Green Alternative would remove vegetation at the POD site only. This alternative would enclose a reach of the LHPS Canal in Logan Canyon that experiences a high rate of seepage and so would have some water conservation benefit. However, because this water would not seep from the canal, it would not contribute to groundwater recharge. The Green Alternative would not enclose long reaches of the LN Canal, so it would not substantially affect groundwater recharge or water conservation associated with that canal. This alternative would abandon a short length of the LN Canal between the Laub Diversion and about 400 North, but changes in the way that reach is used would not affect overall groundwater conditions.

The Green Alternative would not have a significant water quality benefit because it would not separate stormwater and irrigation water in the LN Canal or along the valley reaches of the LHPS Canal. The Green Alternative would have minor safety benefits along the Logan Canyon reach of the LHPS Canal and, like the Orange and Purple Alternatives, would not

carry irrigation water over the historically unstable landslide zone along the Logan Bluff. Overall, the expected beneficial effects of the Green Alternative would not significantly outweigh the adverse effects. NRCS would need to complete additional detailed analysis of the Green Alternative to make a definitive conclusion; because of this, the Green Alternative received a *maybe* indicator for this category in Table 3-6.

The Yellow and Blue Alternatives would modify the LN Canal only. Both of these alternatives would affect riparian vegetation at the POD and upland vegetation along the canal between the POD and the point where the canal crosses Canyon Road. From this point, the Yellow Alternative would probably remove very little landscaped or upland vegetation (if any) because the new pipeline would be under Canyon Road. Because the Blue Alternative would require extensive earthwork along the canal, it would remove all of the landscaped and upland vegetation along the canal between about 750 East and 1100 East.

The Yellow and Blue Alternatives would convey water in a closed conduit for about 1.7 miles. This would result in a minor reduction in the amount of water lost to seepage and available for groundwater recharge and minor water conservation benefits. Both alternatives would separate stormwater and irrigation water, resulting in minor water quality benefits. Because the Yellow Alternative would remove irrigation water from a short segment of the LN Canal, this reach of the canal could be used for stormwater conveyance if the slope instability were addressed. This would result in a minor stormwater conveyance benefit. The Blue Alternative would provide a separate stormwater and collected groundwater conveyance channel for this short reach, but the new stormwater channel would not have as much capacity as the LN Canal did historically.

Although the Blue Alternative could be designed to help stabilize the pipeline within the landslide zone, the risk of landslides would not be completely eliminated, and the presence of an irrigation conveyance along the bluff would continue to pose the risk of property damage or loss of life along Canyon Road. The beneficial environmental effects of the Yellow Alternative might outweigh the potential adverse effects. NRCS believes that, because the Blue Alternative would remove a substantial amount of landscaped and upland vegetation to construct a soil buttress and some risks to life and property would remain, the potential adverse effects might outweigh its benefits.

Economic Effects

The Orange Alternative would have the greatest potential for economic benefit because it would allow the most number of LN Canal shareholders to switch from using pumps to using a pressurized system. If a pressurized system is used, pumps could be eliminated, and shareholders would realize a substantial savings in operating costs. The Purple Alternative would also have some benefit associated with converting to a pressurized system but for a fewer number of shareholders. The Green, Yellow, and Blue Alternatives would not provide the opportunity for shareholders to switch from a gravity-based system to a pressurized system.

The value of conserved surface water would be greatest under the Orange Alternative since that alternative would conserve water along the longest length of the LN and LHPS Canals. The Purple and Green Alternatives would also conserve surface water by enclosing the Logan Canyon reach of the LHPS Canal, but the value of the amount conserved would be lower. The Yellow and Blue Alternatives would have only minor surface water conservation benefits.

The estimated costs of the action alternatives are as follows:

- Orange: $39.5 million to $43.4 million (3100 North option) or $37.0 million to $40.7 million (2900 North option)
- Purple: $20.4 million to $22.4 million
- Green: $18.4 million to $20.2 million
- Yellow: $20.8 million to $22.8 million
- Blue: $24.1 million to $26.5 million

These estimates are intended for comparison purposes. The final costs would be subject to refinement based on market prices for materials and potential design refinements that could result in greater or lesser costs. As shown above, the Orange Alternative would be far more expensive than the least-expensive options, which are the Green and Purple Alternatives.

In Compliance with Federal, State, and Local Laws

All of the alternatives (including the No-Action Alternative) could be implemented consistent with applicable Federal, State, and local laws.

Acceptable to Affected Individuals and Communities

During the planning process that occurred before the EIS process, the Logan & Northern Irrigation Company and the Logan, Hyde Park and Smithfield Canal Company expressed the most positive interest in moving the LN Canal water into the LHPS Canal. Because the irrigation companies are responsible for delivering irrigation water, their ultimate support of the selected alternative is important.

A large percentage of these companies' water shares is dedicated to municipal and industrial uses. The Cities of Logan, North Logan, Smithfield, and Hyde Park and USU also supported moving LN Canal water to the LHPS Canal because of expected water conservation benefits that would result from enclosing the LHPS Canal, which would be required to accommodate the combined total of water flowing in the LHPS Canal if the LN Canal water were moved. Combining the systems would also result in opportunities for irrigation efficiencies by converting a reach of the LN Canal into a pressurized pipeline system that could be used for sprinkler irrigation (most shareholders along the LN Canal currently use pumps and flood irrigation). The Cities of Logan and North Logan were also supportive because moving water to the LHPS Canal could allow them to use the remnant LN Canal channel for stormwater

conveyance, depending on how much of the LN Canal water is placed into a pressurized pipeline.

Cities in the study area support the proposed action because restoring irrigation delivery would help maintain several water-exchange agreements. These exchange agreements allow the stakeholder Cities to use other, higher-quality water sources for culinary purposes. For example, the City of Smithfield obtains the majority of its culinary water from springs in Smithfield Canyon. It then discharges canal water into Smithfield Creek to meet downstream water delivery obligations to maintain water in this creek and to meet Bear River flow requirements. Similarly, pursuant to an agreement with the Logan River Water Users Association, during certain times of the year the City of Logan uses Dewitt Springs water in excess of its decreed Logan River water right to meet culinary demands. This additional water is provided by other water users including the Logan, Hyde Park and Smithfield Canal Company. Dewitt Springs is located in Logan Canyon.

Because of the need to maintain exchange agreements and to realize water conservation, irrigation efficiency, and stormwater conveyance benefits, the Logan & Northern Irrigation Company; the Logan, Hyde Park and Smithfield Canal Company; and stakeholder Cities have agreed to share the cost of the required 25% matching funds for the proposed action under the EWPP (NRCS can provide a maximum of 75% of the project funding). The irrigation companies have committed to providing 60% of the match, while the stakeholder Cities have committed to providing 40% of the match. Cache County agreed to be the project sponsor because of the immediate benefits of maintaining the agricultural-based economy of the county and because multiple jurisdictions in the county would receive secondary benefits from the project.

As the SLO, Cache County has identified a number of objectives it would like the project to achieve (Section 2.2.2.2, SLO Objectives). Many of the County's objectives are encompassed in the EWPP requirements, especially those that focus on safety and environmental and community benefits. Other objectives, such as minimizing impacts to public and private property, minimizing unknown costs and delay, minimizing the need for specialized construction techniques, and minimizing long-term operation and maintenance costs, are not normally part of EWPP evaluations, but they are important to the success of this project.

- **Minimize Impacts to Public and Private Property.** Because it covers the largest area, the Orange Alternative would require a significant number of temporary and permanent easements and would require the most public road and private driveway replacements. The Purple Alternative would also require permanent and temporary easements and private and public road crossings, but the numbers of each would be much lower. The Orange, Purple, and Green Alternatives would temporarily affect the flow of traffic on US 89 in Logan Canyon and city streets and would affect the experience of people using the Logan Golf & Country Club during construction. The Yellow and Blue Alternatives would require the fewest number of temporary and permanent easements and would temporarily affect traffic flow on Canyon Road and adjacent city streets during construction. The Yellow Alternative would also require

relocating a sanitary sewer line and other utilities along Canyon Road; during construction this would require relocating residents living in the area. The Yellow Alternative's potential adverse impacts to private property would be the greatest of all of the initial alternatives.

- **Minimize Unknown Costs and Delay.** All of the action alternatives would be subject to permitting and/or authorization under several Federal, State, and local regulations and policies. Any of the permitting processes could delay project construction. Predicting the extent of delay is speculative, but relatively speaking, those alternatives that cover larger areas of land, that include areas subject to more regulatory oversight (such as land managed by USFS or land in a mapped floodplain), or that require more temporary or permanent property easements would be more likely to have significant delays.
- **Minimize Need for Specialized Construction Techniques.** None of the action alternatives would require any extremely specialized construction techniques. However, all of the alternatives would require specialized construction planning, which could affect the bid process. For example, the Orange, Purple, and Green Alternatives would require constructing a box culvert in a narrow, relatively inaccessible section of Logan Canyon. Most of this reach is also on USFS-managed land and would be subject to the conditions of a USFS special-use permit. Because of accessibility limitations and potential permit conditions, the method of box culvert construction could be logistically challenging. For example, the culvert would probably need to be designed and specially formed (cast) off site and in sections to accommodate the curves of the canal alignment. Each piece of culvert would then need to be delivered to the construction area separately along a very narrow corridor. Culvert sections would probably need to be stored out of the canyon because of space limitations. Finally, USFS might limit construction hours and activity types that could interfere with forest access and use. Potential contractors could believe that these logistical challenges would make construction overly complex and introduce budget risk. However, because contractors make bid decisions based on a number of factors, these potential logistical considerations would probably not substantially affect the project or limit the number of contractors that would bid on this large project.
- **Minimize Operation and Maintenance Costs.** The Orange and Purple Alternatives would enclose long reaches of the LHPS and LN Canals, which would prevent dams in the canals caused by debris and eliminate the need for extensive monitoring and maintenance. Operating the enclosed system would minimize maintenance costs for both the Logan & Northern Irrigation Company and the Logan, Hyde Park and Smithfield Canal Company. The Yellow Alternative would convert a short reach of the LN Canal to pressurized piped flow. However, because a shallow grade and a large pipeline diameter cause slow water velocities, sediment would accumulate in the pipeline, potentially increasing maintenance costs to clean out the pipe on a

regular basis. Because the Blue Alternative would require installing special landslide area stabilization measures and because the stabilized area would require regular monitoring, it would probably result in greater operation and maintenance costs over the costs historically associated with the LN Canal.

People who live along the canals would perceive changes associated with the alternatives differently. Because the Orange, Purple, and Blue Alternatives would affect segments that are in more densely developed areas and are viewed by the most people, these alternatives would be more likely to adversely affect the quality of life of people living or recreating along the canal.

The Purple Alternative did not receive strong negative or positive support from the community or the irrigation company. It is probably an acceptable option to all project stakeholders.

The Green Alternative received some opposition from the Logan Golf & Country Club because this alternative would have construction effects at the golf course that could affect operation of the facility and would change the appearance of the canal, a change that the golf course operator has said would have an adverse effect on the business. This alternative would also require extensive work in and around US 89, a major roadway. Although most of the effects to the golf course and highway would be temporary, the public could perceive these effects as significantly adverse.

Comments received during scoping indicated mixed support for the Yellow and Blue Alternatives. Some people stated that they did not want the LN Canal POD moved from its current location because they want continued access along a reconstructed LN Canal. Other commenters stated concerns about adverse impacts to hydropower generation if the POD were moved. However, the Logan & Northern Irrigation Company has stated that it does not support these alternatives because it views the instability of the Logan Bluff as an unacceptable liability risk. The Logan & Northern Irrigation Company has also stated that it could not provide the entire 25% match if other stakeholders (such as the Cities of Logan and North Logan and the Logan, Hyde Park and Smithfield Canal Company) choose not to participate in the project.

The other stakeholders might not support alternatives that do not provide substantial secondary benefits such as those related to stormwater conveyance. If the stakeholders do not contribute to the EWPP matching funds requirement, the irrigation company has stated that it is not financially capable of providing all of the required 25% matching funds (HDR Engineering, Inc. 2011). Because of this, these alternatives received a *maybe* indicator for this category.

The No-Action Alternative is not acceptable to the Logan & Northern Irrigation Company; the Logan, Hyde Park and Smithfield Canal Company; or the community because it would not address the project need.

Complete with All Necessary Components Included

Any of the action alternatives could re-establish irrigation water delivery as proposed. Because the No-Action Alternative would not re-establish irrigation water delivery, the SLO and/or irrigation company might take future action outside of this EIS to address the project need.

Efficient in Achieving the Desired Outcome

An alternative would be efficient in achieving the desired outcome of re-establishing irrigation water delivery if it is economical, could be constructed quickly with minimal community disruption, and could be constructed without the need for extensive permitting. Because the Orange Alternative would cover the largest area, this alternative would require the most construction effort in terms of labor and materials and would not be the most economical or efficient means of re-establishing delivery of irrigation water. The Orange Alternative would probably require the most extensive agency coordination and permitting because it would require a use permit from USFS; would affect the greatest amount of waters of the U.S.; and would cross the FEMA-mapped floodplain of Green Canyon Creek (and therefore potentially be subject to regulation and permitting for effects in floodplains).

This alternative would also affect the greatest extent of historic resources (the canal structures are probably eligible for listing on the National Register of Historic Places) and would require permanent modifications to the greatest number of public roads (which would require encroachment permits from the municipalities). Innovative construction techniques combined with favorable weather might increase efficiency, but the SLO and/or its contractors would still need to ensure compliance with regulatory requirements.

The Purple Alternative would be more efficient than the Orange Alternative because it could be constructed with less effort (the project area would be smaller and materials quantities lower than with the Orange Alternative), would affect a smaller amount of waters of the U.S., would not cross any floodplains, would affect a smaller extent of historic resources, and would permanently affect fewer public road crossings of the canal.

The Green Alternative would be more economical than the Orange Alternative but less efficiently constructed because it would require partial roadway closures and deep excavations to place a large-diameter pipeline under existing box culverts that pedestrians use to cross under US 89 from parking areas south of the road to the USU campus. These deep excavations could also significantly affect utilities that are in the roadway (such as culinary water lines and electrical lines). The Green Alternative would affect a smaller amount of waters of the U.S., would not cross any floodplains, would affect a smaller extent of historic resources, and would not permanently affect any public roads. However, the Green Alternative would have extensive construction-related effects to US 89, which would require additional authorization from UDOT, and would significantly disrupt the community during construction.

The Yellow and Blue Alternatives would affect the smallest areas, with their impacts limited to the LN Canal. Neither of these alternatives would require a use permit from USFS, which would simplify the planning and construction process. Both of these alternatives would affect far smaller areas of waters of the U.S., would affect a smaller extent of historic resources, and would not permanently affect any public roads. Both alternatives would affect the FEMA-mapped floodplain associated with the Logan River, which could add complexity to the project.

Because of likely water and sewer line impacts, constructing the Yellow Alternative could require temporary relocation of residents living along Canyon Road, which would also add to the project's complexity. Construction of the Blue Alternative could be quite expensive depending on the extent of pipeline stabilization needed for safe operation through the historic landslide area. Because the Yellow and Blue Alternatives would concentrate construction activity in a much smaller area and require less-extensive regulatory approvals, they would efficiently achieve the desired outcome to re-establish irrigation water delivery.

The No-Action Alternative would not achieve the desired outcome.

Economical and Can Be Accomplished Using Least-Damaging Construction Techniques That Retain Existing Landscape and Habitat Characteristics

Because all of the action alternatives would include purchasing and removing structures from an area along the Logan Bluff, all of these alternatives would have a substantial effect on the human-influenced landscape in this area. The Blue Alternative would have a greater effect than the other action alternatives on the human-influenced landscape because it would require removing vegetation and constructing extensive earthwork in the historic landslide area.

The Orange Alternative would be the most expensive alternative because it is the most extensive in length and impact area. However, this alternative would have only minor effects to the existing natural landscape and to natural habitats in Logan Canyon. This alternative would affect the greatest area of human-influenced landscapes next to the Logan Golf & Country Club, residential properties, and agricultural land. With special care, techniques used during construction of the Orange Alternative could minimize damage to areas outside the immediate project footprint.

Because of the way the LHPS Canal is situated in the canyon, people traveling through the area after construction would probably not notice the change in the rock-slope landscape. The Purple Alternative would have the same general landscape and habitat effects in Logan Canyon and to land near the golf course but would have less of an effect to landscapes near residential areas. The Purple Alternative would not affect landscapes adjacent to agricultural land. This alternative would achieve the project need using a smaller footprint, which would make the alternative more economical than the Orange Alternative.

Like the Orange and Purple Alternatives, the Green Alternative would alter the natural landscape and natural habitat in Logan Canyon. The Green Alternative would also affect the landscape of the golf course but would have little or no effect to landscapes near residential areas. The Green Alternative would not affect landscapes adjacent to agricultural land. This

alternative would probably be more economical than the Orange Alternative but would probably be about the same cost as the Purple Alternative.

The Yellow and Blue Alternatives would avoid any effects to natural landscapes and habitats in Logan Canyon. Because most of the Yellow Alternative would be under Canyon Road, it would have minimal long-term effects to the landscapes of adjacent residential areas. The Yellow Alternative would likely be one of the more economical solutions because it would have the shortest length of pipe and would cover a smaller area. However, construction would result in utility impacts and might require extensive dewatering during construction because of the relatively shallow groundwater in the area. Temporarily relocating people who live along Canyon Road would also be costly and could inflate the construction cost of the Yellow Alternative. However, because the work area would be much smaller compared to the Orange, Purple, and Green Alternatives, the temporary relocation might not add to the project cost such that the Yellow Alternative would be substantially less economical.

As described above, earthwork in the historic landslide area for the Blue Alternative would result in a dramatic change to the landscape. With special care, techniques used during construction of the Blue Alternative could minimize damage to areas outside the immediate project footprint. The Blue Alternative would probably be more expensive than the Purple, Green, and Yellow Alternatives because of the earthwork required. However, because it covers a smaller area than the Orange Alternative, the Blue Alternative could be less costly than the Orange Alternative.

The No-Action Alternative would not cause new effects to landscapes or habitats. This alternative is not economical because it would cause significant long-term losses in revenue in the study area because farmland would be converted to dry-land farming or taken out of production. If producers choose to continue irrigating, they would need to secure water from another source, such as from the City or a groundwater well, which would be costly and would cause significant adverse economic impacts to agricultural operations.

Could Be Implemented Consistent with USFS Standards and Guidelines

Implementing the Orange, Purple, or Green Alternative would require a use permit from USFS because these alternatives would modify the LHPS Canal POD and canal on land administered by USFS. In all cases, the SLO, the Logan & Northern Irrigation Company, and/or their contractors would need to ensure compliance with the conditions of the use permit. NRCS assumes that any of these alternatives could be designed and constructed in a manner consistent with USFS standards and guidelines and that any of the options could receive a use permit.

The Yellow and Blue Alternatives and the No-Action Alternative would not require a USFS use permit.

Avoid and Minimize Impacts to Waters of the U.S.

All of the action alternatives would directly affect waters of the U.S. These impacts could not be avoided because the canals are considered waters of the U.S. and all of the action alternatives would affect one or more canals. These alternatives would also affect the Logan River by modifying a POD structure. Because it would cover the greatest area, the Orange Alternative would have the greatest impacts to waters of the U.S. The Yellow Alternative would minimize potential effects because it would affect only the POD structure on the river and the LN Canal at the point where water would discharge from a pipe to the canal at 400 North. All of the action alternatives would avoid impacts to special aquatic sites such as wetlands.

The No-Action Alternative would avoid all impacts to waters of the U.S. Because the LN Canal would remain broken at the landslide site, USACE could determine in the future that this canal is no longer subject to its jurisdiction under CWA Section 404 since it no longer connects the Logan River to Summit Creek.

Comparison Summary

After considering the objectives, NRCS believed that all of the initial action alternatives supported enough of the objectives to remain in consideration as project alternatives. Because considering the No-Action Alternative is a NEPA requirement, NRCS did not consider eliminating the No-Action Alternative.

The NRCS objectives are based on regulatory requirements. NRCS determined that, if an alternative had the same or more Y than N designations in Table 3-6, the alternative would be carried forward into the next step of alternative selection. The only action alternative that did not meet this requirement was the Blue Alternative. However, given high level of public interest in this potential option, NRCS chose not to eliminate the Blue Alternative during this step.

3.4.1.3 Step 3: Alternative Similarities and Differences

In Step 3, NRCS gave equal consideration to all alternatives carried forward from Step 2. Step 3 evaluated how the five action alternatives were similar and sought to identify which of the five alternatives would provide a reasonable spatial (geographical) range as well as a reasonable range of ways to meet the project's purpose and need. Specifically, the EIS team considered the spatial arrangement of the alternatives and how these arrangements were similar or different. After considering these arrangements, the team decided on a range of geographic options (that is, specific canal alignments) that would meet the purpose of restoring water delivery to the existing LN Canal shareholders.

Alternatives in the Northern Half of the Study Area

The Orange and Purple Alternatives are in the northern half of the study area. These two alternatives originate at the same place and would use the LHPS Canal alignment. These alternatives differ in the point where the LN Canal water would be taken out of the LHPS Canal and diverted to the LN Canal. The Orange Alternative would carry the LN Canal water in the LHPS Canal to 3100 North and then to the LN Canal. The Purple Alternative would carry the LN Canal water in the LHPS Canal to Lundstrom Park between 1400 North and 1500 North and then to the LN Canal at about 1500 North.

Both the Orange and Purple Alternatives include a way to serve the LN Canal's upstream customers (between about 400 North/600 East and 1500 North or 3100 North) using a pressurized pipeline system. However, the Orange Alternative would affect a much larger area and would provide a pressurized pipeline system for more of the LN Canal's shareholders.

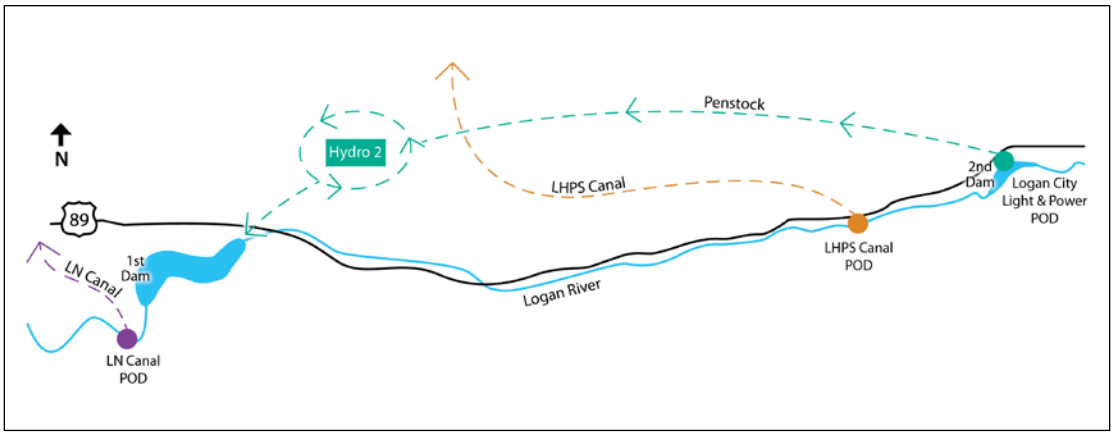
Gravity and Pump Options

As originally proposed, the Orange and Purple Alternatives would be constructed using gravity flow from the LHPS Canal POD just below Second Dam. Based on comments received during scoping, NRCS also considered using pumps at the LN Canal POD just below First Dam to deliver water to the LHPS Canal near the golf course. The following discussion describes the two options.

Gravity Option. The first option would use gravity flow from the existing LHPS Canal POD. This option would require modifying the POD and improving the LHPS Canal to increase its capacity and accommodate larger flow rates. The improvements would include enclosing about 1.6 miles of the open LHPS Canal in a box culvert. The temporary and permanent community impacts along this segment would be minor.

Logan City Light and Power operates hydropower-generation facilities along the Logan River. Historically, the City has diverted water from the river at Second Dam for power generation at its Hydro 2 plant and then returned the water to the river just above the LN Canal POD, near First Dam (Figure 3-11). The water is then available for other users downstream (including the Logan & Northern Irrigation Company). By moving the LN Canal water to the LHPS Canal POD, some of the water historically available for diversion by the City at Second Dam would not be available because it would bypass the Hydro 2 diversion for diversion at the LHPS Canal. Because of this, the water would not be available for power generation.

Figure 3-11. Logan River Diversions



The annual value of hydropower generation impacts is difficult to accurately quantify because water diversions from the Logan River vary based on irrigation needs (which are a function of climatic conditions) and river flows and because the market rate for renewable power fluctuates. Currently, when river flows are adequate, the Logan & Northern Irrigation Company; the Logan, Hyde Park and Smithfield Canal Company; and Logan City Light and Power will be able to divert their maximum allotments of water. Under these conditions, a relocated POD would not affect hydropower generation.

At other times, such as late in the summer when the river flow is reduced, all parties receive less water because water is distributed based on actual river conditions. The power-generation potential of Logan City Light and Power's Hydro 2 plant generally follows the hydrograph of the Logan River. During low river flows, diversions into the power plant are able to generate about 1 to 2 megawatts of power. During spring runoff (May to June), the plant is able to divert at its maximum capacity and generate about 5.5 megawatts of power.

What is a hydrograph?

As used in this document, a *hydrograph* is a chart that shows the change in Logan River flow over time.

Therefore, the potential impacts to hydropower generation would range from 0 to about 1 megawatt if the proposed action were to change the amount of water available for Logan City Light and Power. One megawatt is about the amount of power that 60 cfs can generate in the Hydro 2 plant. The City and the Logan & Northern Irrigation Company are currently negotiating an agreement that would address how the diversions could be operated to avoid or minimize impacts to either party.

Recent studies show that about 20% of the water diverted at the LHPS Canal POD is lost due to seepage through the 1.6-mile section of the canal in the Logan Canyon (Board of Water Resources 2009; Utah Division of Water Resources 2010). The volume of water that could be conserved by reducing the loss due to seepage would average about 8,800 acre-feet annually (Board of Water Resources 2009; Utah Division of Water Resources 2010). The total value of

this conserved water is difficult to predict because no entity has identified a specific use, or mix of uses, associated with this conserved water.

Pump Option. The second option would be to pump water from the Logan River near the LN Canal POD to the LHPS Canal near the golf course at the mouth of Logan Canyon. The effects on Logan City Light and Power described above would be avoided. The pump option might require modifying the LN Canal POD and would require construction of a pump station that could move a maximum of about 70 cfs (about 3,000 maximum horsepower for a 200-foot lift), construction easements, new permanent easements for the pump station and for a new pipeline between the pump station and the LHPS Canal, and installation of about 0.6 mile of pipe. The gravity system could operate under its own power (that is, without external power), but the pump option would require electrical power to operate. Constructing a pump station would introduce a new noise source into a residential environment.

NRCS evaluated a conceptual pump station that included estimated sizes of the pumps and motors that would be needed to move the water to the LHPS Canal. The conceptual design assumed that the pump station would not be enclosed in a structure because of space limitations. Although the plant could be constructed in a way that would reduce noise levels for residents living in the surrounding neighborhood, noise levels would still increase, and mitigation measures were not defined as part of the conceptual design. Given the density of housing in this area, many residents might feel that the introduction of a pumping plant would reduce their quality of life.

Cost Estimates. NRCS completed preliminary cost estimates for each of the options (Appendix C2, Alternatives Development Cost Estimates). The capital cost of the gravity system (constructing the box culvert in the canyon) would be between $9.4 million and $10.3 million. This includes materials, installation labor, equipment, engineering, design, construction oversight, and contingencies. Yearly operation and maintenance is relatively inexpensive for box culverts. Operation and maintenance costs were estimated to be about $30,000 per year, which would total $0.63 million in net present value (discounted at 4.125% per year) over the project's 50-year lifespan. Labor costs for routine maintenance of screens and the box culvert structure would be the largest component of the annual operation and maintenance costs.

In comparison, the capital cost of the pump option would be about $7.8 million to $8.6 million, or about $1.9 million to $2.0 million less than that associated with the gravity system. This capital cost includes construction labor, materials (including the electrical equipment, pumps, controls, and pipeline), and contingencies. However, the annual operation and maintenance cost of pumping ($483,000 per year) is substantially higher than for the gravity option ($30,000 per year). Preliminary calculations estimate that, over 50 years, the present value (total annual costs over 50 years discounted at 4.125% per year) of the operation and maintenance cost of pumping would be about $10.2 million, which is $9.6 million more than for the gravity option. Most of the pump option operation and maintenance costs are the cost of electricity to run the pump motors. The maintenance

calculation includes yearly pump maintenance (labor and some equipment-replacement costs) and pump replacement (mostly equipment cost) after about 20 and 40 years.

Taking into account the present value of the potential lost hydropower of up to a maximum of $4.6 million over 50 years for the gravity option ($218,000 annually), the pump option would cost about $4.96 million more in operation and maintenance costs than the gravity option. This value of $218,000 annually is calculated by assuming that 60 cfs could be diverted away from the turbines over the entire 6-month irrigation season and is the value associated with the potential power lost by preventing water from entering Logan City Light and Power's hydroelectric facility intake at Second Dam and going through the hydroelectric plant.

This potential value of lost hydropower ($4.6 million over 50 years) is higher than what would actually occur, since the actual amount of water that would bypass the Hydro 2 plant would be less than 60 cfs for much of the irrigation season. Operating a pump station is not financially feasible for the Logan & Northern Irrigation Company, especially considering that annual operating costs could not be funded through the EWPP (7 CFR 624.6[b][2][ii]). Table 3-7 compares the operation and maintenance costs of the two options.

Table 3-7. Comparison of Operation and Maintenance Costs of the Gravity and Pump Options

Cost Item	Net Present Value[a]
Pump option operation and maintenance (O&M)[b]	$10,200,000
Gravity option O&M	– $640,000
	$9,560,000
Value of hydropower lost[c]	– $4,600,000
Difference in O&M costs	**$4,960,000**

For cost detail, see Appendix C2, Alternatives Development Cost Estimates.

[a] Calculations assume 50 years of operation and a 4.125% discount rate.

[b] Calculation assumes an average of 60 cfs pumped about 200 vertical feet from the LN Canal POD to the LHPS Canal, a 75% pump hydraulic efficiency, a 92% pump motor efficiency, a 6-month operating period, an energy charge of $0.032/kWh (kilowatt-hour), a power demand charge of $15.51/kW (kilowatt)/month, and 1.5% of capital for annual pump station maintenance. The approximately $8.2-million capital cost includes a 48-inch-diameter pipe to the LHPS Canal.

[c] Calculation assumes an average of 60 cfs diverted from the Logan City Light and Power intake, 218 feet of head available for power generation, an average water-to-wire efficiency of 80%, and energy revenue of $0.032/kWh. The annual cost also includes a power demand revenue of $15.51/kW/month, which was calculated based on a peak diverted flow of 70 cfs. This calculation does not include the hydropower generation over a range of flow rates; it is simply the potential energy that 60 cfs could provide.

Compared to the gravity option, the pump option would increase both energy use and operational cost. The cost of energy for the Orange Alternative pump option exceeds the energy cost savings realized by eliminating shareholder pumping from the existing LN Canal. Adding together the horsepower associated with all individual shareholders' pumps, there would be about 1,000 horsepower in use between 1500 North and 3100 North (HDR Engineering, Inc. 2010). Assuming 1,000 horsepower in use for 8 hours of pumping per day for 6 months, the gravity option could avoid about $49,000 in annual pumping costs.[1] The net present value of this annual cost discounted over 50 years is about $1 million. For detailed calculations, see Appendix C2, Alternatives Development Cost Estimates.

As mentioned for the gravity option, the value of the 8,800 acre-feet of conserved water is difficult to predict. Assuming that the conserved water could be provided strictly for municipal use, an average household consumption of 1 acre-foot per year, and $18 per month ($216 per year) as the current average culinary water rate, the conserved water could be valued at about $1.9 million per year, or a net present value of about $40 million discounted over 50 years.

Alternatives in the Southern Half of the Study Area

The remaining three alternatives (Green, Yellow, and Blue Alternatives) are in the same general area (the south end of the study area). All three would have construction-related impacts in the immediate area, with the Yellow and Blue Alternatives affecting the same general area along Canyon Road and the Green Alternative affecting US 89 and adjacent areas. All three alternatives would discharge back to the LN Canal in about the same location (about 400 North/600 East in Logan). However, the three alternatives are different in terms of the POD that would be used. The Yellow and Blue Alternatives would use the LN Canal POD below First Dam. The Green Alternative could be constructed using either the pump or gravity options described above, meaning it could use either POD.

All of the alternatives would have temporary (construction-related) impacts to the same general area, and all would require temporary construction easements. The Green Alternative (pump option) and Blue Alternative would probably require permanent acquisitions of property for construction, with the Blue Alternative requiring residential acquisitions. The Blue Alternative is the only alternative in the southern part of the study area that would include some restoration of the landslide site. The Green Alternative (gravity option) and the Yellow Alternative would include the purchase of structures in the historic landslide zone along the Logan Bluff, but neither alternative would repair the landslide site.

Because of EWPP limitations, NRCS funding cannot be used to stabilize the entire Logan Bluff hillside to protect residents living in that area from future landslides unless the stabilization measures are required to construct a safe water conveyance as part of the proposed action (EWPP Manual, Title 390, Part 511.4[v]). However, the EWPP allows the

[1] Because the total pumping power consists of several smaller pumps, the assumed power rate for pumping out of the LN Canal (0.0453/kWh) is higher than the rate that was assumed for the pump option and hydropower losses ($0.032/kWh).

purchase of property and structures if removing a building or structure is the least costly alternative, the buy-out is voluntary, and the buy-out does not involve a lessee or tenant (EWPP Manual, Title 390, Part 511.6[B]).

The comments received during public scoping showed moderate support for the Yellow Alternative and very little support for the Green Alternative. The Blue Alternative, which was added as a result of a significant amount of public comments, would involve physical impacts in the same general part of the study area. The Blue Alternative is the only alternative that would address the stability of the landslide site. All three of these alternatives would cause community disruption and would have to be designed by considering the geologic instability in the area. The Green Alternative would probably be the least affected by geologic instability, since it would not be at the toe of the unstable hillside.

3.4.1.4 Step 4: NRCS Guidance on Alternative Selection

In Step 4, NRCS considered the information gathered in support of Step 4 and agency guidance for selecting alternatives. This guidance is presented in the NRCS National Environmental Compliance Handbook (Section 610.B.28, Title 190, Ecological Services).

The guidance specifically states that the EIS does not need to consider every conceivable alternative or speculative alternatives; alternatives that won't work, are not reasonable, or are infeasible, unrealistic, impractical, or not economical; alternatives that would have a similar effect, or greater adverse effect; or alternatives that were not raised to NRCS in the administrative (NEPA) process. The guidance also states that a less extensive search for alternatives is required if impacts are not significant. As stated in Section 5.10, Summary of Mitigation Measures and Adverse Environmental Impacts That Cannot Be Avoided, all expected project impacts are less than significant.

3.4.1.5 Step 5: Alternatives Eliminated from Further Study

Based on information gathered during the first four steps of the process, NRCS eliminated the following alternatives from further study in this EIS:

- Green Alternative
- Yellow Alternative

NRCS also eliminated the pump option for the Orange and Purple Alternatives because of the expected adverse environmental impacts and cost. A pump option for the Green Alternative was eliminated for the same reasons.

The Green Alternative was not carried forward because it would not provide benefits over the Blue Alternative. Both the Green and Blue Alternatives would have temporary, construction-related impacts; would affect the same general geographic area; and would deliver water to the same location at the LN Canal. Additionally, as one of the less costly alternatives, the Green Alternative's costs would be similar to those of the Purple Alternative. The Green Alternative was not strongly supported during scoping (especially compared to the Blue

Alternative). Additional considerations about the Green Alternative that the NRCS took into account when identifying alternatives that would be eliminated from further study include limited secondary benefits (such as stormwater conveyance) and substantial construction-related impacts to US 89, which is a major local highway and the single roadway access to the lower part of Logan Canyon.

As mentioned in Section 3.4.1.2, Step 2: NRCS Objectives, the Logan & Northern Irrigation Company does not support the Yellow or Blue Alternatives because of liability concerns and concerns about its inability to secure funding for the project without the participation of other stakeholders. NRCS decided that the Yellow Alternative would not be carried forward because it would not provide substantial benefits over the Blue Alternative. The Yellow Alternative is in the same general area, would use the same POD, would cost about the same amount, would deliver water to the same location, and received only moderate support during scoping.

The Yellow Alternative would include the same number of structure acquisitions in order to reduce the risks to life and property in the historic landslide zone but would not address the stability of the 2009 landslide site. Some future risk to residents related to the instability of the Logan Bluff would remain under any alternative in this general area. However, The Blue Alternative would provide the benefit of addressing at least some of the risk associated with the historically unstable area along the canal alignment.

Finally, the Yellow Alternative would cause substantial impacts to the local community during construction by requiring residents to be temporarily relocated because of interruptions to utility service. The Blue Alternative might cause some short-term utility interruptions, but they would not require residential relocations or long-term service interruptions that would affect the quality of life of residents near the construction area.

NRCS chose to evaluate the Orange and Purple Alternatives because they are different in location and somewhat different in delivery method. For the Orange Alternative, there are two potential routes (which are in the same general location in the northern part of the study area) for the connecting pipeline that would deliver water from the LHPS Canal to the LN Canal. This EIS considers both of these potential routes (about 3100 North or about 2900 North) as part of the Orange Alternative.

NRCS considered the public comments received in support of the Blue Alternative and decided to analyze this alternative in this EIS. By reconstructing the canal on its historic alignment, the project would stabilize some but not all of the Logan Bluff area. Therefore, the future risk to residents from the instability of the slope along Logan Bluff would remain with or without this alternative.

3.5 Preferred Alternative

NRCS's NEPA manual (Title 190, Subpart B, Section 610.B.28, Alternatives) states that the Draft EIS should identify NRCS's preferred alternative. A *preferred alternative* is the alternative that the lead agency (NRCS) believes would fulfill its statutory mission and responsibilities considering economic, environmental, technical, and other factors (46 *Federal Register* 18026).

Which alternative is the preferred alternative?

NRCS has identified the Purple Alternative as the preferred alternative.

In identifying the preferred alternative, NRCS carefully considered the requirements and intent of the EWPP and the expected beneficial and adverse environmental consequences of each alternative (described in Chapter 5, Environmental Consequences) and has identified the **Purple Alternative** as the preferred alternative. The agency's decision is based on the following considerations:

- The Purple Alternative best fits the EWPP objective to relieve imminent hazards to life and property while still providing for delivery of LN Canal shares in a manner that is economical. Though the Blue Alternative includes measures to minimize some risk associated with the instability of the Logan Bluff, the Purple Alternative also includes removing structures and could be accomplished using construction techniques that are less damaging compared to some of the construction details (such as horizontal drains, drilled pile foundations, and the soil buttress) associated with the Blue Alternative. The Orange Alternative would require the same types of construction techniques as the Purple Alternative, but NRCS believes that the Purple Alternative is more beneficial than adverse in the extent and intensity of its environmental and economic effects than the Orange Alternative.
- As mentioned in Section 3.2.4, Blue Alternative: Reconstruct LN Canal, the Blue Alternative includes measures to stabilize the new pipeline. However, completely protecting the Logan Bluff area from landslide-related hazards is not reasonable given the funding and program limitations of the EWPP. The area along the Blue Alternative alignment would remain susceptible to damage from landslides, and the effects of flooding from a ruptured pipeline cannot be completely eliminated. Because flooding increases the area susceptible to damage, NRCS believes that an alternative that eliminates a large irrigation conveyance system from the area is required.
- The Purple Alternative would conserve about 7,500 acre-feet of water per year by repairing leaks in the Logan Canyon section of the LHPS Canal, a segment that currently loses a substantial percentage of water that is diverted from the Logan River. This amount is less than that conserved by the Orange Alternative because the Orange Alternative would enclose a longer section of open canal and thus further reduce losses associated with evaporation and leakage. However, allowing some

water to continue to percolate into the groundwater can have a beneficial effect on groundwater recharge. NRCS feels that the Purple Alternative best balances the water conservation and groundwater recharge benefits.

- The Purple Alternative would have about 2.6 acres of permanent impact to land along the project corridor and would require fewer permanent and temporary construction easements than the Orange Alternative.
- The Orange and Blue Alternatives could affect FEMA-regulated floodplains. The Purple Alternative is the only alternative that would not cross any FEMA-regulated floodplains.
- The Purple Alternative would have fewer temporary and permanent impacts to public roads than the Orange Alternative and fewer temporary (construction) impacts to utilities than the Orange and Blue Alternatives.
- The Purple Alternative would disturb less vegetation along the LHPS Canal than the Orange Alternative. Also, because the Purple Alternative would allow more of the LHPS Canal to remain open than the Orange Alternative, it would continue to provide wildlife and aesthetic benefits along the LHPS Canal north of Lundstrom Park.
- The Purple Alternative is the least expensive alternative and, considering all adverse impacts and benefits, is the most efficient in achieving the desired outcome of restoring the water delivery capability of the LN Canal.

3.6 Environmentally Preferable Alternative

NEPA Section 1505.2(b) requires that, in cases where an EIS has been prepared, the Record of Decision identify "alternatives which were considered to be environmentally preferable." The environmentally preferable alternative is the alternative that causes the least damage to the biological and physical environment; it also means the alternative that best protects, preserves, and enhances historic, cultural, and natural resources.

Which alternative is the environmentally preferable alternative?

The No-Action Alternative is the environmentally preferable alternative.

As described in Section 5.10, Summary of Mitigation Measures and Adverse Environmental Impacts That Cannot Be Avoided, the action alternatives would cause a number of environmental effects. The action alternatives would cause permanent changes in or would permanently affect the following resources:

- Land use
- Quality of life and scenic beauty
- Recreation
- Farmland
- Riparian and upland vegetation
- Historic resources
- Groundwater

Table 3-8 shows how these impacts compare for the action alternatives. Items in bold are those that would have the least-damaging effect on the specific resource.

Table 3-8. Comparison of Impacts Associated with the Action Alternatives

Impact	Purple Alternative	Orange Alternative	Blue Alternative
Undeveloped land converted to canal easement	2.6 acres	3.6 acres	**0 acres**
Land use: conversion of residential land to development-restricted non-residential use (and residential relocations)	**14 parcels**	**14 parcels**	**14 parcels**
LHPS Canal integration with Logan Golf & Country Club	Changes	Changes	**No change**
Appearance of LHPS Canal	Moderate change	Major change	**No change**
Appearance of LN Canal	**Moderate change**	Major change	Major change
Recreation use of LHPS Canal	Changes	Changes	**No change**
Farmland converted to canal easement	0.3 acre	3.1 acres	**0 acres**
Permanent vegetation loss	Limited riparian vegetation lost at LHPS Canal POD, moderate amount of upland vegetation lost along LHPS and LN Canals	Limited riparian vegetation lost at LHPS Canal POD, most amount of upland vegetation lost along LHPS and LN Canals	**Limited riparian vegetation lost at LN Canal POD, moderate amount of upland vegetation lost along LN Canal**
Loss of open canal for use by wildlife	2.4 miles of LHPS Canal	4.9 to 5.2 miles of LHPS Canal	**0 miles of LHPS Canal, 1.7 miles of LN Canal**
Permanent effects to historic resources	Effects at LHPS Canal POD structure, along 2.4 miles of LHPS Canal, and along about 2 miles of LN Canal	Effects at LHPS Canal POD structure, along 4.9 to 5.2 miles of LHPS Canal, and along about 4.1 to 4.4 miles of LN Canal	**Effects at LN Canal POD structure and along about 1.7 miles of LN Canal**
Water not lost to seepage	7,500 acre-feet per year	**14,700 acre-feet per year (water conservation)**	**1,300 acre-feet per year (groundwater recharge)**

As indicated in Table 3-8, the Blue Alternative is the action alternative that would cause the least damage to the biological and physical environment. Considering only the action alternatives, the Blue Alternative would be the environmentally preferable alternative.

The No-Action Alternative would adversely affect the economy of the study area because of lost agricultural production and could result in regional land-use changes if farmland is converted to other uses. However, compared to the action alternatives, the No-Action Alternative would not cause significant damage to the biological and physical environment, and it would not affect any historic, cultural, or natural resources. Because of this, the No-Action Alternative is the environmentally preferable alternative.

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