Chapter 4: Affected Environment

4.1 Introduction

This chapter describes the existing environment in the study area. This description is not meant to be comprehensive but rather focuses on those resources that could be affected by the project alternatives, that need to be reviewed because of NRCS policy, or that were identified as subjects of concern during the scoping process. The resources discussed in this chapter are the following:

- Land-use plans, policies, and controls (begins on page 4-1)
- Social and economic conditions
  - Community resources (begins on page 4-7)
  - Environmental justice (begins on page 4-10; also discussed in Appendix C4, Demographics and Environmental Justice)
  - Economics (begins on page 4-12)
  - Recreation (begins on page 4-14)
  - Scenic beauty and landscape resources (begins on page 4-18)
  - Energy (begins on page 4-25)
- Natural resources
  - Agriculture (begins on page 4-26)
  - Biological resources (begins on page 4-30)
  - Special-status species (begins on page 4-37; also discussed in Appendix C5, Special-Status Species)
  - Cultural and tribal resources (begins on page 4-40)
  - Topography, soils, and geology (begins on page 4-41)
  - Water resources (begins on page 4-57)

Geographic Scope of This EIS. The study area is shown in Figure 2-1, Project Study Area. The following discussions focus on resources in the study area unless the discussion states otherwise. Some discussions address resources outside the study area; this is done when detailed information specific to the study area is not available or when determining the effects of the project would require analyzing a larger area.

4.2 Land-Use Plans, Policies, and Controls

The study area encompasses part of three cities (Logan, North Logan, and Hyde Park), a small amount of unincorporated land in Cache County, and National Forest System land administered by USFS. This section reviews the land-use plans and regulations for these jurisdictions and describes current and future land use in the study area.

4.2.1 Land Use and Zoning

In compliance with Title 10, Chapter 9a, of the Utah State Code, the Cities of Logan, North Logan, and Hyde Park have established land-use planning and regulatory control over properties within each city's limits through general planning and adoption of zoning regulations. This section describes the general land-use characteristics of the study area based on the zoning of each jurisdiction.

Most of the study area is in the cities of Logan and North Logan. Logan makes up 45% of the study area, while North Logan makes up 41%. Unincorporated land (primarily in the Logan Canyon area) and Hyde Park make up the remaining 14% of the study area (City of Logan 2008; City of Hyde Park 2009; City of North Logan 2010a).

Zoning is the process of establishing regulations and standards for development to ensure that the policies, goals, and objectives of a jurisdiction's general plan are carried out. Each City's zoning map reflects both the existing land-use pattern of the community and the expected, or future, land uses. Figure 4-1 shows the generalized zoning of the study area. In general, about 65% of the study area is zoned for residential uses, primarily single-family residential land use; about 3% for commercial and industrial land uses; about 12% for public institutions including parks, schools, churches, and USU properties; and about 2% for agricultural land use. National Forest System land in Logan Canyon, which makes up about 13% of the land in the study area, is not assigned any zoning designations.

4.2.1.1 Logan

Most (about 61%) of the land in the study area in Logan is developed as or zoned for residential uses. USU (the main campus and other off-campus properties) comprises about 21% of the land in the Logan portion of the study area. Most of the remaining study area land in Logan is designated for public and recreation uses.

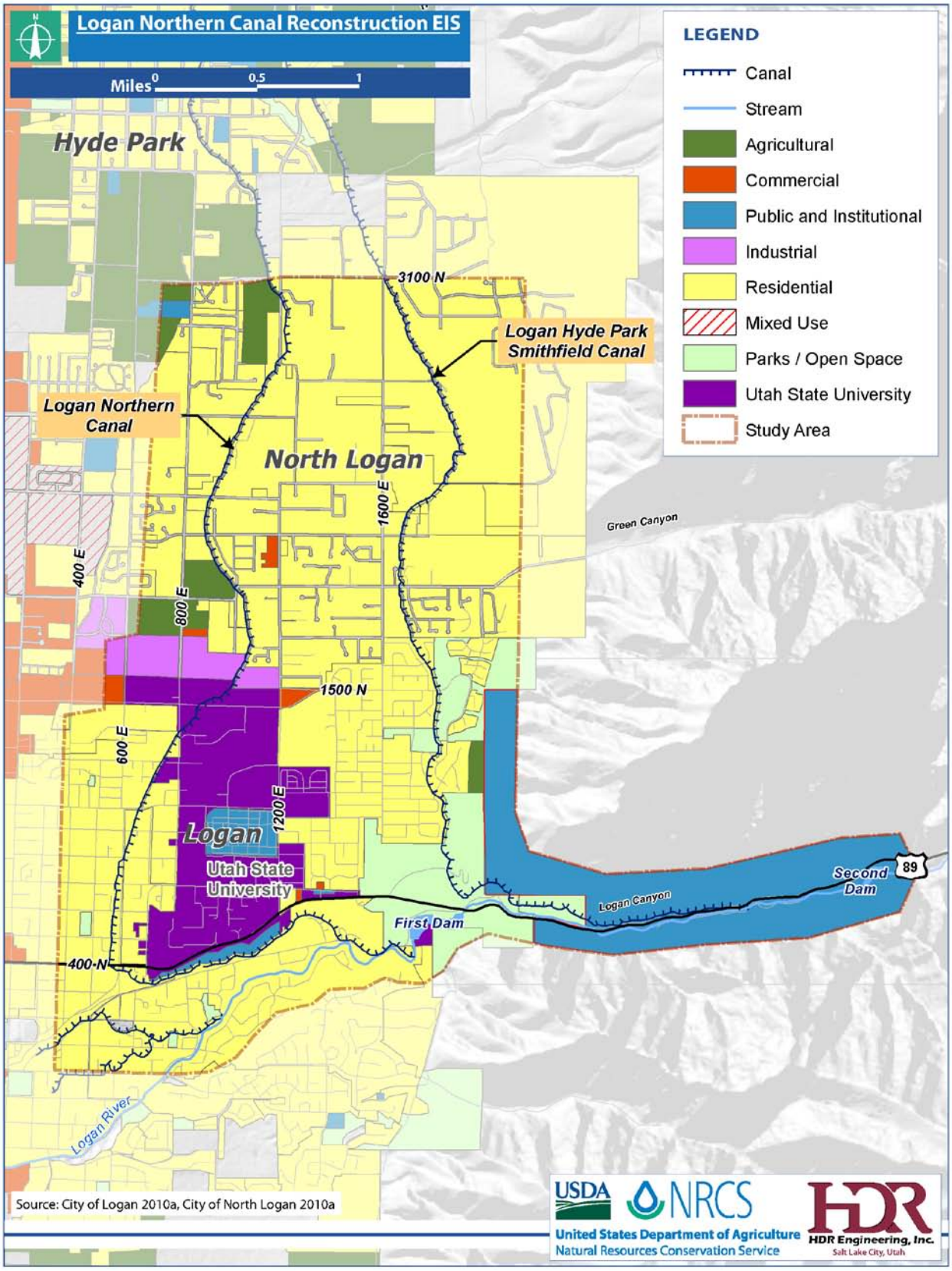
The 2007 Logan general plan provides a framework for future growth and development decisions, including guiding any changes to the zoning map and zoning ordinances. The plan evaluates community desires, changes in population, and trends in land-use development and projects the needs of the city.

What is build-out?

Build-out means that there is no more land available for development because any undeveloped land is already being used for its intended use of open space, agriculture, or other defined uses.

The Logan general plan describes the rate of population growth and land consumption that has been occurring in the city. Between 1952 and 1993, the city's population increased by almost 100% and land development increased by over 200%, resulting in near build-out within the city limits. The population projections cited in the general plan indicate that the city could have a population of over 115,000 by 2050. To address the implications of this population increase, the City is implementing policies to promote compact growth, infill, and redevelopment (City of Logan 2007).

Figure 4-1. Generalized Zoning of and Land Use in the Study Area



4.2.1.2 North Logan

Land uses in North Logan consist predominantly of residential uses. In the study area, the city's land uses include 92% residential, 5% commercial and industrial, and 3% agricultural-zoned land. Overall, about one-third (33%), or 1,400 acres, of the city is undeveloped. This undeveloped area includes land in the foothills along the eastern edge of the city and the study area that would be difficult to develop (City of North Logan 2002).

4.2.1.3 Hyde Park and Cache County

The study area includes a very small part of Hyde Park, which is northwest of North Logan. This area is zoned for agricultural, low-density residential, and public (park) uses (City of Hyde Park 2009).

The part of Logan Canyon in the study area is in an unincorporated area of Cache County but is managed by USFS as part of the Uinta-Wasatch-Cache National Forest. Cache County also administers a small area in the northern part of the study area between about 1000 East and 1200 East and north of about 2600 North. This unincorporated area is used for agriculture and very low-density residential development.

4.2.1.4 Summary of Land Use and Zoning along the LN Canal

Land use and zoning along the LN Canal are primarily single-family residential. The LN Canal touches 234 individual parcels of land by either intersecting them (four parcels) or running adjacent to them (230 parcels). Table 4-1 lists the acreages of different zoning districts within about 50 feet of the LN Canal. Zoning along the canal is generally consistent with the actual land uses. The predominant land use along and near the canal is residential.

Table 4-1. Zoning near the LN Canal

Zoning	Acres	Percent of Total
Agriculture	25	4%
Residential	314	50%
Commercial and manufacturing	43	7%
Recreation	55	9%
Utah State University	171	27%
Public	16	3%

Sources: City of Logan 2010a; City of North Logan 2010a

The general plan of each City also designates land for future uses by identifying districts for particular types of development within the community. The future land-use plans for Logan and North Logan show a mix of land uses along the LN Canal that is planned to continue in the future. These primarily include residential uses in Logan and commercial, mixed-use,

agricultural, and residential land uses in North Logan (City of North Logan 2002; City of Logan 2007).

4.2.1.5 Summary of Land Use and Zoning along the LHPS Canal

Land use and zoning along the LHPS Canal are primarily single-family residential. The LHPS Canal touches 139 individual parcels of land by either intersecting them (131 parcels) or running adjacent to them (eight parcels). Table 4-2 lists the acreages of different zoning districts within about 50 feet of the canal. Zoning along the canal is generally consistent with the actual land uses. The predominant land use along and near the canal is residential.

Table 4-2. Zoning near the LHPS Canal

Zoning	Acres	Percent of Total
Agriculture	0.05	0.01
Residential	356	66
Recreation	148	28
Public	33	6

Sources: City of Logan 2010a; City of North Logan 2010a

4.2.2 General Plan Guidance

4.2.2.1 City of Logan

The City of Logan's general plan (City of Logan 2007) contains management direction that could apply to land along the LN Canal, LHPS Canal, and Logan River in the study area. The plan's Resource Sustainability chapter includes the following statement:

> Logan's natural areas are important to the city and its citizens. From vital ecological functions to aesthetic backdrops, natural areas provide many benefits to the city. Logan's rivers, streams, and canals serve a variety of functions:
>
> - Providing local recreational opportunities,
> - Enhancing the beauty of the city,
> - Providing habitat that supports fish and wildlife,
> - Encouraging tourism.
>
> Containing natural wildlife migration corridors, Logan's waterways provide ecological connectivity. Furthermore, Logan River's mature tree groves provide a major visual backdrop as they meander through the city. All waterways provide visual interest and relief from development. (Section 6.2, Natural Areas)

The general plan also states that "the rivers, canals, and their riparian vegetation that wind through the city and the valley floor" are positive community "billboards" and describes the rivers, canals, and views of nature that surround the community as an element that contributes to Logan's distinctive character (from Section 8.1, Community-Wide Design).

4.2.2.2 City of North Logan

The City of North Logan's general plan (City of North Logan 2002) contains management direction that applies to land along the LHPS Canal. Specifically, Item 1.5.B.23 states that an "upper canal (LHPS Canal) pathway could be maintained along the existing right-of-way. Initially, it would not have to be paved, but eventually it should be improved to provide year-round public access along the entire canal from north to south. However, research into how this can be accomplished needs to be conducted since the existing right-of-way is presently for canal maintenance only."

The general plan also contains a number of elements that address using the canals for conveying stormwater.

4.2.2.3 Cache County

Cache County is the sponsor of the proposed action. The County's primary focus is to re-establish delivery of irrigation water so that the historic and proposed land uses of areas under its jurisdiction and in the study area can continue.

4.2.2.4 Forest Service

The LHPS Canal operates under a special-use permit on National Forest System land, which is administered by USFS, in Logan Canyon. Constructing new facilities or modifying existing facilities on land administered by USFS would require an updated special-use permit. USFS has indicated that activity on National Forest System land would also require a separate special-use permit for construction.

The *Revised Forest Plan for the Wasatch-Cache National Forest* (USFS 2003) provides direction that applies to special uses. Specifically, Forestwide Goal 12, Non-Recreation Authorizations (Special Uses), states:

> Manage the non-recreation authorizations program to balance priorities commensurate with the greater long-term public interest. Current restrictions in funding and personnel preclude additional authorization without reallocating program emphasis.

Subgoals further state:

> 12a. Continue to allow for most currently authorized uses while encouraging opportunities to phase out or move to private lands uses with limited public benefits.
>
> 12b. Minimize the addition of special-use encumbered areas of National Forest.

Finally, uses permitted on National Forest System land should adhere to the following guideline:

> Guideline 81. Before issuing recreation or non-recreation special-use authorizations, ensure that each proposal clearly demonstrates why use of National Forest System lands is necessary and why lands under other ownership cannot be used. Deny proposals for use when the request is based solely on affording the proponent a lower cost of less restrictive location than can be obtained on non-Federal lands, or when reasonable options exist on non–National Forest System lands. Use the process identified in FSH [Forest Service Handbook] 2709.11 [Special Uses Administration] to determine whether special-use proposals will be accepted for detailed review under NEPA. Provide only for authorizations that meet the tests of prudent, reasonable, and absolutely in the public interest.

4.3 Social and Economic Conditions

This section describes the community resources, environmental justice populations, economic conditions, recreation facilities and opportunities, scenic beauty and landscape resources, and energy resources in the study area. Appendix C4, Demographics and Environmental Justice, provides detailed demographic information about the study area.

4.3.1 Community Resources

Community resources include public services such as emergency response and law enforcement services and facilities, schools and universities, and other public amenities such as libraries, government buildings, museums, and churches. This section also includes a general discussion of the road system in the study area. Parks and trails are discussed in Section 4.3.4, Recreation.

4.3.1.1 Emergency and Law Enforcement Services

Table 4-3 lists the emergency and law enforcement service providers in the study area. All of the providers listed serve the study area, but only the North Logan Fire Department and North Park Police Department have facilities in the study area.

The Logan Regional Hospital, located at 1400 North and 400 East, is within the study area.

Table 4-3. Emergency and Law Enforcement Service Providers in the Study Area

Jurisdiction	Type of Service	Provider	Location in the Study Area
City of Logan	Fire	Logan Fire Department	No facilities in study area
	Law enforcement	Logan City Police	No facilities in study area
	Emergency medical	Cache County Emergency Medical Service (EMS), Logan City Fire Department	No facilities in study area
City of North Logan	Fire	North Logan Fire Department	2005 North 1200 East
	Law enforcement	North Park Police Department	2005 North 1200 East
	Emergency medical	Cache County EMS, North Logan Fire Department	2005 North 1200 East (North Logan Fire)
Unincorporated area of Cache County	Fire	Cache County Fire District	No facilities in study area
	Law enforcement	Cache County Sheriff's Office	No facilities in study area
	Emergency medical	Cache County EMS, Logan City Fire Department, North Logan Fire Department	2005 North 1200 East (North Logan Fire)

Sources: Cache County EMS 2010; City of Logan 2010b

4.3.1.2 Schools and Universities

Table 4-4 lists the public schools in the study area. The Logan City School District administers public schools in Logan, while the Cache County School District administers schools in the rest of the study area.

Table 4-4. Public Schools in the Study Area

School	Location
Adams Elementary	415 East 500 North, Logan
Hillcrest Elementary	960 North 1400 East, Logan
Riverside Elementary	1075 Sumac Drive, Logan
North Park Elementary	2800 North 800 East, North Logan
Utah State University	Multiple addresses in Logan

Sources: Cache County School District 2010; Logan School District 2010

Some students who live in the study area might also attend schools outside the study area. For example, Logan High School serves most of Logan but is outside the study area.

In addition to the public schools listed in Table 4-4, there are numerous private schools in the study area. Most of these are preschools.

4.3.1.3 Other Public Amenities

The only libraries in the study area are those located on the USU campus. The Cache County and North Logan libraries are located outside the study area (Cache County 2010b; City of Logan 2010c).

Logan has several post offices. However, only one is located within the study area, and it is on the USU campus. North Logan has one post office, which is located outside the study area (USPS 2010).

USU facilities in the study area that are used by the general public include the Intermountain Herbarium, Nora Eccles Harrison Museum, Art Museum, and Anthropology Museum. North Logan does not have any museums. In addition, Logan has a cemetery located on the USU campus (USU 2010).

There are several churches within and near the study area. The Church of Jesus Christ of Latter-day Saints has several meeting houses throughout the study area in Logan and North Logan. Holy Trinity Lutheran Church is located in the southwestern part of the study area just south of the intersection of 600 North and 700 East (Google 2010).

4.3.1.4 Local Road System

The study area includes one State highway (US 89). U.S. Highway 91 (US 91), which runs north-south, is a major corridor west of the study area. Most roads in the study area are locally maintained arterials and collectors that connect to US 89 or US 91. Major north-south roads include 800 East, 1200 East, and 1600 East. East-west roads connect the downtown area of Logan to the USU campus and provide connectivity to US 91 from residential areas on the east side of the valley throughout the study area.

Several local collector streets and private driveways cross the LN and LHPS Canals in the study area. Crossings range from large box culverts to bridges. In addition to providing ways over the canals, these crossings also facilitate ways for the irrigation companies to easily access the canal maintenance roads.

4.3.2 Environmental Justice

Executive Order 12898, Federal Actions To Address Environmental Justice in Minority and Low-Income Populations, mandates that all Federal actions are reviewed for possible effects on environmental justice populations. *Environmental justice* means that, to the greatest extent practicable and permitted by law, all populations are provided the opportunity to comment before decisions are rendered on, are allowed to share in the benefits of, are not excluded from, and are not affected in a disproportionately high and adverse manner by government programs and activities affecting human health or the environment (USDA Departmental Regulation [DR] 5600-2, item 4[a]). Environmental justice populations include minorities and low-income populations.

What is environmental justice?

Environmental justice means that all populations are provided the opportunity to comment before decisions are rendered on, are allowed to share in the benefits of, are not excluded from, and are not affected in a disproportionately high and adverse manner by government programs and activities affecting human health or the environment.

According to DR 5600-2, Environmental Justice, a *minority* is a person who is a member of one or more of the following population groups: American Indian or Alaskan Native; Asian or Pacific Islander; Black, not of Hispanic origin; or Hispanic. DR 5600-2 defines a *minority population* as any readily identifiable group of minority persons who live in geographic proximity to a project area, and, if circumstances warrant, migrant farm workers and other geographically dispersed/transient persons who could be similarly affected by USDA programs or activities.

DR 5600-2 identifies a *low-income population* as any readily identifiable group of low-income persons who live in geographic proximity to a project area, and, if circumstances warrant, migrant farm workers and other geographically dispersed/transient persons who would be similarly affected by USDA programs or activities. Low-income populations can be identified using data collected, maintained, and analyzed by an agency or from analytical tools such as the annual statistical poverty thresholds from the U.S. Census Bureau's Current Population Reports, Series P-60 on Income and Poverty.

DR 5600-2 does not identify how an environmental justice population should be defined. CEQ's guidance on environmental justice calls for project proponents to identify minority populations where either (1) the minority or low-income population of the affected area exceeds 50% or (2) the minority or low-income population percentage of the affected area is meaningfully greater than the minority population percentage in the general population or other appropriate unit of geographic analysis (CEQ 1997). This EIS uses the second option (the minority or low-income population percentage of the study area is meaningfully greater than the minority or low-income population percentages of Cache County). Since CEQ's guidelines do not define *meaningfully greater*, this EIS considers percentages of at least 10 percentage points higher than the county percentages to be meaningfully greater.

4.3.2.1 Minority Populations

A *minority population* is any readily identifiable group of minority persons who live in geographic proximity to a project area. The minority population of the study area is about 9.8%, which is lower than the minority population of Cache County (10.3%). The population in the study area is predominantly white and not Hispanic. Specific information about minority populations in the study area is included in Appendix C4, Demographics and Environmental Justice.

What is a minority population?

A *minority population* is any readily identifiable group of minority persons who live in geographic proximity to a project area.

NRCS reviewed available information about minorities in the study area to identify potential minority populations. According to this information, areas in the southwestern corner of the study area and the western part of the study area between about 400 East and 1200 East north of about 1500 North and south of about 1800 North have meaningfully greater percentages of minorities than the rest of the study area. These areas are not contiguous, so collectively they do not appear to form a defined minority community.

4.3.2.2 Low-Income Populations

A *low-income household* is one that has a median household income at or below the poverty guideline set by the U.S. Department of Health and Human Services (HHS). A *low-income population* is any readily identifiable group of low-income persons who live in geographic proximity to a project area. Specific information about minority populations in the study area is included in Appendix C4, Demographics and Environmental Justice.

What are census tracts, blocks, and block groups?

Census data are reported for larger geographic areas called *census tracts* and smaller areas within the census tracts called *blocks*. A *block group* is a cluster of census blocks having the same first digit of their four-digit identifying numbers within a census tract.

NRCS reviewed HHS and U.S. Census information about low-income populations. In summary, all Census block groups had a median household income above the HHS 1999 poverty guideline for a three-person household. However, the overall study area has a higher percentage of people living in poverty than does Cache County as a whole. Areas with a proportion of people living in poverty that is at least 10 percentage points higher than the county average are concentrated west of 1200 East and south of 1400 North in Logan. The block groups in this area include areas outside the study area and student housing associated with USU.

4.3.3 Economics

This section describes the economic conditions in Cache County and the study area. The data presented are primarily at the county level, but city-level data are provided where available.

4.3.3.1 Employment

Cache County's economy is diverse but has traditionally been an agriculture-based economy. Because Logan is the largest city, most of the largest employers in Cache County are in Logan. Table 4-5 summarizes the changes in average employment and the number of businesses in Cache County between 2004 and 2009.

Table 4-5. Employment and Businesses in Cache County in 2004 and 2009

Employment Characteristic	2004	2009	Percent Change
Employees	46,886	49,032	4.6%
Businesses	3,033	3,220	6.2%

Source: Utah Department of Workforce Services 2010

The services sector is the largest employer in Cache County and accounts for about 31% of the county's workforce, while the government sector accounts for 24% of the workforce. The large size of the Cache County government workforce is primarily due to USU, which employs about 6,000 people in Logan. Table 4-6 lists the largest employers in Cache County as reported by the Utah Department of Workforce Services. The manufacturing and trade/transportation/utilities sectors are also large employers in Cache County and together accounted for about 35% of the jobs in the county in 2009.

Table 4-6. Largest Employers in Cache County

Employer	Industry	Employees
USU	Higher education	5,000–6,900
Cache School District	Public education	1,000–1,999
Icon main plant	Sports equipment manufacturing	1,000–1,999
JBS Swift Company, Inc.	Meat packing/manufacturing	1,000–1,999
Logan Regional Hospital	Hospital	1,000–1,999
City of Logan	Local government	500–999
Logan School District	Public education	500–999
Schreiber Foods	Cheese manufacturing	500–999
Wal-Mart	Retail	500–999

Source: Utah Department of Workforce Services 2010

Despite the national recession, Cache County has had a modest increase in employment in recent years. Although the unemployment rate in 2010 rose to as much as 5.6%, unemployment in Cache County is considerably below the State and national averages (Utah Department of Workforce Services 2010).

4.3.3.2 Taxes

The study area is primarily made up of land within the incorporated limits of Logan. The City is mainly dependent on a sales tax, which provided 27% of the City's total revenues in 2009, for municipal revenue (City of Logan 2009). Sales taxes from retail sales are mainly generated within the commercial districts of the city, which are on the west side of the study area.

Other taxes collected in the study area include property taxes based on the market value of land, buildings, and personal property such as motor vehicles. Actual tax revenues are based on the value of real property and personal property, both of which have risen in recent years (Table 4-7). Between 2004 and 2009, the value of real and personal property (excluding motor vehicles) increased by 53% in Logan and 70% overall in Cache County.

Table 4-7. Real and Personal Property Value in the Study Area
in millions

Jurisdiction	2004	2009	Percent Change
Logan	$1,431.8	$2,186.0	53%
North Logan	$328.0	$599.4	83%
Hyde Park	$100.6	$200.8	100%
Cache County	$3,244.3	$5,521.0	70%

Source: Utah State Tax Commission 2010

Property values in this table exclude values of motor vehicles.

4.3.3.3 Agricultural Production

According to the 2007 Census of Agriculture, Cache County supports 143,716 acres of cropland, 80,236 acres of which are irrigated (USDA NRCS 2007b). The total market value of crops in 2007 on both dry and irrigated land in the county was $24.3 million, or about $169/acre on average. The market value of irrigated cropland in Cache County was estimated to be $342.36/acre in 2009 (Appendix C3, NRCS Economic Analysis Calculations).

Although most of the study area is built out, it is also a productive agricultural area and depends on irrigation water from the LN and LHPS Canals. In total, the study area contains about 5,140 acres. About 970 acres are estimated to be in cropland or pasture land (Utah Division of Water Resources 2009). Agricultural production is discussed in Section 4.4.1, Agriculture.

4.3.4 Recreation

Recreation resources include parks and trails and other resources commonly used for developed or dispersed recreation such as a golf course and National Forest System land. The resources discussed in this section are shown in Figure 4-2. Other community resources are discussed in Section 4.3.1, Community Resources.

4.3.4.1 Parks and Open Spaces

There are 18 public parks in the study area, 16 in Logan and two in North Logan. Table 4-8 (which follows Figure 4-2) lists the acreages and locations of these parks as well as the amenities that each park provides. In addition to the public parks, there are several small private parks and open spaces throughout the study area that are part of subdivision developments or that are associated with churches. National Forest System land in Logan Canyon and in the southern study area foothills also provides open space for public recreation use.

Figure 4-2. Recreation Resources in the Study Area

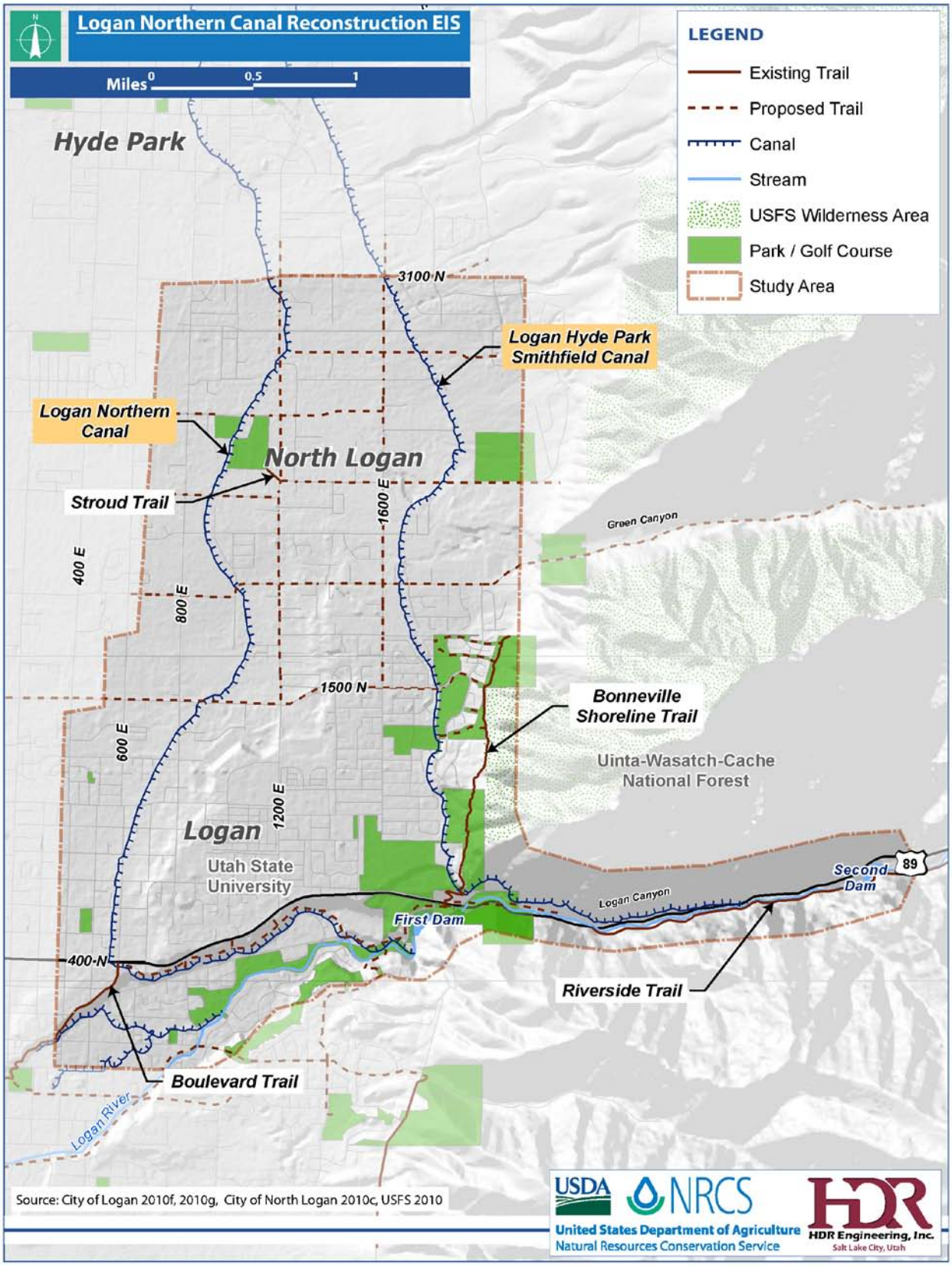


Table 4-8. Public Parks and Open Spaces in the Study Area

Resource Name	Size (acres)	Amenities	Location
Logan[a]			
Morningside Park	1	Picnic areas and playgrounds	450 East 1150 North
Adams Park	5	Picnic areas and playgrounds	550 North 500 East
Jens Johansen Park	2.6	Picnic areas and playgrounds	850 East 100 North
River Hollow Park	4.3	Picnic areas and playgrounds	10 River Park Drive
Sumac Park	0.25	None	1020 Sumac Drive
The Point	0.10	View area	Mountain Road & Cliffside Drive
Quail West Park and open space	0.54	Trails	1473 Quail Way
Quail Bluff Park	0.25	View area	1569 Quail Way
Canyon Entrance Park (at First Dam)	3.27	Picnic areas, trails, wildlife viewing, and fishing	US 89 & Canyon Road
Ray Hugie Hydro Park	3	Picnic areas, playgrounds, wildlife viewing, and fishing	US 89 & Canyon Road
Harris Park and Nature Preserve	70	Trails and fishing	Dry Canyon
Hillcrest Park	5.08	Sports fields	900 North 1500 East
Lundstrom Park	13.33	Picnic areas, playgrounds, sports fields, and trails	1600 East 1350 North
Cliffside Open Space	35	None	Cliffside Drive
Deer Pen Property	82	None	East and west of Aspen Drive
Second Dam Park	2.02	Picnic areas, trails, wildlife viewing, and fishing	US 89 at Second Dam
North Logan[b]			
Elk Ridge Park	24	Picnic areas and sports fields	1100 East 2500 North
Memorial Park	37.3	Walking paths, picnic areas; adjacent to city cemetery	East of LHPS Canal south of 2500 North

Sources: City of Logan, no date; City of North Logan 2003, 2010b

[a] All resources in Logan are owned and managed by the City of Logan.

[b] All resources in North Logan are owned and managed by the City of North Logan.

4.3.4.2 Designated Trails

Designated trails in the study area (Figure 4-2) include the Bonneville Shoreline Trail in Logan and North Logan, Boulevard Trail in Logan, Riverside Trail in Logan, and Stroud Trail in North Logan. The study area also includes some informal trails, which are discussed in Section 4.3.4.3, Other Recreation Resources.

The Bonneville Shoreline Trail is a regional trail that is about 103 miles long and runs from North Logan south to Mapleton in Utah County. When it is fully developed, the trail will run for about 280 miles from the Idaho border south to Santaquin, Utah. The segment of the trail

in the study area runs from the Logan Canyon trailhead north to the Green Canyon trailhead, a distance of about 2 miles. This section of the trail is managed by the City of Logan. Due to its proximity to urban areas and USU, this section of the Bonneville Shoreline Trail is heavily used. The Bonneville Shoreline Trail crosses the LHPS Canal near the mouth of Logan Canyon.

The Boulevard Trail begins in the southwest corner of the study area and runs southwesterly out of the study area along Canyon Boulevard. The trail segment that is in the study area (between about 450 East to 550 East) includes a walkway, park strip, landscaping, and decorative safety fencing (City of Logan 2010d).

The Riverside Trail runs along the Logan River from the mouth of Logan Canyon to the Spring Hollow Campground, which is about 4.2 miles upstream. The trail is cooperatively managed by the Logan Ranger District of the USFS Uinta-Wasatch-Cache National Forest and the City of Logan. The Riverside Trail passes the Stokes Nature Center, a community facility that is operated as a private venture.

The Stroud Trail starts at the corner of 1200 East and 2300 North and is 400 feet long. It links directly to Elk Ridge Park (City of North Logan 2009).

The City of Logan is proposing to construct four to five trails that will link Lundstrom Park with the Bonneville Shoreline Trail using the Deer Pen Property. This project was scheduled to be completed by the end of 2010 (City of Logan 2010e).

The City of North Logan currently identifies canal trails along the LN and LHPS Canals on its Trails Master Plan Map (City of North Logan 2003). This map shows a future trail network throughout the city (City of North Logan 2010c). Many of the proposed future trails are along existing streets in the study area, including 1500 North, 1900 North, 2300 North, 2500 North, 3100 North, 1200 East, and 1600 East.

4.3.4.3 Other Recreation Resources

The Logan Golf & Country Club, an 18-hole golf course, is located at 710 North 1500 East at the mouth of Logan Canyon. In addition to serving golfers, the Logan Golf & Country Club also offers a fitness center, a loop track for cross-country skiing, and children’s activities.

The study area includes part of the Uinta-Wasatch-Cache National Forest. Overall, the Forest covers about 2.1 million acres, but only about 620 acres are in the study area. This section of the Forest is managed as part of the Logan Ranger District, the headquarters of which are located on US 89 at the mouth of Logan Canyon. The headquarters include a visitors’ center. In addition to the Riverside Trail described above, the Uinta-Wasatch-Cache National Forest manages a trailhead parking area on US 89 just below Second Dam. The Stokes Nature Center operates on National Forest System land along the river in the study area under a special-use permit.

Logan residents and USU students use open areas and fields on the main USU campus for informal recreation. Other informal recreation activities in the study area include floating in the canals (especially segments of the LHPS Canal) using inner tubes, wading in the canals,

and hiking and mountain biking along the canals. Many residents of communities in and near the study area consider these recreation opportunities an important community resource. However, the entities that manage the land on which the canals are located and the irrigation companies that operate the canals have not authorized recreation use of the canal alignments. Many segments of the canals are posted with No Trespassing signs.

Cache County does not have formal plans to establish trails along the canal easements but has stated that it supports future use of the canal alignments as greenways, or linear parks, for recreation use and aesthetic appreciation (December 7, 2010, letter to Bronson Smart from Cache County Corporation in Appendix B, Agency Correspondence). These linear parks would probably be landscaped and have multi-use trails.

The City of Logan identifies a future trail along the LN Canal between the point where Canyon Road crosses the LN Canal and about 400 North, where the future trail would connect into an existing trail coming in from the west. The City of North Logan also identifies trails along the LN Canal and the LHPS Canal in areas under its jurisdiction.

4.3.5 Scenic Beauty and Landscape Resources

This section describes the appearance of the study area, including landscape resources along the alternative alignments where new construction would occur. NRCS guidance (General Manual Title 190, Part 410.24) states that contributions to scenic beauty are a normal product of NRCS's work. The guidance states that emphasis is given to soil and water conservation measures that contribute to productive and efficient agriculture, increase the attractiveness of rural America, and are in line with the goals and objectives of the nation's conservation districts.

Landscape resources are features or elements (landforms, buildings, water, and vegetation) that lead to an overall impression of the physical appearance and context of an area. A landscape with a high visual quality can generate emotional effects in a viewer that link to sense of place and quality of life. A positive perceived value of special and unique physical elements can be defined as scenic beauty.

The study area includes Logan Canyon, most of which is Federally owned and managed by USFS as part of the National Forest System. The rest of the study area is in western Cache Valley, which has been historically altered through Euro-American settlement and agricultural production. The existing canal system was originally developed to support settlement and agricultural production and continues to support these uses throughout the study area. As the study area continues to transition from rural, agricultural uses to urbanized uses, the existing landscape elements will also change.

The canal maintenance roads are used as recreation trails through some residential areas in the study area, especially in Logan. The presence of the open channel with flowing water is considered an amenity by many residents because it provides a unique characteristic in an area where there are no naturally flowing waterways. However, some residents who live along the canals consider the open canal a hazard for small children and a safety concern.

4.3.5.1 Logan Canyon (National Forest System Land)

The 2003 *Revised Forest Plan for the Wasatch-Cache National Forest* uses the Scenery Management System (SMS) as a management tool to address landscape resources within the Forest. The part of the study area that is in the Forest falls under *Management Prescription Category 2.5–Forest Service Scenic Byways* and *Management Prescription Category 4.5–Developed Recreation Areas* along Scenic Byway Corridors.

The *Revised Forest Plan* identifies the Landscape Character Theme for land adjacent to US 89 in Logan Canyon as *Developed Natural Appearing* with a *High* Scenic Integrity Objective. Users of Developed Natural Appearing areas are attracted to the natural-appearing landscape but desire a moderate to easy interaction with the landscape through the use of amenities. The *Revised Forest Plan* identifies the Concern Level, which is a measure of the degree of public importance placed on how landscapes are viewed from travelways and use areas, as *Concern Level 1 (Scenic Byways)* (USFS 2003).

This Landscape Character Theme recognizes that there are roads, developed recreation facilities, and concentrated-use areas and that Forest visitors are attracted to the natural-appearing landscape but want amenities that provide access. The High Scenic Integrity Objective indicates that USFS intends to treat the landscape elements adjacent to US 89 in Logan Canyon in such a way that the landscape character appears intact. The *Revised Forest Plan* states that deviations from the elements must repeat the form, line, color, and texture of the natural elements at a scale that prevents the deviated elements from being dominant.

The part of Logan Canyon in the study area that is part of the Uinta-Wasatch-Cache National Forest is along US 89, a Federal and State scenic byway. The LHPS Canal POD is located on the Logan River just downstream of a small recreation parking area and trailhead. The LHPS Canal conveys water from the POD under US 89 to the northwest with fencing surrounding the open channel. The open channel borders US 89 for a short distance before the road descends and falls away from the canal. The canal alignment follows the slope contour upslope of US 89 through the lower part of Logan Canyon. The canal cannot be seen from the road, but a bench in the slope above US 89 can be seen from sections of US 89 and from a trail that follows the south side of the Logan River (Photo 4-1).

Photo 4-1. LHPS Canal on hillside above US 89 in Logan Canyon

4.3.5.2 Cache Valley

Logan

Both the LN and LHPS Canals are integrated with residential and recreational developments through Logan. The LN Canal traverses the Logan Bluff and then travels through a residential area. The LHPS Canal is incorporated as a water feature into the landscape through the Logan Golf & Country Club before weaving through a residential area and passing the eastern edge of Lundstrom Park.

Through the residential areas of Logan, there is very little visual distinction between the alignments for both canals and the surrounding neighborhoods. In most areas, the canals and associated access roads have been incorporated into residential landscaping and backyard features. The canal maintenance roads are used as recreation trails through some residential areas of the city. However, the canal maintenance roads in some areas have been posted with No Trespassing signs by the irrigation companies, since the access roads are not managed or designated for public use.

Photo 4-2 through Photo 4-5 show representative landscapes along the canals in Logan.

Photo 4-2. Canal through a residential area in Logan

Photo 4-3. Canal maintenance road in Logan posted for no trespassing

Photo 4-4. Canal maintenance road in Logan used as a trail

Photo 4-5. Canal incorporated into the urban community in Logan

North Logan and Unincorporated Areas of Cache County

As the canals traverse north into and through North Logan, the developed residential areas transition into very low-density residential and agricultural areas. The dirt-surface canal maintenance roads are also used as recreation trails through some very low-density residential areas in North Logan. In some areas of North Logan, these maintenance roads have been posted with No Trespassing signs by the irrigation companies since the roads are not managed or designated for public use.

The visual landscape elements of the canal alignments vary greatly with differing land-management practices through agricultural areas in North Logan and unincorporated areas of the county. The alignments have a more dominant visual characteristic through some areas, while in other areas the canal features mimic agricultural fields. On some properties, the canals are bordered by large cottonwood trees and willows, while on other properties the canals do not have bordering vegetation, and farmed crops extend to the canal edges.

Photo 4-6, Photo 4-7, and Photo 4-8 show representative landscapes in the North Logan and Cache County parts of the study area.

Photo 4-6. Canal through agricultural land with little to no landscape elements

Photo 4-7. Canal through agricultural land with some landscape elements

Photo 4-8. Canal with more distinguishable landscape elements

4.3.6 Energy

4.3.6.1 Electricity Generation in the Study Area

The Logan City Light and Power Department can generate up to 10% of its residents' power demand using three City-operated power plants. Logan's peak power demand occurs in the summer months and averages about 90,000 kilowatts (kW) (City of Logan 2011). Rocky Mountain Power (a business unit of PacifiCorp) provides the remaining power for Logan and also provides electricity service to North Logan, Hyde Park, and unincorporated areas of Cache County in the study area.

Logan City Light and Power's Hydro 2 and Hydro 3 facilities rely on water in the Logan River to generate power. Hydro 2, which is capable of generating a peak of about 5,500 kW, is located between the LHPS Canal and LN Canal PODs at the mouth of Logan Canyon. Hydro 3 is located just above Second Dam (upstream of the LHPS Canal POD) and is capable of generating 1,300 kW. Currently, Logan City Light and Power takes water used for Hydro 2 at Second Dam, which is above the LHPS Canal POD, and returns the water to the river at First Dam above the LN Canal POD. Figure 3-11, Logan River Diversions, shows the location of Hydro 2 and how it integrates with the river and PODs for the LN Canal and LHPS Canal. During times of peak summer demand, Hydro 2 generation averaged about 3,000 to 4,000 kW from 2005 to 2009, which was about 3% to 4% of the peak demand in Logan.

Rocky Mountain Power provides service to customers in Idaho, Utah, and Wyoming. Rocky Mountain Power's parent corporation, PacifiCorp (which provides service to California, Oregon, and Washington through Pacific Power), generates 10,483 MW (megawatts) using 78 different facilities (Rocky Mountain Power 2010a). In northern Utah, PacifiCorp generates electricity using thermal plants. PacifiCorp operates a hydroelectric facility in southeastern Idaho and a number of wind plants in eastern Wyoming. All of these facilities are connected through an extensive transmission system to provide service in and around the study area (Rocky Mountain Power 2010b).

4.3.6.2 Energy Requirements for Canal Operation

The LN and LHPS Canals are gravity systems that originate at the Logan River. Prior to the 2009 landslide, LN Canal shareholders upstream of about 1500 North used gravity to deliver water to their properties (HDR Engineering, Inc. 2010). Shareholders downstream of 1500 North collectively used about 1,000 horsepower for 8 hours each day over the 6-month irrigation season to deliver water to their properties. Pumping provides the necessary pressure to operate sprinkler irrigation systems. Individual shareholders are responsible for operating and maintaining the pumps.

The pumps used by shareholders are gas/diesel or electric. For electric pumps, the power supplier varies depending on where the pump is located. The amount of power required to operate the pumps depends on the pump size and the area being irrigated.

4.4 Natural Resource Conditions

4.4.1 Agriculture

This section describes the existing agricultural environment in the study area. In general, agricultural uses are concentrated in the northern half of the study area. This section begins with an agricultural "snapshot" and then describes prime farmland, farmland of State and local importance, and water available for agriculture.

4.4.1.1 Agricultural Snapshot

Cache County is one of the primary agricultural production regions in the state. Agriculture plays a large part in Cache County's economy, and the county ranks as one of the highest contributors of agricultural products in the state (USU Extension 2005). The majority of the farming within the county is done in the northern end near the Idaho border, the west-central part of the valley, and the extreme southern end. The majority of all grazing in the county is done in the south end of the valley.

Cache County contributes beef, milk, and cheese products from various production and processing facilities. In both 2004 and 2007, Cache County led the state in barley production. The 2007 Census of Agriculture found that there were 251,550 acres in farms or ranches in the county with an average size of 211 acres. About 57% of the county's land in farms is cropland, while another 35% is pasture (USDA NRCS 2007a). Between 2002 and 2007, Cache County gained almost 5,000 acres of land in farms, and the market value of inventory sold (crop sales plus livestock sales) increased by 41% (USDA NRCS 2007a).

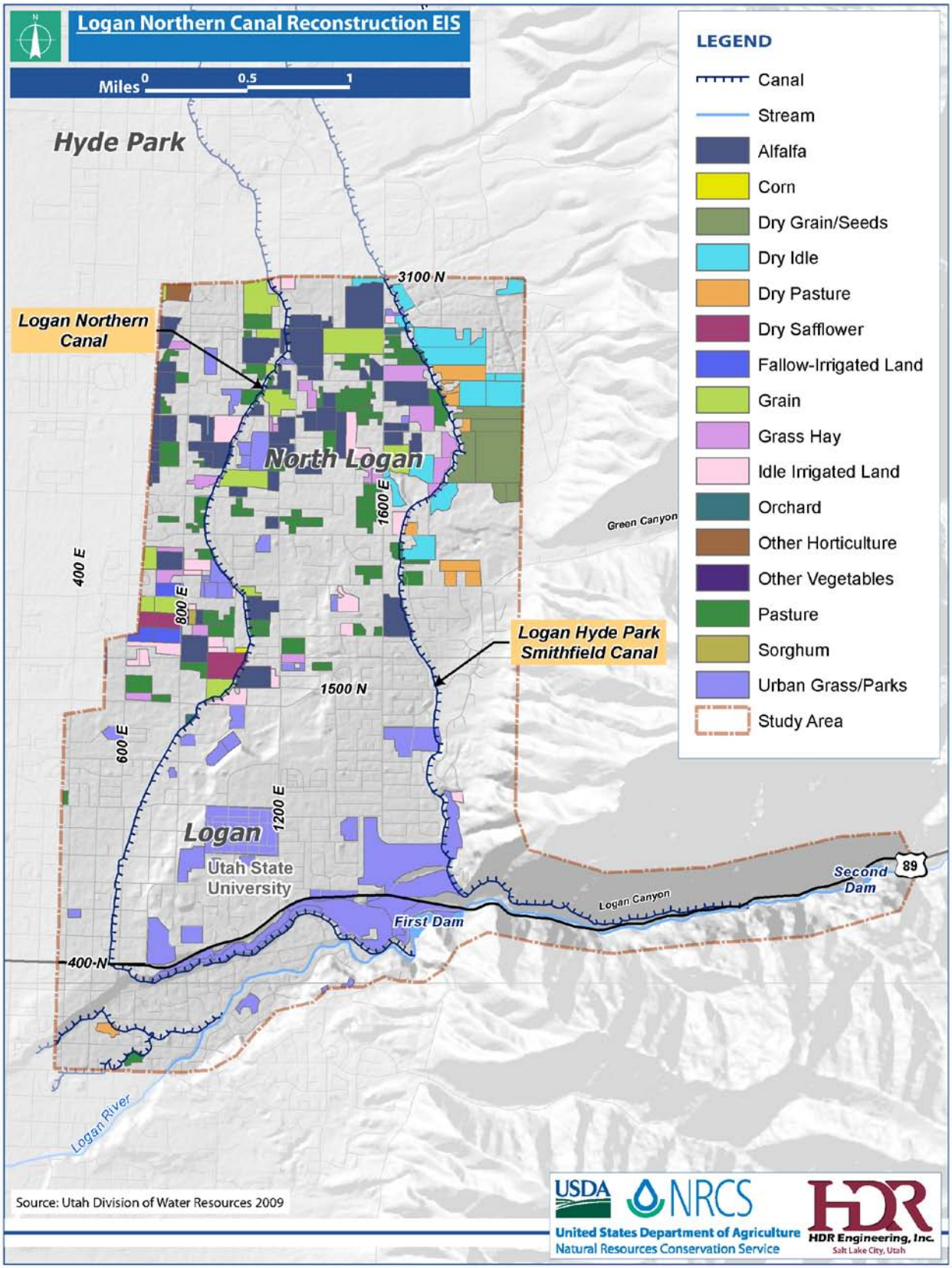
Cache County producers raise various crops. According to the 2007 Census of Agriculture, the top five crop items in Cache County were forage (typically hay and haylage, grass silage, and greenchop), wheat for grain, barley for grain, corn for silage, and safflower, while the top five livestock inventory items were colonies of bees (second in the state), chickens for eggs, cattle and calves, mink and their pelts, and hogs and pigs (USDA NRCS 2007a).

An increasing number of farmers are starting to grow safflower because the majority of its water requirements occur early in the season when there is more water available. After the water-dependent stage, the crop needs very little water to mature.

4.4.1.2 Cropland in the Study Area

In general, agricultural uses are concentrated in the northern half of the study area (Figure 4-3). Farmland in the study area is used for cultivation (cropland), livestock grazing, and dry pasture. For the most part, active agricultural production in the study area focuses on irrigated crops (such as alfalfa and grain) and irrigated pasture land. Crops are frequently rotated; therefore, while these data provide an accurate picture of irrigated cropland in the study area, they might not reflect the most current crop pattern.

Figure 4-3. Cropland and Farmland in the Study Area



A large portion of the irrigated land in the study area is categorized as urban grass and parks. This category is included in Table 4-9 for two reasons. First, some types of urban water uses (primarily for parks, golf courses, and landscaping) affect the amount of water available for agriculture. Second, as shown in the table, in 2009 the largest water-related land-use type in the farmland study area was urban (Utah Division of Water Resources 2009, 2010a).

Table 4-9. Cropland or Farmland in the Study Area in 2009

Crop or Farmland Type	Acres
Irrigated Crop or Farmland	
Alfalfa	273.04
Corn	0.94
Grain	100.71
Grass hay	63.53
Orchard	3.43
Other horticulture	5.98
Other vegetables	1.47
Pasture	174.07
Sorghum	1.55
Total irrigated	**624.72**
Non-irrigated Crop or Farmland	
Fallow-irrigated land	16.92
Dry grain/seeds	80.88
Dry idle	112.55
Dry pasture	36.42
Dry safflower	24.43
Idle-irrigated land	72.71
Total non-irrigated	**343.91**
Urban	
Urban grass/parks	360.50
Total urban	**2,923.44**
Total of all types	**3,892.07**

Source: Utah Division of Water Resources 2009

4.4.1.3 Prime Farmland

The Federal Farmland Protection Policy Act (FPPA) defines *prime farmland* as land that has the best combination of physical and chemical characteristics for producing food, feed, forage, fiber, and oilseed crops and is available for these uses. The land must have the soil

quality, growing season, and moisture supply needed to economically produce sustained high yields of crops when treated and managed (including water management) according to acceptable farming methods (Utah Agricultural Experiment Station 1983).

The FPPA also defines *unique farmland*, which is land other than prime farmland and that is used for the production of specific high-value food and fiber crops. The study area does not include any farmland that is designated as unique.

Table 4-10 shows that the study area contains about 25 acres of prime farmland. It should be noted that 99% of the study area is in the incorporated limits of Logan and North Logan and, therefore, the acreage shown for prime farmland is low. NRCS distinguishes between two types of prime farmland: "prime when irrigated" and "prime when irrigated and drained." According to NRCS, the only prime farmland in the study area is "prime when irrigated" and is located just west of the LN Canal between about 2700 North and 3100 North.

Table 4-10. Specially Designated Farmland in the Study Area

Farmland Designation	Acres
Prime (when irrigated)	25.4
Unique	0.0
Local importance	0.0
Statewide importance	6.3
Total	**31.7**

Source: USDA NRCS 2007b

4.4.1.4 Farmland of Statewide and Local Importance

Farmland of statewide importance is classified by NRCS as farmland of lesser quality than prime or unique farmland that has the soil, water supply, and other characteristics that, with good management, yield productive crops (Utah Agricultural Experiment Station 1983). Based on consultation with NRCS, the study area contains about 6 acres of farmland of statewide importance, all of which is in the same area as the prime farmland in the northern end of the study area (Table 4-10).

Farmland of local importance is either currently producing crops or has the capability to produce crops. Farmland of local importance is land other than prime farmland, unique farmland, or farmland of statewide importance. This land can be important to the local economy due to its productivity. It does not include publicly owned land for which there is an adopted policy preventing agricultural use. Based on consultation with NRCS, the study area contains no farmland of local importance (Table 4-10).

4.4.1.5 Water Available for Agriculture

Cache County is one of the biggest agricultural producers in Utah, and over 70% of the county's water is used for irrigation. At least 60% of the land in Cache Valley is irrigated, and over 75% is used for agriculture. The primary use for the county's water is irrigation using both the flood and sprinkler methods of watering (Gong and others 2009). About 75% of the irrigation water available in Cache County is from river water and runoff. The rivers most used for irrigation are the Cub, Logan, and Blacksmith Fork. Reservoirs in the area contribute another 15%, while deep wells provide the remaining 10% of needed irrigation water (USU Extension 2005).

Before the 2009 landslide, 76% of the 3,279 canal shares were used for agricultural production. About 33% of the 1,996.6 LHPS Canal shares have historically been used for agriculture. Since the 2009 landslide, shareholders in both canals have received about 50% of their water.

4.4.2 Biological Resources

This section describes the typical vegetation and wildlife in the study area (including migratory birds, big game, and noxious weeds). Special-status species are discussed in Section 4.4.3, Special-Status Species.

4.4.2.1 Vegetation

The canals in the study area cross four basic vegetated land types: riparian by the Logan River diversion structures, arid canyon slope in Logan Canyon along the LHPS Canal, urban landscaped, and agricultural.

What is riparian habitat?

Riparian habitat is habitat along a river, stream, canal, or other waterway.

The riparian habitat by the Logan River diversion structures is the smallest habitat area in the study area and consists of only the immediate area surrounding the diversion structures, including the bank and channel area of the river. The vegetation noted during site visits to this area includes species such as coyote willow (*Salix exigua*), box elder (*Acer negundo*), Rocky Mountain maple (*Acer glabrum*), red-osier dogwood (*Cornus stolonifera*), rubber rabbitbrush (*Ericameria nauseosa*), horsetail (*Equisetum* spp.), and poison ivy (*Toxicodendron rydbergii*).

Riparian habitat conservation areas (RHCAs) include traditional riparian corridors, wetlands, intermittent streams, and other areas on National Forest System land that help maintain the integrity of aquatic ecosystems. USFS places RHCAs into four classes:

- **Category 1, Fish-Bearing Streams:** the stream and the area on either side of the stream extending from the edges of the active stream channel to 300 feet slope distance (600 feet, including both sides of the stream channel).
- **Category 2, Permanently Flowing Non-Fish-Bearing Streams:** the stream and the area on either side of the stream extending from the edges of the active stream channel to 150 feet slope distance (300 feet, including both sides of the stream channel).
- **Category 3, Ponds, Lakes, Reservoirs, and Wetlands Greater Than 1 Acre:** the body of water or wetland and the area to 150 feet slope distance from the edge of the maximum pool elevation of constructed ponds and reservoirs or from the edge of the wetland, pond, or lake.
- **Category 4, Seasonally Flowing or Intermittent Streams, Wetlands Less Than 1 Acre, Landslides, and Landslide-Prone Areas:** this category includes features with high variability in size and site-specific characteristics. At a minimum, the interim RHCAs must include landslides and landslide-prone areas 100 feet slope distance in watersheds containing Bonneville or Colorado River cutthroat trout, and 50 feet slope distance for watersheds not containing Bonneville or Colorado River cutthroat trout.

Based on this classification system, the reach of the Logan River on National Forest System land in the study area is considered a Category 1 stream because it is fish bearing. The 600-foot area for the entire length of the river in the project area that is on National Forest System land includes US 89, a paved highway on the right side of the river when looking downstream, and a developed recreation trail on the left side of the river when looking downstream. In no case is the riparian area along this reach of the Logan River fully intact in the 600-foot RHCA area.

What is a talus slope?

A *talus slope* is a slope formed by an accumulation of rock debris.

In Logan Canyon, vegetation along the south-facing, arid canyon slope is sparse with areas of loose talus slopes and rocky outcrops. The species noted during site visits to this area include species such as rubber rabbitbrush, big sagebrush (*Artemisia tridentata*), juniper (*Juniperus* spp.), dog rose (*Rosa canina*), smooth brome (*Bromus inermis*), western white clematis (*Clematis ligusticifolia*), and other grasses and forbs (broad-leaved flowering plants), with mesic species such as box elder and coyote willow present right along the canal edge.

Outside the canyon, both canals pass through the human-made vegetated land types of urban landscaped and agricultural. Urban landscaped areas consist of golf courses, parks, university landscaping, residential yards, and the hillside slope along Canyon Road (below SR 89). The species noted during site visits to this area include some native species such as Fremont cottonwood (*Populus fremontii*), box elder, coyote willow, red-osier dogwood, and crack willow (*Salix fragilis*).

What are mesic species?

Mesic species are those that require a moderate amount of water, as compared to *hydric* (high-water) or *xeric* (low-water) species.

A variety of other, introduced species or planted cultivars also are found in urban landscaped areas. These non-native species include honeylocust (*Gleditsia triacanthos*), Austrian pine (*Pinus nigra*), maples (*Acer* spp.), and dog rose. Herbaceous species found in these areas include Kentucky bluegrass (*Poa pratensis*), reed canarygrass (*Phalaris arundinacea*), Johnsongrass (*Sorghum halepense*), orchardgrass (*Dactylis glomerata*), burdock (*Arctium minus*), white sweetclover (*Melilotus alba*), goatsrue (*Galega officinalis*), Canada thistle (*Cirsium arvense*), curly dock (*Rumex crispus*), Canada goldenrod (*Solidago canadensis*), and a variety of planted or escaped, exotic landscaped species in the yards immediately adjacent to the canals. Areas that have hillside seeps upslope of the LN Canal along Canyon Road support mesic tree and herbaceous species. During site visits to the area, mosses were noted growing just above and on the walls of the canal where the seep water flows into the canal.

Many of the same species are present along the canals in agricultural areas as in the residential areas. However, site visits indicate that hay crops such as alfalfa or grass hay (*Festuca* spp.) or annual crops such as wheat and safflower are present instead of more typical landscaped species. Some agricultural areas are also being used as pasture. Plant species present in pastures include many of the same weedy species along the canals but also pasture grasses such as meadow fescue (*Festuca pratensis*).

4.4.2.2 Aquatic Wildlife Species

The Logan River, which flows into and through the study area, supports communities of aquatic wildlife species of fish and aquatic invertebrates. Fish species include Bonneville cutthroat trout (*Oncorhynchus clarkia utah*), which is a State of Utah sensitive, native species (discussed in Section 4.4.3.2, ESA Candidate, State Sensitive, and Conservation Agreement Species), along with other native species such as mountain whitefish (*Prosopium williamsoni*), mottled sculpin (*Cottus bairdii*), and Paiute sculpin (*Cottus beldingii*). Non-native fish present in this reach of the river include brook trout (*Salvelinus fontinalis*), brown trout (*Salmo trutta*), and rainbow trout (*Oncorhynchus mykiss*). Invertebrates include aquatic snails (such as *Physella* spp., *Pyrgulopsis* spp., and *Stagnicola* spp.), worms, aquatic insects, and immature life stages of insects such as stoneflies, caddisflies, mayflies, midges, horseflies, and black flies (Utah Division of Wildlife Resources 2010).

The non-native brown trout dominates the lower Logan River, including the reach of the river in the study area between First and Second Dams. According to USFS (Chase 2011), the existing fishery appears to be maintained by fish moving from higher in the Logan River into the reach between First and Second Dams and then becoming isolated within this reach. Currently, once fish are in this reach, they cannot move back up above Second Dam. Since there is very little spawning habitat within this reach, there is little recruitment of young fish (Chase 2011). Utah Division of Wildlife Resources records show that the Division stocks the reach of the river in the study area with rainbow trout and cutthroat trout.

Fishery habitat between First and Second Dams has been affected by several factors. In 1960, much of the river within this reach was displaced during road construction that resulted in a channelized river course, a highly confined channel on both banks, and an average gradient of about 3.5%. During the irrigation season, in-stream flow through this reach is highly variable due to a number of permitted diversions (Chase 2011). Diversion structures along the river are generally not screened to exclude fish, so fish can enter water-delivery systems such as irrigation canals.

Currently, a short section of the Logan River beginning just below the LHPS Canal POD is dewatered at times during the irrigation season. It is not known how far below the LHPS Canal POD the stream is dewatered. However, at some point below the LHPS Canal POD, water seeps into the Logan River from groundwater, springs, canal water loss (seepage), and other sources and helps to support the fishery during the late summer months below Second Dam and the LHPS Canal POD (Chase 2011).

4.4.2.3 Terrestrial Wildlife Species

The non-urbanized parts of the study area support a community of terrestrial wildlife species. Wildlife groups include small mammals, invertebrates, reptiles, amphibians, birds (see the section titled Birds on page 4-34), and larger, big-game mammals (see the section titled Big Game on page 4-35). Terrestrial habitats in the study area that are used by these wildlife species include canyon slopes and foothills, riparian areas, and agricultural and recreation land.

Information about small to mid-sized mammals that could be present in the study area is based on professional knowledge, existing information about species distribution in Utah (Utah Division of Wildlife Resources 2010), and the types of habitats present. Small to mid-sized mammals that are probably present in the study area include species such as deer mouse (*Peromyscus maniculatus*), house mouse (*Mus musculus*), western harvest mouse (*Reithrodontomys megalotis*), little brown myotis (*Myotis lucifugus*), long-eared myotis (*Myotis evotis*), silver-haired bat (*Lasionycteris noctivagans*), big brown bat (*Eptesicus fuscus*), meadow vole (*Microtus pennsylvanicus*), striped skunk (*Mephitis mephitis*), mountain cottontail (*Sylvilagus nuttalli*), black-tailed jackrabbit (*Lepus californicus*), least chipmunk (*Neotamias minimus*), long-tailed weasel (*Mustela frenata*), northern raccoon (*Procyon lotor*), coyote (*Canis latrans*), bobcat (*Lynx rufus*), and red fox (*Vulpes vulpes*).

Many of these species are adapted to human-manipulated habitats such as pastures, agricultural fields, and residential yards. Along the canals, rivers, and streams, mammal species such as American beaver (*Castor canadensis*), muskrat (*Ondatra zibethicus*), northern river otter (*Lontra canadensis*), and nutria (*Myocastor coypus*) could possibly reside.

Many different invertebrates including mollusks and insects could inhabit the habitats in the study area. Insect taxonomic groups could include butterflies, wasps, bees, ants, beetles, true bugs, grasshoppers, and flies. Mollusks could include land snails such as *Oreohelix strigosa*.

The study area is also habitat for many reptiles and amphibians, especially in the non-developed areas of the study area. Reptiles present in the study area could include common sagebrush lizard (*Sceloporus graciosus*), common gartersnake (*Thamnophis sirtalis*), eastern racer (*Coluber constrictor*), gophersnake (*Pituophis catenifer*), Great Basin rattlesnake (*Crotalus oreganus lutosus*), and rubber boa (*Charina bottae*). In the mesic parts of the study area, such as in and around the Logan River and the canals or in wet meadows or irrigated fields, amphibian species such as Great Basin spadefoot (*Spea intermontana*), Great Plains toad (*Bufo cognatus*), tiger salamander (*Ambystoma tigrinum*), western (boreal) toad (*Bufo boreas*), western chorus frog (*Pseudacris triseriata*), and Woodhouse's toad (*Bufo woodhousii*) could be present.

Birds

The study area provides habitat for a variety of birds, many of which are protected under the Migratory Bird Treaty Act of 1918. Table 4-11 lists the likely bird species that could be present in the native habitats (excluding residential, agricultural, and commercial areas) found primarily in the eastern part of the study area (that is, surrounding the Logan River inside and by the mouth of Logan Canyon and the benches and foothills of the Bear River Mountains on the east side of Cache Valley).

The bird species listed in Table 4-11 were compiled from recreational birding lists published by the Wasatch Audubon Society (no date) for the lower part of Logan Canyon and First Dam. Some of these species and others are also likely to travel through or nest in non-native habitats located in the central and western parts of the study area, such as agricultural edges and hedgerows, parks, and densely vegetated residential areas. More common bird species, such as starling (*Sturnus vulgaris*), house sparrow (*Passer domesticus*), black-billed magpie (*Pica hudsonia*), and American robin (*Turdus migratorius*), could also nest in non-native habitats.

Table 4-11. Birds Likely To Be Present in the Eastern Part of the Study Area (Logan Canyon Area)

Common Name	Scientific Name	Habitat
American dipper	*Cinclus mexicanus*	Swift mountain streams
Belted kingfisher	*Ceryle alcyon*	Streams and other open water
Blue grouse	*Dendragapus obscurus*	Subalpine conifer and mountain shrub
Broad-tailed hummingbird	*Selasphorus platycercus*	Lowland and mountain riparian
Calliope hummingbird	*Stellula calliope*	Mountain shrub and riparian
Canyon wren	*Catherpes mexicanus*	Canyons, cliffs, rocky areas
Cassin's finch	*Carpodacus cassinii*	Aspen and subalpine conifer
Cedar waxwing	*Bombycilla cedrorum*	Lowland and mountain riparian
Common goldeneye	*Bucephala clangula*	Ponds and lakes
Cordilleran flycatcher	*Empidonax occidentalis*	Subalpine conifer and mountain riparian
Fox sparrow	*Passerella iliaca*	Mountain shrub and riparian
Golden-crowned kinglet	*Regulus satrapa*	Aspen and subalpine conifer
Gray catbird	*Dumetella carolinensis*	Riparian and dense shrublands
Hermit thrush	*Catharus guttatus*	Subalpine conifer and mountain riparian
Hooded merganser	*Lophodytes cucullatus*	Forested wetlands, ponds, and lakes
Lazuli bunting	*Passerina amoena*	Riparian and mountain shrublands
Lincoln's sparrow	*Melospiza lincolnii*	Wet meadow and mountain riparian
Mountain chickadee	*Parus gambeli*	Pinyon-juniper and mixed conifer
Northern pygmy owl	*Glaucidium gnoma*	Mountain riparian and mixed conifer
Orange-crowned warbler	*Vermivora celata*	Mountain shrub and riparian
Rock wren	*Salpinctes obsoletus*	Rocky areas, talus slopes
Swainson's thrush	*Catharus ustulata*	Mountain riparian and aspen
Violet-green swallow	*Tachycineta thalassina*	Mountain riparian and aspen
Warbling vireo	*Vireo gilvus*	Forested and shrubby riparian
White-throated swift	*Aeronautes saxatalis*	Cliffs and rocky canyons
Winter wren	*Troglodytes troglodytes*	Bushy or dense forested areas
Yellow warbler	*Dendroica petechis*	Riparian

Source: Wasatch Audubon Society, no date

Big Game

According to the Utah Division of Wildlife Resources (2010), big-game species that could be present in the study area include mule deer, elk, moose, and cougar. The Division has designated areas as crucial winter range for deer, elk, and moose in the Bear River Mountains, and that range extends into the eastern edge of the study area. The lower Logan Canyon area, including the mouth of the canyon and surrounding benches, is critical-value winter range for mule deer and high-value winter range for elk (Utah Division of Wildlife Resources 2004b, 2005). The eastern border of the study area abuts an area that includes high-value winter range for mule deer, critical winter range for elk, and high-value summer range for moose, since that part of the study area overlaps with the benches and eastern slope of the Bear River Mountains (Utah Division of Wildlife Resources 2004a, 2005). Mule deer

could wander into agricultural areas or residential neighborhoods in the western part of the study area in search of winter food, but those areas are not identified by the Division of Wildlife Resources as valuable range.

Cougars, also known as mountain lions, range throughout much of the mountainous areas of Utah. Although they are protected by the State of Utah, they are also managed as a game species in Utah (Utah Division of Wildlife Resources 2009a). In the last 15 years, an average of 15 cougars per year have been killed by sport hunters in the management unit that includes the project area in Cache County (Utah Division of Wildlife Resources 2009b). Cougars likely range throughout much of Cache County. On rare occasions, cougars are seen moving through populated areas in Cache Valley in the winter (Cache Valley Daily 2009).

4.4.2.4 Noxious Weeds and Invasive Species

Both the State of Utah and Cache County maintain lists of noxious and invasive weed species, which are discussed in this section. Some of these species could be in the study area.

State of Utah Noxious Weed List

The Noxious Weed List for the State of Utah includes 27 weeds categorized into three priority level classes: Class A, Class B, and Class C (Belliston and others 2010; UWCA, no date).

- **Class A** – Early Detection Rapid Response class of noxious weeds that pose a serious threat
  - Black henbane (*Hyoscyamus niger*)
  - Diffuse knapweed (*Centaurea diffusa*)
  - Leafy spurge (*Euphorbia esula*)
  - Medusahead (*Taeniatherum caput-medusae*)
  - Oxeye daisy (*Chrysanthemum leucanthemum*)
  - Perennial sorghum (*Sorghum almum*) including Johnson grass (*Sorghum halepense*)
  - Purple loosestrife (*Lythrum salicaria*)
  - Spotted knapweed (*Centaurea maculosa*)
  - St. Johnswort (*Hypericum perforatum*)
  - Sulfur cinquefoil (*Potentilla recta*)
  - Yellow starthistle (*Centaurea solstitialis*)
  - Yellow toadflax (*Linaria vulgaris*)
- **Class B** – Noxious weeds not native that pose a threat, high priority for control
  - Bermudagrass (*Cynodon dactylon*)
  - Dalmatian toadflax (*Linaria dalmatica*)
  - Dyer's woad (*Isatis tinctoria*)
  - Hoary cress (*Cardaria draba*)

  - Musk thistle (*Carduus nutans*)
  - Perennial pepperweed (*Lepidium latifolium*)
  - Poison hemlock (*Conium maculatum*)
  - Russian knapweed (*Centaurea repens*)
  - Scotch thistle (*Onopordum acanthium*)
  - Squarrose knapweed (*Centaurea virgata squarrosa*)

- **Class C** – Noxious weeds not native that pose a threat to agriculture
  - Canada thistle (*Cirsium arvense*)
  - Field bindweed (*Convolvulus arvensis*)
  - Houndstongue (*Cynoglossum officinale*)
  - Quackgrass (*Elymus repens*)
  - Saltcedar (*Tamarix ramosissima*)

Cache County Noxious/Invasive Weed List

In addition to the State of Utah noxious weed list, Cache County has identified two more noxious weed species for control and two additional invasive species as important invading weeds (Cache County, no date).

- Cache County noxious weed additions
  - Goatsrue (*Galega officinalis*)
  - Puncturevine (*Tribulus terrestris*)
- Cache County important invading weed additions
  - Buffalobur (*Solanum rostratum*)
  - Velvetleaf (*Abutilon theophrasti*)

Based on observations along the existing LN and LHPS Canals, weed problems involve species from the State's Class B and C lists, including hoary cress, perennial pepperweed, Canada thistle, and houndstongue, and the Cache County addition of goatsrue. Other species on these weed lists might be in Cache Valley and even in the study area but were either absent or not apparent along the canals during the field observations.

In addition to noxious or invasive species identified by the State or County, other non-native and potentially invasive species are present in the study area. These species are potentially numerous and include planted or landscaped plants but also include other weedy species such as Russian olive (*Elaeagnus angustifolia*) and common reed (*Phragmites australis*).

4.4.3 Special-Status Species

This section discusses the special-status species that could be present or could have potential habitat in the study area. Special-status species include species that are formally listed or are candidates for listing under the Endangered Species Act (ESA), species identified as sensitive by the State of Utah, and species identified as sensitive by USFS.

Appendix C5, Special-Status Species, is a technical memorandum that describes the species discussed below and their potential to be present in the project area. Appendix D2, Sensitive Species List, includes lists of all Federal, State, and USFS threatened, endangered, and sensitive species, including the USFS management indicator species (MIS), that are listed for Cache County or for the Uinta-Wasatch-Cache National Forest. The species discussed below include only those species with either records of occurrence or habitat in the study area.

4.4.3.1 Threatened and Endangered Species

The Federally listed threatened and endangered species in Cache County, Utah, listed below are those that the Utah Division of Wildlife Resources has recorded and that NRCS biologists have identified as being potentially present in the county (USDA NRCS 2010a; Utah Division of Wildlife Resources 2010). Complete species and habitat descriptions, along with the likelihood of occurrence in the study area, are found in Appendix C5, Special-Status Species.

- Maguire's primrose (*Primula maguirei*) – threatened
- Ute ladies'-tresses (*Spiranthes diluvialis*) – threatened
- Canada lynx (*Lynx canadensis*) – threatened

Appendix C5 includes information about a previously completed survey for Maguire's primrose.

4.4.3.2 ESA Candidate, State Sensitive, and Conservation Agreement Species

Candidates for listing under the Federal ESA, State of Utah sensitive species, and conservation agreement species are not formally protected, but NRCS policy under General Manual Part 190, Section 410.22(E)(7), states that NRCS will use its authorities and programs to provide for the conservation of these species. The species described below are listed by the Utah Division of Wildlife Resources as Federal ESA candidates, conservation agreement species, or wildlife species of concern (Utah Division of Wildlife Resources 2010). Complete species and habitat descriptions, along with the likelihood of occurrence in the study area, are found in Appendix C5, Special-Status Species.

- Greater sage grouse (*Centrocercus urophasianus*)
- Yellow-billed cuckoo (*Coccyzus americanus*)
- Bald eagle (*Haliaeetus leucocephalus*)
- Bobolink (*Dolichonyx oryzivorus*)
- Burrowing owl (*Athene cunicularia*)
- Ferruginous hawk (*Buteo regalis*)
- Grasshopper sparrow (*Ammodramus savannarum*)
- Lewis's woodpecker (*Melanerpes lewis*)
- Long-billed curlew (*Numenius americanus*)
- Sharp-tailed grouse (*Tympanuchus phasianellus*)

- Short-eared owl (*Asio flammeus*)
- Bonneville cutthroat trout (*Oncorhynchus clarkii utah*)
- Fringed myotis (*Myotis thysanodes*)
- Townsend's big-eared bat (*Corynorhinus townsendii*)
- Great Plains toad (*Bufo cognatus*)
- Western toad (*Bufo boreas*)

4.4.3.3 Forest Service Sensitive Species

USFS maintains regional lists of sensitive species independent of State or Federal lists (USFS 2008; Duncan 2010). The Intermountain Region sensitive species list for the Uinta-Wasatch-Cache National Forest includes some of the same species listed in Section 4.4.3.1, Threatened and Endangered Species, and in Section 4.4.3.2, ESA Candidate, State Sensitive, and Conservation Agreement Species (USFS 2008; Duncan 2010). Those species not included in the Federal and State lists that are discussed in those sections are listed below. Species and habitat descriptions, along with the different agency designations and the likelihood of occurrence in the study area, are found in Appendix C5, Special-Status Species.

- Peregrine falcon (*Falco peregrinus*)
- Cache beardtongue (*Penstemon compactus*)
- Cronquist daisy (*Erigeron cronquistii*)
- Frank Smith violet (*Viola frank-smithii*)
- Logan buckwheat (*Eriogonum loganum*)

4.4.3.4 Management Indicator Species (MIS)

USFS also maintains a list of MIS that is used for forest planning. These species are representative species of particular habitat types found on National Forest System land that are thought to be sensitive to National Forest management activities. The *Revised Forest Plan for the Wasatch-Cache National Forest* (USFS 2003) identifies five MIS in the Wasatch-Cache part of the Uinta-Wasatch-Cache National Forest. The plan identifies goshawk (*Accipiter gentilis*), snowshoe hare (*Lepus americanus*), American beaver, Colorado River cutthroat trout (*Oncorhynchus clarki pleuriticus*), and Bonneville cutthroat trout as MIS. Bonneville cutthroat trout is discussed in Section 4.4.3.2, ESA Candidate, State Sensitive, and Conservation Agreement Species. Of the remaining four MIS, the American beaver is the only species that has potential habitat in the study area.

The American beaver lives in ponds, lakes, rivers, and streams and the riparian habitats associated with them. Healthy riparian communities with willows and cottonwoods are essential for providing food and lodge-building materials for the beaver. Because the channel of the Logan River through the study area is narrow and constrained where developments are not located, there is very little potential habitat for the American beaver.

4.4.4 Cultural and Tribal Resources

NRCS conducted a records search of the study area through the Utah Division of State History on March 2, 2010. NRCS also conducted electronic file searches of the General Land Office plat maps and the National Register of Historic Places (NRHP) online database. The LN and LHPS Canals are not listed on the NRHP and have not been formally evaluated for their eligibility for listing.

What are cultural resources?

Cultural resources include any prehistoric or historic district, site, building, structure, or object listed on or eligible for listing on the National Register of Historic Places (NRHP); all records, artifacts, and physical remains associated with NRHP-eligible historic properties; and properties of traditional cultural and religious importance that also meet the NRHP criteria.

The records search results did not include any information about the canals or any structures associated with the canals. To date, NRCS has not completed a formal survey of the canals and associated structures to determine if they are eligible for listing on the NRHP. NRCS plans to conduct a pedestrian-level survey of the area and to finalize what it expects to be the area of potential effects (APE) on cultural resources for each alternative.

Under Section 106 of the National Historic Preservation Act (NHPA), a property can be eligible for listing on the NRHP under the following criteria:

> The quality of significance in American history, architecture, archaeology, engineering, and culture is present in districts, sites, buildings, structures, and objects that possess integrity of location, design, setting, materials, workmanship, feeling, and association, and:
>
> A. That are associated with events that have made a significant contribution to the broad patterns of our history; or
>
> B. That are associated with the lives of significant persons in our past; or
>
> C. That embody the distinctive characteristics of a type, period, or method of construction, or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction; or
>
> D. That have yielded, or may be likely to yield, information important in history or prehistory.

What is Section 106?

Section 106 of the National Historic Preservation Act requires Federal agencies to take into account the effects of their undertakings on historic properties. Under Section 106, a *historic property* is defined as any prehistoric or historic district, site, building, structure, or object listed on or eligible for listing on the National Register of Historic Places.

According to local knowledge and the records maintained at USU, construction of ditch and canal systems in this part of Cache Valley began with Euro-American settlement in the late 1850s and early 1860s. Over the following decade, communities in this part of Cache Valley

expanded the ditch and canal system as settlement continued. Given this history, both canals are probably eligible for listing on the NRHP under Criterion A.

The project area includes parts of the communities of Logan and North Logan. Many of the buildings in these communities are important to the history of the valley, and both cities have buildings that are listed on the NRHP. For example, many of the buildings at USU are listed on the NRHP. The project area probably supports many other buildings that are eligible for listing but that have not been evaluated for eligibility. Some of these potentially eligible buildings are probably present in the southern part of the study area around USU.

On April 20, 2010, NRCS initiated Section 106 consultation by sending notifications to the Utah SHPO at the Utah Division of State History, the Uinta-Wasatch-Cache National Forest, Cache County, the City of North Logan, and representatives of the Logan & Northern Irrigation Company and the Logan, Hyde Park and Smithfield Canal Company.

This initial invitation was followed by an invitation to representatives of the Ute Indian Tribe of the Uintah and Ouray Reservation and the Shoshone Tribe of the Wind River Reservation on July 21, 2010. NRCS sent follow-up letters on September 17, 2010. These follow-up letters identified USFS and USACE as cooperating agencies under NEPA and partners in the EIS process. The letters stated that the project could affect historic properties and invited all recipients to become consulting agencies under Section 106.

The SHPO responded to NRCS's original notification on March 30, 2010. In this response, the SHPO concurred that the proposed project could result in adverse effects but declined to make a formal finding pending the results of the planned pedestrian survey of the alternative alignments.

Copies of all correspondence with the SHPO and the Section 106 consulting agencies are contained in Appendix B, Agency Correspondence. No tribal representatives responded to the July 21 or September 17 invitations.

4.4.5 Topography, Soils, and Geology

4.4.5.1 Topography

The study area is located in the eastern part of Cache Valley, which is a broad, semi-arid, mostly rural valley in northern Utah and southern Idaho. Within Utah, Cache Valley covers about 660 square miles (Bjorklund and McGreevy 1971). The study area is about 8 square miles, is situated entirely within Utah, and is generally bounded by the Bear River Range to the east, the Logan River to the south, and the central part of Cache Valley to the west and north.

What is topography?

Topography refers to the general configuration of the ground surface, including features such as slope and differences in elevation.

The topographic conditions in the study area are shown in Figure 4-4. Topographically, the study area can be considered in three parts: the area north of US 89 (400 North in Logan), the area south of US 89, and the area in Logan Canyon.

Study Area North of US 89. The study area north of US 89 slopes to the west at a gradient of about 7%. The northeast corner of the study area is at an elevation of about 5,160 feet above mean sea level (msl), and the northwest corner is at an elevation of about 4,520 feet above msl. North of US 89, the average elevation is about 4,720 feet above msl.

What is a gradient?

The *gradient* of a slope describes its steepness. A downward slope with a gradient of 7% would lose 7 feet of elevation over a distance of 100 feet.

Study Area South of US 89. The study area south of US 89 includes an approximately 160-foot-high south-facing slope that is referred to as the Logan Bluff. The Logan Bluff descends to the south from US 89 to Canyon Road at an average gradient of about 50%. The existing LN Canal alignment traverses the bluff about 35 feet above Canyon Road. The relatively flat topographic floodplain of the west-trending Logan River is south of the Logan Bluff. The Logan River has down-cut (eroded) into adjacent lacustrine sediments (sediments formed in a lake), which has resulted in a topographic floodplain that is about 50 feet lower than the adjacent lacustrine sediments to the south and about 130 feet lower than the lacustrine sediments to the north. This area is locally referred to as the "Island" because it is surrounded by higher topography (Figure 4-4).

Study Area in Logan Canyon. The study area in Logan Canyon includes the Logan River and the steep slopes of the Bear River Range that descent to the canyon floor. The Logan River discharges into the Little Bear River, which is a tributary of the Bear River, outside the study area.

4.4.5.2 Surface Soils

Surface soils in the study area are shown in Figure 4-5. In general, the study area north of US 89 consists of silty loam trending toward gravelly loam near the eastern study area boundary. The Logan Bluff is characterized as gravelly loam on steeper slopes, and the "Island" is mapped as mostly gravelly loam on mild slopes (USDA NRCS 1974).

Figure 4-4. Topographic Map

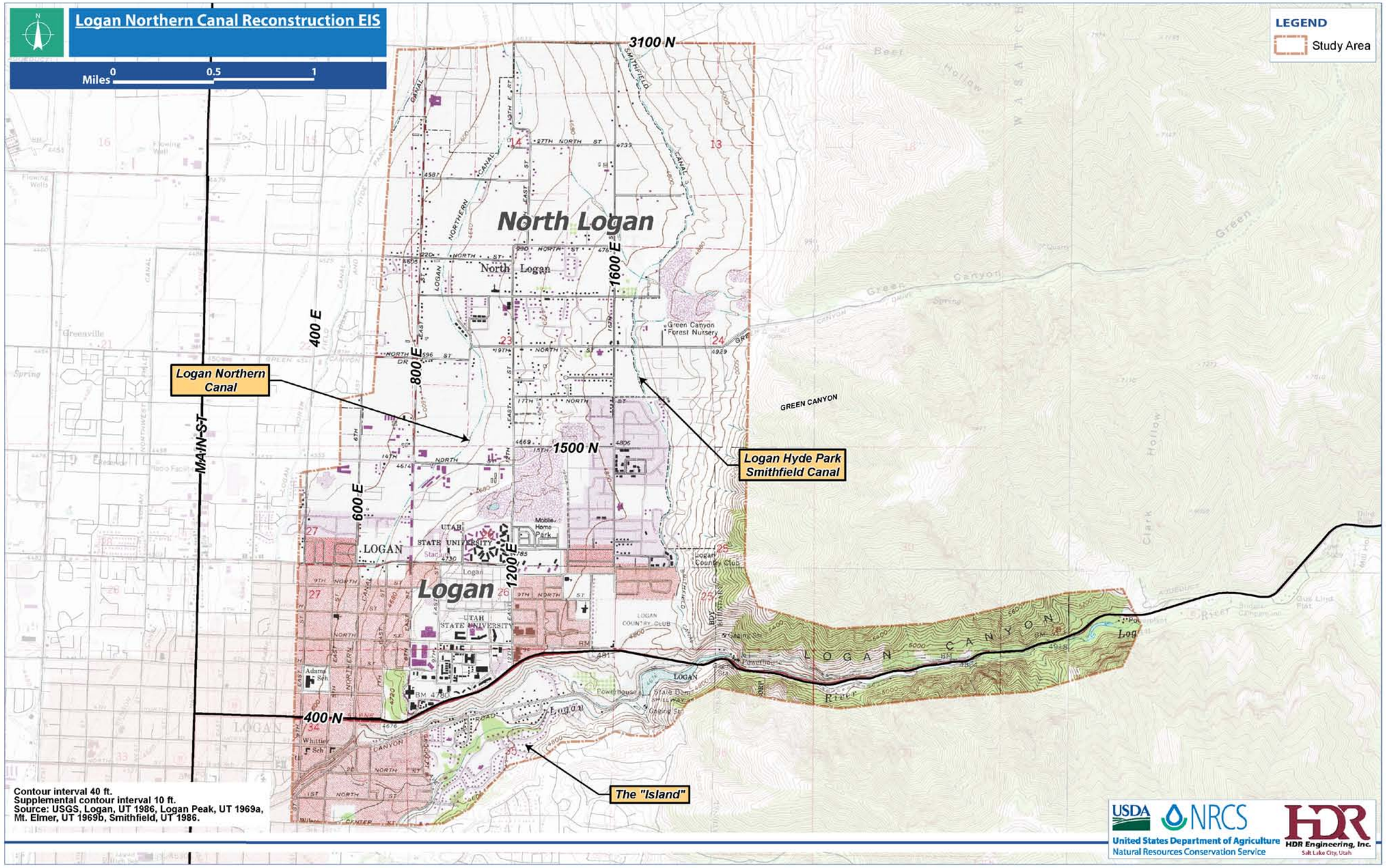
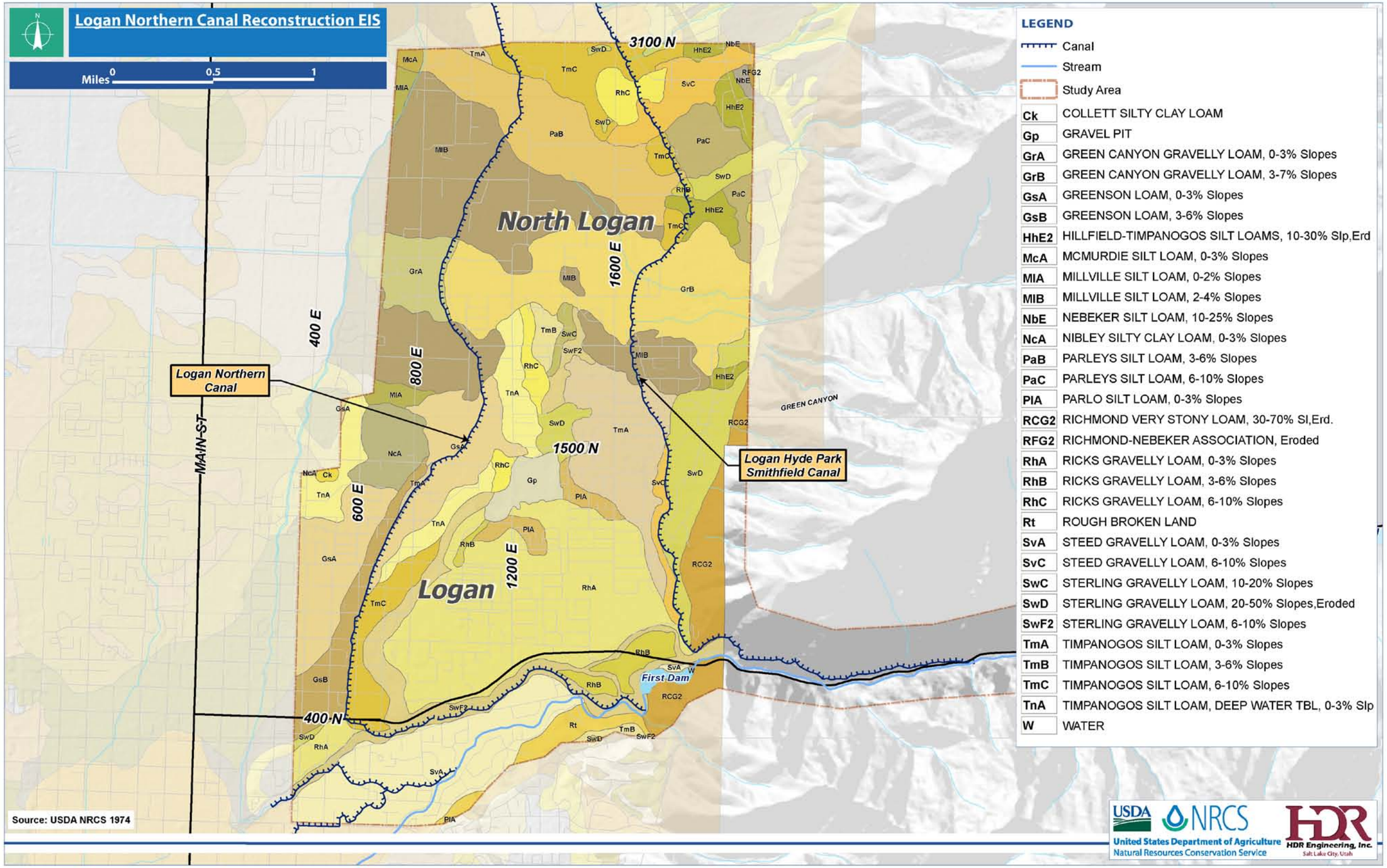


Figure 4-5. Surface Soils Map



4.4.5.3 Geology

This section describes the geology in the study area.

General Geologic Setting

Cache Valley is in the structural transition zone between the Basin and Range and Middle Rocky Mountains physiographic provinces (Stokes 1977). In Utah, the basin is bounded by the West Cache fault zone on the west and the East Cache fault zone on the east. The West Cache fault zone separates the valley from Clarkston Mountain, the Junction Hills, and the Wellsville Mountains; the East Cache fault zone separates the valley from the Bear River Range. These mountains are underlain by a complex sequence of sedimentary rocks ranging in age from the Proterozoic Eon to the Tertiary Period (Solomon and Unger 2010).

What are the Proterozoic Eon, Tertiary Period, and Pleistocene Epoch?

The *Proterozoic Eon* is the eon from about 2.5 billion to 542 million years ago. The *Tertiary Period* is the period from about 65 million to 1.8 million years ago. The *Pleistocene Epoch* is the epoch from about 2.6 million to 10,000 years ago.

Cache Valley was a bay of ancestral Lake Bonneville, which occupied much of northern Utah during the Pleistocene Epoch. Many of the surface deposits in Cache Valley and in the study area were deposited during the Bonneville lake cycle (Gilbert 1890).

Lake Bonneville began slowly rising from a low level about 28,000 years ago,[1] reaching its highest level, the Bonneville high stand, around 15,500 years ago (late Pleistocene time; Oviatt and others 1992), at which time the ancestral lake covered much of western Utah, eastern Nevada, and southern Idaho.

What is the Bonneville high stand?

The *Bonneville high stand* is the level of ancestral Lake Bonneville at its highest water surface elevation. Other high stands, such as the Provo high stand, occurred as the lake receded.

The lake remained at the Bonneville high stand, which in the current project area is about 5,180 feet above msl, for several thousand years. About 14,500 years ago, the lake dropped about 400 feet over a period of a few days to perhaps a week to an elevation of about 4,800 feet (referred to as the Provo high stand; Oviatt and others 1992), as a result of a catastrophic breach at Red Rock Pass in southern Idaho. The lake occupied the Provo high stand for about 500 years. The lake then began receding (in response to climatic conditions), reaching a level at or lower than the present Great Salt Lake about 12,000 years ago (Madsen 2000).

[1] All dates pertaining to Lake Bonneville are in conventional radiocarbon years before present.

Geologic Conditions of the Study Area

The general geologic conditions of the study area are shown in Figure 4-6.

Study Area North of US 89. The part of the study area north of US 89 is underlain by the following deposits and sediments:

- Post–Lake Bonneville alluvial fan deposits (geologic units Qaf1 and Qaf2; Figure 4-6) consisting of boulders to clay (Lowe and Galloway 1993).
- Deltaic sediments (geologic unit Qd3; Figure 4-6), which were deposited as the Logan River discharged into Lake Bonneville when the lake was at an elevation of about 4,800 feet above msl (this elevation is referred to the Provo high stand of former Lake Bonneville). These sediments consist primarily of pebbles to cobbles in a fine- to coarse-grained sand matrix (Lowe and Galloway 1993). Based on review of well logs in the area, this geologic unit also contains discontinuous layers of silt and clay.
- Offshore Bonneville lake cycle sediments (geologic units Qlf_3 and Qlf_4; Figure 4-6) consisting of fine sand, silt, and clay deposited when Lake Bonneville stood at the Bonneville high stand (Lowe and Galloway 1993).
- Nearshore Bonneville lake cycle sediments (geologic unit Qlc4; Figure 4-6) consisting of cobbles to sand deposited when Lake Bonneville stood at the Bonneville high stand (Lowe and Galloway 1993).
- Boulder to sand deposits of unknown origin (geologic unit Qnd; Figure 4-6) (Lowe and Galloway 1993).

What is an alluvial fan?

An *alluvial fan* is a fan-shaped deposit formed where a fast-flowing stream flattens, slows, and spreads, typically at the exit of a canyon onto a flatter plain.

What is a geologic unit?

A geologic unit is a body of rock or soil that has a distinct origin and consists of dominant, unifying features that can be easily recognized and mapped.

Study Area South of US 89. A geologic cross-section that represents the geologic conditions within and south of the Logan Bluff is shown in Figure 4-7. The geologic cross-section is based on water well logs filed with the Utah Division of Water Rights (2010b), published geologic maps (Lowe and Galloway 1993; Evans and others 1996), and published cross-sections within and across Cache Valley (Bjorklund and McGreevy 1971; McGreevy and Bjorklund 1971; Kariya and others 1994; Robinson 1999; Lachmar and others 2004; Thomas and others 2010).

- The bluff is underlain by deltaic sediments associated with the Provo and younger high stands of Lake Bonneville (geologic unit Qlpd; Figure 4-6). These deposits consist of clast-supported pebble and cobble gravel in a matrix of sand and minor silt and sand layers (Evans and others 1996).
- The deltaic sediments are underlain by lacustrine deposits (geologic unit Qlbs; Figure 4-6) associated with the Bonneville high stand; these sediments consist of coarse to fine sand, silt, and minor clay (Evans and others 1996).
- Primarily stream alluvium (geologic units Qal_1 and Qal_2; Figure 4-6) is present in the "Island." These sediments consist of clast-supported pebble and cobble gravel in a matrix of sand, silt, and clay (Evans and others 1996).
- South of the "Island," the study area is underlain by lacustrine sediments (geologic unit Qlbs; Figure 4-6) similar to those that underlie the Logan Bluff (Evans and others 1996).

Study Area in Logan Canyon. The part of the study area in Logan Canyon is underlain by the following deposits:

- Stream alluvium (geologic units Qal_1 and Qal_2; Figure 4-6), which consists of clast-supported pebble and cobble gravel in a matrix of sand, silt, and clay (Evans and others 1996).
- Bedrock units of the Bear River Range (geologic units Ꞓsc, Ogc, Osp, Si, and Dwc; Figure 4-6). These geologic deposits consist primarily of limestone, dolostone, and quartzite (Evans and others 1996).

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Figure 4-6. General Geologic Map

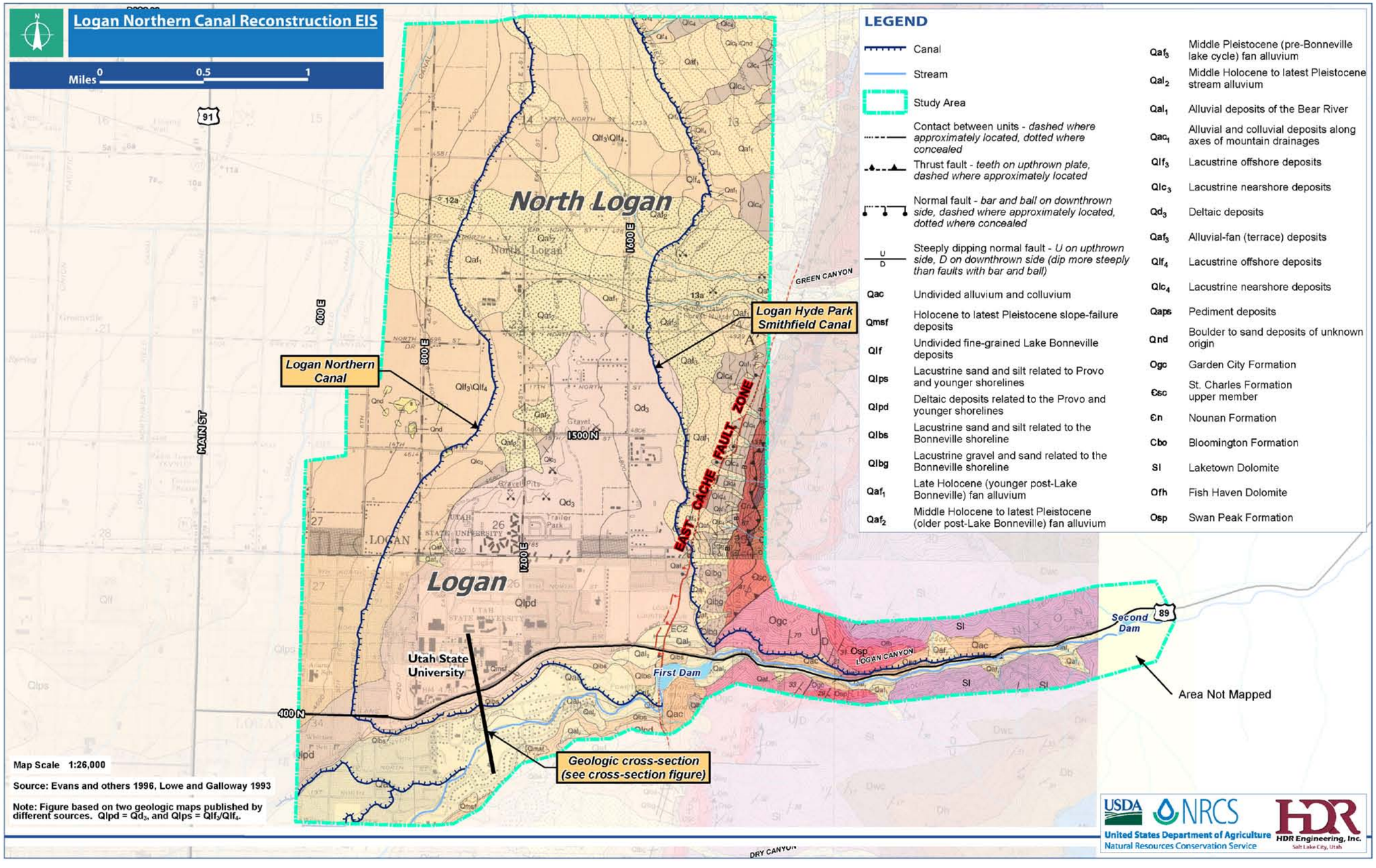
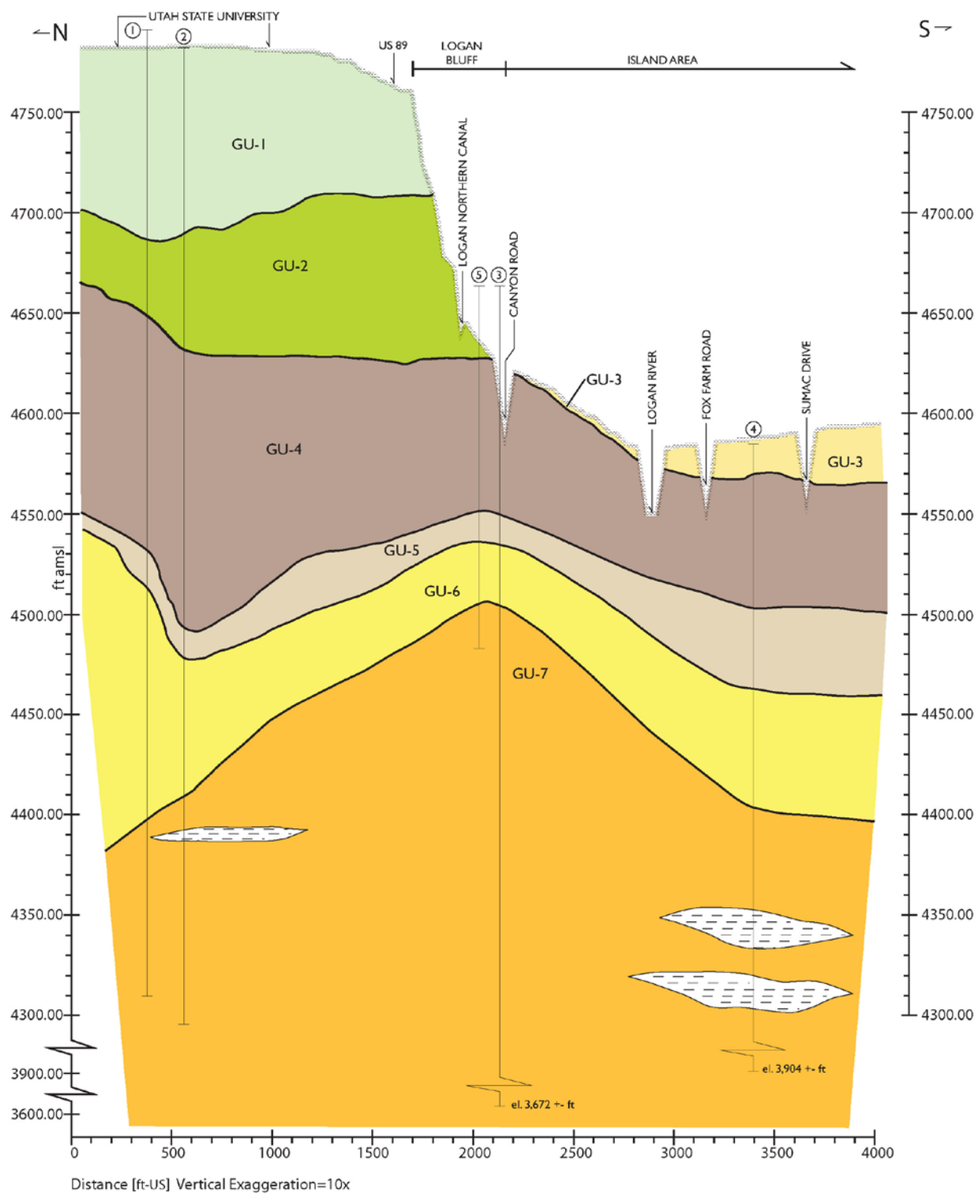
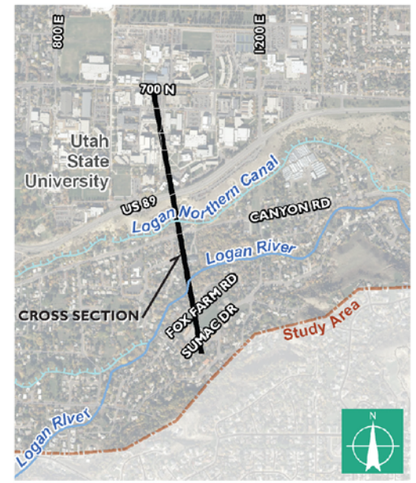


Figure 4-7. Geologic Cross-Section

Logan Northern Canal Reconstruction EIS





Water Well Summary			
Well Number Designation	Water Rights Number	Surface Elevation of Well (ft.)	Depth of Well (ft.)
①	a28982	4,791	430
②	25-8463 25-8765	4,782	434
③	25-3394	4,650	978
④	e90705yk 9925003P00	4,585	681
⑤	25-9878 e90702hd	4,650	180

Source: Utah Division of Water Rights 2010b

Explanation of Geologic Units (GU)

GU-1: Deltaic deposits related to Provo level and younger lacustrine shorelines, generally consisting of clast-supported pebble and cobble gravel in a matrix of sand and minor silt, with thin sand beds; mostly deposited at the time of the Lake Bonneville flood (Evans and others 1996); High permeability (Qlpd, Figure 4-9).

GU-2: Lacustrine sand and silt related to the Bonneville shoreline (high stand), consisting of coarse to fine sand, silt, and minor clay with typically rhythmical bedding, deposited in a near shore environment and within lagoons (Evans and others 1996); likely moderate permeability, less than the overlying GU-1 deposits and may **act as a confining layer to groundwater flow (both horizontally and vertically).**

GU-3: Stream alluvium, consisting of clast-supported pebble and cobble gravel in a matrix of sand, silt and minor clay, with thin sand lenses (Evans and others 1996); moderate to high permeability (Qac and Qcl, Figure 4-9).

GU-4: Lacustrine clays, with discontinuous layers of clayey sand, clayey silt, and gravels; very low permeability, **likely corresponds to upper confining layer of Robinson (1999).**

GU-5: Lacustrine sand, with some discontinuous layers of clay, silt, and gravels; high permeability.

GU-6: Lacustrine clays, with discontinuous layers of clayey sand, clayey silt, and gravels; very low permeability, **likely corresponds to lower confining layer of Robinson (1999).**

GU-7: Deltaic or alluvial fan deposits consisting of primarily gravelly sand with some discontinuous silt and clay layers; high permeability.

Discontinuous clay layer: shape and length unknown

GU1-GU6 are subunits of deltaic deposits (Qlpd, Qd3) and lacustrine deposits related to the Bonnevilleshoreline (Qlbs). Contacts between geologic units are approximate and based on the results of limited subsurface exploration combined with interpolation and extrapolation of subsurface conditions between and beyond exploration locations.

USDA NRCS HDR
United States Department of Agriculture
Natural Resources Conservation Service

General Seismic Setting

Cache Valley is situated in the Intermountain Seismic Belt. This belt is a 100-mile-wide, north-south-trending zone of earthquake activity that extends from Arizona through western Utah to northern Montana. The belt is one of the most seismically active areas in the continental United States (Smith and Sbar 1974). Northern Utah has a record of strong earthquakes, and many earthquakes greater than magnitude 4 have occurred in northern Utah over the past century (University of Utah Seismological Station 2010).

What is the magnitude of an earthquake?

Earthquake *magnitude* is a measure of the energy released by an earthquake. Magnitude is measured on a logarithmic scale, which means that the shaking from a magnitude 5 earthquake is 10 times as strong as the shaking from a magnitude 4 earthquake.

On August 30, 1962, at 6:35 AM, a magnitude 5.7 earthquake occurred in Cache Valley. The epicenter was near Richmond, Utah, about 12 miles north of Logan. In Logan, several large buildings experienced structural damage (Solomon and Unger 2010). The earthquake shaking severity was rated at VII on the Modified Mercalli Intensity (MMI) Scale (USGS 2010a).[1]

There have been no documented earthquakes with epicenters in the study area (University of Utah Seismological Station 2010).

Faulting

The study area includes part of one fault zone, the East Cache fault zone. Other fault zones in the region include the West Cache fault zone (Black and others 2000), the Wasatch fault zone (Personius 1990), and the Temple Ridge fault zone (Westway and Smith 1989). Because it is in the study area, the East Cache fault zone is the focus of the following discussion.

What is a normal fault?

A *fault* is a break in Earth's crust along which blocks of rock slide relative to one another. A *normal fault* is a fault in which the overlying side of the fault has moved downward relative to the underlying side of the fault. The angle of the fault is usually 45 to 90 degrees and in most cases is about 60 degrees.

The East Cache fault zone, which is about 50 miles long, is a down-to-the-west, high-angle normal fault that trends from James Peak, Utah, to northeast of Preston, Idaho. This fault zone forms the boundary between Cache Valley and the Bear River Range on the east side of Cache Valley (Solomon and Unger 2010). Cache Valley is a valley formed by Basin and Range–type faulting that occurs in a transition zone on the western margin of the Middle Rocky Mountains physiographic province. In Utah, the East Cache fault zone is divided into

[1] The U.S. Geological Survey describes a MMI VII earthquake as "[d]amage negligible in buildings of good design and construction; slight to moderate [damage] in well-built ordinary structures; considerable damage in poorly built or badly designed structures; some chimneys broken" (USGS 2010b). The Association of Bay Area Governments augments the definition of a MMI VII earthquake to include "...waves on ponds; water turbid with mud. Small slides and caving in along sand or gravel banks. Large bells ring. Concrete irrigation ditches damaged" (ABAG 2010).

three sections—the northern, central, and southern sections—based on fault-zone complexity, geomorphology, and expression of surface fault scarps (McCalpin 1989, 1994).

The central section of the fault zone crosses the southeast part of the study area (Figure 4-6). This section extends from Green Canyon south to Blacksmith Fork Canyon (a distance of 9.6 miles) and is defined by a single-fault trace along the steep range front (Solomon and Unger 2010).

What is a scarp?

A *scarp* is a steep cliff or slope formed by faulting.

The central section of the fault zone is the most active of the three sections and shows evidence of activity during the Holocene Epoch (McCalpin 1989, 1994; Black and others 2003). Because of this relatively recent activity, the East Cache fault zone is considered an active fault. The length of the central section and the amount of displacement along the central section indicate that it can generate earthquake magnitudes in the range of 6.6 to 7.1, which could cause surface displacement of 1.6 to 6.2 feet (Solomon and Unger 2010).

What is the Holocene Epoch?

The *Holocene Epoch* is the epoch that began about 10,000 years ago.

Radiocarbon ages indicate that the most recent surface-faulting earthquake on the central section occurred between about 4,000 and 4,200 years ago, with a recurrence interval of 9,000 to 11,500 years (Haller and others 2005). This recurrence interval and the recent surface-faulting earthquake occurring between about 4,000 and 4,200 years ago suggest a low probability that the East Cache fault zone would experience a surface fault rupture within the lifetime of the project (about 50 years).

What is a surface fault rupture?

A *surface fault rupture* is the displacement seen on the ground surface when the sides of the fault have moved up or down as a result of a large earthquake.

Subsurface Geologic Conditions

Data on subsurface geologic conditions for the study area are scarce. The primary source of direct subsurface information is water well logs. Published geologic cross-sections within and across Cache Valley provide indirect information about subsurface geologic conditions (Bjorklund and McGreevy 1971; McGreevy and Bjorklund 1971; Kariya and others 1994; Robinson 1999; Lachmar and others 2004; Thomas and others 2010). This information is reflected in the geologic cross-section (Figure 4-7).

4.4.5.4 Geologic Hazards

Geologic hazards in the study area include rock falls, landslides, and secondary effects of seismic ground shaking (earthquakes). Earthquakes cause a variety of hazards in addition to ground shaking, including liquefaction and related ground failure, slope failure, surface faulting, and various types of flooding (Solomon and Unger 2010).

Rock Falls

The only area in the study area that is susceptible to rock falls is Logan Canyon. This area has relatively steep slopes (greater than 30 degrees) that descend to the canyon floor. Solomon and Unger (2010) classify Logan Canyon as a high rock-fall hazard potential area, which is defined as:

> All slopes greater than 35 degrees, below barren rock outcrops littered with abundant rock-fall boulders, and associated rock fall shadows. Rock-fall sources are typically underlain by fractured and jointed limestone and dolomite that generate large, angular blocks of debris.

What is rock fall?

Rock fall refers to the relatively free-falling or precipitous movement of a newly detached segment of bedrock of any size from a cliff or other very steep slope.

The normal operating procedures for the LHPS Canal include inspecting the canal through Logan Canyon and removing rocks from the canal. This ongoing maintenance is required to keep the LHPS Canal free of rocks and able to safely accommodate water.

Landslides

As described in Section 2.2.1.2, Address the Remaining Hazards Associated with the Landslide Zone, and as shown in Figure 2-3, Historic Landslides, the Logan Bluff south of US 89 in the study area has a history of landslides. The instability along the bluff is due to various factors, including the properties of the geologic units that make up the bluff, topography, and the migration of groundwater from areas north of the bluff. Another cause is saturation of sediments from subsurface ponding of water along the more impervious geologic units as indicated by the numerous springs along the bluff. Based on the long history of landslides in this area and the hydrology and geologic parameters of the Logan Bluff, future landslides are likely to occur.

Surface Fault Rupture

The central segment of the East Cache fault zone crosses the east part of the study area (see Figure 4-6 and the section titled Faulting on page 4-51), including the LHPS Canal and the LN Canal west of First Dam.

Solomon and Unger (2010) have delineated a special-study area for surface-fault-rupture hazards for the central segment of the East Cache fault zone. Because of the potential for surface fault rupture, Solomon and Unger recommend site-specific fault investigations prior to development in this area. The purpose of a fault investigation is to evaluate the earthquake history of the area, characterize the zone of deformation, and determine building setbacks. The procedures of such investigations should follow the criteria of Christenson and others (2003). Setbacks and other hazard-reduction techniques may vary for the siting of infrastructure facilities that must commonly cross faults, such as highways, utilities, pipelines, canals, and water impoundment and storage facilities. The investigation methods should be the same for the siting of these infrastructure facilities as for structures designed for human occupancy[1] and critical facilities.[2]

Earthquakes

Large, damaging earthquakes are rare events in Cache Valley, but active faults in the area can produce earthquakes at least as large as magnitude 7.4 (Cluff and others 1974; Glass and others 1976; McCalpin 1994; Black and others 2000; McCalpin and Solomon 2001; Black and others 2003). Such large earthquakes could cause strong ground shaking, which could trigger liquefaction, earthquake-induced flooding and seiches, seismically induced land-sliding, and subsidence. These hazards could cause catastrophic property damage, economic disruption, and loss of life in the study area (Solomon and Unger 2010).

Table 4-12 shows anticipated ground accelerations for the study area. Ground accelerations were determined for a point near the center of the study area with coordinates of latitude 41.7 degrees North and longitude 111.8 degrees West. The ground accelerations in Table 4-12 include estimated peak (bedrock) ground acceleration, the 0.2-second spectral response acceleration, and the 1.0-second spectral response acceleration for 2% and 10% probabilities of exceedance. For example, Table 4-12 shows that the study area has a 10% probability of experiencing a peak ground acceleration of at least 0.172 g within the next 50 years.

What is ground acceleration?

Ground acceleration is a measure of how hard the earth shakes during an earthquake, generally expressed in *g*, which is the acceleration due to Earth's gravity.

[1] A *structure designed for human occupancy* is typically considered to be any structure used or intended for supporting or sheltering any use or occupancy, which is expected to have an occupancy rate of at least 2,000 person-hours per year, but does not generally include an accessory building (that is, a structure not designed for human occupancy, which can include tool or storage sheds, gazebos, swimming pools, and so on).

[2] *Critical facilities* are Category II and III structures as defined in the 2000 International Building Code (IBC, table 1604.5, page 297; International Code Council 2000) and Category III and IV structures in the 2003 IBC (table 1604.5, page 272; International Code Council 2003), and include schools, hospitals, fire stations, high-occupancy buildings, water-treatment plants, and facilities containing hazardous materials (IBC building occupancy classes E, H, and I structures; see table 1) (Christenson and others 2003). Critical facilities include essential facilities.

Table 4-12. Anticipated Ground Accelerations for the Study Area

Ground Acceleration	Probability of Exceedance	
	10% in 50 Years	2% in 50 Years
Peak (bedrock) ground acceleration	0.172 g	0.379 g
0.2-second spectral response acceleration	0.416 g	0.918 g
1.0-second spectral response acceleration	0.138 g	0.326 g

Source: Peterson and others 2008

For purpose of this EIS, the peak (bedrock) ground acceleration was not adjusted for the effects of soil amplification. Such adjustments should be performed during site-specific design of structures.

The following paragraphs discuss the potential liquefaction, seiche, flooding, landslide, and subsidence hazards associated with seismic ground shaking.

Liquefaction Potential. Strong ground shaking can cause liquefaction, which generally occurs in areas of shallow groundwater and sandy soils (Solomon and Unger 2010). Liquefaction can cause various kinds of ground failure. Cache County generally has a lower liquefaction potential than do other counties in Utah (Anderson and others 1994), but in the study area, the "Island" and the topographic floodplain associated with the Logan River have the highest liquefaction potential (Anderson and others 1994; McCalpin and Solomon 2001; Solomon and Unger 2010).

What is liquefaction?

Liquefaction is the temporary transformation of a saturated, cohesionless soil into a fluid as a result of ground shaking during an earthquake.

Table 4-13 defines the categories of liquefaction potential. Anderson and others (1994) report that the part of the study area north of US 89 and the Logan Bluff area is situated in an area of low and very low liquefaction potential. The topographic floodplain area south of the Logan Bluff associated with the Logan River (that is, the "Island") is situated in an area of moderate-to-high and moderate-to-low liquefaction potential. Finally, the part of Logan Canyon that is in the study area is situated in an area of very low liquefaction potential.

Table 4-13. Definitions of Liquefaction Potential

Liquefaction Potential	Probability That the Critical Ground Acceleration Needed To Induce Liquefaction Will Be Exceeded in 100 Years
Very low	Less than 5%
Low	5% to 10%
Moderate	10% to 50%
High	Greater than 50%

Source: Anderson and others 1994

A recent study by Solomon and Unger (2010) evaluated liquefaction susceptibility using geologic units and depth to groundwater. This study produced similar findings as those presented by Anderson and others (1994).

Seiches and Earthquake-Induced Flooding. Seiches and seismically induced failure of canals in the study area could cause flooding of downslope areas. Earthquakes could also produce flooding by damaging water storage or conveyance structures such as dams, pipelines, and canals (Solomon and Unger 2010). The East Cache fault zone crosses the LHPS Canal and the west end of First Dam, so downslope areas could experience earthquake-induced flooding from the LHPS Canal.

What is a seiche?

A *seiche* is an oscillation or standing wave in an enclosed body of water.

Seismically Induced Landsliding. Strong ground shaking can cause slope failures. Rock falls and landslides are common in steep terrain during moderate and large earthquakes (Solomon and Unger 2010). The 1962 earthquake near Richmond, Utah, caused a landslide in Logan Canyon that covered part of US 89 (Eldridge and O'Brien 2001).

The Logan Bluff area is well documented for slope instability and landslides that are not associated with seismic events. Landslides and slope instability in this area would be much worse during seismic ground shaking, and seismically induced landslides could occur in the Logan Bluff area. The potential for rock falls in Logan Canyon would also be much higher during seismic ground shaking.

Subsidence. During a large surface-faulting earthquake, subsidence can occur because the ground surface tilts on the side of the fault that drops downward. This tilting can affect broad areas that extend for miles from the surface trace of the fault (Solomon and Unger 2010). When the ground surface tilts, this can damage gravity-flow structures such as irrigation or drainage canals and prevent them from working properly. Because the study area is located on the down-dropped side of the East Cache fault zone and the fault zone crosses the east part of the study area, the LHPS and LN Canals could be affected by earthquake-induced subsidence.

What is subsidence?

Subsidence is a gradual sinking of land with respect to its previous level.

4.4.6 Water Resources

This section describes the existing water resources in the study area. These resources are surface waters (which include natural streams, irrigation canals, and wetlands), water quality, stormwater, floodplains, and groundwater resources. This section also describes water use and water rights in the study area.

4.4.6.1 Surface Waters

This section describes the existing conditions of the surface waters in the study area. The surface waters in the study area are the Logan River, Green Canyon Creek, the LN Canal, and the LHPS Canal. The surface waters are shown in Figure 4-8.

What is a stream?

In Section 4.4.6.1, the term *stream* is used as a general term to describe linear waterways such as rivers, creeks, washes, and canals.

The U.S. Environmental Protection Agency (EPA) has primary responsibility for regulating waters of the U.S. under the CWA. According to 40 CFR 230.3(s), *waters of the U.S.* are:

1. All waters which are currently used, or were used in the past, or may be susceptible to use in interstate or foreign commerce, including all waters which are subject to the ebb and flow of the tide;
2. All interstate waters including interstate wetlands;
3. All other waters such as intrastate lakes, rivers, streams (including intermittent streams), mudflats, sandflats, wetlands, sloughs, prairie potholes, wet meadows, playa lakes, or natural ponds, the use, degradation or destruction of which could affect interstate or foreign commerce including any such waters:
   (i) Which are or could be used by interstate or foreign travelers for recreational or other purposes; or
   (ii) From which fish or shellfish are or could be taken and sold in interstate or foreign commerce; or
   (iii) Which are used or could be used for industrial purposes by industries in interstate commerce;
4. All impoundments of waters otherwise defined as waters of the United States under this definition;
5. Tributaries of waters identified in paragraphs (s)(1) through (4) of this section;
6. The territorial sea;
7. Wetlands adjacent to waters (other than waters that are themselves wetlands) identified in paragraphs (s)(1) through (6) of this section; waste treatment systems, including treatment ponds or lagoons designed to meet the requirements of the CWA (other than cooling ponds as defined in 40 CFR 423.11[m] which also meet the criteria of this definition), are not waters of the United States.

The waters of the U.S. in the study area are the Logan River, Green Canyon Creek, and several unnamed streams and wetlands.

EPA has delegated regulation of waters of the U.S. under Section 404 of the CWA to USACE. Waters of the U.S. are sometimes referred to as *jurisdictional waters* because they are under the jurisdiction of USACE.

Recent guidance in the *U.S. Army Corps of Engineers Jurisdictional Determination Form Instructional Guidebook* (USACE and EPA 2007) defines *jurisdictional waters* as certain geographical features (such as ditches and canals) that transport relatively permanent flow (a continuous flow of water during at least one season) directly or indirectly into or between two (or more) waters of the U.S., including wetlands. Both the LHPS Canal and the LN Canal meet this definition because they convey water from the Logan River to Summit Creek (which is a tributary of the Bear River). Summit Creek is in Smithfield, which is outside the study area (Figure 4-9).

Since the canals are waters of the U.S., activities that would discharge fill material to the canals would be regulated under Section 404.

Figure 4-8. Surface Waters in the Study Area

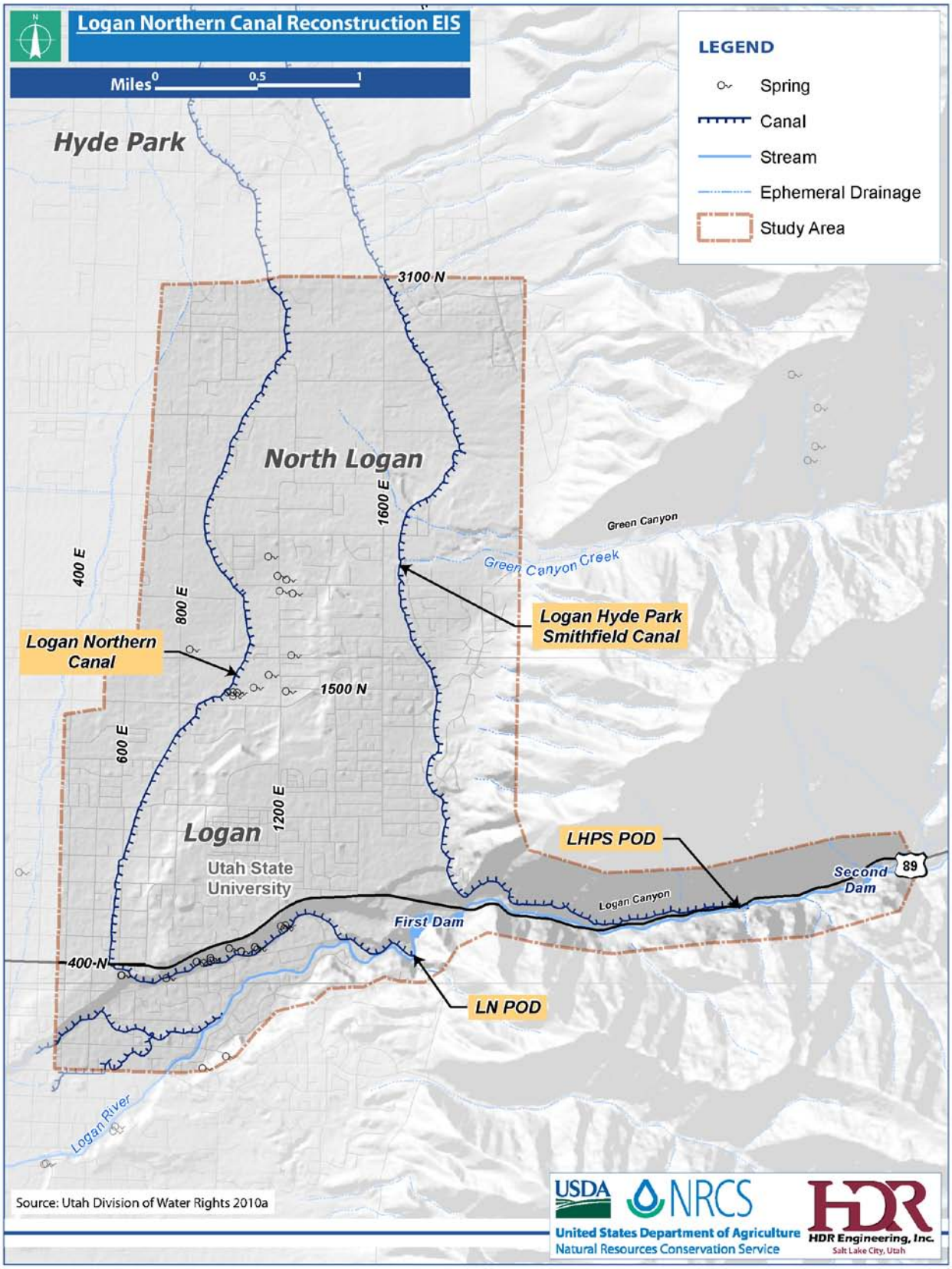
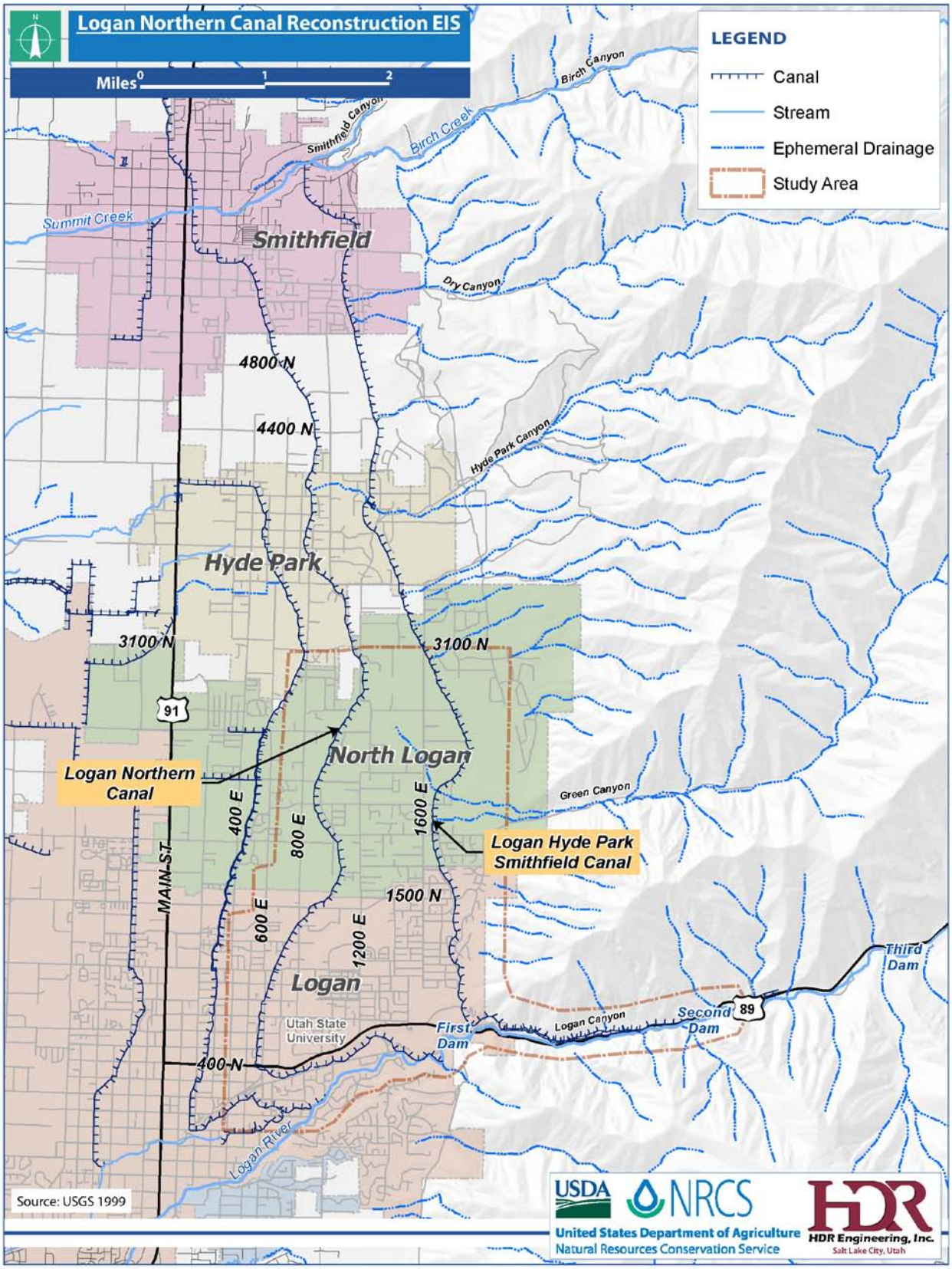


Figure 4-9. Logan Northern Canal and Logan Hyde Park Smithfield Canal Alignments

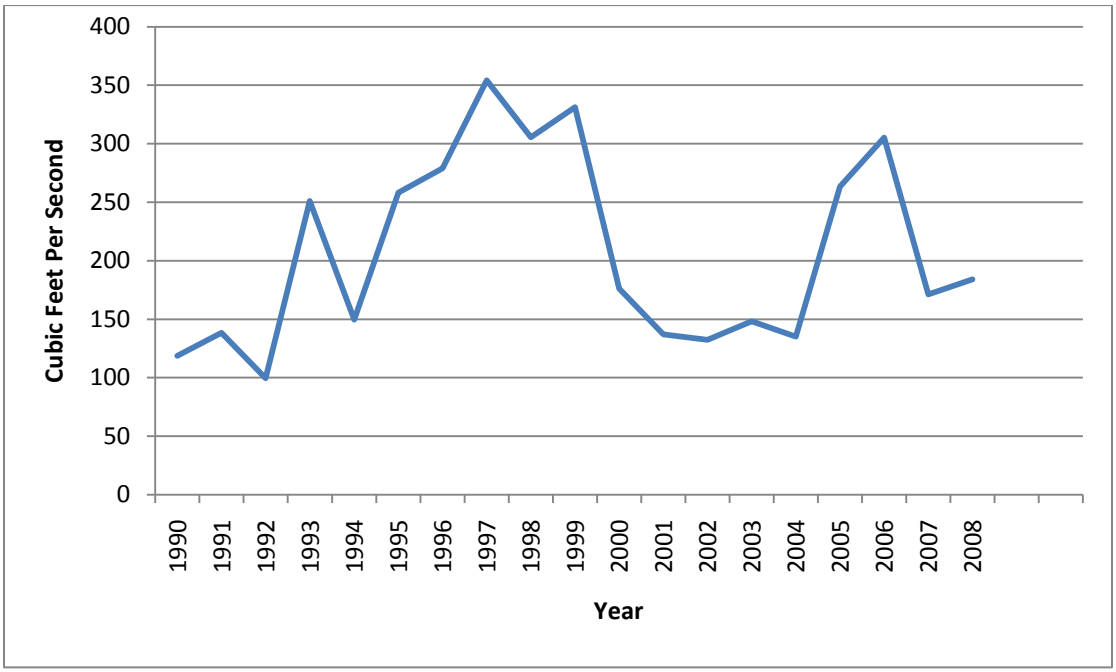


Logan River

The Logan River is a perennial water course that travels through Logan Canyon, flows into and through Logan, and continues westerly through Cache County before joining the Little Bear River, which flows into the Bear River. The Logan River is the largest tributary to the Bear River (Utah Division of Water Resources 2004). The river flows west through the southern part of the study area.

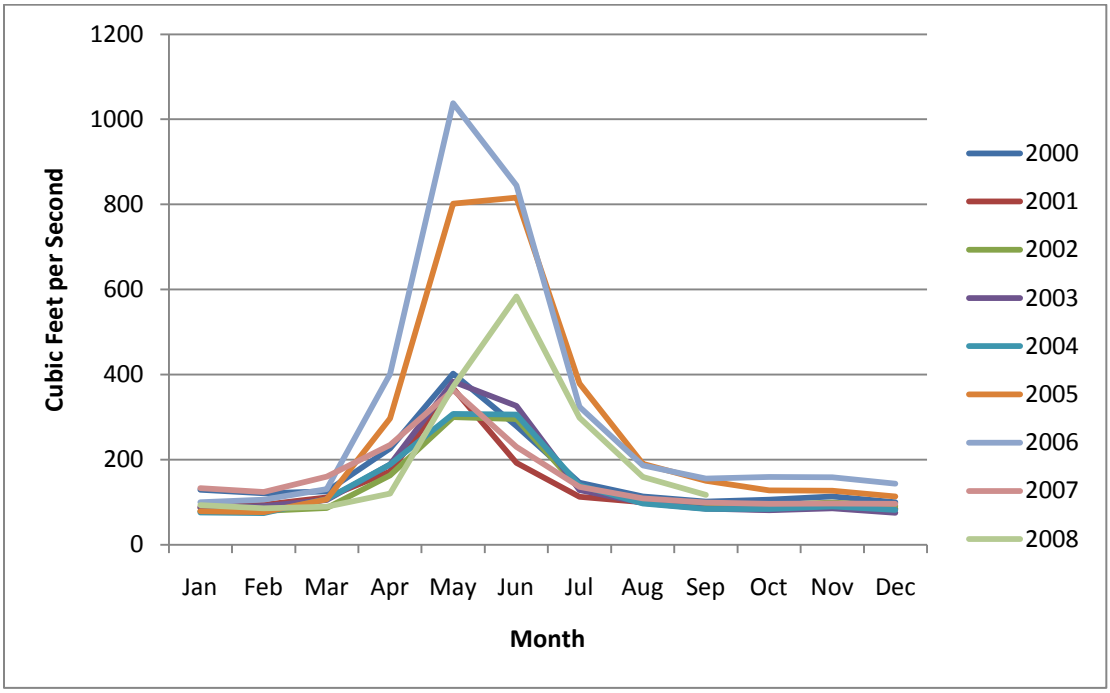
The U.S. Geological Survey (USGS) operates a flow gage (number 10109000) on the Logan River above First Dam. Data collected at this gage show that the average annual flow of the Logan River from 1990 through 2008 was 207 cfs (USGS 2010c). Average annual flows for the past 18 years are illustrated in Chart 4-1, and average monthly flows between 2000 and 2008 are shown in Chart 4-2.

Chart 4-1. Average Annual Flows in the Logan River as Reported by USGS Gage 10109000 above First Dam



Source: USGS 2010c

Chart 4-2. Average Monthly Flows in the Logan River as Reported by USGS Gage 10109000 above First Dam



Source: USGS 2010c

Flows in the Logan River vary from year to year and generally follow multiyear drought-and-wet-precipitation weather cycles. Flows in the river also vary from month to month and are influenced by storms, temperature, and spring runoff from melting winter snow.

USFS classifies and protects riparian areas that border the reaches of rivers that pass through National Forest System land, including the Uinta-Wasatch-Cache National Forest. Activities that affect these riparian areas are subject to review by USFS and must remain in compliance with the *Revised Forest Plan for the Wasatch-Cache National Forest* (USFS 2003). In the *Revised Forest Plan*, USFS lists the riparian area along the Logan River as *Riparian Class 1*. A Class 1 rating indicates that an area has a high existing or potential value for resources such as water quality, wildlife and fish habitat, and recreation.

What are riparian areas?

Riparian areas are areas that border a river, canal, or other waterway. They are wetter than and provide different habitat than the surrounding upland areas.

In the study area, the Logan River has two dams that allow water to be diverted for agricultural, industrial, municipal, and residential irrigation use and hydropower use. There are also numerous small structures (such as diversion structures) for other uses. Records on file with the Utah Division of Water Rights show that the State Dam (referred to in this EIS as First Dam) is owned by USU, is 30 feet high, and retains about 70 acre-feet of water (Utah Division of Water Rights 2010c). The LN Canal POD is located below First Dam. First Dam

and the LN Canal POD are not located National Forest System land. Second Dam is located about 2 miles upriver of First Dam on National Forest System land. The information on the Utah Division of Water Rights website regarding Second Dam (Utah Division of Water Rights 2010c) identifies the owner as Logan City Light and Power. Second Dam diverts water to the penstocks for the Logan City Light and Power Hydro 2 power plant. According to that information, this dam has a low hazard rating, no reported structural height, and a capacity of about 9 acre-feet.

The LHPS Canal POD is located on the Logan River about 0.3 mile below Second Dam. This POD is on National Forest System land. The LHPS Canal POD diverts water to LHPS Canal. Currently, Logan City Light and Power and the Logan, Hyde Park and Smithfield Canal Company diversions use most of the water that is in the reach of the river from Second Dam to the LHPS Canal POD during the late summer months; this generally results in minimal flow below the LHPS Canal POD during this period.

However, USGS gage data from gage 10109000 above First Dam suggest that the Logan River gains flow from groundwater, springs, and other sources in the reach from the LHPS Canal POD to First Dam. No other data are available for the reach of the river between the Logan City Light and Power Hydro 2 POD (at Second Dam) and First Dam. Because of this, NRCS does not have detailed information about the sources and quality of the inflows to the Logan River or quantities of water below the LHPS Canal POD.

From the LHPS Canal POD to the National Forest System land boundary (a distance of about 0.8 river mile), the Logan River might receive water that seeps from the 4,000 linear feet of the existing LHPS Canal on National Forest System land. This seepage might contribute water to the Logan River during the irrigation season. As discussed in Section 4.4.6.5, Groundwater Resources, NRCS estimates that the seepage loss rates from the LHPS Canal through Logan Canyon average about 6.5 cfs/mile (Weber 2004; Molina 2008). Some of this seepage reaches the Logan River. Based on observational data, the river gains water between the LHPS Canal POD and First Dam.

Other Water Courses

There are many small water courses in the eastern part of the study area (Figure 4-8). These water courses include Green Canyon Creek and are identified as *supporting intermittent streams* on the Logan, Utah, and Smithfield, Utah, USGS 7.5-minute quadrangle maps (USGS 1998a, 1998b). Many of these small water courses terminate at the LHPS Canal. Green Canyon Creek flows past the LHPS Canal and terminates farther west in Cache Valley.

LN Canal

Management and operation of the LN Canal is discussed in Section 2.1.2, Canal Management and Operation. The LN Canal begins at a POD structure below First Dam on the Logan River and ends north of Smithfield, Utah. Figure 2-2, Route of Logan Northern Canal, shows the route of this canal. The character of the canal changes at various places along its alignment

according to whether it is in an urban area or in an area currently used for agriculture. For the purpose of this discussion, the canal alignment through the study area is divided into three sections that have similar physical characteristics and land uses: the Upper Reach, the Logan City Reach, and the Lower Reach.

Upper Reach: POD to 400 North. The Upper Reach is shown in Figure 4-15 at the end of this chapter. Water is diverted from the Logan River into an open, trapezoidal channel that traverses the Logan Bluff. A dirt-surface maintenance road follows much of the canal; this road is used by the Logan & Northern Irrigation Company, the canal operator.

Currently, the canal has a small diversion at about 1100 East in Logan called the Laub Diversion. The Laub Diversion provides a point from which water can be diverted from the canal back to the Logan River. Historically, this section of the canal conveyed irrigation water, stormwater from US 89 and adjacent parking areas, water from seeps and springs along the Logan Bluff, and, occasionally, excess culinary water from the City of Logan's Crockett Avenue Well.

Prior to the 2009 landslide, the Logan & Northern Irrigation Company diverted irrigation water from mid-April through mid-October. Since the landslide, some irrigation water has been temporarily diverted at the POD during the irrigation season to serve shareholders between the POD and the Laub Diversion. Under this temporary system, all remaining water is removed from the canal at the Laub Diversion and is eventually discharged back to the river. Two temporary check dams (sandbags and pumps) currently keep incidental water collected by the LN Canal through the bluff area from flowing into the landslide area.

Logan City Reach: 400 North to 1500 North. The Logan City Reach is shown in Figure 4-16 at the end of this chapter. The canal water flows through this residential area in an earthen ditch that has culverts and pipes to convey the water under streets. The maintenance road continues to follow this reach of the canal. This reach conveys irrigation water, stormwater that is discharged at multiple locations by the City of Logan, and, occasionally, excess culinary water from a City of Logan well at about 700 North/600 East. Before the 2009 landslide, LN Canal shareholders were provided irrigation water from this reach.

Since the 2009 landslide, the East Bench Irrigation Company has temporarily provided some irrigation water to the LN Canal at 700 North through a pipeline under the USU campus. This temporary supply to the LN Canal is not considered to be a permanent source of irrigation water. Stormwater continues to be discharged into the canal in this reach.

Lower Reach: 1500 North to 3100 North. The Lower Reach is shown in Figure 4-17 at the end of this chapter. The canal water flows through this agricultural and residential area in an earthen ditch that has culverts to convey the water under streets. The maintenance road continues through this reach and is used for maintenance and unauthorized public recreation (trail) use. This section of the canal conveys irrigation water, stormwater that is discharged at multiple locations by the City of North Logan, and, occasionally, excess culinary water from a well operated by the City of North Logan. Before the 2009 landslide, LN Canal shareholders were provided irrigation water from this reach.

Since the 2009 landslide, some irrigation water has been temporarily provided using the Logan storm drain system between Lundstrom Park and the canal at 1500 North. This temporary supply to the LN Canal is not considered to be a permanent source of irrigation water. Stormwater continues to be discharged into the canal in this reach.

LHPS Canal

Management and operation of the LHPS Canal is discussed in Section 2.1.2, Canal Management and Operation. The LHPS Canal begins at the POD structure below Second Dam on the Logan River upstream (east) of Logan and ends north of Smithfield. The character of the canal changes at various places along its alignment according to whether it is in an urban area or in an area currently used for agriculture. For the purpose of this discussion, the canal alignment through the study area is divided into three sections that have similar physical characteristics and land uses: the Logan Canyon Reach, the Logan City Reach, and the North Logan City Reach.

Logan Canyon Reach: POD to Logan Golf & Country Club. The Logan Canyon Reach is shown in Figure 4-18 at the end of this chapter. Water is diverted from the Logan River into a box culvert that crosses under US 89 in Logan Canyon. The canal then traverses the south-facing slope of Logan Canyon on land managed by USFS to the Logan city municipal boundary. This section has historically been subject to rock fall and has lost water through seepage (Molina 2008). At the canyon mouth, the canal turns northerly and flows through the Logan Golf & Country Club as an open water feature with golf cart and pedestrian bridges spanning the canal.

This section of the canal conveys only irrigation water diverted at the POD. No shareholders take irrigation water in Logan Canyon.

Logan City Reach: Logan Golf & Country Club to Green Canyon Drive. The Logan City Reach is shown in Figure 4-19 at the end of this chapter. Water is conveyed through the golf course and residential areas in Logan and residential and agricultural areas in North Logan in an open, earthen ditch that has multiple culverts and pipes to convey water under streets. This section of the canal conveys irrigation water, incidental water discharges (such as golf course drainage and water tank overflow), and stormwater that is discharged at multiple locations from the Logan and North Logan storm drain systems. This reach also intercepts and carries runoff that drains from several unnamed intermittent drainages. LHPS Canal shareholders are provided irrigation water from this reach.

After the 2009 landslide that damaged the LN Canal, the operation of this section of the LHPS Canal was modified to provide some irrigation water to LN Canal shareholders. The operational changes included two temporary connections: one using the East Bench Irrigation Company's pipeline under USU and one using the Logan storm drain system between Lundstrom Park and the LN Canal at about 1500 North. These temporary diversions discharged into the LN Canal at 700 North and 1400 North, respectively, and are not permanent sources of irrigation water for the LN Canal shareholders.

North Logan City Reach: Green Canyon Drive to 3100 North. The North Logan City Reach is shown in Figure 4-20 at the end of this chapter. Water is conveyed through this agricultural and residential area in an open, earthen ditch with culverts that convey water under streets. This section of the canal conveys irrigation water and stormwater that is discharged at multiple locations from the North Logan storm drain system. This reach also intercepts and carries runoff that drains from several unnamed intermittent drainages. LHPS Canal shareholders are provided irrigation water from this reach.

After the 2009 landslide, the operation of this section of the LHPS Canal was affected by upstream operational changes that allowed some LN Canal water to be delivered to LN Canal shareholders.

Wetlands

Figure 4-10 shows the potentially jurisdictional wetlands in the study area. The wetlands shown are those identified through the National Spatial Data Infrastructure (NSDI) database (USFWS 1986) and through a field survey in 2010.

The NSDI database identifies the locations of wetlands across the country based on information collected in 1986 as a result of the Emergency Wetlands Resources Act. NSDI-mapped wetlands have not been verified as jurisdictional under the CWA, and, because the data are almost 25 years old, many of the wetlands originally mapped probably no longer exist. However, the NSDI information does provide general information about the distribution of potentially jurisdictional wetlands.

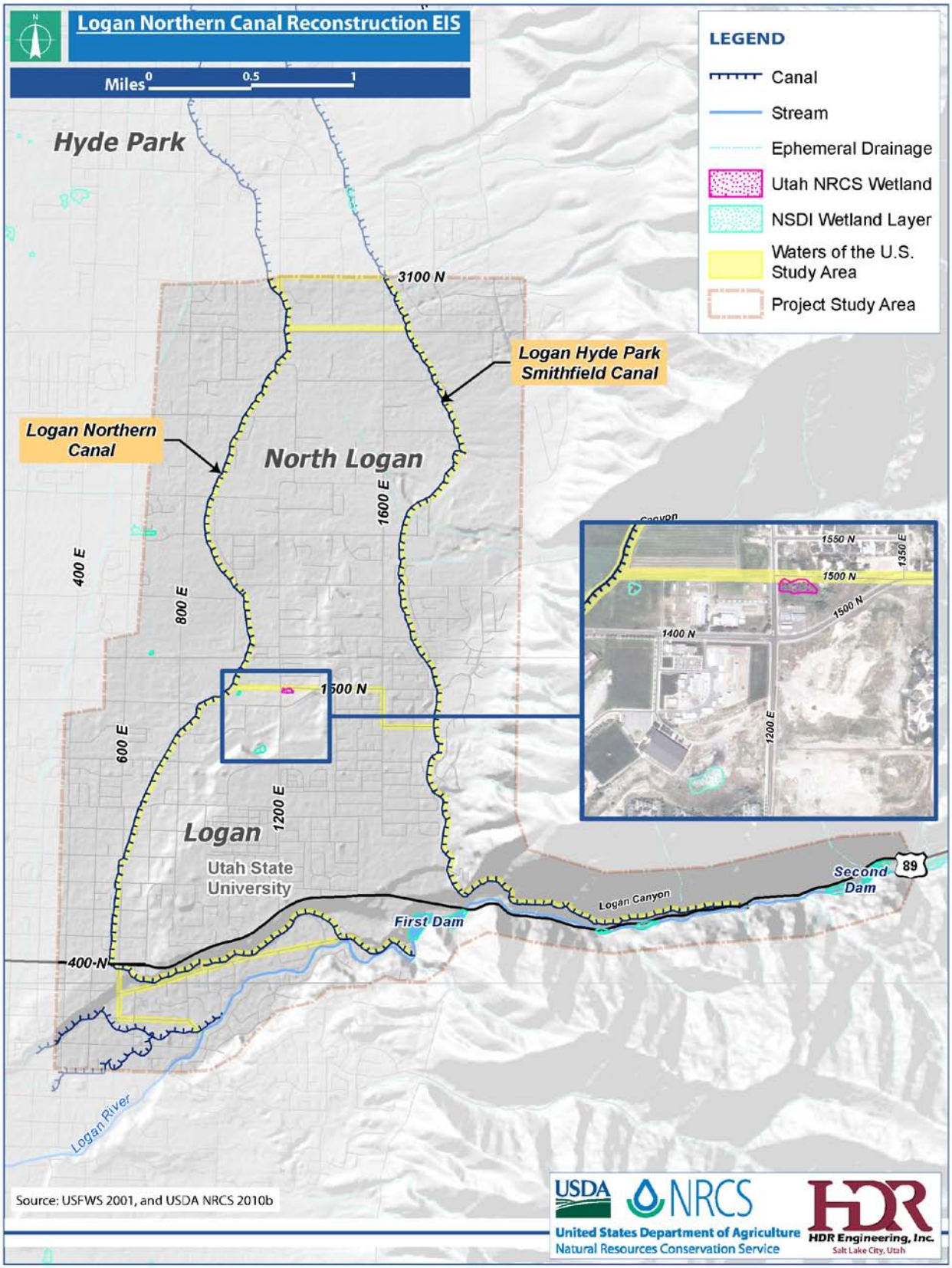
In September 2010, NRCS delineated, or identified, *potentially* jurisdictional wetlands in waters of the U.S. study areas that followed the alternative alignments (the waters of the U.S. study areas are shown on Figure 4-10). This delineation followed guidance provided in the *Corps of Engineers Wetlands Delineation Manual* (Environmental Laboratory 1987) and the *Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Arid West Region*, Version 2.0 (Environmental Laboratory 2008).

Through the wetland delineation, NRCS identified 0.58 acre of potentially jurisdictional wetlands. Several sections of the banks of both the LN and LHPS Canals have side bank areas with soils that support wetland vegetation. These areas are dominated by hydrophytic vegetation, but the soils fail to show any indicators of hydric soils as defined in the 2008 *Regional Supplement*. NRCS submitted the results of the delineation to USACE in October 2010 for its review (USDA NRCS 2010b), and USACE issued a preliminary jurisdictional determination (PJD) on January 5, 2011 (USACE 2011). The PJD states that USACE agrees that the potentially jurisdictional features presented in the delineation report, which include 0.72 acre of wetlands and about 55,349 linear feet of canals or other water bodies, might be subject to USACE's jurisdiction under Section 404 of the CWA (Appendix B, Agency Correspondence).

What are hydrophytic vegetation and hydric soils?

Hydrophytic vegetation is plants that are adapted to prolonged conditions of saturated soil. *Hydric soils* are soils that are saturated, flooded, or ponded during part of the year and so develop specific and identifiable soil characteristics.

Figure 4-10. Wetlands in the Study Area



4.4.6.2 Water Quality

Under the CWA, every State must establish and maintain water quality standards designed to protect, restore, and preserve the quality of waters in the state. These standards consist of narrative standards for all waters, specific numeric standards for protecting beneficial uses, and antidegradation provisions. EPA has delegated implementation of some CWA requirements, including those identified in Section 303 of the CWA, to State agencies.

In Utah, the Division of Water Quality applies numeric standards to measure the quality of waters in the state as described in Section 303. Water bodies are assigned beneficial uses such as providing agricultural water, providing drinking water, supporting wildlife, and supporting recreation. Numeric standards for water quality, which are established in support of the Division of Water Quality's Section 303 program, are intended to protect these beneficial uses by limiting the amounts of certain pollutants in the water. In addition, the Division of Water Quality and Utah Administrative Code Rule R317-2-3 have established antidegradation provisions. These provisions are intended to maintain high-quality waters at levels above the applicable water quality standards.

Impaired Waters

Under Section 303(d) of the CWA, States and authorized tribes must identify waters for which a water quality standard has not been met, even if the required minimum levels of pollution-control technology have been adopted. Such waters are called *impaired waters* and are identified as such on a Section 303(d) list.

What is a Section 303(d) list?

When a lake, river, or stream fails to meet the water quality standards for its designated beneficial use, Section 303(d) of the CWA requires that the State place the water body on a list of "impaired" waters, which is also known as a Section 303(d) list.

The Utah Division of Water Quality lists the section of the Logan River in the study area as protected for the following beneficial uses (Utah Rule R317-2-13, effective October 1, 2010):

- Class 2B: Protected for infrequent primary and secondary contact recreation
- Class 3A: Protected for cold-water species of game fish and other cold-water aquatic life
- Class 3D: Protected for waterfowl, shore birds, and other water-oriented wildlife not included in Classes 3A, 3B, or 3C, including the necessary aquatic organisms in their food chain
- Class 4: Protected for agricultural uses

The Division of Water Quality monitors waters in the state to determine whether they are meeting their designated beneficial uses. When the quality of a surface water does not meet the standards associated with its beneficial uses, Section 303(d) of the CWA requires that the affected waters be placed on the State's list of impaired waters.

The Division of Water Quality's *Draft 2010 Integrated Report* identifies the reach of the Logan River from Third Dam in Logan Canyon downstream to Cutler Reservoir as not supporting the Class 3A beneficial use because of the amount of total phosphorous in this reach. However, because total phosphorous is a water quality indicator and not a water quality standard, the Division of Water Quality has not listed the Logan River as a stream Assessment Unit that is impaired and in need of a Total Maximum Daily Load (TMDL) analysis (Utah Division of Water Quality 2010). Therefore, the Logan River through the study area is not on the State's 303(d) list.

What is a TMDL analysis?

A *TMDL (Total Maximum Daily Load) analysis* is a calculation of the maximum amount of a pollutant that a water body can receive and still meet water quality standards.

High-Quality Waters

In addition to designating some waters as impaired waters, the Utah Division of Water Quality also designates some waters as high-quality waters. *High-quality waters* are waters of the state whose quality is better than the water quality standards associated with their beneficial uses. The Division's antidegradation policy (Utah Administrative Code, Rule R317-2-3) requires maintaining high-quality waters unless the Utah Water Quality Board determines that allowing lower water quality is necessary to accommodate important economic or social development in the area where the waters are located. The categories used to describe waters under the antidegradation policy are different from the categories applied under the CWA Section 303(d) program.

What is an antidegradation policy?

The State's *antidegradation policy* requires maintaining high-quality waters, which are waters of the state whose quality is better than the water quality standards associated with identified beneficial uses. The policy is applied through the State's *antidegradation standards*.

The antidegradation policy designates the Logan River as a *Category 1 high-quality water* for the reach that is in Logan Canyon and on Federally owned land. Category 1 waters have exceptional recreational or ecological significance or have been determined to be a State or national resource that requires protection.

This EIS assumes that the Logan River is designated as a *Category 3 water* downstream of the canyon because it is not specifically listed as a Category 1 or 2 water. Category 3 waters are those that are not protected as high-quality waters. This EIS also assumes that Green Canyon Creek is designated as a *Category 3 water* through the study area because it is also not specifically listed as a Category 1 or 2 water.

4.4.6.3 Stormwater

Stormwater runoff in the study area generally flows from developed and undeveloped areas from the eastern part of the study area to the west. The LN and LHPS Canals intercept and

collect much of this stormwater. In the study area, the canals are an important component of the stormwater systems in Logan and North Logan. Downstream communities outside the study area also depend on the canals for collecting and conveying stormwater.

The canals are connected to natural drainages and urban stormwater drainage by diversion structures, pipes, and overflow structures. Historically, the irrigation canals intercepted stormwater runoff from the foothills and agricultural land, and this still occurs in the study area. In developed or urbanized areas, the Cities of Logan and North Logan collect and convey stormwater to the canals through a drainage system consisting of curb and gutter, detention facilities, and discharge pipes.

In the recent past, stormwater entering the canals has caused flooding downstream in Hyde Park and Smithfield. The irrigation companies actively manage the canals to remove debris, reduce irrigation flows, and reduce canal flows before and during storms to alleviate downstream flooding. Because the canals were originally built to carry irrigation water and because the canals lose capacity as they travel away from the POD, the addition of non-detained stormwater from developed areas can overwhelm the canal system and cause flooding. Debris can make the problem worse by obstructing a canal or taking up space in a canal.

To control any additional stormwater entering the canal systems, the Cities of Logan, North Logan, Hyde Park, and Smithfield adopted the Northern Cache Valley Storm Water Design Standards (City of Logan and others 2009). These design standards require new developments and redeveloped areas to detain and treat stormwater runoff before discharging it into the canals. The City of Logan has a stormwater master plan (Psomas 2001), as does the Cache County Urbanized Area (JUB 2003). These master plans specifically identify drainage areas, existing and future stormwater flows based on land use, and the types of storms for which the systems are designed.

In addition to stormwater master plans, the Cities of Logan, North Logan, and Hyde Park also have Utah Pollutant Discharge Elimination System (UPDES) General Permits for Discharges from Small Municipal Separate Storm Sewer Systems. These UPDES permits, which are issued by the Utah Division of Water Quality, require municipalities and Counties to reduce pollutant discharges to stormwater to the maximum extent practicable by implementing a stormwater management plan and best management practices.

4.4.6.4 Floodplains

Floodplains are defined as normally dry areas that are occasionally inundated by high stream flows or high lake water. Development in floodplains can reduce their flood-carrying capacity and extend the flooding hazard beyond the developed area.

What is a regulatory floodplain?

A stream has a *regulatory floodplain* if the floodplain is identified and mapped by FEMA.

Floodplains are mapped by FEMA and managed at the local level by communities to prevent flooding. The

measures used by communities to prevent flooding include zoning, special subdivision or building standards, and special-purpose floodplain ordinances. Development in the mapped zones that could affect the base flood elevation is regulated by local and Federal agencies. A *base flood elevation* is the elevation to which floodwater is expected to rise during the base flood, where the base flood is the flood having a 1% chance of being equaled or exceeded in any given year. This regulatory standard is also referred to as the *100-year flood*.

Some of the streams and canals that traverse the study area have FEMA-defined regulatory floodplains. These are shown on Flood Insurance Rate Maps (FIRMs) produced by FEMA and are managed by a local floodplain administrator.

FIRMs That Apply to the Study Area. FEMA shows mapped, regulatory floodplains on the following FIRMs (FEMA 1984a, 1984b, 1986, 1987):

- Community Panel No. 490019 0006 B, effective date September 28, 1984
- Community Panel No. 490019 0005 B, effective date September 28, 1984
- Community Panel No. 490024 0005 B, effective date March 18, 1986
- Community Panel No. 490012 0006 B, effective date February 1, 1987

Floodplain Zones in the Study Area. The following mapped FEMA Special Flood Hazard Areas are present in the study area (Figure 4-11). A Special Flood Hazard Area is the area that would be covered by floodwaters and where floodplain management must be enforced.

- **Zone A2:** Areas that could be flooded by a 100-year flood (that is, a flood with a 1% chance of occurring each year), as determined by detailed methods.
- **Approximate Zone A:** Areas that could be flooded by a 100-year flood, as generally determined using approximate methods.
- **Zone B:** Areas between the limits of the base flood and the 500-year flood (that is, a flood with a 0.2% chance of occurring each year).
- **Zone C:** Areas that are not Special Flood Hazard Areas and that have minimal chance of flooding. Zone C areas are higher than the elevation of the 500-year flood.

Within the study area, FEMA has mapped two flooding risk areas: the Logan River and the surrounding land below First Dam, and the area around Green Canyon Creek. The floodplain associated with the Logan River is Zone A2 (FEMA 1984a, 1984b). Base flood elevations are shown in Figure 4-11 for Zone A2. The LN Canal POD is located within the Logan River mapped Zone A2 floodplain (FEMA 1984a). The LHPS Canal POD is not located in a FEMA mapped floodplain.

The floodplain associated with Green Canyon Creek is mapped Approximate Zone A, and other areas in North Logan are mapped Zone C. The Green Canyon Creek Zone A is crossed by both the LN Canal and the LHPS Canal (FEMA 1986, 1987).

Areas around the Logan River, around Green Canyon Creek, and in unincorporated areas of Cache County are mapped Zone C (FEMA 1986, 1987).

Figure 4-11. Mapped Floodplains in the Study Area

4.4.6.5 Groundwater Resources

Groundwater resources in Cache Valley and the study area are both confined and unconfined. Confined groundwater is trapped between two impervious layers of rock or clay soils, and unconfined groundwater is not restricted by impervious layers of rock. Confined groundwater in the study area occurs where permeable water-bearing beds of gravel or sand are overlaid by relatively impermeable beds of clay or silt. Within Cache Valley, the confining layers extend from the sides of the valley toward the middle of the valley (Utah Department of Natural Resources and U.S. Geological Survey 1971). Because the study area is closer to the mountains than to the middle of the valley, the water-bearing layers are not completely confined.

The study area is primarily mapped as a recharge zone. Once in the ground, some groundwater travels close to the surface and emerges in discharge areas as seeps or springs. The western part of the study area is mapped as a discharge zone (Figure 4-12). Groundwater flow through the study area is generally to the west from the Bear River Range on the east toward the middle of the valley.

What is a recharge zone?

A *recharge zone* is an area into which precipitation infiltrates into the ground to become groundwater.

Groundwater is recharged from direct precipitation that infiltrates into soil, from the streams that flow from the mountains into the valley, and from irrigation systems (Utah Department of Natural Resources and U.S. Geological Survey 1971). Groundwater levels fluctuate in direct response to the amount of annual precipitation, with groundwater rising in the spring when the snow melts. Seasonal fluctuations are also influenced by irrigation flows.

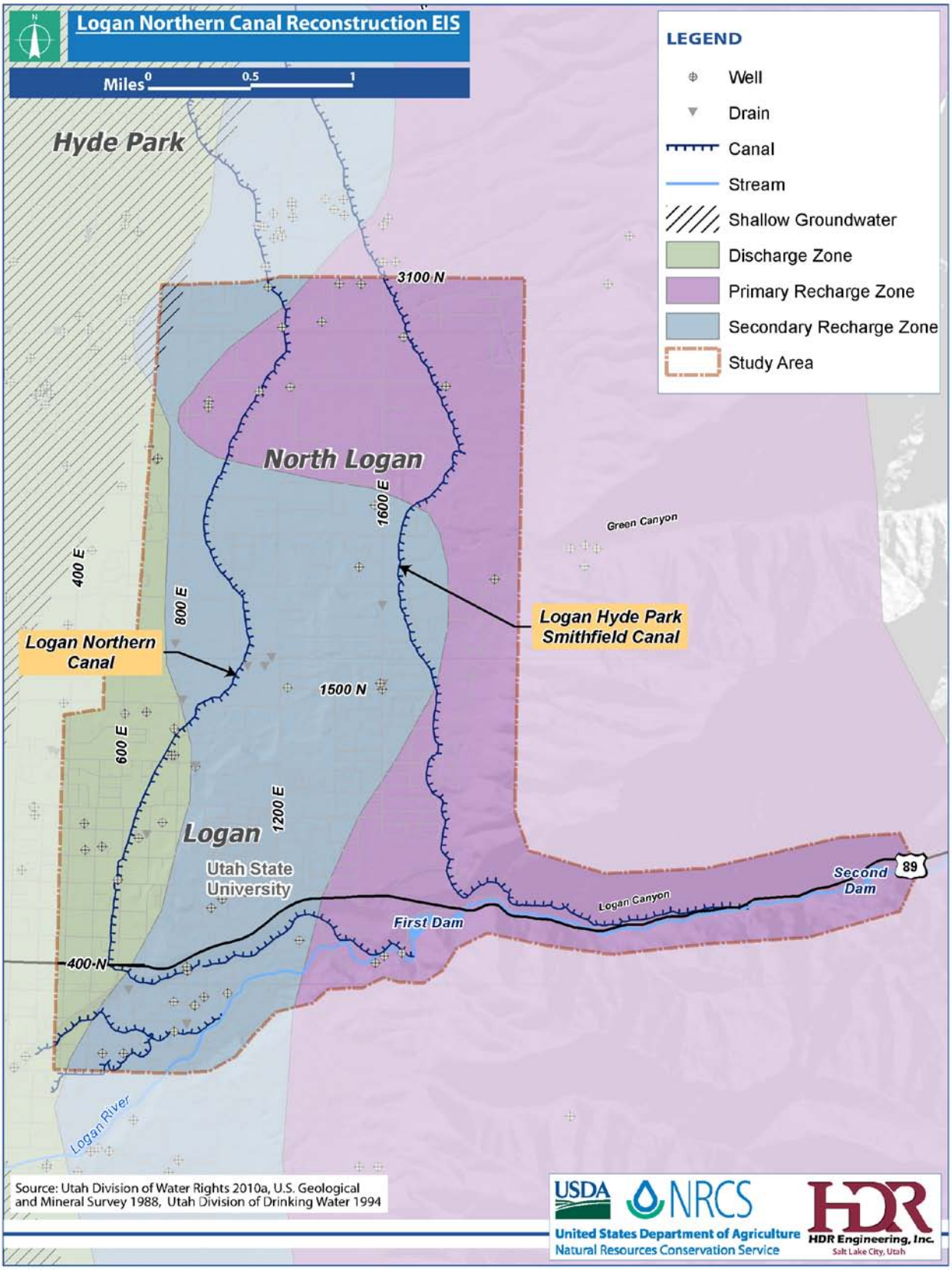
The annual Cache Valley groundwater recharge from infiltration, seepage from streams and canals, and other sources is estimated to be about 222,000 acre-feet (Utah Division of Water Resources 2004). The Utah Division of Water Rights established groundwater management guidelines in the 1999 Interim Cache Valley Ground-Water Management Plan (Utah Division of Water Rights 1999). The guidelines allow the State Engineer to review new applications to appropriate groundwater.

What is an acre-foot?

An *acre-foot* is unit of measurement that describes a volume of water. One acre-foot is a volume of water equal to covering 1 acre of land with 1 foot of water.

The reaches of the LN Canal and LHPS Canal through the study area are primarily unlined. This causes irrigation water to be lost through seepage but provides a source for recharging groundwater. A 2004 seepage study (Weber 2004) of several canals evaluated several areas along the LHPS Canal beginning at the canal's gage location in Logan Canyon and ending just south of North Logan. This study found that seepage rates varied along the LHPS Canal alignment, with an average flow rate loss of about 3 cfs/mile.

Figure 4-12. Groundwater Zones in the Study Area



Another seepage study completed in 2008 (Molina 2008) assessed many Cache Valley canals, including the LN and LHPS Canals, over 5 summer months. Based on the data from 2008, the weighted average losses for the LN and LHPS Canals were 2.2 cfs/mile and 4.9 cfs/mile, respectively. Using the 2008 study and applying these average figures to the total lengths of the LN and LHPS Canals in the study area (about 5 miles each) over the 6-month irrigation period, the estimated seepage loss is about 13,000 acre-feet per year. The total annual groundwater recharge is estimated at about 222,000 acre-feet from the following sources: all canals provide 86,000 acre-feet, precipitation provides 90,000 acre-feet, other sources contribute 45,000 acre-feet, and streams provide 1,000 acre-feet (Utah Division of Water Resources 2004).

Using information presented by Weber (2004) and Molina (2008), NRCS estimates that the average seepage rate is about 6.5 cfs/mile of LHPS Canal through Logan Canyon during the irrigation season (actual rates vary). Accordingly, NRCS estimates that about 6.5 cfs is lost from the LHPS Canal between the LHPS Canal POD and the canyon mouth, a distance of about a mile. Some of the seepage losses from the LHPS Canal in the canyon are probably conveyed to the groundwater and to the Logan River.

4.4.6.6 Water Use and Water Rights

All surface waters and groundwater in Utah are public property. A *water right* is a right to divert water (remove it from its natural source) and beneficially use it. The Utah Division of Water Rights is the State agency that regulates the legal use of water through appropriation. A *perfected water right* describes a specific water source and POD, the nature and extent of use, the place of use, and the date when the use was granted. The Division of Water Rights maintains a database that contains information on water rights, including the geographic location of the POD.

The Logan & Northern Irrigation Company and the Logan, Hyde Park and Smithfield Canal Company hold water rights that are diverted using the LN Canal and LHPS Canal, respectively. The LN and LHPS Canals provide this water based on shares to land owners, land managers, and municipalities during the irrigation season. Shareholders receive the water from the canals through diversions onto their properties. Shareholders access water for agricultural use, for municipal use (in residential, university, and park irrigation systems), and to use as exchanges for municipal use (such as the water exchanged by the City of Smithfield for spring water in Smithfield Canyon and by the City of Logan for spring water in Logan Canyon).

Shareholders use canal water to irrigate land through either flood irrigation or sprinkler irrigation systems. Sprinkler irrigation systems require land owners to pump water from the canal and sometimes filter the water to protect the pump system. Flood irrigation does not require pumping, but it is less efficient than sprinkler systems at applying water to the irrigated properties. NRCS estimates that flood irrigation is 40% to 65% efficient, whereas properly designed and operated sprinkler systems are 75% to 85% efficient (USDA NRCS 2006b).

The general plans of the Cities of Logan and North Logan encourage the conservation of water by converting irrigation systems from flood irrigation to sprinkler systems (City of North Logan 2002; City of Logan 2007).

Surface Water Rights

Figure 4-13 shows the PODs for the surface water rights in the study area (Utah Division of Water Rights 2010a, 2010b). The POD sources for surface water rights can be springs, drains, streams, rivers, or lakes. There are 241 surface water PODs and 57 springs in the study area.

The Logan & Northern Irrigation Company has several water rights with many surface and groundwater PODs. There are five water rights associated with the LN Canal POD on the Logan River downstream of First Dam: 25-3056, 25-6110, 25-6111, 25-6112, and 25-6113 (Table 4-14; Utah Division of Water Rights 2010b).

After the 2009 landslide, the Logan & Northern Irrigation Company requested and was granted a temporary change (t36289) in its water rights from the State Engineer. This change added the LHPS Canal POD as a temporary LN Canal POD and allowed delivery of about 50% of the LN Canal irrigation water to shareholders immediately after the 2009 landslide occurred. Water was temporarily conveyed from the LHPS Canal to the LN Canal using a pipeline installed by the City of Logan through Lundstrom Park and the city's storm drain system. USU also provided use of its system to temporarily provide water from the LHPS Canal to the LN Canal.

Figure 4-13. Points of Diversion in the Study Area

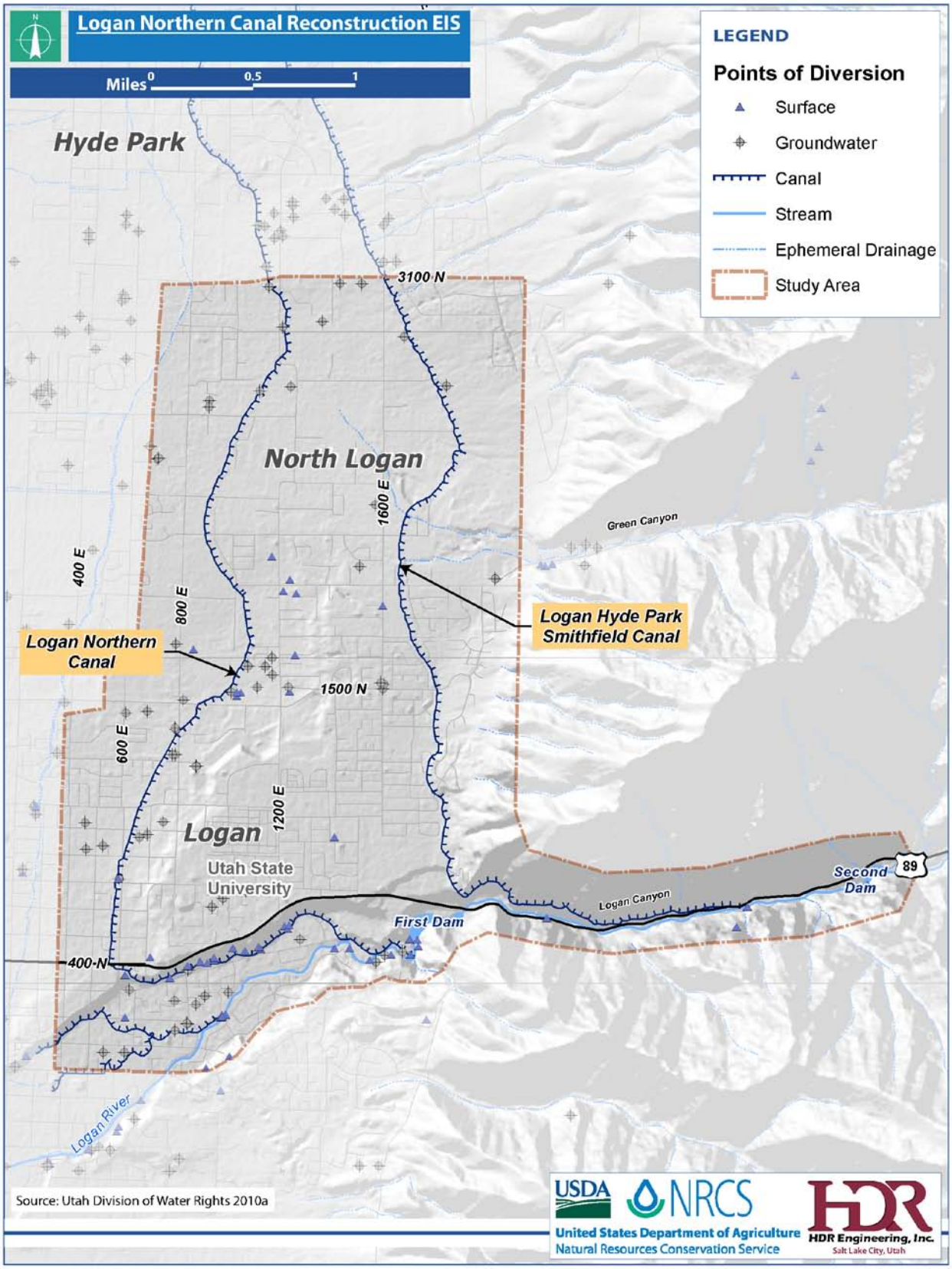


Table 4-14. Summary of LN Canal Water Rights

Water Right Number	Flow (cfs)	Kimball Decree Award[a] or Application	Period of Use	Priority Date
25-3056	10.0	A10531	April 1 – October 31	November 19, 1928
25-6110	68.1	219a	April 1 – October 31	May 1, 1860
25-6111	7.9	219b	April 1 – July 31	May 1, 1860
25-6112	27.2	219c	April 1 – July 14	May 1, 1860
25-6113	20.0	219d	October 1 – October 10	May 1, 1860

Source: Utah Division of Water Rights 2010b

[a] Kimball Decree awards are rights decreed in the matter of *Utah Power & Light Company v. Richmond Irrigation Company, et al.*, February 21, 1922.

The Logan & Northern Irrigation Company submitted a permanent water right change application (a36298) that is pending approval. This permanent change would allow some of the LN Canal water to be diverted at the LHPS Canal POD. The LHPS Canal diversion is about 2 miles upstream of the LN Canal POD on the Logan River and downstream of Second Dam (Figure 4-8).

The water in the Logan River is highly managed by the Logan River Water Commissioner. Flow in the reach of the river between Second Dam and the LN Canal POD has historically been diverted and used by four primary water rights holders: the Logan, Hyde Park and Smithfield Canal Company; USU; Logan City Light and Power; and the Logan & Northern Irrigation Company. Figure 4-8 shows the location of the LN Canal and LHPS Canal PODs. The Logan City Light and Power POD is at Second Dam. For a schematic of the river diversions, see Figure 3-11, Logan River Diversions.

Prior to the 2009 landslide, Logan City Light and Power diverted its water right into a penstock at Second Dam. This water was taken through its Hydro 2 plant at the mouth of Logan Canyon and then discharged back into the river near First Dam. The LN Canal POD is below this discharge point.

If the permanent change is approved, some of the water historically diverted at the LN Canal POD could be permanently diverted upstream at the LHPS Canal POD. Under an approved permanent change, the Logan & Northern Irrigation Company; USU; Logan City Light and Power; and the Logan, Hyde Park and Smithfield Canal Company would continue to operate in a manner that ensures that there is no impact to legal users or that adequately compensates affected parties.

Groundwater Rights

Groundwater PODs are usually associated with groundwater wells. Figure 4-13 shows the 87 groundwater wells for which there are water rights in the study area. Groundwater is used for domestic water supplies, irrigation, municipal water supplies, and stock watering.

Public Water Supply Wells. Throughout Utah, groundwater wells provide drinking water to residents. Utah Administrative Code Section R-309-600, Source Protection: Drinking Water Source Protection for Ground-Water Sources, identifies procedures to prevent groundwater discharges and restrict certain land uses to protect drinking water and describes drinking water source protection zones. Drinking water source protection zones are surface and subsurface areas surrounding a groundwater source of drinking water that supplies a public water system and identifies a travel time for which contaminants are reasonably likely to move toward and reach the groundwater source.

According to the Utah Division of Drinking Water (2010), there are five public water sources in the study area. Figure 4-14 identifies the drinking water source protection zones that are associated with these sources and that cross the study area. Local ordinances restrict certain activities and land uses depending on where such uses occur in relation to the protection zones. The drinking water protection zones are as follows:

- **Zone 1:** the area within a 100-foot radius of a well or margin of the groundwater collection area.
- **Zone 2:** the area within a 250-day groundwater time of travel to the well or margin of the groundwater collection area, the boundary of the aquifer that supplies water to the groundwater source, or the groundwater divide, whichever is closer.
- **Zone 3:** the area within a 3-year groundwater time of travel to the well or margin of the groundwater collection area, the boundary of the aquifer that supplies water to the groundwater source, or the groundwater divide, whichever is closer.
- **Zone 4:** the area within a 15-year groundwater time of travel to the well or margin of the groundwater collection area, the boundary of the aquifer that supplies water to the groundwater source, or the groundwater divide, whichever is closer.

Figure 4-14. Drinking Water Source Protection Zones in the Study Area

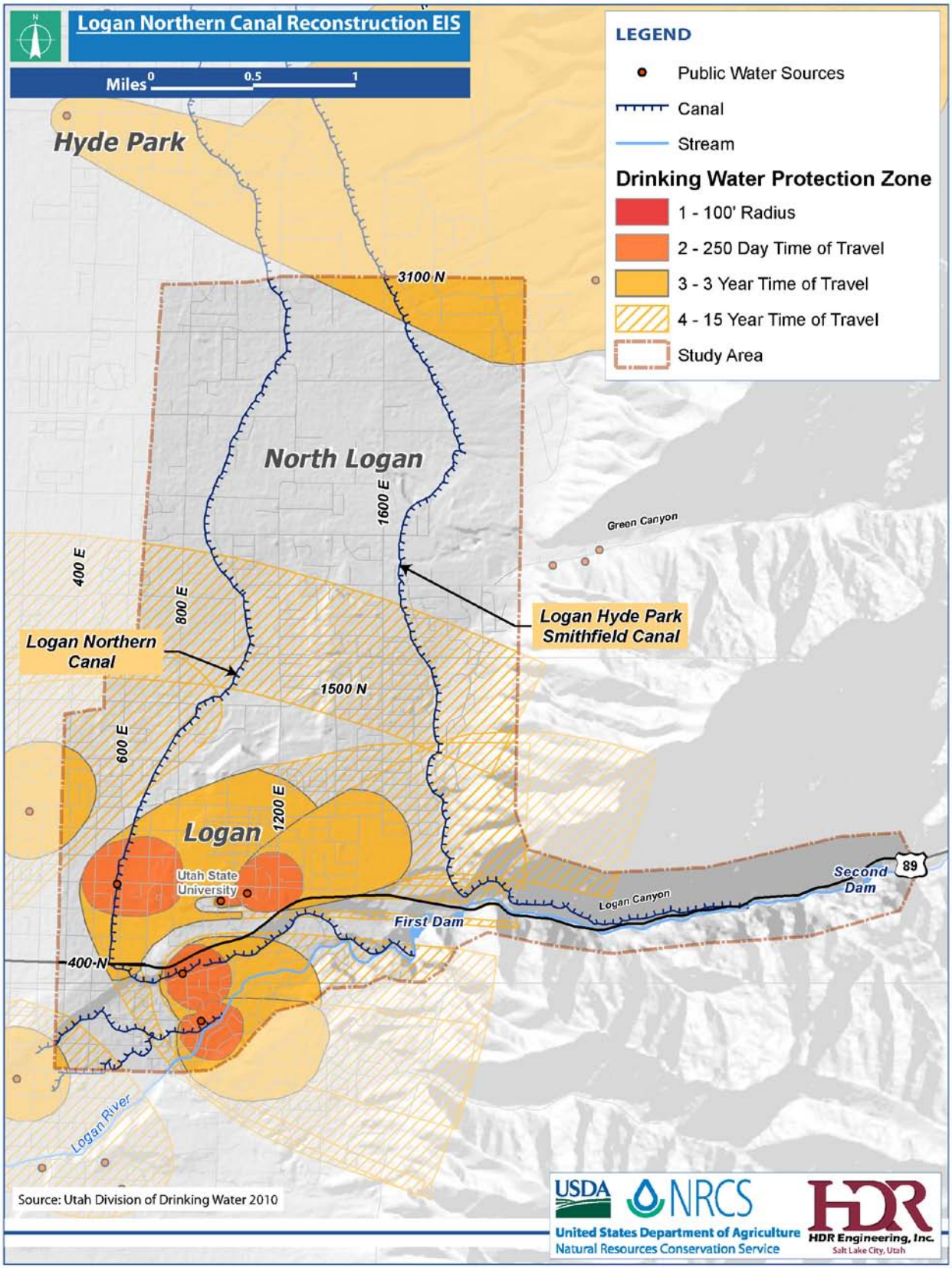


Figure 4-15. Logan Northern Canal, Upper Reach (1 of 3)

Figure 4-16. Logan Northern Canal, Logan City Reach (2 of 3)

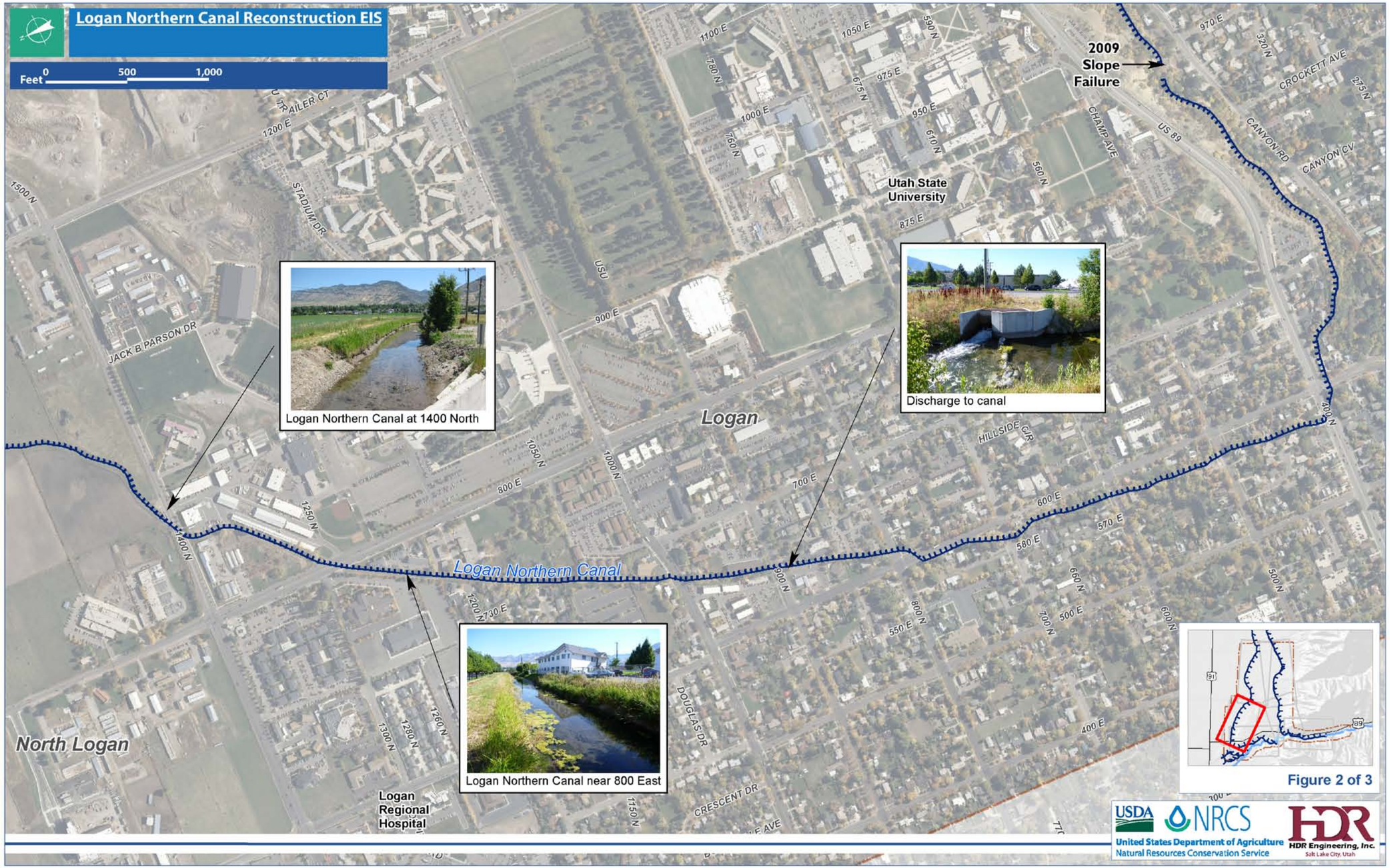


Figure 4-17. Logan Northern Canal, Lower Reach (3 of 3)

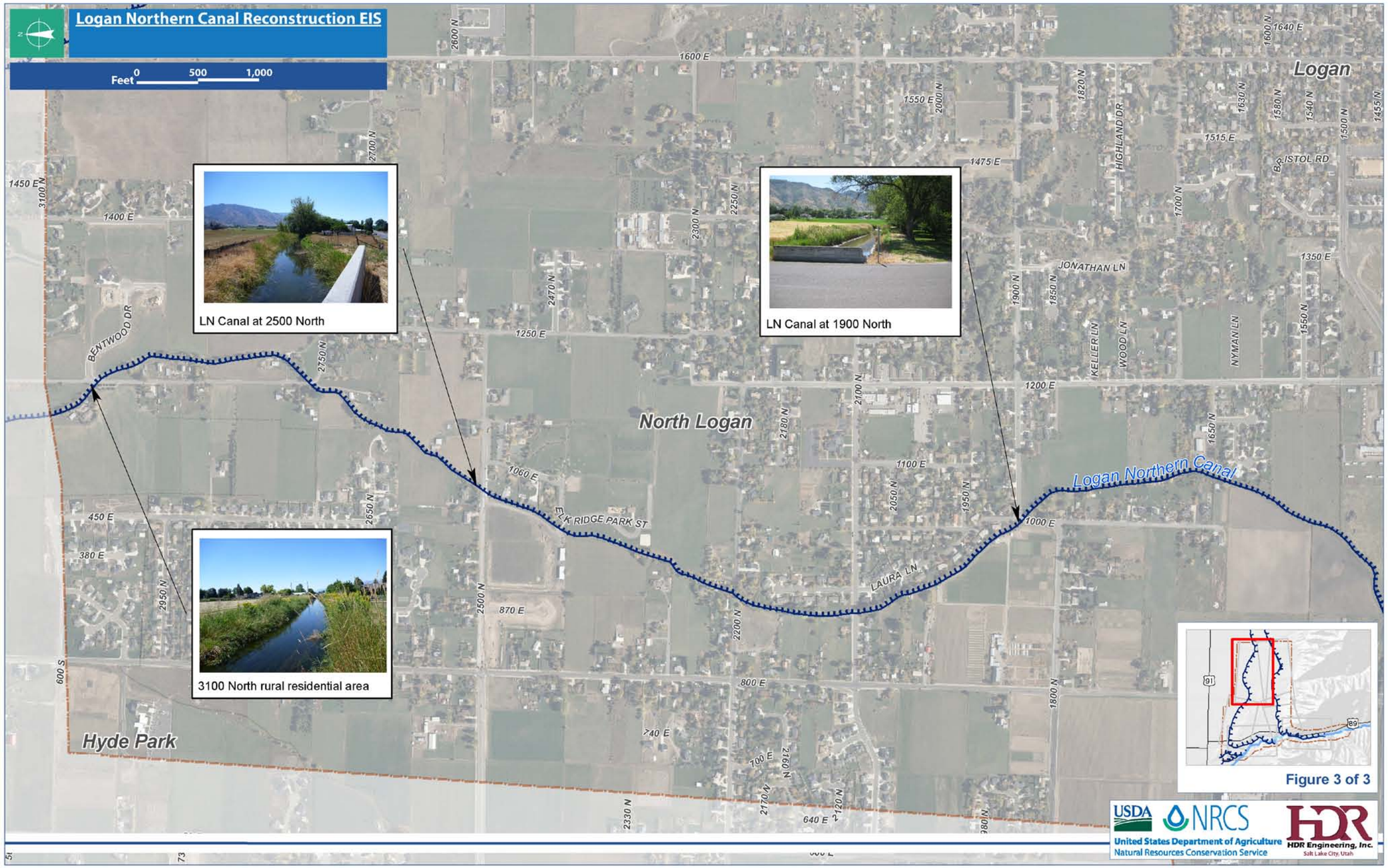


Figure 4-18. Logan Hyde Park Smithfield Canal, Logan Canyon Reach (1 of 3)

Figure 4-19. Logan Hyde Park Smithfield Canal, Logan City Reach (2 of 3)

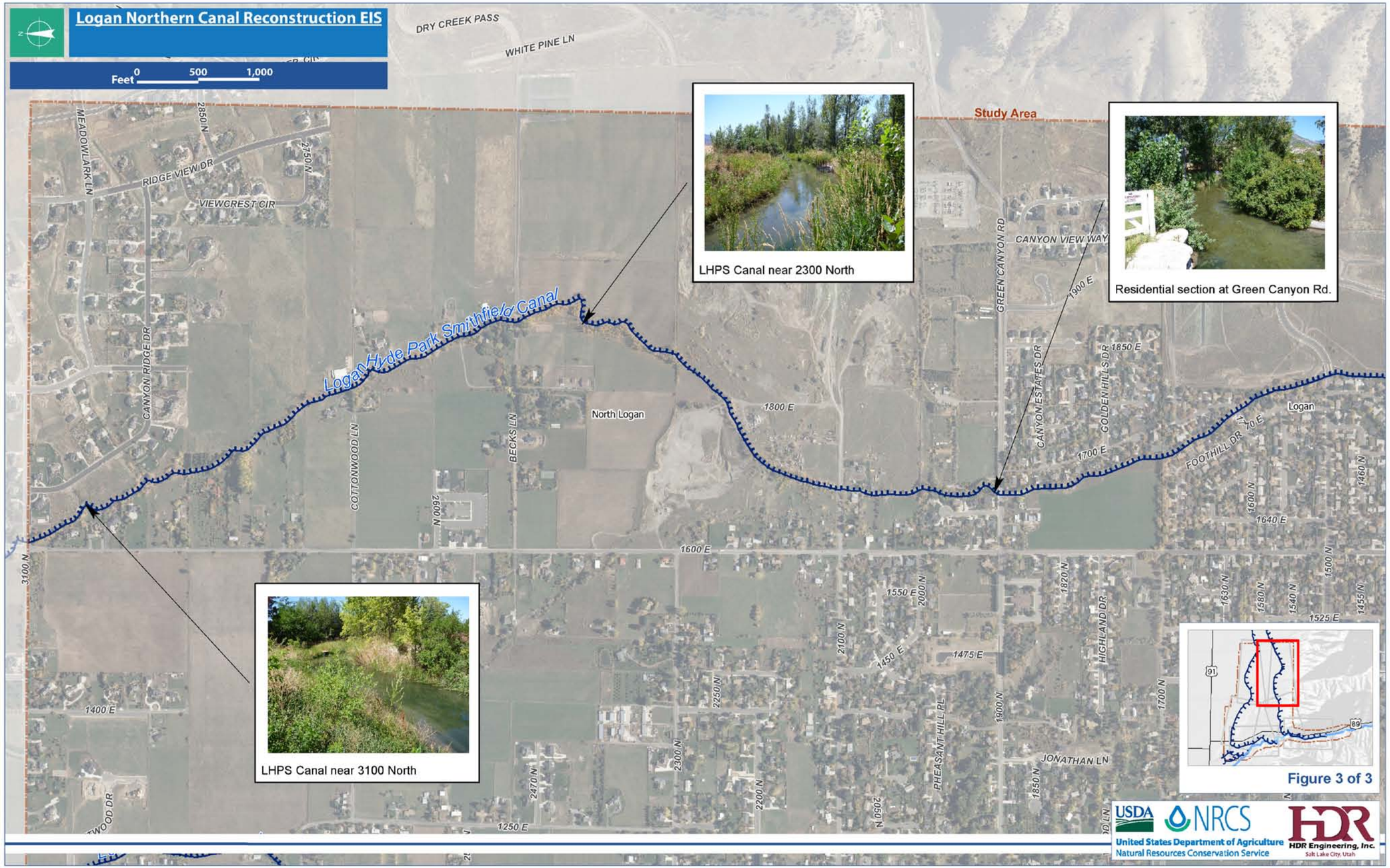



Figure 4-20. Logan Hyde Park Smithfield Canal, North Logan City Reach (3 of 3)