3.0 AFFECTED ENVIRONMENT

This chapter describes the affected environment associated with the Proposed Action and alternatives. The affected environment is the physical area that bounds the environmental, sociological, economic, or cultural features of interest that could be impacted by the Proposed Action or alternatives. When preparing this Draft EIS, the best available information was used to describe existing environments and Proposed Action facilities and activities. The information serves as a baseline from which to identify and evaluate environmental changes resulting from the Proposed Action and alternatives. The baseline conditions, for the purposes of analysis, are the conditions that currently exist.

In the following sections, the term "project area" refers to the area that encompasses the proposed ROW and associated Proposed Action components, as well as the area immediately adjacent to the proposed facilities. The study area, or Region of Influence (ROI) varies depending on the resource being analyzed and the predicted locations of direct and indirect impacts from the Proposed Action or alternatives. The Area of Potential Effect (APE), as used in the Cultural and Historic Resources section, is synonymous with the project area.

Based on consideration of the issues raised during the public scoping process, as well as guidance from the NEPA and related statutes, the following critical elements of the environment are considered in the evaluation of the Proposed Action and alternatives.

- Geologic Resources
- Soil Resources
- Water Resources
- Vegetation Resources
- Wildlife Resources including Wild Horses and Burros
- Land Use
- Areas of Critical Environmental Concern, Wilderness, and Other Special Use Areas
- Recreation
- Air Quality
- Noise
- Visual Resources
- Socioeconomics
- Environmental Justice
- Hazardous and Solid Waste
- Paleontological Resources
- Cultural and Historic Resources

The following resources do not occur in the project area and are not addressed further in this Draft EIS.

Wild and Scenic Rivers – There are no federally designated Wild and Scenic Rivers in the project area.

Prime and Unique Farmlands – There are no prime and unique farmlands near the project area.

Indian Trust Assets – There are no Indian Trust Assets in the project area.

3.1 GEOLOGIC RESOURCES

The ROI for geologic resources includes the area adjacent to the proposed ROW, nearby off-site areas subject to disturbance from the Proposed Action or alternatives, and those areas beneath new facilities that would remain inaccessible for the life of the project.

3.1.1 Data Collection Methods

Physiography, geologic history, and structural geology, as well as issues related to seismicity, are described in this section. Geology for the region, with the emphasis on local conditions, was derived from maps and reports published by federal and state agencies (e.g., USGS, Nevada Bureau of Mines and Geology [NBMG], and BLM). In addition to these published reports, consultants' reports specific to the area (e.g., CH2MHill 2002a, Vidler 2007a and 2007b, and LCWD and Vidler 2008) are referenced for interpretation of local geologic conditions in the Clover Mountains and Tule Desert areas.

Seismicity in the area was evaluated by reviewing the USGS and NBMG earthquake databases and University of Nevada Reno Seismology Laboratory Earthquake Catalogue.

3.1.2 Physiography and Topography

The ROI is located in Clover Valley, Tule Desert, and Virgin River Valley Hydrographic Areas. All three Hydrographic Areas are located in the eastern portion of the Basin and Range Physiographic Province, which encompasses more than 380,000 square miles within portions of seven western states (**Figure 3-1**). The province is tectonically active and contains distinctive topography, rock types and structure, and geologic and geomorphic history. The Basin and Range Province is characterized by numerous regularly spaced, fault-bounded mountain ranges separated by intervening valleys and deep alluvial basins.

The principal mountain ranges in the project vicinity include the Clover Mountains on the north, the Meadow Valley Mountain Range on the west, the Mormon Mountains on the south–southwest, and the Tule Springs Hills on the east.

In the northern reach of the ROI, erosion in the steep mountainous terrain of the Clover Mountains has deposited thick sedimentary fill within the Clover Valley to the north and the Tule Desert to the south.

The valley deposits can be several thousand feet thick with poorly sorted alluvial deposits adjacent to mountain bases, fine-grained playa deposits in dry lake beds, and well sorted sediments in the valley sand dunes.

The physiography in the southern reach of the ROI is characterized by a more subdued topographic relief. Principal features in the southern reach include Mormon and Flat Top Mesa and alluvial fans that emanate from the Mormon Mountains. The LCLA development area is located within dissected hills in the northern portion of the Virgin River Valley.

3.1.3 Stratigraphy and Geologic History

The Basin and Range Province is tectonically active and was formed within approximately the last 20 million years as a result of crustal extension believed to be linked to transform-boundary interaction between the Pacific and North American lithospheric plates (Tschanz and Pampeyan 1970). For the last several million years, these faults have raised and occasionally tilted the mountains and lowered the basins, resulting in sediment-filled basins that are tens of thousands of feet thick in some areas (Price et al. 1999). The Basin and Range topography seen today was developed during the Late Cenozoic Era. Mountain ranges were uplifted and eroded, resulting in the alluvial sedimentary deposits that fill the basins. Lake beds and playa deposits were eventually formed as the climate became dryer following the end of alpine glaciation during the late Quaternary Period. This geologic history and resultant stratigraphy is summarized in **Table 3-1**.

Table 3-1 General Regional Stratigraphy

Stratigraphic Unit *(from youngest to oldest)*	**Description**
Quaternary and upper Tertiary basin-fill deposits	Unconsolidated deposits of fluvial, fanglomerate, lake, and mudflow derived sediments underlain by the Tertiary Muddy Creek and Horse Spring formations. Composed of poorly to moderately consolidated siltstone, gypsiferous sandstone, conglomerate, gypsum and tuff, with interbedded basalt and lava flows.
Lower and middle Tertiary rocks	Principally volcanic rocks consisting of ash-flow and ash-fall tuffs. The unit is locally underlain by sandstone, siltstone, and conglomerate.
Late Paleozoic and Mesozoic sedimentary rocks	Principally siltstone, sandstone, shale, limestone, and gypsum. This unit can contain significant carbonate rocks, but is mostly non-carbonate in composition; represented by the Mesozoic Moenkopi Formation.
Paleozoic carbonate rocks	Primarily limestone and dolomite containing varying amounts of interbedded siltstone and shale.
Precambrian and Cambrian non-carbonate rocks	Principally siltstone, sandstone, granite, and metamorphic rocks including quartzite, gneiss, and schist.

Source: CH2MHill 2002a

Geomorphic units in the vicinity of the ROI include 1) folded and faulted mountain ranges, 2) the intermediate slopes below the mountains and slightly above the valley floor, and 3) the valley floor (Longwell et al. 1965). The overall elevation of these units ranges from less than 2,000 feet above mean sea level (amsl) in the LCLA development area to about 7,620 feet amsl at Sawmill Peak in the Clover Mountains.

3.1.3.1 Clover Valley

The Clover Valley is bounded by the Cedar Range to the north and the Clover Mountain Range to the south. The Beaver Dam State Park on the Utah border defines the boundary to the east, and the valley funnels out near the City of Caliente where Clover Creek joins Meadow Valley Wash (**Map 3-1**). Elevation decreases from 5,800 feet near the east side to 4,500 feet at Caliente. Clover Valley is approximately 20 miles long in the east-west direction and 15 miles wide. The valley is sparsely inhabited, serving principally recreational and ranching interests.

Site-specific geologic data for the Clover Valley Hydrographic Area were developed as a result of recent well siting investigations conducted by Vidler Water Company (Vidler). A geologic map of Clover Valley presented on **Map 3-2a** and **3-2b** was constructed by Vidler (2007a) based on modified interpretation of geology by Ekren et al. (1977) and Page et al. (2005 and 2006). The geologic map units are not consistent between the two authors however, and a modified interpretation was incorporated into this analysis. A stratigraphic column that illustrates the combined geologic map unit interpretation is shown in **Figure 3-2**. This stratigraphic column shows the map symbols, brief description of the geologic map units, the age relationship, and the thickness (in meters) of each unit. For a detailed description of each geologic map unit reference is made to Ekren et al. (1977) and Page et al. (2005 and 2006). The stratigraphic relationship of the geologic map units in Clover Valley was analyzed by conceptual reconstruction of the Caliente Caldera Complex (described further in Section 3.1.4.1). This conceptualization was used to determine potential geologic formations that may occur or may have been emplaced during the orogeny that formed this caldera. Three geologic cross-sections were developed by Vidler (2007a) and are provided on **Figures 3-3** through **3-5**. Locations of these cross-sections are illustrated on **Map 3-2a**.

Geologic cross-section A-A' extends from southwest in the Clover Mountains through Sheep Flat and Pine Ridge Reservoir and to the northeast of Clover Valley (**Figure 3-3**). The Caliente caldera is the main structural feature on the southwestern portion of the cross-section, as represented by the Tertiary intrusive volcanics that are of Miocene – Oligocene in age (~ 27 million years before present time [Ma]). This provides the source of both lava flows and ash-fall tuffs that are distributed throughout Clover Valley and other basins in southeastern Nevada (Vidler 2007a).

The other significant observation is the lack of an identifiable unit beneath the bedded tuff or tuffaceous sandstone unit (Ts4) of Miocene age in cross-section A-A'. This would represent the oldest exposed extrusive volcanic unit in Clover Valley. Therefore, it is possible that several other geologic formations may be present beneath the bedded tuff or tuffaceous sandstone; these would include the Tertiary intrusives and/or undifferentiated Mesozoic and Paleozoic rocks (Vidler 2007a).

Cross-section B-B’ (**Figure 3-4**) extends from the southwestern edge of the Clover Mountains through Little Rock Canyon northeast into the headwaters of Beaver Dam Wash near the Nevada/Utah border, while cross-section C-C’ (**Figure 3-5**) transects the southern end of Clover Valley trending east-west and intersects both cross-sections A-A’ and B-B’.

Both cross-sections B-B’ and C-C’ illustrate the probable occurrence of the intrusive volcanics representing the remnant caldera (geologic unit Tai). They also illustrate the stratigraphic column based on the exposed geologic units and their maximum thickness from known outcrops. As was evident in cross-section A-A’, no geologic unit or formation is identified below the bedded tuff or tuffaceous sandstone unit. Based on the known thickness of the overlying formations, and an assumption that there is a change in lithology below these formations, the potential Tertiary intrusives of the remnant caldera (Tai) have been identified (Vidler 2007a).

3.1.3.2 Tule Desert and Virgin River Valley

The Tule Desert is bounded by the Clover Mountains to the north and northwest, the Tule Springs Hills to the east, and the East Mormon and Mormon Mountains to the south and southwest, respectively. Elevations range from 7,415 ft amsl at Mormon Peak in the south to 7,400 ft amsl to the north in Clover Mountains. The east and west sides are bounded by low ridges and hills from 5,100 ft amsl to about 4,100 ft amsl. Covering an area of approximately 125,000 acres, the Tule Desert is approximately 26 miles long and 12 miles wide (CH2MHill 2002a). The basin floor slopes topographically from elevation 4,800 ft amsl at Sam’s Camp well at the north to 3,000 ft amsl at Toquop Gap in the south.

Based on surface geophysics conducted by Zonge (2002 and 2008 as cited in LCWD and Vidler 2008) and by the USGS (2006), and subsequently confirmed by test drilling, the subsurface of the Tule Desert consists of a complex paleo-surface of bedrock with considerable topographic relief formed by erosion and faulting. This surface is mantled by as much as 3,000 ft of unconsolidated alluvium and colluvium. Geophysical investigations suggest that the bedrock is dominated by north-south trending structures.

The lower part of the unconsolidated sediments consist predominantly of clayey gravels in which limestones are the dominant lithic types, while the gravel clasts are primarily of volcanic origin in the upper several hundred feet. The lithic properties of the alluvial deposits attest to millions of years of accumulation mirroring the sequential geologic history of the surrounding highlands (LCWD and Vidler 2008).

The subsurface of the northern one half of the Tule Desert Groundwater Basin appears to be dominated by about 700 ft of unconsolidated sediment overlying the Triassic-aged (205 to 240 Ma) Moenkopi Formation. Beneath the southern one half of the basin, the Moenkopi is absent, and Paleozoic limestones are covered with up to 1,250 ft of unconsolidated sediments. The contact from Moenkopi to Paleozoic limestone occurs somewhere between wells MW-1 and PW-1 (**Map 3-3**). This abrupt change significantly affects water levels and is most easily explained by an east-west fault (LCWD and Vidler 2008).

Along the east and west margins of the basin, paralleling the basin bounding normal faults, are thick, wedge-shaped, accumulations of colluvium derived from the adjacent highlands. Along the east side of the basin at MW-8 (**Map 3-3**), approximately 1,600 ft of unconsolidated sediments that eroded from the adjacent Moenkopi Formation were documented by drilling. More than 3,000 ft of colluvium of brecciated limestone clasts and volcanic gravels were documented along the west side at MW-9 (LCWD and Vidler 2008).

The tops of remnant limestone highlands protrude through the unconsolidated sediments across the southern third of the basin. The paleo-surface of the limestone has significant structural and erosional relief, as illustrated by the geology at well PW-2. Although the well site is only about one half mile east of a limestone hill extending approximately 350 ft above the basin floor, 1,250 ft of unconsolidated sediments overlay bedrock at this location. Well PW-2 was drilled to 2,750 ft and penetrated 1,500 ft into the carbonates. Carbonate hills protrude through the alluvium at numerous locations across the southern third of the basin (LCWD and Vidler 2008).

In a general sense, the subsurface of the Tule Desert Groundwater Basin appears to mirror the geologic and topographic complexity of the surrounding hills and highlands except that the bedrock surface has been faulted down and covered by hundreds to thousands of feet of unconsolidated sediments (LCWD and Vidler 2008).

Much of the basin-fill deposits in the lower Virgin River Valley north of the Virgin River, including in the vicinity of the LCLA development area, consist of the Muddy Creek Formation. The Muddy Creek formation consists of buff- to yellow-colored layers of sandstone, siltstone, clay, and gypsum. The valley floor is predominantly composed of depositional lakebed material of sand, silt, and clay. Subsequent faulting of this depositional material has resulted in a series of scarps that dominate the area and are often referred to as Nevada badlands. Intermittent streams that flow only during sudden, heavy rainfall events have continually eroded the floodplain to create deeply incised channels that are present in the area today.

3.1.4 Structural Geology and Faulting

The three dominant structural events that shaped the region are known as the Sevier Orogeny, the Laramide folding and thrust faulting, and the Basin and Range block faulting. The Sevier Orogeny resulted in the folding, uplift and eastward thrusting of Paleozoic (more than 270 Ma) sedimentary rocks. The Laramide thrust faults were low-angle faults that moved Paleozoic rocks eastward and were part of a period of uplift, intrusion, and compression (ENSR 2004). Basin and Range faulting produced the north-south trending mountain ranges and basins by large-scale movement of crustal blocks along high-angle normal faults that trend north-south (ENSR 2004). Faulting in the Basin and Range Province continues today.

The crust within the Basin and Range Physiographic Province is extending and shearing in response to the motion between the Pacific and North American plates. The extension causes normal faults that further result in downthrown blocks (basins), uplifted blocks (mountains), and tilted blocks (combination of mountains and basin) (dePolo et al. 2000). As opposed to normal faults, which involve vertical movement of the crust due to extension, strike-slip faults generally involve no vertical motion, but instead are associated with lateral motion of the crust. Oblique-slip faults are faults in which blocks of rock slip up or down, then past each other diagonally.

3.1.4.1 Clover Valley

The Caliente caldera is the main structural feature in the area. The Caliente Caldera (caldron) complex was formed as a result of voluminous eruptions of tuffs and lavas during the Tertiary period (at least 24 Ma to 13.5 Ma). The caldera is an east-elongated complex with dimensions of 50 miles east-west and 22 miles north-south (Page et al. 2005). The caldron boundaries of the complex are entirely buried beneath postcaldron rhyolite lavas, welded tuffs, or alluvium, except on the west side where a lobe of the complex has resurged. This domical lobe is bounded on three sides by Paleozoic rocks. The boundary of the complex on the south side was drawn to exclude the Paleozoic rocks at the north end of Tule Desert and those in Pennsylvania Canyon. The northern boundary was drawn to exclude the Paleozoic rocks exposed north of Caliente and on the north end of Cedar Range. The eastern boundary is extremely vague and could actually extend into Utah (Ekren et al. 1977).

The extent of the caldera illustrates the extreme impact the structural stresses had in this area after the volcanism occurred. It is evident that extreme tensional forces were acting in this area during this period of significant volcanism, pulling apart the caldera. Meanwhile, forces were being exerted from the south to north, causing the formation of what are now the Clover Mountains. The Caldera includes numerous northwest-southeast trending strike slip faults showing relative movement along the faults, and normal faults showing the downthrown block of the fault (Vidler 2007a). The numerous fault zones may provide important conduits for groundwater flow in the area (Page et al. 2005).

Structural features in the Clover Valley area are depicted on cross-sections A-A’ through C-C’ (**Figures 3-3** through **3-5**), described above. Geologic cross-section A-A’ shows the southernmost edge of the Caliente caldera as mapped by Page et al. (2005) (**Figure 3-3**). The prominent feature identified in cross-section A-A’ is the horst and graben structure and the associated numerous normal faulting shown in the middle of the diagram. Horst and graben structures typically occur as a result of extensional stresses. The graben structure is bounded on the south by the southern branch of the Sheep Flat Fault and to the north by the northern extension of Sheep Flat Fault. Sheep Flat represents the center of the graben structure that has been downthrown and is of significant interest, as several proposed well sites are located on the perimeter of Sheep Flat and hence the perimeter of the graben structure (Vidler 2007a).

Cross-section B-B’ (**Figure 3-4**) illustrates the probable occurrence of the intrusive volcanics representing the remnant caldera and the terminal extent of the graben structure that was prominent in cross-section A-A’.

Cross-section C-C’ (**Figure 3-5**) transects the graben structure represented by Sheep Flat and also illustrates the probable occurrence of the intrusive volcanics representing the remnant caldera.

3.1.4.2 Tule Desert and Virgin River Valley

Several north-striking, inactive faults have been identified within the vicinity of the Tule Desert,. These include the Gourd Spring fault, the East Tule Desert fault, the Tule Corral fault, and the East Tule Springs Hills fault (**Map 3-1**).

A geologic map of the Tule Desert showing locations of three cross-sections is presented on **Map 3-3**. The map is based on the work of Page et al. (2005) and modified based on new drilling data collected by Vidler (2007b). This map forms the basis for the geologic cross-sections that were constructed by Page et al. (2005). Portions of these cross-sections, through the Tule Desert, have been truncated as shown on **Map 3-3.** The truncated cross-sections are provided in **Figure 3-6.**

Figure 3-6 shows two roughly east-west cross-sections. A-A' extends through the central portion of Tule Desert, and B-B' extends through the Mormon and East Mormon Mountains south of Tule Desert.

A north-south cross-section J–J' extends north into the Tule Desert through and to the west of the East Mormon Mountains. Cross-section J–J' intersects cross-section B–B' south of Tule Desert and west of the East Mormon Mountains.

In addition to describing the current condition of geologic resources in the project area, the following discussion details specific geologic features that have direct bearing on local groundwater resources and will set the stage for the analysis of impacts. Cross-section A–A' shows thick sequences (approximately 15,000 feet or ~4.6 km) of Mesozoic (green) and Paleozoic (blue) rock units, in addition to volcanic (red), alluvial (yellow), and basement (brown) rock units. As the cross-section is drawn farther south of the Tule Desert, significant changes occur through the Mormon and East Mormon Mountains. Significant uplift and faulting has occurred in this area that exposed much of the Mesozoic (green) and Paleozoic (blue) units, which have been eroded away and therefore are no longer present (**Figure 3-6**).

Cross-section B–B' shows extensive Cambrian and Proterozoic (brown) units at or near land surface. These rocks are not considered part of the regional aquifer system, and in fact are reported to act as barriers to groundwater flow in the Mormon Mountains (Burbey 1997). Cross-section B–B' also shows that the Mesozoic and Paleozoic rock units dip steeply to the east. This supports easterly regional groundwater flow that follows the stratigraphic formational contacts (**Figure 3-6**).

Cross-section J–J' (**Figure 3-6**) shows the Paleozoic rock units truncated by the Cambrian and Proterozoic rocks that form the base of the East Mormon Mountains. The existing Paleozoic rocks are also drawn up and folded due to faulting associated with the formation of the East Mormon Mountains (Page et al. 2005). The geologic formations shown in cross-section J–J' would cause groundwater to flow around the East Mormon Mountains and potentially along stratigraphic formational contacts to the south and southeast.

The structural geology information for the Virgin River Valley Hydrographic Area is described in detail in the Toquop Energy Project EIS (BLM 2003). According to the analysis conducted for that EIS, in the vicinity of the proposed LCLA development, numerous small, unnamed vertical-offset faults have displaced Muddy Creek and younger alluvial deposits. The local washes are thought to follow the trace of some of these faults, which are fairly evenly spaced and trend between north and north-northwest. Although these local, small offsets are potentially active (having experienced movement in recent geologic time), any future displacement is not anticipated to result in a significant earthquake (BLM 2003).

3.1.5 Seismicity

The Basin and Range Province is one of the most seismically active regions in the United States.

Nevada is the third most active seismic state after California and Alaska. Over the last 150 years, an earthquake of Richter scale magnitude 7 or greater has occurred in Nevada approximately every 30 years (NBMG 2006).

Between 1852 and 2006, eight earthquakes greater than a magnitude 5 have been recorded in the region (UNR 2006). The largest earthquake recorded in the area was a magnitude 6.1 event that occurred in the Clover Mountains in 1966. The most recent earthquake in the region, recorded on August 6, 2007, was a magnitude 4.0 event that occurred near the Town of Panaca.

According to recent maps developed by the USGS for southern Nevada, the project area is located in a relatively dormant seismic region (USGS 2006). The potential for future seismic activity was examined using seismic mapping, which indicated a very low potential for earthquakes and associated ground acceleration.

3.2 SOIL RESOURCES

This section describes the soil conditions and potential for landslide and subsidence in the ROI. The ROI for soil resources includes the area adjacent to the proposed ROW and nearby off-site areas subject to disturbance from the Proposed Action or Alternative 1 and those areas beneath new facilities that would remain inaccessible for the life of the project.

3.2.1 Data Collection Methods

Information regarding soil distribution and type was derived from the Soil Survey of Lincoln County, Nevada, South Part, published by the U.S. Department of Agriculture (USDA), Natural Resources Conservation Service (NRCS) (NRCS 2000). Landslide and subsidence potential data were adopted from a CH2MHill (2002a) report prepared for the Toquop Energy Project EIS.

3.2.2 Existing Conditions

A mosaic of 29 soil types is represented in the project area. Each soil series and its general location within the project area is summarized in **Table 3-2**.

Table 3-2 Soil Series1 Descriptions

Name	Location	Slope (%)	Depth	Drainage	Wind Erodibility Group[2]	Surface Texture
Acoma	Fan remnants, Fife Flat area	2 to 15	Very deep	Well drained	4	Gravelly, sandy loam
Acti	East Pass area	30 to 50	Shallow	Well drained	7	Gravelly loam
Arada	Sand sheets, Mormon Mesa area	2 to 8	Very deep	Somewhat excessively drained	1	Fine sand
Arizo	Drainageways and stream terraces, Tule Desert	0 to 8	Very deep	Excessively drained	4	Very cobbly loamy sand
Aymate	Fan remnants, Carp Road	0 to 8	Moderately deep	Well drained	3	Gravelly sandy loam
Braken	Pediments, Toquop Energy Plant Site	2 to 8	Deep	Excessively drained	4	Gravelly fine sandy loam
Canutio	Alluvial fans, fan remnants and inset fans, Tule Desert	0 to 8	Very deep	Well drained	4-5	Gravelly sandy loam

Table 3-2 Soil Series1 Descriptions

Name	Location	Slope (%)	Depth	Drainage	Wind Erodibility Group[2]	Surface Texture
Capsus	Clover Mountains	15 to 30	Shallow	Well drained	7	Very cobbly sandy clay loam
Cath	Fan remnants, Clover Mountains	2 to 4	Deep	Well drained	3	Coarse sandy loam
Chinkle	Mountains	8 to 50	Very shallow	Well drained	5	Very gravelly very fine sandy loam
Dalian	Fan remnants, Tule Desert	4 to 8	Very deep	Well drained	5	Very gravelly fine sandy loam
Decan	Fan remnants, Clover Mountains	2 to 15	Moderately deep	Well drained	5	Gravelly clay loam
Faleria	Clover Mountains	30 to 75	Deep	Well drained	4	Gravelly sandy loam
Geta	Inset fans, stream terraces, Tule Desert	0 to 8	Very deep	Well-drained	1-4	Very fine sandy loam
Kanackey	Mountains	15 to 50	Very shallow	Well drained	6	Very gravelly loam
Knob Hill	Inset fans, Tule Desert	2 to 4	Very deep	Somewhat excessively drained	2-5	Loamy sand
Laross	Clover Mountains	30 to 75	Deep	Well drained	6	Cobbly loam
Mormon Mesa	Fan remnants, Southern Tule Desert	0 to 15	Shallow	Well drained	3	Gravelly fine sandy loam
Mormount	Fan remnants, Southern Tule Desert	2 to 15	Shallow	Well drained	5	Gravelly very fine sandy loam
Motoqua	Southern slopes, Clover Mountains	8 to 50	Very shallow	Well drained	5	Very gravelly sandy loam
Naye	Fan remnants, Tule Desert	4 to 8	Moderately deep	Well drained	4	Gravelly fine sandy loam
Oleman	Fan remnants, Tule Desert	2 to 15	Shallow	Well drained	5	Very gravelly fine sandy loam
Rapado	Fan remnants, Tule Desert	4 to 30	Moderately deep	Well drained	5	Very gravelly sandy loam
Shankba	Mountains	15 to 50	Shallow	Well drained	5	Very gravelly fine sandy loam
Slidymtn	Clover Mountains	15 to 30	Shallow	Well drained	5	Very gravelly sandy loam
St. Thomas	East Mormon Mountains	15 to 50	Very shallow	Well drained	5-8	Extremely stony fine sandy loam
Thunderbird	Southern slopes, Clover Mountains	30 to 5 0	Moderately deep	Well drained	6	Cobbly loam
Turba	Clover Mountains	30 to 50	Shallow	Well drained	5	Very gravelly sandy loam
Typic Torriothents	Pediments, Toquop Energy Plant area	30 to 70	Very deep	Well drained	5	Very gravelly sandy loam
Winklo	Tule Desert	30 to 50	Moderately deep	Well drained	5	Very cobbly
Zaqua	Tule Desert	30 to 50	Shallow	Well drained	5	Very gravelly sandy loam
Zeheme	Toquop Gap	15 to 75	Very shallow	Well drained	8	Very gravelly fine sandy loam

Source: NRCS 2000

1 Soil series are groups of soils that have similar characteristics and fall within specific ranges and limitations. They are the lowest category of soil taxonomy and are concepts that represent what the soil actually looks like. Soil map units are geographic areas dominated by one or more soil series and can contain small pockets of soils that are very different from the most prevalent soil series.

2 Wind erosion hazards are rated by the Natural Resources Conservation Service using wind erodibility groups; soils assigned to Group 1 are the most susceptible to wind erosion, and those assigned to Group 8 are the least susceptible.

Soils in the Clover Mountain area were formed in residuum and colluvium from Tertiary volcanic rock and ash. Along the southern edge of the Clover Mountains, and extending into the Tule Desert, the project area is underlain by Quaternary alluvium and the Muddy Creek Formation of the upper Tertiary period. The soils on the buttes and mesas consist of fairly loose and silty sands that are capped with caliche rock. The caliche acts as a restrictive layer in the soil profile and helps reduce soil erosion. The hilly topography in the southern reach is composed of pebbles, loose silty sands, and sandstone. Major washes and drainages consist of both loose and solidified sands.

Soil erosion hazards from water are defined based on specific soil properties including texture, structure, and permeability, and local site conditions such as slope and surface cover. The NRCS uses K factors to indicate the susceptibility of a soil to sheet and rill erosion. Values of K range from 0.02 to 0.69. The higher the value, the more susceptible the soil is to sheet and rill erosion. Most of the soils in the project area have low K factors (between 0.05 and 0.20) and therefore are not very susceptible to erosion. Nine of the soils series have moderate K factors between 0.20 and 0.40; however, most of these soils are found on slopes between 0 and 15 percent and therefore exhibit low water erosion potential. Two soil series with moderate K factors, Typic Torriorthents and Thunderbird, occur on slopes between 30 and 75 percent. These soils exhibit high water erosion potential.

Wind erosion hazards are rated by the NRCS using wind erodibility groups. Wind erodibility groups are made up of soils that have similar properties affecting their resistance to soil blowing. Most of the soils in the project area are in wind erodibility groups 4 through 8, which identify them as being moderate to slightly erodible. Four soil series (Cath, Aymate, Mormon Mesa, and Badlands) are in group 3, which identifies them as being highly erodible. One soils series (Arada) is in group 1, which is extremely erodible. Vegetation is difficult to establish on these soils.

Site design, especially for the buried pipelines, must consider risk of corrosion to uncoated steel or concrete. Risk of corrosion pertains to potential soil-induced electrochemical or chemical actions that dissolve or weaken these materials. All soils within the project area have a moderate to high risk for corrosion to uncoated steel. With the exception of the soils immediately north of the LCLA development, all other soils in the project area have a low risk for corrosion of concrete. The Bracken and Typic Torriorthents series soil are classified with high risk for concrete corrosion.

All soils in the ROI, excluding Acoma, Braken, Dalian, and Geta soils, are difficult to excavate to shallow depths, such as trenches or holes dug to a maximum depth of 5 or 6 feet, because the shallow soils have a high content of rocky materials. Depending on the depth to bedrock, slope, presence of cemented pans or cutbacks that cave, special construction procedures may be required.

The Southern Nevada Complex fires burned large portions of the Tule Desert and surrounding hills in the Halfway and Duzac areas in June, 2005. A total of 739,000 acres of land in southern Nevada burned over 19 days, with approximately 281,000 acres of the fire occurring in the Halfway and Duzac portions of the complex, adjacent to the LCLA ROI. Nearly all of the soil types in the ROI were affected to some degree by the fires, but most of the burn occurred on the Mormon Mesa, Rapado-Oleman and Mormount-Canutio soils. Because most vegetation in the burn area has been removed, these areas will have a higher susceptibility to wind and water erosion in the future.

3.2.3 Landslides and Subsidence

Landslides are generally initiated in saturated soil on steep slopes. Slides begin and continue movement on a distinct shear surface that usually forms a relatively impervious layer to the downward percolation of water. This surface may be a bedding plane in solid rock or layers within a soil mantle such as a clay lens. Within the Tule Desert, slopes are primarily level to gentle sloping. Areas in the Clover Mountains, especially the area south of East Pass, may be susceptible to landslides due to their steep slopes.

Subsidence hazards involve either the sudden collapse of the ground to form a depression or the slow subsidence or compaction of the sediments near the Earth's crust. Carbonate rocks, such as limestone, are highly susceptible to dissolution by groundwater given the appropriate chemistry that can result in systems of caves and sinkholes. Caves are underground open spaces formed by dissolution of calcite in the limestone as a result of circulating groundwater. Most caves are thought to form near the water table. A sinkhole is a large dissolution cavity that is open to the Earth's surface. Some sinkholes form when the roofs of caves collapse; others can form at the surface by dissolving the rock downward. No caves or sinkholes have been identified in or near the vicinity of the project area.

CH2MHill (2002a) evaluated potential for land subsidence in two areas of the basin fill deposits within Tule Desert. The first location is in the vicinity of well MW-2, and the second is in the vicinity of PW-1 and MW-4. In both cases, the conditions allowed for a maximum amount of settlement of 0.3 and 0.6 inch, respectively, with high values corresponding to reduction in porosity of less than 1 percent, which is considered negligible (CH2MHill 2002a).

3.3 WATER RESOURCES

The ROI for water resources (both groundwater and surface water) includes two separate areas: 1) the area adjacent to the proposed ROW and immediate vicinity and 2) the Hydrographic Areas or watersheds where the project would be located (Clover Valley #204, Tule Desert #221, and Virgin River Valley #222). A nearby Hydrographic Area of interest includes the Lower Meadow Valley Wash (#205) located west of the project area. The locations of these basins in relation to the project area are shown on **Map 3-1**.

3.3.1 Surface Water Resources

3.3.1.1 Data Collection Methods

This section addresses regional and local surface water hydrology, including climatic conditions, stream flows, water quality, water use, and water rights in the ROI. The source of the water for local springs and surface water features is also discussed in this section. For the description of surface water resources, the area of delineation is represented by the basin, or watershed, which includes the area drained by a stream system and bounded by topographic divides.

Data on the stream flows were obtained from USGS water reports. Water quality information, including 303(d) lists of water quality-limited streams and Total Maximum Daily Load (TMDL) reports, were accessed from the NDEP web page (NDEP 2003a). Water rights data were acquired from Nevada Division of Water Resources' water rights database (NDWR 2007).

Additional data sources reviewed for this Draft EIS include USGS topographic maps, Nevada Division of Water Resources reports and water rights database, reports by various scientific organizations (e.g., the Western Regional Climate Center), local entities (e.g. Meadow Valley/Clover Creek Technical Review Team), the 2003 and 2007 Toquop EISs (BLM 2003 and 2007), and consultants' reports specific to the area (e.g., Bio-West Inc. 2005; CH2MHill 2002a, 2002b, Daniel B. Stevens and Associates (DBS&A) 2008; Vidler 2007a, 2007b, and 2007c; and LCWD and Vidler 2008).

3.3.1.2 Hydrologic Setting

The USGS and the NDWR have divided the state into discrete hydrologic units for water planning and management purposes. Altogether, 256 Hydrographic Areas and Sub-areas have been identified within the 14 major hydrologic units called Hydrographic Regions or Basins (NDWR 2006). All project components would be located within the Clover Valley (#204), Tule Desert (#221), and Virgin River Valley (#222) Hydrographic Areas, which are all part of the Colorado River Basin Hydrographic Region (# 13) (**Map 3-1**).

The Lower Meadow Valley Wash Hydrographic Area (#205) is located directly to the west of the Tule Desert Hydrographic Area. All surface water within these four Hydrographic Areas that does not evaporate or infiltrate into the ground ultimately drains into the Virgin and Muddy Rivers, which in turn connect to Lake Mead and Colorado River. Available streamflow in the Muddy River is diverted into Bowman Reservoir before reaching Lake Mead.

3.3.1.3 Local Climate

Climate and climate variability have a significant influence on the water resources in the project area. The arid climate of the project area reflects the desert environment that characterizes much of southeastern Nevada. In the Clover Mountain area, the climatic regime transitions from arid to sub-alpine. **Table 3-3** summarizes relevant statistics on climatic conditions representative of the project area and surrounding vicinity. The project area is subject to extreme temperature variations between summer daytime highs, which can exceed 100 degrees Fahrenheit (°F) for weeks at a time, and winter nighttime lows, which typically dip well below freezing during December and January.

Of particular importance to the surface water hydrology, however, is the amount and pattern of precipitation. On the local valley floors, and on the lower elevations of the surrounding mountains and hills, the average annual precipitation is usually less than 10 inches per year (Walker 2002, as cited in BLM 2003). This precipitation falls as rain, typically during two different seasons. The greatest amount usually falls during the winter (January to March) as regional cold fronts from the west produce relatively long-duration, but low-intensity rainfall events. Precipitation is also likely to occur during the summer (July to September) as a result of generally localized, short-duration, high-intensity convectional storms (thunderstorms fueled by rising warm air masses).

Table 3-3 Summary of Climatic Statistics in the Vicinity of the Project Area

Location	Elevation (ft amsl)	Average Annual Total Precipitation (inches)	Maximum Average Monthly Precipitation and Minimum Average Monthly Precipitation (inches)	Maximum Average Monthly Temperature and Minimum Average Monthly Temperature (°F)
Bunkerville, Nevada (near Mesquite) Period of Record: 12/01/1979 to 04/30/2007	1,550	6.34	0.97 (Feb) 0.13 (May and June)	105.9 (Jul) 29.2 (Dec)
Caliente, Nevada Period of Record: 08/01/1928 to 06/30/2007	4,400	9.09	1.03 (Mar) 0.36 (Jun)	95.5 (Jul) 17.8 (Jan)
Elgin, Nevada (SE) Period of Record: 05/01/1965 to 6/30/1985	3,300	14.1	2.52 (Mar) 0.14 (Jun)	100.1 (Jul) 30.7 (Dec and Jan)
Elgin, Nevada Period of Record: 03/01/1951 to 06/30/2007	3,400	12.20	2.02 (Feb) 0.34 (Jun)	98.7 (Jul) 27.9 (Dec)

Source: Western Regional Climate Center (2007)
amsl – above mean sea level

With increasing elevations in the mountains that surround the project area, the amount of precipitation generally increases to more than 10 inches per year. Within the Clover Mountains, the elevations reach more than 7,000 feet. The corresponding precipitation amounts in these elevations are estimated to average between 13 and 16 inches per year (Walker 2002, as cited in BLM 2003).

A recent study by Jeton (2006, as cited in DBS&A 2008) determined that the average annual precipitation in the Tule Desert was approximately 12 inches between 1961 and 2000, based on predictions from a precipitation predictor called the Precipitation-Elevation Regressions on Independent Slopes Model (PRISM).

The Western Regional Climate Center (WRCC), along with Desert Research Institute (DRI), has installed a weather station located in the upper part of Garden Wash at an elevation of 4,853 ft amsl, where they collect climatic data. Total annual precipitation at this station was 8.2 to 9.3 inches for water year 2006 (October 2005 through September 2006) and 6.6 to 7.5 inches for water year 2007 (October 2006 through September 2007) (DBS&A 2008).

Surface evaporation rates run counter to local precipitation amounts and are relatively high. On the local valley floors, the average annual potential surface evaporation is considerably higher than the average annual rainfall, primarily because of the generally high air temperatures and the typically low relative humidity in the arid valleys. On the floor of the Virgin River Valley, for example, the annual potential evaporation rate has been reported by Woessner et al. (1981, as cited in BLM 2003) to be approximately 80 inches, or roughly 27 times the average annual precipitation at a similar location.

3.3.1.4 Surface Water Features

The Clover Mountains, located in the northern part of the project area, create a divide between the Tule Desert and Clover Valley watersheds. Any surface water within the Tule Desert and downstream Virgin River Valley Hydrographic Areas flows south toward the Virgin River and ultimately, into Lake Mead. Surface water within the Clover Valley Hydrographic Area flows into Clover Creek, a tributary of Meadow Valley Wash, which flows south into Muddy River and ultimately into Lake Mead (**Map 3-1**).

3.3.1.4.1 Clover Valley and Meadow Valley Wash

Within the Clover Valley Hydrographic Area, all surface water draining the northern portion of the project area flows in a northerly direction into Clover Creek. Clover Creek is an ephemeral drainage that becomes intermittent just downstream of Big Spring, which provides the majority of water to the creek (Meadow Valley/Clover Creek Technical Review Team [MVCCTRT] 2000). Clover Creek joins the perennial Meadow Valley Wash just north of the City of Caliente. Pine Wash and several small unnamed drainages originate in the Clover Mountains. These are ephemeral drainages that flow only for short durations as a result of snowmelt and precipitation events. Clover Creek is located north of the proposed well field.

Meadow Valley Wash is a perennial stream incised through volcanic rocks in the northern part and primarily through basin-fill deposits in the southern part of the Lower Meadow Valley Wash Hydrographic Area. The wash trends southward to the Muddy River, which drains into the Colorado River to the southeast. South of the 37th degree N latitude, Meadow Valley Wash becomes ephemeral due to pumping, evapotranspiration, and infiltration along its course (Burbey 1997). An additional source for the Muddy River is a series of springs located approximately 10 miles northwest of its confluence with Meadow Valley Wash. At the confluence with the Meadow Valley Wash, the Muddy River flows southeast through Lower Moapa Valley into Lake Mead. Significant drainages into Meadow Valley Wash include the Antelope Canyon drainage west of Caliente and the Cottonwood Wash located 22 miles south of Caliente.

The Meadow Valley Wash starts off at an elevation of 4,400 ft at Caliente and drops to less than 1,600 ft as it reaches Moapa, resulting in major temperature and climate differences between the upstream and downstream parts of the Hydrographic Area. The Wash also passes through highly variable geologic settings including wide alluvial valleys and constricted, steep canyons. These variable climatic and geologic conditions result in variable groundwater – surface water patterns. In areas where arroyo tributaries deposit large quantities of sediment, often a large portion of the surface streamflow infiltrates into the unconsolidated sediments and becomes a groundwater flow. Streamflow loss to groundwater often also occurs where Meadow Valley Wash transitions from a narrow canyon reach into a broad valley underlain by coarse alluvial deposits. For example, this occurs near Elgin, where the wash exits the narrowest part of Rainbow Canyon and the stream goes dry (Bio-West, Inc. 2005).

Within the Lower Meadow Valley Wash Hydrographic Area, Provencher et al. (2003, as cited in Bio-West, Inc. 2005) describes Meadow Valley Wash as perennial from Caliente to Elgin but intermittent farther south, depending on where the bedrock interfaces with the alluvium. However, Averett (1995, as cited in Bio-West, Inc. 2005) considered Meadow Valley Wash perennial down through Leith, where it sank into the alluvium. From this point downstream to just north of Carp, Averett (1995, as cited in Bio-West, Inc. 2005) considered Meadow Valley Wash ephemeral and described the flow south of Carp as mostly perennial to the confluence with the Muddy River.

Streamflow measurements were available from one USGS monitoring station located on Meadow Valley Wash near Caliente. Streamflow statistics for this station are summarized in **Table 3-4**.

Table 3-4 Streamflow Statistics for USGS Monitoring Station on Meadow Valley Wash

Station Name	Meadow Valley Wash near Caliente, NV
Station Number	9418500
Drainage Area (mi^2)	1,670
Elevation (ft amsl)	4,200
Period of Record	1951-2007
Mean Annual Flow (cfs)	10.1
Highest Annual Mean (cfs)	61.5 (1993)
Lowest Annual Mean (cfs)	0.41 (2004)
Maximum Peak Flow (cfs)	8,000 (1/10/2005)

Source: USGS 2007 mi^2 – square miles cfs – cubic feet per second ft amsl – feet above mean sea level

The mean annual streamflow at the Meadow Valley Wash is reported to be 10.1 cfs near the City of Caliente. Streamflows at the Caliente station typically vary between 1.0 and 10.0 cfs, with no flow at times during some years. Highest monthly streamflows occur during early spring, while the lowest monthly streamflows occur during the summer and early fall (USGS 2007). Normal flow in southern portions of Clover Creek (downstream of Big Spring) is less than 2.0 cfs (MVCCTRT 2000).

The Meadow Valley and Clover Creek drainages often experience periodic flooding, especially from rain or snow events in the winter months. Two flood-control dams (Pine Canyon and Matthews Canyon), located in the upstream Clover Valley watershed, were constructed in the late 1950s and are used following storms to regulate the streamflows and sedimentation (MVCCTRT 2000).

Available information on local surface water/groundwater interaction in the Clover Valley is limited. To date, no studies have been done to identify the recharge and discharge from the fractured-rock aquifer and its interconnection with surface water in the Clover Valley. In general, surface water could be susceptible to groundwater withdrawal (Elliot et al. 2006). However, in Clover Valley, potential hydraulic connection with the surface water could be hindered by a layer of volcanic material, more than 3,000 feet thick, overlying the regional fractured-rock aquifer. Conversely, the presence of numerous faults in the area could also serve as conduits for groundwater movement.

Water chemistry data, principally the isotope deuterium, can be used for tracing the origin of the water discharging from local water features. CH2MHill (2002b) sampled two local springs (Sheep Spring and Unnamed Spring) located in the southern and western parts of the Clover Valley Hydrographic Area. Both springs yielded a deuterium value (expressed using the unit of measure "permil") of -87 permil, which indicate that the recharge is from local precipitation. For comparison, values of deuterium from the deep fractured-rock aquifer are typically on the order of -100 permil. These data suggest that the spring water source is local and is not hydraulically connected to the deep regional fractured flow system beneath Clover Valley (Vidler 2007c).

Similarly, limited information is available on the interaction between the fractured-rock groundwater in the Clover Valley and surface water in the Meadow Valley Wash Hydrographic Area. Based on the isotope studies by CH2MHill (2002b). Deuterium abundance from a surface water sample collected at Cottonwood Creek and a spring sample from Mudhole Spring, located in the northeastern part of the Meadow Valley Wash Hydrographic Area were -91 and -86 permil, respectively. These values contrast with values of deuterium on the order of -100 permil that correspond to deep, regionally flowing groundwater. Accordingly, the limited data available suggest that surface water in this part of the Meadow Valley Wash is not connected with the deep regional aquifer system.

3.3.1.4.2 Tule Desert and Virgin River Valley

The principal surface water feature in the vicinity of the project area is the Virgin River, which flows southwesterly approximately 3 miles south of the LCLA development area. The Virgin River originates in Utah near Zion National Park and, upon exiting a gorge through the Beaver Dam Mountains ("the Narrows"), the river flows through the lower Virgin River Valley on its way toward the Overton Arm of Lake Mead on the Colorado River.

The flow in the Virgin River is quite variable both seasonally and annually, and differences in the reported values are largely a function of the particular period of record that corresponds to the reported value. Streamflow measurements for the Virgin River were available from two USGS monitoring stations. One is located at Littlefield, Arizona, approximately 9 miles upstream of the City of Mesquite, Nevada; and the second station is located near Overton, Nevada, approximately 5 miles upstream of Lake Mead. Streamflow statistics for the Virgin River and its perennial tributary Beaver Dam Wash are summarized in **Table 3-5**.

The mean annual streamflow at the Littlefield station is reported to be 242 cfs, which translates to approximately 175,300 AFY. The highest monthly stream flows occur during the months of April and May, while the lowest monthly stream flows occur in the summer (USGS 2007).

Table 3-5 Streamflow Statistics for USGS Monitoring Stations – Virgin River Valley

Station Name	Virgin River at Littlefield, AZ[1]	Virgin River near Overton, NV[2]	Beaver Dam Wash at Beaver Dam, AZ[1]
Station Number	9415000	9415240	9414900
Drainage Area (mi^2)	5,090	ND	575
Period of Record	1929-2007	2003-2005	1993-2007
Mean Annual Flow (cfs)	242	69	2.73
Highest Annual Mean (cfs)	825 (2005)	69 (2004)	4.96 (1998)
Lowest Annual Mean (cfs)	100 (1991)	69 (2004)	1.58 (2004)
Maximum Peak Flow (cfs)	61,000 (1/01/89)	35,000 (1/11/05)	15,000 (1/11/05)

mi^2 – square miles; cfs – cubic feet per second

The principal components to the flow of the Virgin River in the vicinity of the project area include: 1) flow from upstream, 2) inflow from local tributaries, 3) direct precipitation, and 4) irrigation return flow (residual water applied to crops in the river flood plain that infiltrates the soil and subsequently discharges to the river). At Littlefield, Arizona, upstream of the project area, discharge from a series of locally recharged springs is also an important component of flow in the Virgin River. These springs are discussed further in Section 3.3.1.5 – Local Springs.

Within the lower Virgin River Valley, the only perennial tributary of the Virgin River is the Beaver Dam Wash, which joins the Virgin River just upstream of Littlefield. Although the Beaver Dam Wash is perennial along several reaches, little or no surface flow actually occurs at the confluence with the Virgin River during most of the year. Estimated annual discharge rates for this wash are highly variable, but the long-term (1970 to 1994) annual average is roughly 12.5 cfs or 9,000 AFY (Holmes et al. 1997, as cited in BLM 2003). The mean annual streamflow at the Beaver Dam USGS station located near the confluence with Virgin River is significantly lower at 2.73 cfs (2,000 AFY) (USGS 2007). All other tributaries to the Virgin River within the lower Virgin River Valley are ephemeral washes, which only flow for short periods in response to significant rainfall events.

As it proceeds toward Lake Mead, flow in the Virgin River decreases as a result of: 1) consumptive use (through irrigation and other agricultural water demands), 2) evapotranspiration (the combined effect of direct evaporation and transpiration by natural vegetation along the river), and 3) infiltration into the local groundwater system (BLM 2003).

Specifically, portions of the Virgin River are diverted for irrigation at Mesquite, Bunkerville, and Riverside. These three diversions are estimated to reduce the river flow collectively by approximately 162.4 cfs or 117,000 AFY (USGS 2003). Historically, this has meant that, some of the time, all of the available water has been diverted during periods of low flow (June through August). These diversions, together with evapotranspiration and infiltration, cause the river to lose flow as it makes its way toward Lake Mead. Specific studies on the interaction between groundwater and the Virgin River have concluded that, between Littlefield and its confluence with Lake Mead, the river is basically a "losing" reach (water from the river infiltrates the subsurface and recharges groundwater) (USGS 2003). Further discussion on the groundwater/surface water interaction in the Virgin River Valley is presented in the CH2MHill Water Resources Technical Report (CH2MHill 2002a).

Compared with the mean annual streamflow at the Littlefield gaging station (242 cfs or 175,300 AFY), streamflow from a USGS station located 5 miles upstream of Lake Mead is significantly lower at only 69 cfs (50,048 AFY) (**Table 3-4**). Other reported streamflow values for the Virgin River at its mouth in the Overton Arm of Lake Mead range from 17,400 to 138,400 AFY depending on the period of measurement (BLM 2003).

Any surface drainage from the Tule Desert and southwestern portion of the Virgin River Valley is carried by the Toquop Wash, which flows south-southeast to the Virgin River. Several small unnamed washes direct localized surface runoff into progressively larger drainages of the Toquop Wash. Two of the larger drainages of the Toquop Wash are Garden and Sams Camp Washes, which both originate at the base of the Clover Mountains. As with all of the other washes leading to the Virgin River below Littlefield, the Toquop Wash is ephemeral and flows only for short durations as a result of significant precipitation events. Although flow of the Toquop Wash has not been directly quantified, it has been estimated by Glancy and Van Denburgh (1969) to contribute an average of approximately 1,400 AFY to the Virgin River.

3.3.1.5 Local Springs

Two types of springs occur in or near the ROI: (1) local springs, which are recharged by precipitation and are not connected to deep underlying groundwater and (2) regional springs, which are partially derived from the carbonate aquifer and are located outside of the project area. Local springs are described in this section, while the regional springs are discussed in Section 3.3.2.5.

Clover Valley and Lower Meadow Valley Wash: Several springs are located within the Clover Valley and Lower Meadow Valley Wash Hydrographic Areas. These springs are located in the Clover Mountains straddling both hydrographic areas and in the Mormon Mountains within the southeastern part of the Lower Meadow Valley Wash Hydrographic Area. Information on these local springs is limited. One spring (Big Spring) has been reported to provide the majority of water to the Clover Creek and is located approximately 12 miles upstream of the City of Caliente (MVCCTRT 2000). Locally sourced and regional springs of interest are shown on **Map 3-4**.

Based on isotope studies by CH2MHill (2002b), deuterium abundance from three springs in the Clover Mountains (Sheep Spring, Mud Hole Spring, and Unnamed Spring, also referred to as Ella Spring) and from two springs in the Mormon Mountains (Davies and Horse Springs) contrasts with values of deuterium that correspond to deep, regionally flowing groundwater. Accordingly, the data suggest that these springs are locally recharged and are not representative of deep water sources.

According to the Clover Valley Well Siting Report (Vidler 2007a) these springs only discharge small volumes and depend on local climatic conditions. The hydrogeochemical survey of springs in the Clover Mountains report that all of these springs dry up during the summer, suggesting that a source of water in these springs would be local recharge (McHugh and Ficklin 1984).

Tule Desert: There are several small springs in the mountains and hills that surround the Tule Desert. Most of these springs are in the Clover Mountains, but a few are located in the Tule Springs Hills and the East Mormon Mountains. The discharge from these local springs, however, does not contribute significantly to surface flows in the area. The discharge from these springs is typically very low (all are lower than 0.002 cfs and most are less than half that rate) and, if not captured for stock water, either evaporates directly or soaks into the ground where it subsequently evaporates or is lost through transpiration by plants. Similarly, these springs do not contribute to flows in the Virgin River (CH2MHill 2002a).

Based on geochemical and isotope studies conducted by CH2MHill (2002b), the local springs in the Tule Desert are recharged by local precipitation, and the water likely travels a relatively short distance (on the order of a few miles or less) before discharging to the surface. These studies included chemical analyses of stable isotopes of deuterium and oxygen-18, age dating by C-14 and tritium, chloride, total dissolved solids (TDS), and major ion chemistry.

Based on the age dating methods by carbon-14 and tritium, the groundwater from the regional fractured-rock aquifer system is tens of thousands of years old, while the spring water is only tens of years old. The groundwater from the production wells would have to be much younger if the spring water was hydraulically connected to the deep fractured-rock aquifer (CH2MHill 2002b).

Deuterium isotope abundance in water from local springs in Tule Desert varied between -88 to -76.5 permil, and contrasts with values of deuterium on the order of -100 permil that correspond to deep, regionally flowing groundwater in the carbonate aquifer systems (CH2MHill 2002a and 2002b). Accordingly, the data indicate that local recharge is the source for all of the springs in the area. This is consistent with the findings by Prudic et al. (1995), who states that "many small springs in the local mountains typically represent perched local systems that are not connected to surrounding and underlying groundwater."

The sources of the Littlefield Springs reportedly include both a portion of the Virgin River that infiltrates upstream in Utah and emerges downstream at Littlefield and local recharge from the Beaver Dam Mountains (Trudeau et al. 1983, as cited in BLM 2003; Cole and Katzer 2000, as cited in BLM 2003). In addition to these local springs, several springs of regional importance lie outside of the project area. These include the springs that rim the Overton Arm of Lake Mead and Rogers and Blue Point Springs, which are addressed further in Section 3.3.2.5.

3.3.1.6 Surface Water Quality

Section 303(d) of the Federal Clean Water Act requires States to develop a comprehensive list of waterbodies that are impaired by point and/or non-point sources. Section 303(d) also requires that States develop TMDLs for all impaired waters.

Nevada's water quality standards, contained in NAC 445A.119 – 445A.225, define the water quality goals for a waterbody by: 1) designating beneficial uses of the water and 2) setting criteria necessary to protect the beneficial uses. The 303(d) list of impaired streams, TMDLs, and the designated beneficial uses for the streams in the ROI and downstream receiving bodies are described in the following sections.

3.3.1.6.1 Clover Valley and Meadow Valley Wash

The Muddy River from its source to Glendale is included on Nevada's 2004 303(d) list as impaired from iron, temperature, and total phosphorus, and the segment from Glendale to Lake Mead as impaired from boron, iron, and temperature (NDEP 2005a). Currently, there are no TMDLs associated with Muddy River (NDEP 2005a). No other streams in the vicinity of the project area are listed as impaired on Nevada's 2004 303(d) list of water quality-limited streams.

The designated beneficial uses for the Meadow Valley Wash and Muddy River include irrigation, watering of livestock, recreation not involving contact with water, industrial supply, propagation of wildlife, and propagation of aquatic life (NDEP 2003b).

Clover Creek within the Clover Valley Hydrographic Area is designated as Class B water. The beneficial uses of class B water are municipal or domestic supply (or both) with treatment by disinfection and filtration only, irrigation, watering of livestock, aquatic life and propagation of wildlife, recreation involving contact with the water, recreation not involving contact with the water, and industrial supply (NDEP 2003b).

3.3.1.6.2 Tule Desert and Virgin River Valley

The Virgin River is generally characterized by high concentrations of TDS – on the order of 1,000 to 3,000 milligrams per liter (mg/L) (Glancy and Van Denburgh 1969, Woessner et al 1981, as cited in BLM 2003). Water quality samples from the USGS monitoring station at Littlefield reported specific conductance values from 1,630 to 2,780 microSiemens per centimeter (uS/cm) between November 2004 and August 2005. This range corresponds to approximately 1,060 to 1,807 mg/L of TDS (USGS 2005). Composed mainly of calcium, sodium, sulfate, and chloride, the concentration of TDS shows a strong inverse correlation with the flow of the river. Concentrations of TDS are most dilute when flows are highest, and tend to increase during periods of low flow. During low-flow periods, the flow in the river is dominated by discharges from springs with high TDS concentrations and irrigation return flows, which also tend to concentrate salts (BLM 2003).

In addition, because the quantity of irrigation return flow increases with distance downstream along reaches where irrigated agriculture is present, the concentration of TDS has similarly been shown to increase with distance downstream for the same reaches (Glancy and Van Denburgh 1969; Woessner et al. 1981, as cited in BLM 2003). Specifically, a 30 percent increase (between 2,000 mg/L and 2,700 mg/L) in TDS concentration between Littlefield and Riverside was reported by Glancy and Van Denburgh (1969).

The Virgin River also carries a large quantity of suspended solids that gives it its characteristic muddy appearance. The material in suspension is largely silt- and clay-sized particles, while the transported material along the river bed is largely sand-size. The average annual quantity of suspended material passing by Littlefield is reported to be 2.7 million tons, with the minimum reported value being less than 1 million tons and the maximum value more than 6 million tons (Glancy and VanDenburgh 1969). Annual suspended sediment discharge measured at the USGS monitoring station at Littlefield averaged at 1,313,000 tons between November 2004 and August 2005 (USGS 2005).

Nevada's 2004 303(d) list of water quality-limited streams lists the segment of Virgin River from the Nevada/Utah border to Lake Mead as impaired due to boron, iron, temperature, total phosphorus, and selenium (NDEP 2005a). A TMDL report for boron was submitted and approved by EPA in January 2003 for this segment of Virgin River (NDEP 2003a). NAC 445A.144 provides numeric criteria for "total recoverable" boron concentrations as needed to support irrigation and livestock beneficial uses. Of the two criteria, the boron standard for irrigation uses is the most restrictive. According to the Gold Book (EPA 1986), boron is an essential element for the growth of plants; however, higher levels may have toxic impacts to sensitive crops. The established criterion of 750 micrograms per liter (ug/L) is thought to protect sensitive crops during long-term irrigation (NDEP 2003a).

The designated beneficial uses for the Virgin River include irrigation, watering of livestock, recreation not involving contact with water, industrial supply, propagation of wildlife, and propagation of aquatic life (NDEP 2003b).

No surface water quality information is available for ephemeral drainages in the Tule Desert Hydrographic Area.

3.3.1.7 Surface Water Use and Water Rights

Nevada water law is set forth in the NRS Chapters 532 through 538. The Nevada Division of Water Resources, headed by the State Engineer, is responsible for the administration and enforcement of Nevada's water law. This includes overseeing the permitting and appropriation, adjudication, distribution, and management of the state's surface and groundwater.

Surface water rights, including those associated with springs in the Clover Valley and Lower Meadow Valley Wash Hydrographic Areas, are designated primarily for irrigation and stock water use (NDWR 2007).

All surface water rights in the Tule Desert Hydrographic Area are permitted for stock watering (NDWR 2007). The nearest surface water rights in the Virgin River Valley Hydrographic Area are located south of the LCLA development area, near the communities of Mesquite and Riverside. These water rights are primarily associated with irrigation, storage, power, and municipal water use (NDWR 2007). Water rights associated with springs in the Nevada portion of the Virgin River Valley Hydrographic Area are designated exclusively for wildlife and stock water use (NDWR 2007). Surface water rights within the Hydrographic Areas included in the ROI are summarized in the **Appendix D**.

3.3.2 Groundwater Resources

3.3.2.1 Data Collection Methods

This section characterizes the local groundwater conditions and their relationship to the regional groundwater system. The geographic extent evaluated for the regional groundwater system encompasses southern Nevada. Groundwater systems are directly linked to the geological conditions described in Section 3.1, Geology. Discussion on sources of the water for springs of regional importance as it relates to potential project-induced impacts is also presented in this section. Groundwater quality, use, and water rights in the ROI are also described.

The data sources reviewed for this Draft EIS include USGS reports and maps; NDWR reports and data obtained from their website (e.g., NDWR 2006), various scientific publications (e.g., Rush 1964), the 2003 and 2007 Toquop EIS (BLM 2003 and 2007), and consultants' reports specific to the area (e.g., CH2MHill 2002a, 2002b, 2007; DBS&A 2008; Vidler 2007a and 2007d; and LCWD and Vidler 2008). Consultants' reports prepared on the regional and local hydrogeology contain a more detailed discussion and analysis of many of the groundwater-related topics presented in this Draft EIS.

For the description of groundwater resources, the area of delineation is defined in terms of 1) groundwater in the underlying rocks or 2) the area of groundwater flow from source areas located either in the bounding mountain ranges or upstream basins toward discharge areas in the downgradient basins.

3.3.2.2 Regional Setting

Groundwater resources in Clover Valley, Tule Desert, Lower Meadow Valley Wash, and a portion of the Virgin River Valley are part of the Colorado River Flow system located within the southern portion of the Carbonate-Rock Province (Prudic et al. 1995). "Carbonate-Rock Province" is a descriptive term primarily used by hydrogeologists. The Carbonate-Rock Province is defined as that part of the Basin and Range Province (**Figure 3-1**) in which groundwater flow occurs in highly fractured and carbonate-rock aquifers of Paleozoic age. Hence, the groundwater aquifers are referred to as either the fractured-rock or carbonate-rock aquifer. The Carbonate-Rock Province encompasses the eastern half of the Great Basin and includes areas of eastern Nevada and western Utah and small parts of Arizona and Idaho (Harrill and Prudic 1998) (**Figure 3-7**).

The carbonate-rock regional aquifer system consists of several major flow systems which are bounded by plutonic rocks that have intruded the carbonate rocks, by faults that juxtapose relatively impermeable units against the carbonate rocks, and by groundwater divides (Plume and Carlton 1988).

Recent research on the Basin and Range Carbonate-Rock Aquifer System Study (BARCASS; Welch and Bright 2007) was initiated in December 2004 through federal legislation (Section 131 of the LCCRDA) directing the Secretary of the Interior to complete a water resources study through the USGS, Desert Research Institute, and State of Utah. The BARCASS study was designed as a regional water resource assessment, with particular emphasis on summarizing the hydrogeologic framework and hydrologic processes that influence groundwater resources. The BARCASS report only covers the water resources for White Pine County, Nevada, and adjacent areas in east-central Nevada and western Utah. The methods applied and developed will eventually apply to the areas discussed in this Draft EIS; however, such an application is at least several years away.

3.3.2.3 Regional Groundwater Occurrence

Within the Basin and Range Province, groundwater occurs in both the sediments that have filled the valleys to their current elevations (basin-fill deposits) and the underlying rock that also comprises the surrounding hills and mountains. Groundwater is, therefore, stored and conveyed through two principal aquifer systems: 1) saturated, poorly consolidated shallow basin-fill deposits and 2) the underlying fractured-rock aquifer including sedimentary carbonate (limestone, dolomite) or volcanic (tuff, rhyolite, basalt) rocks.

In general, the basin-fill aquifer systems are localized and relatively shallow. Groundwater in these deposits generally flows in directions that coincide with decreasing ground surface elevations. The underlying fractured-rock aquifer systems, on the other hand, are regional features in which groundwater flows irrespective of the local topography and Hydrographic Area boundaries.

Groundwater in the deep fractured-rock systems flows in response to regionally controlled hydraulic gradients driven by regional recharge and discharge areas, and is generally not significantly influenced by conditions in the overlying basin-fill aquifer systems (USGS Professional Papers 1409 A through H, Welch and Bright 2007). In addition, although individual rock formations are laterally discontinuous and typically highly deformed structurally, the basic rock types are essentially continuous and transcend the boundaries of the Hydrographic Areas. As a result, it is very difficult, if not impossible, to place lateral bounds around the fractured-rock aquifer systems (Dettinger 1992). The regional flow direction in the deep fractured-rock aquifer is generally from north to south (Schaefer 1996). The conceptual nature of these flow systems is shown in the diagram on **Figure 3-8**.

Groundwater flow is influenced by a combination of topography, climate, and geology. Groundwater moves through permeable zones under the influence of hydraulic gradients from areas of recharge to areas of discharge, and this movement can be discussed in terms of local, intermediate, and regional flow systems as shown in Figure 3-8. These groundwater terms are adopted from the terminology developed by Toth (1963) and Freeze and Cherry (1979), and are defined on the basis of depth of groundwater flow and length of the flow path.

Local flow systems are characterized by relatively shallow and localized flow paths that terminate at upland springs. Local springs are low volume, tend to have temperatures similar to annual average ambient atmospheric conditions, and have discharge that fluctuates according to the local precipitation.

Intermediate flow systems include flow from upland recharge areas to discharge areas along the floor of the intermontane valley. Within intermediate flow systems, springs typically discharge near the intersection of the alluvial fan and the valley floor near the range front. Intermediate flow system springs often are of moderate volume and tend to have less variable flow relative to local springs.

Regional groundwater flow follows large-scale (tens to hundreds of miles) topographic gradients as water moves toward low altitudes in the region. Discharge from these regional flow systems manifests as large springs and, in some areas, as extensive wetlands. None of these wetlands, however, occur in the ROI. It has been recognized that certain large volume springs in the eastern Great Basin cannot be supported by the available recharge from local surrounding mountain ranges, and that the flow from these springs must be supported in part from regional groundwater flow originating outside the basin. Regional groundwater flow is driven by hydraulic gradients that are continuous over long distances. Deep regional flow through basin-fill or consolidated bedrock aquifers is unconstrained by local topographic or drainage features. Under pre-development conditions, recharge to the regional groundwater flow system primarily originates in mountains and may travel beneath several basins and through multiple mountain ranges before reaching its ultimate discharge area (Welch and Bright 2007).

Inputs to a groundwater system include direct recharge from precipitation, infiltration from streams, flow from an adjacent groundwater system, and recharge from human activities such as agricultural irrigation.

Recharge most commonly occurs in two areas. One of these areas is where water seeps down into fractures in the bedrock of the mountain uplands. Another area is where streamflow infiltrates underlying or adjacent bedrock or alluvium at the range front or in the valleys (Harrill and Prudic 1998).

Groundwater outputs from a basin include discharge from springs, discharge to streams and lakes, evapotranspiration (ET), flows across a groundwater flow system boundary to an adjacent system, and pumping for various uses. Activities such as groundwater pumping for agricultural uses and human consumption remove water from storage in a groundwater system and thereby reduce hydraulic heads, which are measured as groundwater levels in open wells. Groundwater pumping also can affect streams or springs in direct hydraulic connection with the groundwater system because declining groundwater levels can lead to increased recharge from streams and decreased spring flow.

The project area is located in a groundwater area referred to as the Carbonate-Rock Province due to the groundwater flow being strongly influenced by the carbonate-rock aquifers of Paleozoic age. Dominated by limestones and dolomites, the carbonate rocks in this region are brittle and subject to fracturing and faulting and, under the right geochemical conditions, can dissolve and form cavities that further enhance the ability of these rocks to store and transmit groundwater. The large geographic area underlain by these carbonate rocks, together with their demonstrated capacity to transmit large volumes of groundwater, is evidence that the carbonate rocks of Nevada comprise aquifer systems of regional scale and significance (Dettinger et al. 1995). The conceptual regional flow system depicted in **Figure 3-8** is similar to that found at the project area with the permeable consolidated rock area representing the fractured rock believed to exist beneath the Clover Valley and observed in bore holes beneath the Tule Desert areas.

Due to its significance, the Carbonate-Rock Province has been studied extensively on a regional scale by the USGS (Harrill and Prudic 1998). Computer models of the regional carbonate aquifer systems, developed by the USGS, indicate that the total volume of groundwater that flows through these aquifers is approximately 1.5 million AFY. This volume is for the entire Carbonate-Rock Province, and is based on fairly sparse data. Specifically, within the Nevada portion of the Colorado River Basin, the flow through the carbonate aquifer is estimated by the USGS to be more than 200,000 AFY. These estimates are based on very general assumptions for conditions in the Tule Desert and Virgin River Valley. It is important to note that data on the carbonate-rock aquifer system in these areas were limited at the time of the Harrill and Prudic (1998) study. Groundwater in storage for the Colorado Flow system has been estimated by Harrill et al. (1988) at 440,000 AFY.

3.3.2.4 Local Hydrogeology

The Hydrographic Areas in the ROI and the Lower Meadow Valley Wash are part of two groundwater flow systems (BLM 2006e). The Clover Valley and the Lower Meadow Valley Wash Hydrographic Areas are part of the Meadow Valley Wash flow system, while the Tule Desert and the Virgin River Valley Hydrographic Areas are part of Virgin River Valley flow system. Both Meadow Valley Wash and Virgin River Valley flow systems are part of the Colorado River Flow System. Both flow systems are depicted on **Map 3-5** and described further in the following paragraphs. These flow systems correspond conceptually to the intermediate flow paths depicted in **Figure 3-8**.

3.3.2.4.1 Clover Valley and Meadow Valley Wash

Most of the groundwater within the Meadow Valley Wash flow system is stored in and transmitted through the Tertiary and Quaternary alluvial valley fill. Deeper Paleozoic carbonate rocks also transmit large amounts of groundwater which is recharged primarily by precipitation in the mountains bordering Patterson Valley and through underflow from Lake Valley, both located north and upgradient of the project area. The total annual recharge into this system has been estimated by Rush (1964) at 27,000 AFY.

Within the Meadow Valley Wash flow system, the regional groundwater flows from the northern reaches of the system, where most of the recharge occurs, south towards the discharge areas. Groundwater is discharged via evapotranspiration, wells and springs, and surface or subsurface outflows in the downgradient areas. A large portion of regional groundwater is discharged by Panaca Spring, located approximately 14 miles northeast of Caliente and subsurface outflow in the Lower Moapa Valley near Glendale. Panaca Spring discharges approximately 8,000 AFY (Rush 1964).

Rush (1964) also estimated the volume of water stored in the upper 100 feet of the saturated thickness of alluvium to be 8 million acre-feet, out of which 650,000 acre-feet would be in Clover Valley and 2.8 million in the Lower Meadow Valley Wash Hydrographic Area. The preliminary perennial yield of the whole Meadow Valley Flow system was estimated at 25,000 AFY (Rush 1964). As depicted in **Map 3-6**, groundwater flow within the Meadow Valley Wash flow system is from north to south (Vidler 2007d)**.**

Site-specific hydrogeology data available for the Clover Valley Hydrographic Area are limited. Recent well siting investigations conducted by LCWD contain the most comprehensive hydrogeology information for the area to date (Vidler 2007a). Vidler reports that there are several existing wells and springs in the Clover Valley Hydrographic Area; however, none are representative of deep water sources nor are they highly productive. Springs are recharged locally from the surrounding hills and mountains and are likely structurally controlled by extensive faulting in the area. The springs exhibit limited discharge, with likely increases in flow during the spring snow melt and summer monsoons.

Based on the Vidler (2007a) well siting investigation, the groundwater in Clover Valley may be present in 1) the alluvial deposits; 2) extrusive Tertiary volcanics including ash-flow tuffs, bedded tuffs, and tuffaceous sandstones; and 3) undifferentiated Mesozoic and Paleozoic Rocks (**Figure 3-9**).

The few wells that have been drilled in Clover Valley serve domestic and stock watering purposes. Based on the NDWR Well Driller's Log Database, these wells are between 38 and 499 ft bgs, with water depths ranging between 8 and 299 ft bgs (NDWR 2007). These wells are likely completed in the younger alluvium or one of the extrusive volcanic units and produce water from those zones. They may produce enough water to sustain a family ranch, but may not be useful for providing a sustainable municipal water supply.

It is anticipated that water from a regional source in the Clover Valley would be encountered between 1,200 to 1,500 ft bgs. This estimate is based on an unpublished water level contour map of the groundwater basins to the north of Clover Valley and water level data from LCWD constructed monitor and test wells in Tule Desert (Vidler 2007a).

Based on the Clover Valley Well Siting memo (Vidler 2007a), there are 11 wells proposed in the Clover Valley Hydrographic Area. Locations of these wells are depicted on **Map 3-4** and details are summarized in **Table 3-6**. Well sites CWS-A, B, D, E, F, and G have the potential to encounter older rocks including Mesozoic and Paleozoic strata at depth. Well site CWS-A, along with sites CWS –D, E, F, and G, are in alignment with the southern Sheep Flat Fault and are intended to intersect this fault at depth. Well site CWS-B is in alignment with the northern Sheep Flat Fault and is also intended to intersect this fault at depth. Well sites CWS-C, H, I, J, and K are anticipated to encounter extrusive Tertiary volcanics including ash flow tuffs, bedded tuffs, and tuffaceous sandstones. The well yields will depend both on the intrinsic permeability of the volcanic units that occur in this area and the nature of those units. If the tuffaceous sandstone is sufficiently permeable and is highly faulted and fractured, then it may be relatively high yielding

Table 3-6 Summary of Proposed Wells in the Clover Valley

Proposed Well Name	Anticipated groundwater medium	Anticipated depth to water (ft bgs)
CWS-A	Mesozoic and Paleozoic	1,200 -1,500
CWS-B	Mesozoic and Paleozoic	1,200 -1,500
CWS-C	Tertiary volcanics	1,200 -1,500
CWS-D	Mesozoic and Paleozoic	1,200 -1,500
CWS-E	Mesozoic and Paleozoic	1,200 -1,500
CWS-F	Mesozoic and Paleozoic	1,200 -1,500
CWS-G	Mesozoic and Paleozoic	1,200 -1,500
CWS-H	Tertiary volcanics	1,200 -1,500
CWS-I	Tertiary volcanics	1,200 -1,500
CWS-J	Tertiary volcanics	1,200 -1,500
CWS-K	Tertiary volcanics	1,200 -1,500

The regional fractured-rock aquifer beneath Clover Valley is likely under semi-confined conditions at the proposed well field. There is too much low permeability strata above the volcanic and the carbonate rocks for groundwater to occur under water table conditions.

All of the ash-flow tuffs, bedded tuffs, sandstones, and any other material on top of the fractured rock aquifer would likely form a barrier between any groundwater occurring near the surface and the deep regional groundwater. Most of these deposits weather to clays over time if they are not indurated (hardened after they are emplaced). Therefore, it can be assumed that the fractured-rock aquifer represents a confined system that is disconnected from the local system.

A conceptual stratigraphic column presented in **Figure 3-9** illustrates the geologic units and their hydrologic significance with respect to the regional groundwater flow system and its relationship to local springs and surface water in the Clover Valley. As seen in this figure, the overlying tuffs, ash flows, and other extrusive volcanics form an extensive confining unit above either the Tertiary intrusives of the caldera or the Paleozoic carbonate rocks, and therefore serve as a hydraulic barrier between the local and the fractured-rock aquifers. Beneath the confining units, the volcanic intrusives or carbonate rocks are anticipated to be highly fractured and faulted and would form the basis of the regional fracture flow system in Clover Valley. The existence of the regional flow system beneath the Lower Meadow Valley Wash (**Map 3-1**) is generally accepted by most hydrogeologists (Dettenger 1995). However, regional flow beneath Clover Valley, as implied in **Figure 3-8**, has not been demonstrated due to the lack of deep observational boreholes.

Recharge from the surrounding Clover and Delamar Mountains surrounding Lower Meadow Valley Wash Hydrographic Area was estimated by Rush (1964) to be 1,300 AFY. Recharge from Meadow Valley Mountains, estimated to be 1,000 AFY, probably flows southward toward the Muddy River Springs area and does not significantly contribute to the Meadow Valley Wash Hydrographic Area (Burbey 1997).

No water level data are available from the carbonate rock aquifer within the Lower Meadow Valley Wash Hydrographic Area. Water levels within the basin-fill are shallow throughout most of the area. Measured depth to groundwater from six wells located in the Lower Meadow Valley Wash Hydrographic Area varied between 13 to 58 ft bgs (NDWR 2006).

Groundwater flow within the Lower Meadow Valley Wash Hydrographic Area in both shallow alluvium and deep carbonate rocks is inferred to be from north to south (Burbey 1997). Rush (1964) estimated that between 4,000 and 8,000 AFY of groundwater may leave the area as a subsurface outflow near Glendale, located at the southernmost part of the valley. The amount of discharge surpasses the amount of recharge; therefore, additional sources of recharge must be available. These sources include 1) recharge from volcanic rocks in the northern part of the Hydrographic Area, 2) surface water that infiltrates into the basin fill, or 3) subsurface inflow from outside of the Hydrographic Area (Burbey 1997).

The groundwater storage in the carbonate rocks of the Lower Meadow Valley Wash Hydrographic Area has been estimated to be about 2.7 million acre-feet, while storage within the basin-fill has been estimate at about 700,000 acre-feet (Burbey 1997).

3.3.2.4.2 Tule Desert

General studies of the hydrogeology of the Tule Desert area can be found in published literature dating back to the early twentieth century (Carpenter 1915, as cited in BLM 2003). Specific data were not available until recently because the groundwater resources of the Tule Desert had been developed only minimally in the past.

Site-specific information on hydrogeology of the Tule Desert area was obtained from wells drilled in recent years by the LCWD. Several monitoring wells (MW-1 through MW-8, MW-10), two far field monitoring wells (FF-1, and FF-2B), and three test/production wells (PW-1, PW-2, and TW-1) have been installed, sampled, and tested since 2000. Wells are screened to allow water to enter only at a specific depth and to exclude sediments and debris. MW-1 and MW-2 are each nested wells (one well with two screen locations, one screened in the shallower basin-fill and another screened in the deeper fractured rock) within a common borehole. MW-3 well is screened in the fractured volcanic rock, MW-4 is screened in the fractured carbonate rock, and MW-5 is screened in the basin-fill (CH2MHill 2002a). Both FF-1 and FF-2B were installed in 2005 and are screened in fractured carbonate rock. Four wells were installed in spring of 2006 – three monitoring wells (MW-6, MW-7, and MW-8) and a test well (TW-1). In 2007, additional two monitoring wells (MW-9 and MW-10) and a test well (TW-2) were installed. Additional information came from a livestock well completed in basin-fill deposits, commonly referred to as the Tule Desert Well. The well information summary is presented in **Table 3-7**. Locations of existing wells in the Tule Desert are shown on **Map 3-4**. Up to 15 additional wells may be constructed within the Well Field area indicated on Map 2-1 but the locations for only three of these wells have been proposed to date.

A detailed N-S hydrogeologic cross-section has been constructed representing the area between MW-10 in the north, through the FF-2B, and extending almost to Interstate Highway 15 at the south, **Figure 3-9** (LCWD and Vidler 2008). The location of this section is shown on **Map 3-4**. **Figure 3-9** shows the subsurface geology across the central portion of Tule Desert. At MW-7 in the center of the north section, a relatively thin saturated unconsolidated aquifer overlies saturated rocks of the Moenkopi Formation. At this location, within the upper part of the Moenkopi Formation there are thin limestone beds capable of producing small quantities of good quality water. However, most of the Moenkopi Formation contains abundant layers of gypsiferous rocks which, if open to a well, produce poor quality water (**Map 3-4**).

For the purpose of describing the hydrogeology in the Tule Desert, the groundwater system was informally divided into a shallow and deep system (LCWD and Vidler 2008). The shallow, or basin-fill, system includes the alluvium, Tertiary volcanics, and Mesozoic Formations. The deep system consists of the Paleozoic limestones. The two hydrologic systems have different gradients and implied flow directions. Groundwater flow through the Tule Desert in the basin-fill deposits is believed to occur toward the south and southeast. Based on the groundwater flow analysis and water balance presented by LCWD and Vidler (2008), 6,000 to 18,000 AFY exit the basin across the southern end (flow beneath the Mormon Mountains), and an additional 5,000 to 28,000 AFY of groundwater outflow to the southeast (beneath the Tule Springs Hills).

3.3.2.4.2.1 Tule Desert Groundwater in Basin-Fill

Based on the borehole logs discussed above with respect to **Figure 3-9**, the basin-fill in the Tule Desert consists of older alluvium of Pleistocene and Pliocene age, consisting primarily of unconsolidated sands and gravels alternating with layers of silt and clay. The available data suggest that, although a general pattern to the layering is discernable, discrete layers within the basin-fill deposits are laterally discontinuous. Consequently, although the lower portions of the basin-fill are saturated, a single continuous aquifer unit is difficult to identify. In addition, groundwater is likely to be locally perched (that is, it occurs as laterally discontinuous pockets of saturated sediments that are independent of a specific basin-fill aquifer).

Every well drilled in the Tule Desert Groundwater Basin to date encountered groundwater. The depth to water ranges from about 484 ft at MW-3 to 1,135 ft bgs at MW-6 (**Map 3-4**). With the exception of MW-3, MW-6, and MW-10 in the northern part of the basin and at FF-1 and FF-2b in the extreme southern end, saturated alluvium overlies bedrock. The exception wells are all located on the periphery of the basin and water levels in these wells are below the alluvium/bedrock interface (no alluvium was present at FF-1 and FF-2b). The pumping tests conducted at PW-1 in 2001 (CH2MHill 2002b) indicate that the alluvium is in direct hydraulic communication with the Paleozoic carbonates at this location.

At PW-1 there are approximately 150 ft of saturated alluvium overlying the top of rock while at PW-2 the saturated alluvium is about 600 ft thick. The only well installed in the alluvium that can be pumped is MW-5, and the yield is less than 5 gallons per minute (gpm) although it is of good quality. Around the periphery of the basin, the alluvium generally abuts bedrock. There are no known areas where the alluvial "aquifer" is discharging from the basin and, therefore, it appears to act as a reservoir for locally derived recharge and is providing recharge of the underlying bedrock through vertical leakage.

The USGS (1971) estimated the total volume of groundwater in storage within the uppermost

100 feet of saturated sediments in the Tule Desert to be approximately 530,000 acre-feet. Recharge to groundwater in the Tule Desert basin-fill deposits comes from direct precipitation on the surrounding upland areas, particularly those portions of the Clover Mountains, Mormon Mountains, and Tule Springs Hills. The precipitation in the Clover Mountains, Mormon Mountains, and Tule Springs Hills areas percolates down through the subsurface and reaches groundwater in amounts proportional to elevation.

The approach to estimating recharge most commonly taken in the hydrologic literature (Glancy and Van Denburgh 1969; Prudic et al. 1995; Maxey and Eakin 1949, as cited in BLM 2003) is to assume conservatively that precipitation falls on the valley floor, but does not infiltrate and recharge groundwater. This is primarily because of the high potential for evaporation. It is important to note that Katzer et al. (2002) believe that significant groundwater recharge occurs through the infiltration of runoff in the principal ephemeral washes feeding the Toquop Wash, and that the Toquop Wash contributes to groundwater recharge.

Estimates of groundwater recharge in the Tule Desert vary significantly from 2,100 AFY (Glancy and Van Denburgh 1969) to approximately 8,968 AFY (Katzer et al. 2002). Recharge to the basin-fill deposits also could be occurring due to upward leakage from the underlying fractured-rock aquifer, but there is no definitive quantification of this potential recharge component (BLM 2003).

The most recent estimates of recharge were provided by DBS&A (2008), who determined that the groundwater recharge originating from within Tule Desert ranges from roughly 3,500 to 10,000 AFY by variety of techniques and with a range of different precipitation rates. Most of the analyses fall in the range of 4,000 to 8,000 AFY, centering on about 6,000 AFY. The recharge rates were calculated by physically based water balance models, by empirical models based on transfer equations (e.g., Maxey-Eakin method); by chloride measurements in precipitation, runoff, soil, and groundwater; and by analysis of infiltration from surface runoff. These approaches comprise a significant improvement in the data available to scientists who conducted the reconnaissance investigation 40 years ago (DBS&A 2008). The issues of recharge and perennial yield are discussed further in this section.

3.3.2.4.2.2 Tule Desert Groundwater in Fractured Rock

The specific composition of the fractured-rock aquifer in the Tule Desert varies laterally across the basin as a result of vertical offset from faulting and local deposits of volcanic origin. In the central and northern half of the Tule Desert, the bedrock appears to be dominated by Moenkopi Formation (**Figure 3-9**). Based on test drilling at MW-7, at least 2,000 ft of Moenkopi Formation is present (LCWD and Vidler 2008). **Table 3-7** lists the wells installed in the Tule Desert as part of this project, the aquifer type (geologic material) encountered, and several additional properties of the wells.

Underlying the Moenkopi Formation and extending from the north end of the basin to beneath the Mormon Mountains are continuous Paleozoic carbonates. These carbonates are part of the Regional Carbonate Aquifer and are represented here to be approximately 8,000 feet thick. The regional groundwater flow within the carbonates is from north to south, and wells tapping it, such as PW-1, can produce yields of 700 to 1,000 gpm of good quality water.

Table 3-7 Current LCWD Production/Test/Monitoring Wells in the Tule Desert				
Well ID	Date Completed	Screen Interval [ft bgs]	Groundwater Medium	Depth to Groundwater [a] [ft bgs]
PW-1	Aug-01	1000-1780*	Carbonate Rock	715.0 [b]
PW-2	Jun-08	1500-2700*	Carbonate Rock	657.3 [f]
MW-1S	Nov-00	677-730	Basin-fill	713.9
MW-1D	Nov-00	945-1045	Carbonate Rock	712.64
MW-2S	Dec-00	640-740	Basin-fill	494.04
MW-2D	Dec-00	1435-1540	Triassic Undivided	504.57
MW-3	Oct-01	920-1980*	Volcanic Rock	486.26
MW-4	Feb-02	1108-1148	Carbonate Rock	712.71
MW-5	Jan-02	750-810	Basin-fill	713.21
MW-6	Dec-05	1560-1940*	Quartzite	1140.81
MW-7	Jan-06	1607-2536*	Triassic Undivided	714.34
MW-8	Feb-06	2146-2640*	Triassic Undivided	1045.89
MW-10	Jun-07	2500-3740*	Volcanic Rock	668.6[e]
TTW-1	Mar-06	1980-2260*	Triassic Undivided	734.9 [d]
FF-1	Mar-05	520-560	Carbonate Rock	420.39
FF-2B	May-05	2060-2110	Carbonate Rock	720.16
Tule Desert Well	Apr-53	Unknown	Basin-fill	388.1[c]

a = all depth to groundwater data as of July 2007 unless otherwise noted; b = as of Oct 2005; c = as of March 2005; d = as of May 2006, e = as of Nov 2007, f = as of Aug 2007
* indicates multiple screened intervals within range noted; ft bgs – feet below ground surface
Source: all data come from Vidler 2008, with the exception of water level data for PW-1, TTW-1, and Tule well, which come from Feast Geosciences 2006, as cited in Vidler 2007d

The Tertiary volcanic rocks penetrated at MW-3 extend out into the basin to an unknown extent (**Map 3-3**). They are not present at MW-7, nor are they present at MW-9, approximately 2.5 miles south of MW-3. From MW-7 to MW-6, the Moenkopi Formation thins or is faulted out, so that only a thin portion of the formation was penetrated at MW-6. Most of the bedrock portion penetrated by the borehole at MW-6 was composed of complexly faulted and mineralized limestones and quartzites (LCWD and Vidler 2008).

In the southern half of the basin, the Moenkopi Formation is absent and Paleozoic limestones are present. The contact from Moenkopi to Paleozoic limestone occurs somewhere between wells MW-1 and PW-1 (**Map 3-3**). Between PW-1 and PW-2, the Paleozoic formations change from almost all carbonate at PW-2 to a carbonate over a shaley, gypsiferous unit into coarse sandstone at PW-1. Geophysical investigation indicates at least one fault between the two wells. The presence of a fault is also suggested by the significantly different water chemistry between these wells as discussed by CH2MHill (2007). The depth of the fault system is not known at this time and is shown penetrating to the bottom of the section with the regional hydraulic conductivity increasing southward.

Well PW-2 in the south center of the basin penetrated 1,500 ft of Paleozoic limestone and produced 1,000 gpm of very high quality water. Monitor wells FF-1 and FF-2b, at the southern ends of the basin, were also installed into Paleozoic limestone produce more than 100 gpm. Vidler interprets this information to indicate that the Paleozoic formations beneath the Tule

Desert Groundwater Basin are sufficiently fractured and permeable to produce water in sufficient quantities for development.

As discussed in the previous section, the groundwater flow can be divided into two distinct systems. Within the deep system, groundwater inflow into the Tule Desert Groundwater Basin is shown on **Map 3-9**. The observational data used to construct this map are also shown beside each well. Flow in the Paleozoic carbonate aquifer, as expressed by wells PW-1, PW-2, FF-1, and FF-2b, is generally to the south as shown on **Map 3-9**. However, there are significant local variations in the flow directions and gradient at the extreme south end of the basin as a result of the hydrologic effects from the topographically elevated and structurally complex Mormon Mountain uplift and northern end of the north-south linear East Mormon Mountains. The gradient was calculated using the range of hydraulic conductivity values from pumping tests at PW-1 and PW-2 under the assumption that the hydraulic properties at these wells are representative of the regional carbonate aquifer. The gradient determined for a portion of the aquifer extending approximately 36 miles north from the northern end of the Tule Desert was 0.0066. The chemistry, deuterium isotope, and yield at PW-1 indicate that there is a continuum of carbonate rock that makes up the regional carbonate aquifer extending to the north between the Clover Mountains and Lime Mountain, and that the Tule Desert is part of the regional carbonate aquifer system of groundwater generally moving from north to south across Nevada. The deuterium isotope signature of groundwater sampled from well MW-10 indicates regional groundwater also enters the basin through the abutting Clover Caldera Complex and from beneath the extrusive volcanic rocks covering the northern end of the Tule Desert (CH2MHill 2007).

Most of the groundwater beneath the Tule Desert is regional carbonate aquifer groundwater moving from north to south in response to regional gradients as shown conceptually in **Figure 3-8** and specifically in **Figure 3-9**. Comparison of the groundwater elevations between the two flow systems indicates a general downward gradient from the shallow system into the deep regional carbonate system throughout most of the Tule Desert Groundwater Basin. Vertical downward gradients within the project area have been inferred using the alluvial/bedrock well pair MW-2 (deep and shallow screens). In addition, there are downward gradients from the alluvium into the bedrock and at MW-4, but at MW-5, the gradients are slightly upward. At PW-2, there are probably downward gradients based on short-term water level measurements taken before and after zone tests. The pumping tests conducted at PW-1 in 2001 (CH2MHill 2002b) show that the alluvium is in direct hydraulic communication with the Paleozoic carbonates at this location. Based on these observations, subsequent aquifer modeling has assumed that the deep aquifer is either unconfined or at most semi-confined.

Additional recent information has been compiled by LCWD and Vidler (2008) and was presented to the NSE in January 2008. The salient points from these studies which were conducted by CH2MHill (2002b and 2007) and DBS&A (2008) are provided below:

- There is a distinctly low geothermal gradient within the Tule Desert of 17.4 degrees Celsius per kilometer (°C/km) of depth, which is much lower than the expected geothermal gradient of between 30 to 36°C/km typically found in the Basin and Range Physiographic Province. This lowering of the temperature is most likely due to the deep circulation of water within the regional carbonate-rock aquifer beneath the Tule Desert.

Such circulation implies that deep groundwater may be circulating beneath the Tule Desert Basin in the carbonate aquifer.

- The geochemical temperatures calculated by assuming chemical equilibria between the dissolved chemical concentrations, observed in nine of the 14 wells tested in Tule Desert with the minerals encountered during drilling of the wells, indicate that a portion of the extracted water is derived from the warmer regional deep carbonate-rock aquifer. Cool temperatures would indicate that the source of the water is shallow recharge.
- The stable isotope and ion chemistry data from water in well PW-1 indicate that the source of the water is the regional deep carbonate -rock aquifer with deuterium isotope values of -101 permil and oxygen-18 of -14 permil, while groundwater deuterium isotope values of -92 permil and oxygen-18 of -13 permil from well PW-2 imply groundwater from PW-2 is not 100 percent from the regional deep carbonate aquifer.
- Carbon-14 values are significantly different between the groundwaters from the two wells with water from PW-1 having a value of 0.9 percent modern carbon (pmc) and water from PW-2 having a value of 14.4 pmc. The carbon-14 isotope data indicate that groundwater from well PW-2 is significantly younger than that of well PW-1. Further calculations indicate that groundwater pumped from PW-2 represents 80 percent local recharge from the Mormon Mountains and 20 percent regional carbonate aquifer groundwater
- Based on the apparent carbon-14 ages for groundwater in the regional deep carbonate aquifer north of Tule Desert compared to that of the water in PW-1, the regional carbonate aquifer is moving through Tule Desert at a rate on the order of 50 feet/year (ft/yr). The carbon-14 data also support the conclusions that significant local recharge from the Mormon Mountains provides a significant source of groundwater in the southern end of the Tule Desert Groundwater Basin.

Thus, the above observations of major ion and isotopic chemistry data support the conclusions that groundwater in the regional carbonate aquifer enters the Tule Desert from the north through both the volcanics (at least on the eastern side of the Clover Mountains) and the thick deep section of Paleozoic carbonate rocks that form the regional deep carbonate aquifer system. The regional deep carbonate groundwater then flows south through the Tule Desert and mixes with local recharge from the Mormon Mountains.

Aquifer tests have been performed on eight wells installed in Tule Desert to determine the hydraulic properties of the various geologic materials (**Table 3-8**). The first tests were performed in 2002 on well PW-1 and have been reported in the EIS prepared for Toquop Energy (BLM 2007b). This test indicated that the transmissivity of the carbonate aquifer is approximately 14,500 gallons per day per foot (gpd/ft) (CH2MHill 2002a). The transmissivity is a measure of the potential amount of water that can flow through aquifer material at a specified location and is expressed in units that take into account the thickness of the aquifer at the location where the test was conducted. More recently, aquifer properties were updated from tests conducted on the newly installed wells PW-2, FF-1, and FF-2b and a multi-well test was performed at the previously installed well PW-1. The transmissivity values at the two production wells, PW-1 and PW-2, range from 3,500 to approximately 27,000 gpd/ft in good agreement with the value of 14,500 gpd/ft reported previous (LCWD and Vidler 2008).

Table 3-8 Aquifer Parameter Data

Well	Test Conditions	Data	Parameter Results: Transmissivity (gpd/ft)	Parameter Results: Storage Coefficient	Comments
PW-1[1]	9-day Step Test/Recovery	PW-1 drawdown Step test	12,000		Multi-Well Test: Step 1: 600gpm for 2 days Step 2: 800 gpm for 2 days Step 3: 1,100 gpm for 1 day Step 4: 1,400 gpm for 4.3 days
		PW-1 recovery Step test	11,600		
	25-hour, 600gpm Constant Rate Test	PW-1 drawdown	14,500	0.005	
		PW-1 recovery	15,800		
		MW-1 (deep) (hand measured)	17,000	0.01	
		MW-4 drawdown	24,000	0.012	Completed in same unit as PW-1 (pumped well)
		MW-5 drawdown	27,000	0.035	Completed in Basin Fill/Unconsolidated Sediments
PW-1[2]	9-day Step Test/Recovery	PW-1 drawdown Step test	9,710	0.0031	Single well data analysis with AQTESOLV 2007
PW-2[2]	1 day Step Test	PW-2 drawdown	3,559	0.0048	Step 1: 600 gpm for 3 hrs. Step 2: 800 gpm for 3.3 hrs. Step 3: 1000 gpm for 5.8 hrs
	7-day Constant Rate Test	PW-2 drawdown	5,066	0.00034	Unconfirmed
MW-6[2]	7-hour, 20 gpm Constant Rate Test	drawdown	240-350		Single Well Test
MW-7[2]	10-hour, 25 gpm Constant Rate Test	drawdown	100-178		Single Well Test
MW-10[2]	30 gpm, airline failure	drawdown	Very low		Single Well Test, drew down to pump at 30 gpm, t=3.3 hrs., valve back to 20 gpm to sample no wl meas.
TTW-1[2]	27-hour, 25 gpm Constant Rate Test	drawdown	90-132		Single Well Test
FF-1[2]	20 hour step test	drawdown and recovery	16,744	0.0144	Step 1: 30 gpm for 100 mins. Step 2: 50 gpm for 100 mins. Step 3: 70 gpm for 16.3 hrs.
FF-2b[2]	23 hour step test	drawdown and recovery	63,297	0.0159	Step 1: 50 gpm for 80 mins. Step 2: 73 gpm for 100 mins. Step 3: 120 gpm for 169 mins. Step 4: 150 gpm for 16.7 hrs.

Notes:
1 Hydrosystems, Inc. 2002, as cited in Vidler 2007d; CH2MHill 2002a
2 Feast Geosciences 2007, as cited in Vidler 2007d

The ability of the aquifer to store groundwater (storativity) was also determined from the aquifer tests. Values of storativity, which is the volume of water pumped by a well per foot of water level decline per unit area of the fractured-rock aquifer, have been calculated to range between approximately 0.005 and 0.012. Small values of this order of magnitude indicate that pumping results in very little release of groundwater from storage and confirms the observation that the groundwater is partially confined under pressure within the fractures of the rock. Based on the value of 0.005 for aquifer storativity, the volume of groundwater within the uppermost portion (that is, an aquifer thickness of no more than 1,000 feet) of the fractured-rock aquifer is estimated to be approximately 400,000 AFY (CH2MHill 2002a).

The aquifer tests also revealed that, at the local scale, water levels in the rock and overlying basin-fill deposits behave similarly in response to pumping, although with much less water level decline in the basin-fill. As a result, it appears that there is significant hydraulic interconnection between the two aquifers, and that they effectively act as one unit at the local scale. In the vicinity of PW-1 and MW-4, the vertical component of hydraulic gradient is slightly upward, implying that groundwater has a slight tendency to flow from the rock upward into the basin-fill deposits in this area (BLM 2003).

Farther to the north and laterally upgradient, however, the vertical gradient is downward at MW-2. The downward gradient implies that groundwater tends to flow from the basin-fill deposits into the fractured rock at this location. Therefore, although the results of aquifer testing indicate that groundwater in the basin-fill and groundwater in the fractured-rock aquifer responds to pumping essentially as a unit, groundwater in the two aquifers originates from different sources and flows differently, if not independently, through the Tule Desert.

The available water chemistry data indicate groundwater in the basin-fill within the Tule Desert and groundwater in the fractured-rock aquifer within the Tule Desert have different chemical compositions, which indicates different origins. This conclusion is based on the similarity to the regional carbonate-rock aquifer system, with no detectable tritium (an unstable isotope of hydrogen). Tritium, if detected, indicates water less than 50 years old because high levels of tritium originated with aboveground nuclear testing in the late 1950s. Groundwater in the basin-fill, however, was shown to be less depleted in deuterium, higher in chloride, and to contain detectable tritium (BLM 2003), indicating a lack of connection with the groundwater in the fractured-rock aquifer.

The results of the aquifer testing also provide insight into how much water the proposed LCWD wells can pump. While the production well PW-1 was pumped at a rate as high as 1,400 gpm for several days, the resulting water level response indicates the long-term sustained safe yield to be approximately 550 gpm or about 887 AFY (BLM 2003). This predicted pumping rate for PW1 led to the LCWD decision to develop up to 15 wells in the Tule Desert to produce the planned total pumpage of 9,340 AFY.

3.3.2.4.1. Virgin River Valley

Because of the significant depths to the underlying carbonate rocks within the Virgin River Valley Hydrographic Area, groundwater is accessible largely only from the basin-fill aquifers. The basin-fill principally consists of the Muddy Creek Formation, which is typically overlain by older alluvium where alluvial fans abut against the local mountains, and younger alluvium along the floodplain of the Virgin River (Glancy and Van Denburgh 1969).

Groundwater enters the Virgin River Valley from the north via the regional flow system and from areas to the east of the Tule Desert. Groundwater from the Tule Desert flows southward through the fractured-rock aquifer and, at the north edge of the Virgin River Depression, it discharges into the basin-fill aquifer of the Virgin River Valley. Groundwater also enters the Virgin River Valley from the east including recharge from Beaver Dam Wash and mountain-front recharge from the Beaver Dam and Virgin Mountains (Las Vegas Valley Water District 1992, as cited in BLM 2003).

Groundwater in the Virgin River Valley is also recharged directly by the Virgin River and locally by residual irrigation water applied to crops in the Virgin River floodplain. The Virgin River is essentially a “losing” river, which means that water from the river infiltrates the subsurface and recharges groundwater. The evidence that the local and regional groundwater systems in the Virgin River Valley do not flow into the Virgin River is further discussed in CH2MHill Water Resources Technical Report (CH2MHill 2002a). The direction of groundwater flow is generally toward the southwest parallel to the Virgin River (Katzer et al. 2002; Las Vegas Valley Water District 1992, as cited in BLM 2003).

Estimates of the amount of groundwater inflow, including groundwater recharge, to the Virgin River Valley vary based on the assumptions and the data available to the authors. Glancy and Van Denburgh (1969) roughly estimated the combined inflow and recharge to be approximately 6,700 AFY. Katzer et al. (2002) estimated the total recharge to the Virgin River groundwater system to be on the order of 85,000 AFY. This difference cannot be reconciled at this time without further study.

The transmissivity of the Muddy Creek Formation in the Virgin River Valley is reported to be relatively low, with values typically lower than 10,000 gpd/ft (Johnson 2000). Higher transmissivity areas within the Muddy Creek Formation have been discovered where faulting has reportedly facilitated the development of potential localized conduits between the Muddy Creek Formation and the underlying fractured rock (Johnson 2000). The total volume of groundwater in storage within the uppermost 100 feet of saturated sediments in the Nevada portion of the Virgin River Valley has been reported by Las Vegas Valley Water District (1992, as cited in BLM 2003) to be approximately 2.9 million acre-feet based on a specific yield of 10 percent. Katzer et al. (2002) estimate the available perennial yield of the basin-fill aquifer system in the Virgin River Valley to be approximately 40,000 AFY.

3.3.2.5. Regional Springs

Several springs of regional importance lie outside of the immediate project area. These include the Muddy Springs, located approximately 28 miles southeast of the project area within the downstream Muddy River Springs Hydrographic Area, and a series of springs that rim the Overton Arm of Lake Mead (including Rogers and Blue Point – approximately 56 miles southeast of the project area).

The water that discharges from springs around the Overton Arm of Lake Mead is reported to originate from multiple points, with the discharge resulting from local recharge and the regional carbonate aquifer (Pohlmann et al. 1998, as cited in BLM 2003). Within the Meadow Valley Wash Hydrographic Area, Burbey (1997) identified a distinct groundwater flow system extending as a narrow zone southward from the Mormon Mountains that may contribute to flow in Rogers and Blue Point Springs located in the Overton Arm of Lake Mead (Burbey 1997).

CH2MHill (2002b) analyzed chemistry data (including deuterium and oxygen 18 isotopes, carbon 13 and 14) and general chemistry parameters (including cations, anions, chloride, and TDS) to determine if there was any connection between the regional fractured-rock aquifer system flow through Tule Desert and these springs (among other water resources in southeastern Nevada). CH2MHill (2002a, 2002b) concluded that the water chemistry data indicate that the origin of Rogers Spring and nearby Blue Point Spring is most likely not from the north and that the contribution of groundwater to the springs is from a flow path that likely does not originate in Tule Desert. However, the elevations of these springs are higher than the pre-Lake Mead confluence of the Muddy River and the Virgin River, indicating that flow from the Virgin Valley is also unlikely. Thus, based on current information, it is not possible to identify the source of water to these springs.

The source of the water in Muddy Springs, located approximately 20 miles west of the proposed LCLA development, has been a subject of several studies (Eakin 1964, 1966; Prudic et al 1995; Burbey 1997). These studies concluded that the discharge from Muddy River Springs is being supplied primarily from a regional carbonate aquifer via the White River Flow System. The White River Flow System is separate from that of Meadow Valley Wash and Virgin River Flow systems, where the Proposed Action's facilities and groundwater withdrawals are proposed.

3.3.2.6. Groundwater Quality

The carbonate-rock aquifer is contained within the Basin and Range Principal Aquifer, one of 16 principal aquifers selected for study by the U.S. Geological Survey's National Water Quality Assessment Program. Water samples from 30 ground-water sites (20 in Nevada and 10 in Utah) were collected in the summer of 2003 and analyzed for major anions and cations, nutrients, trace elements, dissolved organic carbon, volatile organic compounds (VOCs), pesticides, radon, and microbiology (Shaefer et al. 2005).

Primary drinking-water standards were exceeded for several inorganic constituents in 30 water samples from the carbonate-rock aquifer. The maximum contaminant level was exceeded for concentrations of dissolved antimony (6 µg/L) in one sample, arsenic (10 µg/L) in eleven samples, and thallium (2 µg/L) in one sample. Secondary drinking-water regulations were exceeded for several inorganic constituents in water samples: chloride (250 mg/L) in five samples, fluoride (2 mg/L) in two samples, iron (0.3 mg/L) in four samples, manganese (0.05 mg/L) in one sample, sulfate (250 mg/L) in three samples, and total dissolved solids (500 mg/L) in seven samples (Shaefer et al. 2005).

3.3.2.6.1. Clover Valley and Meadow Valley Wash

Water quality data from seven springs located in the Clover Valley Hydrographic Area were obtained as part of a hydrogeochemical study designed to determine the mineral resource potential in the area (McHugh and Ficklin 1984). The water from these springs may be classified as calcium bicarbonate and calcium-sodium bicarbonate. The concentration of TDS provides a general indication of water quality. TDS concentrations from these springs varied between 150 to 345 mg/L, indicating very good water quality. The concentration of arsenic from one spring was measured at 0.025 mg/L, exceeding the primary federal drinking water standard of 0.01 mg/L. However, based on isotope studies by CH2MHill (2002b) these springs are locally recharged and are not representative of deep water sources. No water quality data from wells were available from the Clover Valley Hydrographic Area.

Water quality data from six groundwater wells in the Lower Meadow Valley Wash Hydrographic Area were summarized by Rush (1964). Generally, TDS concentrations increase southward along the wash. Specific conductance of water from three wells near Caliente varied from 522 to 793 micromhos per centimeter (micromho/cm), while samples from three wells located on alluvial plains near Carp, Rox, and Glendale showed higher conductance values varying from 812 to 1,540 micromho/cm. In the southern part of lower Meadow Valley, mineral content of the groundwater is high for several possible reasons: 1) in its downgradient migration, the percolation time is long and the water has contacted a large amount of rock material; 2) some of the water has been recycled several times through the soil by irrigation and natural flow; and 3) a large amount of evapotranspiration takes place locally in the area, causing increased mineral concentration (Rush 1964).

3.3.2.6.2. Tule Desert and Virgin River Valley

The water quality of the fractured-rock aquifer is represented by twelve wells analyzed in May and July 2006. The results of the water quality analyses are summarized in **Table 3-9.** Based on water quality samples from the LCWD wells, the water quality of the basin-fill deposits appears to be generally good. TDS concentrations from basin-fill wells varied between 302 to 624 mg/L, which represents good quality water. TDS and aluminum concentrations exceeded the secondary drinking water standards in MW-2, while the arsenic concentration was measured at the primary drinking water standard level in the water sample from MW-5 monitoring well. Based on samples from these wells, the general character of the groundwater in the basin-fill deposits is sodium-calcium sulfate-bicarbonate.

TDS values from PW-1, MW-2, MW-4, FF-1, and TTW-1 varied between 421 and 691 mg/L. These data are representative of relatively good quality water, although in some instances they narrowly exceed the secondary drinking water standard for TDS of 500 mg/L. TDS values from MW-6, MW-7, MW-8, and FF-2B were significantly higher, ranging from 1,472 to 3,056 mg/L. TDS, iron, dissolved manganese, chloride, and sulfate concentrations exceeded the secondary drinking water standards from various fractured-rock aquifer samples, while arsenic concentrations exceeded the primary drinking water standard in the three fractured rock water samples (Vidler 2007e). The general character of the groundwater in the fractured rock is sodium sulfate and calcium-magnesium sulfate based on the data presented in **Table 3-9**.

As expected, deuterium abundance values in water from basin fill and volcanic aquifers were higher, varying from -89 to -97 permil, than those from the deep carbonate aquifer and Triassic undivided rocks, which ranged between -99 to -102 permil.

Based on water quality data described in Glancy and Van Denburgh (1969) and the Las Vegas Valley Water District (1992, as cited in BLM 2003), the general character of the groundwater in the floodplain of the Virgin River tends to be mixed cation (sodium, potassium, magnesium) sulfate-type water. Groundwater from wells above the floodplain tends to be composed of predominantly sodium sulfate plus chloride.

The concentrations of TDS in wells along the river are very high, with values ranging from approximately 2,100 mg/L to more than 3,000 mg/L, indicating relatively poor quality water. The TDS concentrations in wells above the floodplain are generally much lower — on the order of around 400 mg/L to 620 mg/L. Some of these wells above the floodplain, however, have TDS values that approach 2,000 mg/L. Wells operated by the Virgin Valley Water District that penetrate the Muddy Creek Formation have had problems in the past producing water that meets drinking water standards, but the water quality tends to improve in the immediate vicinity of faulted areas (Johnson 2000).

Table 3-9 Summary Of 2006 Groundwater Quality Data

Parameter	Units	PW-1	MW-2	MW-2	MW-3	MW-4	MW-5	MW-6	MW-7	MW-8	TTW-1	FF-1	FF-2b	Drinking water standards
Well Source	--	Carbonate	Fill	Carbonate	Volcanic	Carbonate	Fill	Quarzite	Triassic Undivided	Triassic Undivided	Triassic Undivided	Carbonate	Carbonate	--
Date Sampled	--	7/25/2006	7/25/2006	7/25/2006	7/26/2006	7/26/2006	7/26/2006	7/26/2006	5/16/2006	5/19/2006	5/11/2006	7/27/2006	7/27/2006	--
Temperature	˚C	28.8	24.5	24.4	26.6	27.0	25.8	31.4	31.8	29	28.4	23.0	25.5	--
Conductivity	uS/cm	928	2247	559	3350	712	431	4345	2890	2030	999	718	1696	--
pH	Standard Units	8.14	8.60	8.30	9.65	8.43	9.28	7.94	7.20	7.38	8.65	8.19	8	--
ORP	mv								-165	-100	-225			--
Silica	mg/L	21	15	27	2.6	32	19	21	17	19	17	6.6	<2.5	NS
Aluminum	mg/L	<0.5	0.59	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.05-0.2 a
Dissolved Iron	mg/L	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	6.4	1.3	0.6	<0.2	<0.2	0.3 a
Dissolved Manganese	mg/L	0.033	<0.02	<0.02	<0.02	<0.02	<0.02	0.12	0.35	0.13	0.054	0.033	0.3	0.05 a
Calcium	mg/L	46	160	2.6	230	31	9.3	62	380	160	49	24	140	NS
Magnesium	mg/L	15	<0.5	<0.5	0.54	17	6.7	11	130	56	19	17	100	NS
Sodium	mg/L	150	45	130	550	92	84	920	210	240	120	140	84	NS
Potassium	mg/L	6.5	4.6	6.4	5.3	9.5	7.7	40	12	5.4	13	3.8	6.4	NS
Alkalinity	mg/L	140	550	470	36	120	140	430	210	140	190	180	36	NS
Sulfate	mg/L	360	29	65	1800	160	83	1400	1300	1200	270	170	1100	250 a
Chloride	mg/L	7.4	45	41	65	6.4	6.8	340	55	11	15	16	20	250 a
Fluoride	mg/L													4
Arsenic	mg/L	0.0027	0.0026	0.0047	0.0099	0.0033	0.010	0.13	0.013	0.0043	0.011	0.0021	0.0027	0.01
Total Dissolved Solids	mg/L	691	624	538	2675	421	302	3056	2232	1777	619	486	1472	500 a
δOxygen-18	permil	-13.5	-12.1	-13.2	-11.7	-13.5	-13.1		-13.2	-13.7	-13.8			--
Deuterium	permil	-102	-89	-99	-92	-99	-97		-99	-100	-101			--
Carbon-13	permil								-4.2		-3			
Carbon-14	pmc								5.5+0.6		1.7+0.2			

Source: LCWD 2007

Notes:

NS = No Standard mg/L = milligrams per liter uS/cm = microSiemens per centimeter mv = millivolts a = secondary drinking standard

ORP = oxidation reduction potential pmc=percent

Bold Values represent exceedance of primary drinking water standard

Italic Bold Values represent exceedance of secondary standard

3.3.2.7. Groundwater Use and Water Rights

Nevada water law is set forth in the NRS Chapters 532 through 538. The Nevada Division of Water Resources, headed by the State Engineer, is responsible for the administration and enforcement of Nevada's water law, which requires that an applicant provide evidence of an actual beneficial use for the water right requested (NRS § 533.035). The applicant must satisfactorily prove to the NSE the intended beneficial use with reasonable due diligence including the financial ability to construct a water development project (NRS § 533.035).

Groundwater rights within the Clover Valley Hydrographic Area are associated with municipal, irrigation, and stock water use. Permitted yields vary between 0.001 and 6 cfs. Four LCWD applications, for a total of 20 cfs, were filed in 2001 and are still pending (NDWR 2007).

Permitted groundwater rights in the Lower Meadow Valley Wash Hydrographic Area are primarily designated for municipal, commercial, industrial, and irrigation use. Five Moapa Valley Water District applications, for a total of 24.4 cfs, are still pending (NDWR 2007).

The basin-fill deposits in the Tule Desert Hydrographic Area have seen little development for water supply. One well that taps groundwater in the basin-fill is known as the Tule Desert Well and supports seasonal livestock grazing. Based on the NDWR Well Driller's Log Database, two other wells associated with agricultural use are present in the Tule Desert Hydrographic Area. These wells are 566 and 605 ft deep; however, it has not been determined if these wells are currently being used. Groundwater in the fractured-rock aquifer within the Tule Desert has not been developed.

Groundwater rights permitted by the NSE's Office are limited to the above-mentioned Tule Desert Well (with an annual duty of 3.62 AFY) and one LCWD well, with a permitted annual duty of 2,100 AFY (see ruling 5181 below). Pending groundwater applications include one LCWD and three Virgin Valley Water District applications. Diversion rates for these applications vary between 6 and 10 cfs, and they are associated with municipal or quasi-municipal use. An additional six applications filed by the LCWD in March 2007 for a total of 30 cfs, are still pending action by the NSE (NDWR 2007).

The NSE has addressed issues pertaining to groundwater withdrawals from the Tule Desert Hydrographic Area and so far has granted an appropriation of 2,100 AFY to the LCWD in 2002 (Ruling #5181 presented in **Appendix A1**). The NSE has considered testimony and evidence supplied by multiple parties and concluded that:

> *The recharge in the Tule Desert Hydrographic Area has previously been established as 2,100 acre-feet annually, with a perennial yield established as 1,000 acre-feet annually. The perennial yield of a groundwater reservoir may be defined as the maximum amount of ground water that can be salvaged each year over the long term without depleting the groundwater reservoir. Perennial yield is ultimately limited to the maximum amount of natural recharge that can be salvaged for beneficial use. If the perennial yield is continually exceeded groundwater levels will decline. Withdrawals of ground water in excess of the perennial yield contribute to adverse conditions such as water quality degradation, storage depletion, diminishing yield of wells, increased economic pumping lifts, land subsidence and*

possible reversal of groundwater gradients which could result in significant changes in the recharge-discharge relationship.

Application by LCWD for an additional 7,240 AFY in the Tule Desert Hydrographic Area is being held in abeyance until further data are collected and submitted to the NSE. Therefore, the exact amount of groundwater granted to the LCWD will be determined through the process established by the NSE in the future.

The basin-fill deposits in the Virgin River Valley, principally the Muddy Creek Formation, have been developed to supply both potable water to the communities of Mesquite and Bunkerville, Nevada and water for irrigation along the Virgin River (BLM 2003). In addition, Tule, Gourd, and Snow Water Springs (along the eastern flanks of the East Mormon Mountains) and Tule Springs Hills have been tapped to provide stock water. Because of the significant depths to the underlying carbonate rocks within the Virgin River Valley, this source of groundwater has not been developed. The current total groundwater permitted from the Virgin River Valley hydrographic area is approximately 12,300 AFY, actual use is approximately 5,000 AFY. A summary of all the groundwater rights within the ROI and Hydrographic Area of Interest is included in **Appendix D**.

Permitted water and pending water right applications, as well as estimated perennial yields for Hydrographic Areas in the ROI and adjacent Hydrographic Areas of Interest, are summarized in **Table 3-10**. Two of these areas (Lower Meadow Valley Wash and Virgin River Valley) are designated basins. The NSE defines designated groundwater basins as "basins where permitted ground water rights approach or exceed the estimated average annual recharge and the water resources are being depleted or require additional administration." Under such conditions, a state's water officials will so designate a groundwater basin and, in the interest of public welfare, declare preferred uses (e.g., municipal and industrial, domestic, agriculture).

Table 3-10 Perennial Yield and Water Rights in ROI and Hydrographic Area of Interest

Hydrographic Area	Designated Basin[1]	Perennial Yield[2] (AFY)	NDWR Permitted † Annual Duty[3] (AFY)
Clover Valley	No	1,000	3,787
Tule Desert	No	1,000	2,104
Virgin River Valley	Yes	3,600*	12,343
Lower Meadow Valley Wash	Yes	5,000	23,480

[1] NDWR 2005
[2] NDWR 1992
[3] Permitted Water Rights Reported as Annual Duty in AFY (NDWR 2007)
*Recharge to the Basin
† not all permitted annual duty necessarily withdrawn
AFY – acre-feet per year

3.4 VEGETATION RESOURCES

3.4.1 Data Collection Methods

The analysis of existing conditions and potential effects from the Proposed Action is primarily based on the *Lincoln County Land Act Groundwater Development and Utility Right of Way Project Environmental Impact Statement Rare Plant Report* (ARCADIS 2006a). Additional sources of information have been cited where they are used. USGS topographic maps, aerial photographs, and several technical documents on area resources were reviewed to assess the topography, predominant landforms, and major vegetation associations within and adjacent to the project area. Special status species information presented is based on coordination with regulatory and resource agency personnel and the best available scientific information on the distribution and abundance of the affected species. This includes the most recent results of survey and monitoring efforts, consultation with technical experts, and detailed review of pertinent biological and management literature.

This section describes the vegetation resources within or potentially within the project area. The project area is located in the Great Basin and Mojave Desert biomes (**Map 3-7**). The Mojave Desert biome can be distinguished from the Great Basin biome by the presence and abundance of its different plant species.

The principal distinguishing feature of the two biomes is the presence of creosote bush (*Larrea tridentata*) in the Mojave Desert biome and its absence from the Great Basin biome. Alternatively, big sagebrush (*Artemisia tridentata*) dominates much of the Great Basin biome, but it is mostly absent from the Mojave Desert biome except at moderate to high elevations in the mountains.

The ROI for direct effects on vegetation resources consists of the entire width of the temporary disturbance corridor (300 feet). The ROI for indirect effects includes three hydrographic areas in which the project is located (Tule Desert, Clover Valley, and Virgin River Valley Hydrographic Areas) and a fourth Hydrographic Area of Interest (Lower Meadow Valley Wash Hydrographic Area).

The Lower Meadow Valley Wash Hydrographic Area has been included as a Hydrographic Area of Interest because it is located downstream of Clover Creek, a creek in the Clover Valley Hydrographic Area, and directly to the west of the Tule Desert Hydrographic Area where groundwater pumping would occur.

3.4.2 Great Basin Biome

The northern portion of the LCLA project area is within the Great Basin biome, which begins around East Pass and extends north into the Clover Mountains (**Map 3-7**). Permanent water sources consist of small springs found in the canyons of the Clover Mountains. The Great Basin biome covers approximately 46 percent of the project area. The communities typical of the Great Basin biome include: Mountain Shrub, Piñon-Juniper, Sagebrush/Perennial Grasses, and Blackbrush. Vegetation within the area is typical of the Great Basin types with big sagebrush, forest lands, and bunch grasses. The foothills and valley bottoms are dominated by sagebrush and rabbitbrush communities with grass in the understory. The south slope of the Clover Mountains contains communities (blackbrush and manzanita/ceanothus) that are common to the transition to the Mojave Desert. Common Great Basin vegetation associations are listed in **Table 3-11**.

Table 3-11 Common Great Basin Vegetation Associations in the Project Area

Common Name	Scientific Name
Big sagebrush	*Artemisia tridentata*
Singleleaf piñon pine	*Pinus monophylla*
Utah juniper	*Juniperus osteosperma*
Ponderosa pine	*Pinus ponderosa*
Rabbitbrush	*Chrysothamnus* spp.
Blackbrush	*Coleogyne ramosissima*
Manzanita	*Arctostaphylos* spp.
Ceanothus	*Ceanothus* spp.

The Clover Mountains contain extensive stands of piñon-pine and juniper trees as well as the last remaining large stands of ponderosa pine trees within the area. These communities have an understory of sagebrush and other mountain shrubs and small amounts of grass. Large areas of the sagebrush and piñon-juniper have been burned and then planted with grass species to increase the forage capacity for livestock as well as wild horses and wildlife. Riparian habitats within the Meadow Valley Wash also are included in the Great Basin biome.

3.4.2.1 Mountain Shrub Vegetation Community

The Mountain Shrub vegetation community occurs at the base of the Clover Mountains and covers approximately 8 percent of the total project area. Approximately 23 percent of the Mountain Shrub community within the project area was burned in the 2005 wildfire. Dominant species for this community are listed in **Table 3-12**.

Table 3-12 Common Plant Species in the Mountain Shrub Community in the Great Basin Biome

Common Name	Scientific Name
Oaks	*Quercus* sp.
Ceanothus	*Ceanothus* spp.
Silktassel	*Garrya* sp.
Manzanita	*Arctostaphylos* spp.
Snowberry	*Symphoricarpos* sp.

3.4.2.2 Piñon-Juniper Vegetation Community

The piñon-juniper vegetation community is dominated by a canopy of singleleaf piñon pine and Utah juniper. It covers approximately 30 percent of the total project area. Juniper communities are widely distributed in open canopy stands and typically occur at lower elevations in the Piñon-Juniper zone. In southern Nevada, Piñon-Juniper communities commonly appear with species listed in **Table 3-13**.

Table 3-13 Common Plant Species in the Piñon-Juniper Community in the Great Basin Biome	
Common Name	**Scientific Name**
Singleleaf piñon pine	*Pinus monophylla*
Utah juniper	*Juniperus osteosperma*
Ponderosa pine	*Pinus ponderosa*
Blackbrush	*Coleogyne ramosissima*
Sagebrush	*Artemisia* spp.
Bitterbrush	*Purshia tridentata*

This ecosystem also includes ponderosa pine, which appears in small cluster communities in the Clover Mountains on north and northwest-facing slopes and covers less than 0.5 percent of the project area. The proposed ROW would traverse two small ponderosa pine stands in Township 6 South, Range 69 East, Sections 27 and 35 northwest of the proposed booster station CBS-1.

3.4.2.3 Sagebrush/Perennial Grasses

Sagebrush and Sagebrush/Perennial Grasses occur mainly in the Great Basin in lowland steppes and valleys at elevations below 6,000 feet and cover approximately 9 percent of the total project area. Sagebrush communities are often considered steppe or shrub steppe because of the role of grasses. In parts of the Great Basin, grasses are important understory elements in distinctly Shrub-Steppe communities. This vegetation class includes shrubs and grasses listed in **Table 3-14**. One of the most significant changes in the sagebrush-grass zone has been the invasion of introduced plant species such as cheatgrass (*Bromus tectorum*), halogeton (*Halogeton glomeratus*), and other annuals at the expense of the native bunchgrasses and forbs.

Table 3-14 Common Plant Species in the Sagebrush/Perennial Grasses Community in the Great Basin Biome	
Common Name	**Scientific Name**
Shrubs	
Rabbitbrush	*Chrysothamnus* spp.
Bitterbrush	*Purshia tridentata*
Cliffrose	*Cowania mexicana*
Spiny hopsage	*Grayia spinosa*
Shadscale saltbush	*Atriplex contertifolia*
Grasses	
Wheatgrass	*Agropyron* spp.
Bluegrass	*Poa* spp.
Needlegrass	*Stipa* spp.
Ricegrass	*Achnatherum hymenoides*
Fescues	*Festuca* spp.
Big galleta	*Hilaria jamesii*

3.4.2.4 Blackbrush

Typically a transitional vegetation class between Mojave Desert scrub and Great Basin shrubs, Blackbrush usually occurs at elevations between 4,000 and 5,000 feet. This vegetation community covers approximately 15 percent of the total project area (approximately 5 percent of it occurs within the Great Basin biome). Blackbrush is associated with juniper and shrubs such as spiny hopsage, shadscale saltbush, and creosote. In the project area, this vegetation class occurs on slopes and in valleys in the Clover Mountains and south into the Tule Desert. Approximately 67 percent of the Blackbrush community within the project area was burned in the 2005 wildfire.

3.4.2.5 Riparian

There are no riparian areas within the proposed ROW. There are patches of riparian communities within the ROI for indirect effects along Clover Creek totaling approximately 367 acres; however, these acreages are based on aerial infared photography and the riparian communities along Clover Creek have not been surveyed or characterized from the ground (BioWest 2005). Bat surveys were conducted at two sites along Clover Creek in 2003 - one just east of Caliente and the other just north of Big Spring. Habitats at both sites were described as springs supporting willow riparian; however, no acreage data were provided (Kenney and Tomlinson 2005). Twelve woody riparian vegetation communities (approximately 763 acres) are present within Lincoln County downstream of the confluence of Clover Creek along Meadow Valley Wash. Riparian Forest, Fremont Cottonwood Forest, and Arrowweed Shrubland are the dominant native woody riparian vegetation communities, and Tamarisk Woodland is the dominant non-native riparian community within Meadow Valley Wash (Bio-West, Inc. 2005).

3.4.3 Mojave Desert Biome

The southern portion of the LCLA project area is within the Mojave Desert biome. The portion of this biome within the project area begins around East Pass and extends south into the Tule Desert (**Map 3-7**). The topography is characterized by high mountain ranges with intervening valleys and canyons featuring broad alluvial fans and bajadas. The climate in the Mojave Desert is typified by hot dry summers and cool dry winters with annual precipitation ranging between 4 and 12 inches.

The Mojave Desert biome covers approximately 54 percent of the project area. The southern portion of the LCLA project area can be further characterized as southern desert shrub. Vegetative communities found in southern desert shrub include Mojave Creosote Bush Scrub, Mohave Desert Wash Scrub, Blackbrush, and Non-Native Grassland. Southern desert shrubs generally occur between 1,500 and 5,000 feet in elevation. The vegetation in the southern portion of the LCLA project area is representative of a more mesic portion of the Mojave Desert based on the dominance/presence of Blackbrush on most sites and elevations mostly above 2,100 feet. Plants representative of the southern and northern Desert Shrub communities are listed in **Table 3-15**.

Table 3-15 Common Plant Species in the Southern and Northern Desert Shrub Communities in the Mojave Desert Biome

Common Name	Scientific Name
Southern Desert Shrub Community	
Creosote bush	*Larrea tridentata*
Shadscale saltbush	*Atriplex contertifolia*
White bursage	*Ambrosia dumosa*
Joshua tree	*Yucca brevifolia*
Mojave yucca	*Yucca schidigera*
Whitethorn acacia	*Acacia constricta*
Mormon tea	*Ephedra nevadensis*
Range ratany	*Krameria parvifolia*
Desert trumpet	*Eriogonum inflatum*
Desert sand verbena	*Abronia villosa*
Big galleta	*Hilaria rigida*
Indian ricegrass	*Oryzopsis hymenoides*
Spiny hopsage	*Grayia spinosa*
Northern Desert Shrub Community	
Blackbrush	*Coleogyne ramosissima*
Creosote bush	*Larrea tridentata*
Yucca	*Yucca* spp.
White bursage	*Ambrosia dumosa*
Rabbitbrush	*Chrysothamnus* spp.
Snake weed	*Gutierrezia* spp.
Big galleta	*Hilaria jamesii*
Indian ricegrass	*Achnatherum hymenoides*
Sand dropseed	*Sporobolus cryptandus*

Cactus species, such as beavertail (*Opuntia basilaris*), staghorn cholla (*Opuntia acanthocarpa*), hedgehog (*Echinocereus engelmannii*), and barrel cactus (*Ferocactus wislizenii*), are present throughout the project area. All species in the cactus family (Cactaceae) and members of the genus *Yucc*a and *Agave* are protected by Nevada State Law (NRS 527.060-120).

3.4.3.1 Mojave Creosote Bush Scrub

This vegetation class includes Mojave mixed scrub and creosote-bursage vegetation that is characterized by widely spaced shrubs, usually with bare ground between them. Dominant and associate species within this vegetation community are listed in **Table 3-16**. This vegetation community covers approximately 38 percent of the total project area. Approximately 41 percent of the Mojave Creosote Bush Scrub Community within the project area was burned in the 2005 wildfire.

This community exhibits a higher susceptibility to large wildfires compared to historical conditions in years following high amounts of rainfall. This increased susceptibility is potentially related to the presence of abundant non-native grasses that provide a continuous fuelbed in years following high rainfall (Brooks and Matchett 2006). Additionally, the severity of wildland fires in eastern Nevada has increased in recent years as a result of changes in land use practices (e.g., reduced livestock grazing) and human-caused climate change (BLM 2000). In 2005, wildfires burned approximately 739,000 acres of land in southern Nevada including approximately 589,000 acres in the Clover Mountain, Meadow Valley, and Tule Desert portions of the Southern Nevada Complex (Mizer, pers. comm. 2008). Of the 2005 fire complex, approximately 716 acres burned within the 300-foot temporary and permanent disturbance corridor (**Map 3-7**). The disturbance caused by fire has allowed for an increased presence of non-native grassland. This non-native grassland provides a more continuous fuel load than that in adjacent unburned areas. Overall, the change from native vegetation, such as scattered shrubs interspersed with forbs, perennial grasses, and some succulents, to a non-native annual grassland increases susceptibility of the area to future wildland fires.

Table 3-16 Dominant and Associate Plant Species in the Mojave Creosote Bush Scrub Vegetation Community

Common Name	Scientific Name
Dominant Species	
Blackbrush	*Coleogyne ramosissima*
White bursage	*Ambrosia dumosa*
Creosote bush	*Larrea tridentata*
Desert saltbush	*Atriplex polycarpa*
Desert thorn	*Lycium* spp.
Spiny hopsage	*Grayia spinosa*
Shadscale	*Atriplex confertifolia*
White brittlebush	*Encelia farinosa*
Associate Species	
Agave	*Agave* spp.
Joshua tree	*Yucca brevifolia*
Mojave yucca	*Yucca schidigera*
California barrel cactus	*Ferocactus cylindraceus* var. *cylindraceus*
Beavertail cactus	*Opuntia basilaris*
Silver cholla	*Opuntia echinocarpa*
Diamond cholla	*Opuntia ramosissima*
Mojave prickly-pear	*Opuntia erinacea*
Mormon tea	*Ephedra nevadensis*
Range ratany	*Krameria parvifolia*
Desert trumpet	*Eriogonum inflatum*
Big galleta	*Pleuraphis rigida*
cephalocereus	*Cephalocereus senilis*
Indian ricegrass	*Achnatherum hymenoides*

3.4.3.2 Mojave Desert Wash Scrub

The Mojave Desert Wash Scrub community consists of scrubby vegetation in sandy arroyos primarily along Toquop Wash and accounts for less than 1 percent of the total project area. Dominant species of the community include cat claw (*Acacia greggii*), desert willow (*Chilopsis lineris* ssp. *Arcuata*), Mormon tea, and indigo bush (*Psorothamnus fremontii*); desert willow and cat claw are less common components of this community and are sparse in the project area. Other species that occur in this community type in the project area include desert broom (*Baccharis sarathroides*) and big galleta (*Pleuraphis rigida*). Much of the surface area within this community is bare ground (ARCADIS 2006a).

3.4.3.3 Blackbrush

Typically a transitional vegetation class between Mojave Desert Scrub and Great Basin Shrubs, Blackbrush usually occurs at elevations of 4,000 to 5,000 feet. This vegetation community covers approximately 15 percent of the total project area (approximately 10 percent of it occurs within Mojave Creosote Bush Scrub). Blackbrush is associated with juniper and shrubs such as spiny hopsage, shadscale, and creosote. In the project area, this vegetation class occurs on slopes and in valleys in the Clover Mountains and south into the Tule Desert.

3.4.3.4 Virgin River Riparian

Riparian habitat associated with the Virgin River occurs approximately 3 miles south of the project area. This community consists primarily of coyote willow (*Salix exigua*), Gooding's willow (*Salix goodingii*), arrowweed (*Pluchea sericea*), cottonwood (*Populus* spp.), cattail (*Typha* spp.), and various sedges and grasses. Tamarisk (or salt cedar [*Tamarix* spp.]) is rapidly becoming a dominant invasive species along this riparian corridor.

3.4.4 Non-Native Invasive Species and Noxious Weeds

Noxious weeds are defined under Nevada law (NRS 555.005) as any species of plant that is or is likely to be detrimental or destructive and difficult to control or eradicate. They are also defined by the U.S. Department of Agriculture Animal and Plant Health Inspection Service under the Federal Noxious Weed Act. Noxious weeds are those weed species that are included on the State of Nevada noxious weed list (NDA 2006). Non-native invasive species are those species that are undesirable and exhibit ecological risks similar to noxious weeds but are not listed on the federal or Nevada noxious weeds list.

Related to field studies for this Draft EIS, biological field crews were tasked to note the presence of noxious and invasive non-native plant species within the project area. Biologists reviewed the Federal Noxious Weed List (USDA 2006), BLM National List of Invasive Weed Species of Concern (BLM 2007b), and Nevada State Noxious Weed List (Invasive.org 2006) prior to conducting field surveys of the Proposed Action and Alternative 1 alignments. Although formal noxious weed inventories were not conducted for analysis in this Draft EIS, information from other weed inventories conducted in nearby areas between 2001 and 2004 located Russian knapweed (*Acroptilon repens*), tamarisk (*Tamarix* spp.), and whitetop (*Lepidium draba*) (BLM 2006b).

Field observations found large populations of cheatgrass (*Bromus tectorum*) and red brome (*Bromus rubens*) in the burn area, which is located in the southern portion of the project area (**Map 3-7**). This species also occurs sporadically within shrublands throughout the project area (ARCADIS 2006a). Cheatgrass is highly invasive and is the fuel most commonly associated with the chance of ignition and rate of spread of wildland fires in Nevada. The maturation of cheatgrass in the late spring or early summer (as opposed to native grasses, which mature in late summer and early fall) extends the fire season into the hottest months of the year. The dense growth and fine texture of cheatgrass provide a continuous fuel source to spread wildfires (Young and Clements 2006). No notable populations of noxious weeds were identified within the project area.

Non-native grassland occurs in various locations within the project area as understory communities within shrublands and woodlands. This vegetative type also occurs in the area that was affected by the wildfire in 2005. Dominant grass species include primarily red brome, cheatgrass, and Mediterranean grass (*Shismus* spp.). The area that was burned in 2005 represents an area of disturbance that favors the spread and establishment of noxious and invasive weed species (Waggoner, pers. comm. 2007). Non-native annual grasses increase the risk of fire and often increase in dominance after fire events.

Other common invasive non-native species that may occur in the project area are listed in **Table 3-17**. Of these species, Russian knapweed, perennial pepperweed, saltcedar, whitetop, and Sahara mustard are listed on the Nevada noxious weed list (NDA 2006).

Table 3-17 Invasive Non-Native Plant Species that may Occur in the Project Area[1]

Common Name	Scientific Name
Cheatgrass	***Bromus tectorum***
Mediterranean grass	***Schismus* spp.**
Perennial pepperweed*	*Lepidium latifolium*
Red brome	***Bromus rubens***
Redstem filaree	*Erodium cicutarium*
Russian knapweed*	*Acroptilon repens*
Russian thistle	*Salsola tragus*
Sahara mustard*	*Brassica tournefortii*
Saltcedar*	*Tamarix* spp.
Whitetop*	*Lepidium draba*

[1] Species in bold font are known to occur within the project area.
* Species that are listed on the Nevada List of Noxious Weeds (NDA 2006)

3.4.5 Special Status Plant Species

For the purposes of this Draft EIS, special status plant species in the project area include federally threatened, endangered, proposed, and candidate species, Nevada BLM Sensitive species, State of Nevada classified species, and protected species of cactus and yucca. The BLM Sensitive species exclude taxa that are federally listed, proposed, or candidate species.

3.4.5.1 Federally Threatened, Endangered, Proposed, and Candidate Plant Species

As a component of the ESA Section 7 consultation process, a list of threatened and endangered plant species that may occur in or near the project area was obtained from the USFWS on May 12, 2006 (**Appendix E-1**). The USFWS identified one listed plant species, the threatened Ute ladies'-tresses orchid (*Spiranthes diluvialis*), that may occur in or near the project area.

The Ute ladies'-tresses orchid is a federally listed threatened species that occurs primarily in seasonally moist peat, sand, silt, or gravel soils near wet meadows, springs, lakes, ponds, or perennial streams. Ute ladies'-tresses orchid is commonly associated with horsetail (*Equisetum* spp.), milkweed (*Asclepias* spp.), verbena (*Verbena* spp.), blue-eyed grass (*Sisyrinchium montanum*), reedgrass (*Calamagrostis* spp.), goldenrod (*Solidago* spp.), and arrowgrass (*Triglochin* spp.) (USFWS 1992). Potential habitat for this species does not occur within the ROI. The only known extant population within Nevada is near Panaca Spring in northern

Lincoln County (Fertig et. al 2005). This population is outside of the ROI for vegetation, and no suitable habitat for this species occurs within the ROI.

The Las Vegas buckwheat (*Eriogonum corymbosum* var. *nilesii*) is federally listed as a candidate species. Habitat for this species includes gypsum soils, often forming low mounds or outcrops in washes and drainages, or in areas of generally low relief, surrounded by a creosote-bursage zone. Seventy-two acres of occupied habitat for this species occurs near the project area (Styles, pers. comm. 2008). However, there are no known populations within the proposed right-of-way.

3.4.5.2 BLM Sensitive Species

The BLM policy is to provide BLM Sensitive species with the same level of protection as is provided for species that the USFWS lists as candidate species (BLM Manual 6840.06 C). This level of protection functions to "ensure that actions authorized, funded, or carried out do not contribute to the need for the species to become listed". Species are designated as Sensitive by the BLM when they occur on BLM lands and when their conservation status can be significantly affected through BLM management activities. The BLM Manual 6840.06 E provides factors by which a native species may be listed as Sensitive. These include:

- Could become endangered or extirpated from a state, or within a significant portion of its range, in the foreseeable future;
- Is under status review by the USFWS and/or National Marine Fisheries Service;
- Is undergoing significant current or predicted downward trends in:
  - Habitat capability that would reduce a species' existing distribution, and/or;
  - Population or density such that federally listed, proposed, candidate, or state listed status may become necessary
- Typically consists of small and widely dispersed populations;
- Inhabits ecological refugia or specialized or unique habitats; and
- Is state-listed, but may be better conserved through application of BLM Sensitive species status.

Forty-six BLM Sensitive plant species were identified as potentially occurring within the jurisdiction of the BLM Ely Field Office (July 2003) (**Appendix E-2**). Prior to initiating field work, ARCADIS and BLM biologists reviewed each species to assess for presence of potential suitable habitat (e.g., soil, elevation, vegetation community associations) within the project area. Twenty-four of the 46 plant species were identified as potentially occurring within the project area (**Table 3-18**). Information on habitat requirements for each of these species included in **Table 3-18** was obtained from the Nevada Natural Heritage Program (NNHP) Nevada Rare Plant Atlas, and various Nevada Rare Plant Fact Sheets (NNHP 2001, 2005a, 2005b

Table 3-18 BLM Sensitive Plant Species that May Occur in or near the Project Area	
Common Name (Scientific Name)	**Habitat**
White bearpoppy *Arctomecon merriamii*	On a wide variety of dry to sometimes moist basic soils including alkaline clay and sand, gypsum calcareous alluvial gravels, and carbonate rock outcrops.
Meadow Valley sandwort *Arenaria stenomeres*	Carbonate cliffs, ledges, canyon walls, and rocky slopes on all aspects above the creosote bush zone.
Eastwood milkweed *Asclepias eastwoodiana*	In open areas on a wide variety of basic (pH usually 8 or higher) soils including calcareous clay knolls; sand, carbonate, or basaltic gravels; or shale outcrops; generally barren and lacking competition; frequently in small washes or other moisture-accumulating microsites in the shadscale, mixed-shrub, sagebrush, and lower piñon-juniper zones.
One-leaflet Torrey milkvetch *Astragalus calycosus var. monophyllidius*	Decaying carbonate-derived young soils with sparse vegetation in sagebrush and piñon-juniper communities.
Needle Mountain milkvetch *Astragalus eurylobus*	Generally deep, barren, sandy, gravelly or clay soils derived from sandstone or siliceous volcanics frequently in or along drainages. Known to occur in the Clover Mountains.
Threecorner milkvetch *Astragalus geyeri var. triquetrus*	Deep sand, unconsolidated dunes as well as areas of consolidated sand; strongly associated with sand derived from the Muddy Creek Formation, a tertiary aged sedimentary rock. Known to occur in Toquop Wash.
Straw milkvetch *Astragalus lentiginosus var. stramineus*	Deep, loose, sandy soils in washes, flats, roadsides, steep aeolian slopes, and stabilized dune areas, with creosote-bursage shrubland in drier areas and saltcedar-arrowweed communities in wetter washes. Can withstand moderate temporary disturbance. Dependent on sand dunes or deep sand in Nevada.
Halfring milkvetch *Astragalus mohavensis var. hemigyrus*	Carbonate gravels and derivative soils on terraced hills and ledges, open slopes, and along washes in the creosote-bursage, blackbrush and mixed shrub zones.
Remote rabbitbrush *Chrysothamanus eremobius*	Crevices or rubble of north-facing carbonate cliffs in and just below the piñon-juniper-sagebrush zone with little leaf mountain mahogany, prickleleaf, three leaf sumac and rock goldenrod.
White River catseye *Cryptantha welshii*	Dry, open, sparsely vegetated outcrops, and derived sandy to silty or clay soils of whitish calcareous or carbonate deposits, often forming knolls or gravelly hills, and on soils adjacent to such habitats, mostly in Juniper-sage-rabbitbrush vegetation with various grasses and forbs.
Clokey buckwheat *Eriogonum heermannii var. clokeyi*	Carbonate outcrops, talus, scree and gravelly washes and banks in the creosote-bursage, shadscale and blackbrush zones.
Scarlet buckwheat *Eriogonum phoeniceum*	White tuffaceous knolls, bluffs and rocky flats, openings in piñon and juniper woodland, with big sage, antelope bitterbrush and rock goldenrod.
Sticky buckwheat *Eriogonum viscidulum*	Deep, loose, sandy soils in washes, flats, roadsides, steep aeolian slopes and stabilized dune areas, with creosote-bursage shrubland in dryer areas and slatcedar-arrowweed communities in wetter washes. Can withstand moderate temporary disturbance. Dependent on sand dunes or deep sand in Nevada. Occurs in Toquop Wash.
Las Vegas buckwheat *Eriogonum corymbosum*	On or near gypsum soils, often forming low mounds or outcrops in washes and drainages.
Pioche blazingstar *MentzeliaMontpelier argillicola*	Dry, soft, silty clay soils on knolls and slopes with sparse vegetation consisting mainly of pygmy sagebrush, money buckwheat, broom snakeweed and purple sage.
Beaver dam breadroot *Pediomelum castoreum*	Dry, sandy deserts.

Table 3-18 BLM Sensitive Plant Species that May Occur in or near the Project Area

Common Name (Scientific Name)	Habitat
Parry's sandpaper plant *Petalonyx parryi*	Gypsum soils. Occurs in Toquop Wash.
Beatley scorpion plant *Phacelia beatleyae*	Dry, open nearly barren scree and loose gravelly soils on slopes and bases of white to brownish volcanic tuff outcrops on all slopes and aspects, and in adjacent drainages, in the mixed-shrub, blackbrush, shadscale and upper creosote-bursage zones.
Clarke phacelia *Phacelia filiae*	Flat areas or low knolls of valley floors and foothills of desert mountains on light-colored soils including calcareous sandstone, siltstone, tuffaceous claystone and limestone occurring with shadscale, blackbrush and creosote.
Palmers phacelia *Phacelia palmeri*	Gypsum soils. Occurs in Toquop Wash.
Parish phacelia *Phacelia parishii*	Moist to superficially dry, open, flat to hummocky, mostly barren, often salt-crusted silty-clay soils on valley bottom flats, lake deposits and playa edges, often near seepage areas, sometimes on gypsum deposits, surrounded by saltbush scrub vegetation but with few immediate associates such as shadscale, fourwing and silverscale saltbush, Sandberg bluegrass, Nuttall's povertyweed, Fremont's phacelia, yellow pepperweed and greasewood. Aquatic or wetland dependent in Nevada.
Schlesser pincushion *Sclerocactus schlesseri*	Open, stable or stabilized, gravelly, sandy silt or silty clay soils derived from somewhat ashy and gypsiferous lacustrine sediments, on mesic microsites created and maintained by gentle north to east aspects, dense shrub and grass canopies, high clay and silt content of the soil, and cryptobiotic soil crusts, usually associated with such soil crusts in the shadscale zone with the shadscale saltbush and James' galleta.
Jones globemallow *Sphaeralcea caespitosa*	Sevy Dolomite rock calcareous soil, mixed shrub, piñon-juniper and grass community.
Charleston grounddaisy *Townsendia jonesii var. tumulosa*	Open, sparsely vegetated calcareous areas on shallow, gravelly, carbonate soils on slopes and exposed knolls in forest clearings mostly in the montane conifer zone with ponderosa pine, extending to the piñon-juniper, mountain mahogany and lower subalpine conifer zones, recurring on knolls of white, alkaline, calcareous, silty lacustrine deposits in the upper shadscale/mixed-shrub and lower sagebrush zones.

Surveys for special status plant species were conducted throughout all areas within the proposed ROW and included a 300- to 500-foot corridor (based on habitat and topography) centered on the proposed pipeline (ARCADIS 2006a). All surveys were conducted during the appropriate flowering seasons (May and September 2006) by botanists qualified to: 1) assess potential habitat for these species and 2) identify individuals in their vegetative and flowering forms.

These surveys identified four BLM Sensitive plant species within the project area: Needle Mountain milkvetch, sticky buckwheat, Parry's sandpiper plant, and Palmer's phacelia (**Map 3-7**).

Needle Mountain milkvetch was identified in the Clover Mountains. A large population was noted along a gravel road in Township 5 South, Range 70 East, northeast and southeast ¼ of the southeast ¼ of Section 32. This occurrence followed the road for a mile or more and was extremely abundant in the area. This was the only occurrence noted, but the population numbered in the thousands and extended well beyond the survey width of the ROW. Surveys were also conducted in the mid-1980s; these surveys indicated that the population was more than 6,273 individuals (NNHP 2001).

Isolated populations of sticky buckwheat were found from Toquop Wash to the east following the existing transmission lines. Individuals were widely spaced, and no clear population boundaries were evident. This species is a small annual, the population size of which likely fluctuates widely from year to year. It occurred primarily on red sands and was previously known to occur in Toquop Wash. The NNHP reports the statewide population of sticky buckwheat to be more than 25,000 individuals (NNHP 2001).

Parry's sandpaper plant and Palmer's phacelia both occur on the gypsum soils on Toquop Wash. Both species were extremely common on the gypsum soils of the area. Exact counts were not made, as the populations numbered in the thousands and extended well beyond the project ROW boundary.

3.4.5.3 State of Nevada Protected Species

All cactus and yucca species native to the State of Nevada are protected and regulated by NRS 527.060-120. The field surveys conducted for the Draft EIS included an inventory of cactus and yucca species occurring within the project area including agave (*Agave* spp.), California barrel cactus (*Ferocactus cylindraceus* var. *cylindraceus*), beavertail cactus (*Opuntia basilaris*), silver cholla (*Opuntia echinocarpa*), diamond cholla (*O. ramosissima*), Mojave prickly-pear (*Opuntia erinacea*), Joshua tree, and cephalocereus (*Cephalocereus senilis*) (ARCADIS 2006a). All of these species, except for Mojave prickly-pear were recorded as occurring within the project area. The results of the cactus inventory are described in ARCADIS 2006a.

3.5 WILDLIFE RESOURCES

3.5.1 Data Collection Methods

The analysis of existing conditions is primarily based on the field surveys conducted in the project area, the Nevada Wildlife Action Plan (NDOW 2005), data available on the USFWS website, and data from the NNHP. Additional sources of information have been cited where used. Wildlife and special status species information presented is based on coordination with regulatory and resource agency personnel and the best available scientific information on the distribution and abundance of the affected species. This includes the most recent results of survey and monitoring efforts, consultation with technical experts, and detailed review of pertinent biological and management literature.

This section describes the wildlife resources within or potentially within the project area. The ROI for wildlife resources, including threatened, endangered, and candidate wildlife species, consists of areas that may be affected by permanent and temporary features of the Proposed Action or Alternative 1 and also those areas where groundwater withdrawal may impact surface waters. The extent of the ROI for wildlife resources is based on the effects on surface waters discussed in the analysis provided in the Water Resources section of this document. Based on these criteria, the ROI for direct impacts on wildlife resources includes those areas in the immediate vicinity of the Proposed Action construction, operation, and maintenance activities. The ROI for indirect effects includes three hydrographic areas in which the project is located

(Tule Desert, Clover Valley, and Virgin River Valley Hydrographic Areas) and a fourth Hydrographic Area of Interest (Lower Meadow Valley Wash Hydrographic Area). The Lower Meadow Valley Wash Hydrographic Area (particularly the Meadow Valley Wash) has been included as a Hydrographic Area of Interest because it is located downstream of Clover Creek, a creek in the Clover Valley Hydrographic Area, and directly to the west of the Tule Desert Hydrographic Area where groundwater pumping would occur.

3.5.2 Environmental Setting

A wide variety of wildlife resources typical of the Mojave Desert and Great Basin ecological systems is present within the project area. The vegetation types or communities that comprise the wildlife habitat in the project area include Mojave Creosote Bush Scrub, Mojave Desert Wash Scrub, Salt Desert Scrub, Mountain Shrub, Blackbrush, Piñon-Juniper, Sagebrush/Perennial Grasses, and Non-Native Grassland. Surface water sources potentially available to wildlife species include isolated springs, stock ponds, and wildlife water developments (water sources created specifically for wildlife). **Appendix E-3** provides a list of common wildlife species expected to occur within the project area. The general types of wildlife that may occur within the project area are large mammals, small mammals, bats, reptiles, amphibians, birds (including raptors), and fish.

The mountain lion (*Puma concolor*), mule deer (*Odocoileus hemionus*), Nelson (desert) bighorn sheep (*Ovis canadensis nelsoni*), and elk (*Cervus elaphus*) utilize all of the mountain ranges around the southern extent of the project area as well as the Clover Mountains in the northern portions of the project area (Hardenbrook, pers. comm. 2007).

Seven big game and 26 small game wildlife water developments are located within 10 miles of the project area. Three of the big game wildlife water developments are located in Beaver Dam State Park, and the other four are located in the Mormon Mountains. The 26 small game wildlife water developments are all located within the Mormon Mountains (Stevenson 2006).

3.5.3 Special Status Wildlife Species

Special status wildlife species in the project area include federally threatened, endangered, proposed, and candidate species, Nevada BLM Sensitive species, and State of Nevada classified species. The BLM Sensitive species exclude taxa that are federally listed, proposed, or candidate species.

3.5.3.1 Federally Threatened, Endangered, Proposed, and Candidate Wildlife Species

As a component of the ESA Section 7 consultation process, a list of threatened, endangered, and candidate species was obtained from the USFWS on May 12, 2006 (Williams 2006). This list is included as **Appendix E-1** of this document. The USFWS identified six federally listed species and one candidate species that may occur in or near the project area. These seven species are the southwestern willow flycatcher (*Empidonax traillii extimus*), Yuma clapper rail (*Rallus longirostris yumanensis*), Virgin River chub (*Gila seminuda*), and woundfin (*Plagopterus argentissimus*) (all listed as endangered); the desert tortoise (*Gopherus agassizii*) (Mojave population) and Big Spring spinedace (*Lepidomeda mollispinis pratensis*) (both listed as threatened); and the yellow-billed cuckoo (*Coccyzus americanus*) (Western Distinct Population Segment – listed as a candidate species). The desert tortoise is the only species among these seven that occurs within the project area. The ROI for indirect effects supports habitat for the southwestern willow flycatcher, Yuma clapper rail, yellow-billed cuckoo, Virgin River chub, and woundfin.

The Big Spring spinedace is presently only known to occur in Condor Canyon just northeast of Panaca, Nevada. The Big Spring spinedace was transplanted above a barrier falls in 1980 and is now thought to occupy most of the suitable habitat within Condor Canyon. A 4-mile stretch of the Meadow Valley Wash within Condor Canyon and 50 feet of riparian habitat on both sides of the wash are listed as critical habitat for the Big Spring spinedace (USFWS 1985). This species does not occur, and there is no known habitat for it, within the project area or ROI for indirect effects. The nearest known occurrence of this species is approximately 24 miles north of the northernmost extent of the project area and outside of the ROI.

3.5.3.1.1 Desert Tortoise

The desert tortoise was federally listed as endangered under emergency provisions of the ESA on August 4, 1989 (54 Federal Register 32326). This listing was modified to include only the Mojave population, and the listing changed to threatened on April 2, 1990 (55 Federal Register 12178). The desert tortoise is classified as threatened and protected by the State of Nevada under NAC 503.080.

The desert tortoise is most commonly found within the desert scrub vegetation type where creosote bush scrub occurs, but may also be found in association with succulent scrub, cheesebush (*Hymenoclea salsola* A. Gray var. *salsola)* scrub, blackbush scrub, hopsage scrub, shadscale scrub, microphyll woodland, Mojave saltbush-allscale scrub, and scrub-steppe vegetation types of the desert and semi-desert grassland complex (USFWS 1994a).

Activity patterns of the desert tortoise are closely related to ambient temperatures and forage availability. They spend much of their lives in burrows and emerge in late winter and early spring to feed and mate. This species remains active through the spring and may emerge again after summer storms. While aboveground, the desert tortoise feeds on herbaceous vegetation, which typically consists of grasses and annual flowers (USFWS 1994a).

The USFWS designated 6.4 million acres of critical habitat for the Mojave population of the desert tortoise in 1994. Critical habitat is defined in Section 3 of the ESA as "those areas that have biological or physical features that are essential to the conservation of the species." Critical habitat is delineated in areas that meet this criterion.

The USFWS used the following primary constituent elements to determine areas that were appropriate to define as critical habitat for the desert tortoise:

- Sufficient space to support viable populations within each of the six recovery units (Western Mojave, Eastern Mojave, Northern Colorado and Eastern Colorado [California]; Northeastern Mojave [Nevada]; and Upper Virgin River [Utah]) and provide for movements, dispersal, and gene flow;

- Sufficient quantity and quality of forage species and the proper soil conditions to provide for the growth of such species;
- Suitable substrates for burrowing, nesting, and overwintering;
- Burrows, caliche caves, and other shelter sites;
- Sufficient vegetation for shelter from temperature extremes and predators; and
- Habitat protected from disturbance and human-caused mortality (USFWS 1994b).

There are 244,900 acres of designated critical habitat for the desert tortoise in Lincoln County. The Proposed Action and Alternative 1 would cross the Beaver Dam Slope Critical Habitat Unit of designated desert tortoise critical habitat (USFWS 1994b). Desert tortoise critical habitat in and near the project area is shown on **Map 3-8**. The proposed ROW would also cross the Beaver Dam Slope and Mormon Mesa Areas of Critical Environmental Concern (ACECs) (BLM 2000).

Surveys were conducted by ARCADIS within the project area between October 19 and 23, 2006. The strip-transect method was used to sample distribution and relative abundance of tortoise sign throughout the project area. Transects were 1.5 miles long by 10 yards wide and were walked in an equilateral triangle with 0.5 mile to a side. Results of the surveys showed that desert tortoise populations are distributed relatively evenly along the LCLA project ROW. However, nearly all sign were inferred (burrows). Scat and a shell were also found. Only one live tortoise was found along the ROW during the survey, and it was not found within a transect. During the rare plant surveys conducted for the project, a whole shell was found along the ROW, and a live tortoise was found outside the project area. Surveys indicated that desert tortoise densities ranged from 0 to 10 tortoises per square mile (ARCADIS 2006b). The highest densities were found in creosote-bursage community in an undeveloped desert area along the Proposed Action ROW. Only two tortoise sign were found in any of the burned areas along the LCLA project ROW (ARCADIS 2006b).

The Proposed Action would occur within the Northeastern Mojave Recovery Unit. Results of rangewide population monitoring (2001 to 2005) indicate that desert tortoise densities were lowest in this recovery unit during the sample period. Population monitoring data are insufficient at this time to determine population trends by recovery unit (USFWS 2006b).

Approximately 45 percent of the Proposed Action ROW is within desert tortoise habitat, and 14 percent of it is within designated critical habitat. Approximately 40 percent of the Alternative 1 ROW is within desert tortoise habitat, and 14 percent is within designated critical habitat.

3.5.3.1.2 Southwestern Willow Flycatcher

The southwestern willow flycatcher is a federally listed endangered neo-tropical migrant bird species. It winters in Mexico, Central America, and possibly northern South America (Sogge et al. 1997). Arizona, southern California, New Mexico, extreme southern portions of Utah and Nevada, and southwestern Texas comprise the majority of the historic and current breeding range of this subspecies. Southwestern willow flycatchers breed between early May and late August. The southwestern willow flycatcher breeds only in dense riparian vegetation near surface water or saturated soil.

Nests are generally located in thickets of shrubs or trees that are approximately 6 to 98 feet tall with dense foliage from ground level up to approximately 13 feet (USFWS 2002).

Habitat for the southwestern willow flycatcher includes riparian areas along rivers, streams, or other wetlands with dense growth of willows (*Salix* spp.), arrowweed (*Pluchea sevicea*), and tamarisk (*Tamarix* spp.). Other common plant species associated with nesting habitat include cottonwoods (*Populus* spp.), seepwillow (*Baccharis* spp.), boxelder (*Acer negundo*), stinging nettle (*Urtica* spp.), blackberry (*Rubus* spp.), and Russian olive (*Eleagnus angustifolia*) (USFWS 2002). During migration, this species may be encountered in all but the sparsest of desert habitats.

The southwestern willow flycatcher was listed as endangered by the USFWS on March 29, 1995. On July 22, 1997, the USFWS designated critical habitat for this species, which was subsequently rescinded by court order. On October 19, 2005, the USFWS again designated critical habitat for the species (70 Federal Register 60886; 74 miles of the Virgin River are part of this critical habitat). The critical habitat unit along the Virgin River is the closest southwestern willow flycatcher critical habitat to the project area (approximately 3 miles south of the southern end of the LCLA development area and within the ROI for indirect effects). This critical habitat is shown in **Map 3-9.**

Suitable and potential habitat for the southwestern willow flycatcher also occurs within the Meadow Valley Wash approximately 12 miles west of the project area (**Map 3-8**). A southwestern willow flycatcher habitat assessment conducted in Meadow Valley Wash identified approximately 557 acres of suitable habitat for this species scattered throughout the wash, with the best habitat to support nesting populations of southwestern willow flycatchers in Rainbow Canyon, approximately 3 miles south of Caliente, Nevada. Two breeding observations and two non-breeding observations were made in Rainbow Canyon in 2004 during this habitat evaluation. An additional five historic records of southwestern willow flycatchers have been identified within Rainbow Canyon in the Meadow Valley Wash (Bio-West, Inc. 2005). The Clover Creek drainage also supports a small amount of habitat for the southwestern willow flycatcher (approximately 10 miles northwest of the project area), but none have been observed in this area (MVCCTRT 2000).

3.5.3.1.3 Yuma Clapper Rail

The Yuma clapper rail is a federally listed endangered species that typically occurs in sedimented, shallow water cattail (*Typha latifolia*) and bulrush (*Scirpus acutus*) marshes. Nests are constructed primarily in mature cattail-bulrush habitat along margins of freshwater marshes near the water's edge. Areas where cattail and bulrush are dissected by narrow stream channels seem to support the densest populations of Yuma clapper rails. The closest potential habitat for the Yuma clapper rail to the project area is along the Virgin River, approximately 3 miles south of the southern end of the LCLA development area and within the ROI.

3.5.3.1.4 Yellow-billed Cuckoo

The yellow-billed cuckoo is a federal candidate for listing as threatened or endangered west of the Rocky Mountains. On July 18, 2001, the USFWS issued a 12-month finding on the petition to list the western yellow-billed cuckoo in the western continental United States. The western yellow-billed cuckoo was placed on the list of candidate species as a result of higher priorities taking precedence. Western populations of this species have declined due to loss or degradation of up to 90 percent of its riparian habitat throughout its historic range.

The historic breeding range of the yellow-billed cuckoo included most of North America from southern Canada to Mexico, but presently is restricted to scattered areas where suitable habitat exists. This species breeds in large blocks of riparian habitats, particularly woodlands with cottonwoods, willows, and dense understory foliage (USFWS 2001). A habitat assessment conducted in 2004 in Meadow Valley Wash identified approximately 253 acres of potentially suitable yellow-billed cuckoo habitat. There have been two recent yellow-billed cuckoo sightings within Meadow Valley Wash. In 2001, a yellow-billed cuckoo was observed approximately 0.5 mile north of Elgin (approximately 12 miles southwest of the Clover wellfield and approximately 20 miles downstream of Caliente), and in 2002, a possible nesting pair was observed near Rox (approximately 30 miles west of the LCLA development area and approximately 60 miles downstream of Caliente; Bio-West, Inc. 2005). Suitable habitat for this species may also occur along the Virgin River approximately 3 miles south of the southernmost extent of the LCLA development area.

3.5.3.1.5 Virgin River Chub

The Virgin River chub is a federally listed endangered species that historically occurred in the Virgin River from La Verken Springs, Utah, downstream to the confluence of the Virgin River with the Colorado River in Nevada (USFWS 1989). Presently, this species is known to occur in the Virgin River from La Verken Springs, Utah, downstream to the Mesquite Diversion in Nevada. The middle and the upper portions of the Muddy River in Nevada contain another distinct population of this species, which is isolated by Lake Mead. Riverine habitat for the Virgin River chub typically includes areas of slow to moderate flow with deep runs or pools where large boulders or root snags provide instream cover. Designated critical habitat for this species exists in the Virgin River and its 100-year floodplain from the confluence with La Verkin Creek in Utah downstream to Halfway Wash in Nevada (USFWS 2000). There is no potential habitat for the Virgin River chub within the project area. The closest waterway that may be occupied by the Virgin River chub is the Virgin River near Mesquite, Nevada, approximately 3 miles south of the LCLA development area and within the ROI (**Map 3-9**).

3.5.3.1.6 Woundfin

The woundfin is a federally listed endangered species that historically occurred in the Salt, Verde and Gila Rivers in Arizona; the lower Colorado River; and the Virgin River in Nevada and Utah (USFWS 1989). Currently, this species is only known to occur in the main stem of the Virgin River from La Verkin Springs in Utah downstream to Lake Mead and in the lower portions of La Verkin Creek in Utah. Woundfin typically occupy runs and quiet waters adjacent to riffles. Designated critical habitat for this species exists in the Virgin River and its 100-year floodplain from the confluence with La Verkin Creek in Utah downstream to Halfway Wash in Nevada (USFWS 2000). There is no potential habitat for the woundfin within the project area. The Virgin River near Mesquite, Nevada is the closest potential habitat for the woundfin. This area is approximately 3 miles south of the southern end of the LCLA development area and within the ROI (see **Map 3-9**).

3.5.3.2 BLM Sensitive Wildlife Species and State of Nevada Classified Wildlife Species

A search of the Nevada Natural Heritage Database and the species lists provided by the NDOW, and BLM indicated that numerous special status wildlife species may occur in the project area or in the ROI. Special status species include Nevada BLM sensitive species as well as State of Nevada classified species including those found in the Nevada Wildlife Action Plan. These species are listed in **Appendix E-2**. Species' ranges, habitat preferences, and known occurrences within Nevada were determined using information obtained from the BLM, the NNHP, Stebbins (2003), Peterson (1990), Fitzgerald et al. (1994), Gullion et al. (1959), NDOW (2005), and regional biologists (Abele pers. comm. 2006a, 2006b, 2006c; Morefield pers. comm. 2006a and 2006b).

3.5.3.2.1 Mammals

Thirty-two special status mammal species may occur in the project area or the ROI, including 18 bats, 11 small mammals, two large mammals, and one carnivore (kit fox) (**Appendix E-2**).

Although they may occur in the area, no caves or mines that could provide habitat for bats were found by biologists conducting other biological field surveys in 2006. However, potential day roosts for bats may exist in the form of cracks and crevasses in rock formations as well as mature trees in the Clover Mountains in the project area or in the ROI. In 2004, 11 species of bats were identified during surveys conducted in the ROI at Beaver Dam State Park, Clover Creek (north of Big Spring approximately 12 miles southeast of Caliente), Meadow Valley Wash (south of Elgin), Snow Spring, and Meadow Valley Wash (Carp) (Kenney and Tomlinson 2005) (**Table 3-19**).

Desert bighorn sheep occur in mountain ranges surrounding the southern portions of project area including the Mormon Mountains and Tule Springs Hills. These populations are managed by NDOW as a big game species.

Table 3-19 Bat Species Detected in 2004 Surveys at Five Sites

Common Name	Scientific Name	Location
California myotis	*Myotis californicus*	Clover Creek (north of Big Spring); Meadow Valley Wash (Carp)
Fringed myotis	*Myotis thysanodes*	Clover Creek (north of Big Spring)
Western pipistrelle	*Pipistrellus hesperus*	Clover Creek (north of Big Spring); Meadow Valley Wash (Carp)
Pallid bat	*Antrozous pallidus*	Meadow Valley Wash (Carp)
Long-legged myotis	*Myotis volans*	Meadow Valley Wash (Carp)
Small-footed myotis	*Myotis ciliolabrum*	Clover Creek (north of Big Spring)
Big brown bat	*Eptesicus fuscus*	Meadow Valley Wash (Carp)
Yuma myotis	*Myotis yumanensis*	Meadow Valley Wash (south of Elgin)
Silver-haired bat	*Lasionycteris noctivagans*	Meadow Valley Wash (Carp)
Big free-tailed bat	*Nyctinomops macrotis*	Clover Creek (north of Big Spring); Meadow Valley Wash (Carp)
Brazilian free-tailed bat	*Tadarida brasiliensis*	Clover Creek (north of Big Spring); Meadow Valley Wash (Carp)

Source: Kenney and Tomlinson 2005

The desert kangaroo rat (*Dipodomys deserti*), Desert Valley kangaroo mouse (*Microdipodops megacephalus albiventer*), desert pocket mouse (*Chaetodipus penicillatus*), Merriam's shrew (*Sorex merriami leucogenys*), sagebrush vole (*Lemmiscus curtatus*), brush mouse (*Peromyscus boylii*), and vagrant shrew (*Sorex vagrans*) are the only special status species of small mammals that potentially occur in the project area or in the ROI. No location data are available for these species, but their distribution and range overlap the project area, and suitable habitat is present within the project area and ROI.

3.5.3.2.2 Reptiles and Amphibians

Fifteen special status reptile and amphibian species may occur in the project area or the ROI including 13 reptiles and two amphibians (**Appendix E-2**).

The banded Gila monster (*Heloderma suspectum cinctum*) and the chuckwalla (*Sauromalus* [*ater*] *obesus*) are two special status species of reptiles that may occur in the project area or ROI (**Appendix E-2**). The ranges of the banded Gila monster and the chuckwalla overlap the project area, and suitable habitat for these species occurs in the project area. No individuals or populations of Gila monsters or chuckwallas were found within the proposed ROW (ARCADIS 2006a and 2006b) during field surveys for desert tortoise and rare plants conducted in the spring and fall of 2006; however, these species are expected to occur in low numbers in the Tule Desert. The project area contains suitable reptile habitat, which includes deep, dissected washes along with natural cavities that may provided shelter for Gila monsters as well as boulders that may provide habitat for chuckwallas.

Habitat for the banded Gila monster typically consists of boulders, shrubs, and trees that provide shelter, as do mammal burrows and woodrat nests (Stebbins 2003). This species is the largest carnivorous, and only venomous, lizard in the United States. Due to its rarity in the wild, the banded Gila monster has become highly prized by some collectors, even though collection of this species is illegal. This species is rarely active above ground, and thus it is observed infrequently. Potential habitat for the banded Gila monster occurs in the Tule Desert portion of the project area, and this species is assumed to occur within the project area in low densities.

The chuckwalla is a large, flat lizard that typically occurs in areas dominated by rocks, boulders, rocky cliff faces, rocky outcrops, lava flows, rocky hillsides, and sometimes flat rocky ground (Stebbins 2003). No specific occurrence data were available for the project area. The range of this species overlaps the project area, and suitable habitat exists within the Tule Desert. Therefore, it is assumed that this species occurs in the project area.

Other species of special status reptiles that potentially occur in or near the project area include the western banded gecko (*Coleonyx variegatus*), Great Basin collared lizard (*Crotophytus bicinctores*), desert iguana (*Dipsosaurus dorsalis*), long-nosed leopard lizard (*Gambelia wislizenii*), desert horned lizard (*Phrynosoma platyrhinos*), Sonoran mountain kingsnake (*Lampropeltis pyromelana*), Sonoran lyre snake (*Trimorphodon biscutatus*), long-tailed brush lizard (*Urosaurus graciosus*), and desert night lizard (*Xantusia vigilis vigilis*) (**Appendix E-2**).

The northern leopard frog (*Rana pipiens*) and the Arizona toad (*Bufo microscaphus*) are the only two BLM Sensitive amphibian species that potentially occur in the ROI (there is no potential habitat in the project area). Potential habitat for these species occurs in the Meadow Valley

Wash. Twelve documented occurrences of the Arizona toad are known from the Meadow Valley Wash. Five observations were from Rainbow Canyon, two were made near Elgin, one was made just north of Carp, one was made at Vigo, and three observations were made at the Lincoln/Clark County line (Bio-West, Inc. 2005).

3.5.3.2.3 Migratory Birds

All migratory bird species that may occur in the project area, with the exceptions of rock pigeons (*Columba livia*), house sparrows (*Passer domesticus*), and European starlings (*Sturnus vulgaris*), are protected under the Migratory Bird Treaty Act of 1918 (MBTA), as amended (16 U.S.C. 703-712). The MBTA states that it is unlawful to take, kill, or possess migratory birds, their parts, nests, and eggs (16 U.S.C. 703-711). For migratory game species, the treaty order is carried out cooperatively with the states (e.g., NDOW), which set and enforce legal harvest laws and regulations. Any impacts to migratory birds are primarily a concern during the breeding season, when most species protected under the MBTA are expected to occur in the project area.

Some typical nesting species of migratory birds that have the potential to occur in the project area are the black-chinned sparrow (*Amphispiza bilineata*), cactus wren (*Campylorhynchus brunneicapillus*), horned lark (*Eremophila alpestris*), greater roadrunner (*Geococcyx californianus*), ash-throated flycatcher (*Myiarchus cinerascens*), Say's phoebe (*Sayornis saya*), verdin (*Auriparus flaviceps*), loggerhead shrike (*Lanius ludovicianus*), mourning dove (*Zenaida macroura*), and burrowing owl (*Athene cunicularia*). In the forested areas of the Clover Mountains, the northern flicker (*Colaptes auratus*), dark-eyed junco (*Junco hyemalis*), mountain bluebird (*Sialia currucoides*), mountain chickadee (*Poecile gambeli*), piñon jay (*Gymnorhinus cyanocephalus*), and western scrub-jay (*Aphelocoma californica*) can also likely be considered locally nesting species (Peterson 1990).

Migratory birds which typically occur in the ROI (Clover Creek, Meadow Valley Wash, and Virgin River) include ash-throated flycatcher, loggerhead shrike, phainopepla (*Phainopepla nitens*), Lucy's warbler (*Vermivora luciae*), sage sparrow (*Amphispiza belli*), western bluebird (*Sialia mexicana*), Wilson's warbler (*Wilsonia pusilla*), yellow-breasted chat (*Icteria virens*), blue grosbeak (*Guiraca caerulea*), and Scott's oriole (*Icterus parisorum*) (National Audubon Society 2005). Several other migratory bird species are listed as special status species within the region. The full list of these species is included in **Appendix E-2**.

Of these species, the burrowing owl has the highest likelihood of being impacted by the Proposed Action due to its behavior and habitat. Within Nevada, this species occurs in areas dominated by short vegetation where small mammal burrows are available for nesting. Suitable burrows for this species exist in the project area.

Raptors are relatively common throughout the project area. Special status raptor species that commonly nest in the more rugged upland and canyon habitats include prairie falcon (*Falco mexicanus*) and golden eagle (*Aquila chrysaetos*).

3.5.3.2.4 Fisheries

There are no perennial waters within or in the immediate vicinity of the project area. Clover Creek is the closest intermittent stream to the project area. It runs generally east to west and is north of the northernmost extent of the proposed well field in the Clover Mountains. It typically flows year-round near Caliente, where it flows in to the Meadow Valley Wash, but becomes dry in spots going upstream toward Big Spring (Styles, pers. comm. 2007). Big Spring is approximately 4 miles north of this point and provides the majority of water to Clover Creek (MVCCTRT 2000). Clover Creek contains two Nevada BLM Sensitive native fish, including the Meadow Valley Wash desert sucker (*Catostomus clarki* ssp.) and the Meadow Valley Wash speckled dace (*Rhinichthys osculus* ssp.) (Meadow Valley/Clover Creek TRT 2000). It is also known to support a self-sustaining rainbow trout (*Oncorhynchus mykiss*) fishery in the Little-Big Springs reach (Kipke pers. comm. 2007). Several species of game fish, including rainbow trout(*Oncorhynchus mykiss*), brown trout (*Salo trutta*), largemouth bass (*Micropterus salmoides*), smallmouth bass (*Micropterus dolomieu*), crappie (*Pomoxis* spp.), and channel catfish (*Ictalurus punctatus*), were introduced beginning in 1945 and continuing to 1980. NDOW does not currently manage this fishery, as it is detrimental to native fish populations. Recent surveys have revealed that, of these game species, only the rainbow trout population persists in Clover Creek. A total of 19 trout were caught at two sampling locations in 2007 (NDOW 2005 and 2007).

The Meadow Valley Wash, located approximately 12 miles west of the project area, is the closest perennial waterway that supports fish populations. The Meadow Valley Wash is an approximate 110-mile wash that begins in the mountains of eastern Lincoln County and drains into the Muddy River near Glendale, Nevada. The Meadow Valley Wash is perennial from its source to Caliente. South of Caliente, it has been described as perennial from Caliente to Elgin but intermittent further south. Meadow Valley Wash is primarily a perennial stream with a mix of riffles, runs, and pools through Rainbow Canyon (Bio-West, Inc. 2005).

The Meadow Valley Wash supports populations of two special status species of fish including the Meadow Valley Wash desert sucker and Meadow Valley Wash speckled dace. Both species have been documented sporadically and in low numbers from Elgin to Vigo (Bio-West, Inc. 2005).

Fish sampling conducted along the Meadow Valley Wash and Clover Creek in 2007 captured Meadow Valley Wash speckled dace and Meadow Valley Wash desert suckers at all five sites that were sampled. A total of 1,220 speckled dace and 804 desert suckers were captured at three sites along Meadow Valley Wash; and 287 speckled dace and four desert suckers were captured at two sites along Clover Creek (NDOW 2007).

The Virgin River supports two special status species including the flannelmouth sucker and Virgin River spinedace, which are known to occur in the mainstream of the river. The closest waterway that may be occupied by these species is the Virgin River near Mesquite, Nevada, approximately 3 miles south of the LCLA development area and within the ROI.

3.5.3.2.5 Invertebrates

There are no Nevada BLM Sensitive invertebrates that potentially occur in the project or ROI.

3.5.4 Wild Horses and Burros

On December 15, 1971, Congress enacted the Wild and Free-Roaming Horse and Burro Act which authorized the BLM to manage wild horses and burros on public lands. The Act mandated that wild and free-roaming horses and burros be protected from unauthorized capture, branding, harassment, or death. Areas of public land that were identified as habitat for wild horses and burros in 1971 were delineated as Herd Management Areas (HMAs).

The following BLM-administered HMAs are crossed by or located adjacent to the project area:

- Mormon Mountains
- Meadow Valley Mountains
- Blue Nose Peak
- Delamar Mountains
- Clover Mountains
- Applewhite
- Clover Creek

The project area crosses the eastern portions of both the Blue Nose Peak and Clover Mountains HMAs. The Blue Nose Peak HMA has an estimated wild horse population of six horses with an Appropriate Management Level (AML) of one horse, and the Clover Mountains HMA has a wild horse population of approximately 35 animals with an AML of one to 16 individuals. The wild horse population of the Clover Mountains HMA moves back and forth between the Clover Mountains HMA and the Clover Creek HMA, so estimating populations within these HMAs on any given day is difficult.

3.6 LAND USE

The ROI evaluated for land use includes the area immediately adjacent to the proposed ROW and the local road network that would be used during construction and operation of the Proposed Action. Regional transportation routes that provide access to the BLM- and county-managed roads within the project area include I-15, south of the project area, and Highway 93, north of Caliente. The ROI for land use is entirely within Lincoln County on lands managed by the BLM Ely District. Land ownership within the ROI is shown on **Map 3-9**.

3.6.1 Data Collection Methods

Existing land use data were collected through analysis of aerial photography, USGS topographic maps, review of existing regional and local studies and plans, and through on-line database searches of the BLM LR2000 system.

3.6.2 Existing Conditions

Lincoln County is Nevada's third largest county, encompassing 10,634 square miles in southeastern Nevada. It is bordered by Clark County to the south; Nye County to the west; White Pine County to the north; and to the east by the Utah Counties of Millard, Beaver, Iron, and Washington and the Arizona County of Mohave.

The community of Pioche is the Lincoln County seat, with three additional population centers located in Alamo, Caliente, and Panaca. The federal government administers approximately 98 percent of the land in Lincoln County, with the BLM managing approximately 83 percent of total Lincoln County acreage. State lands comprise less than 0.5 percent of Lincoln County. The nearest state-owned property includes Beaver Dam State Park located north of the Clover Mountains and Kershaw Ryan State Park located along the Meadow Valley Wash south of Caliente. **Table 3-20** lists federal, state, and local government and private lands in Lincoln County.

Table 3-20 Federal, State, Local Government and Private Lands in Lincoln County

Categories	Acres	Percentage of Total
Federal Agencies		
BLM[1]	5,660,396	83.04
U.S. Forest Service	30,703	0.45
USFWS[1]	785,227	11.52
Other Federal Agencies	223,961	3.29
Total Federal Lands	6,700,287	98.29
State Government	18,802	0.28
Local Government and Private Lands	97,509	1.43
TOTAL	**6,816,598**	**100.00**

[1] The BLM and USFWS acreages are approximate and do not include pending land exchanges.
BLM – Bureau of Land Management
USFWS – U.S. Fish and Wildlife Service
Source: Zimmerman and Harris 2000; USFWS 2006c

Existing land use in the project area includes open range for livestock grazing, ROWs for utility infrastructure (including the designated LCCRDA utility corridor), and special designation areas such as ACECs and Wildernesses. With the exception of the utility corridors along the southern end of the project area, the project area is undeveloped land. Remnants of exploratory gypsum mining activities are present near the proposed Toquop Energy Project; however, there are no active mining operations in the project area. **Table 3-21** lists the BLM-approved ROWs in the project area.

Isolated pockets of private lands are located in the Clover Mountains. The small settlement of Barclay, originally called Clover Valley, is located along Clover Creek north of the project area. The community includes several homesteads and a historic schoolhouse. The Union Pacific Railroad (UPRR) line parallels Clover Creek through the community. Active farming is present in the area surrounding the community. Other private lands near the proposed ROW include a single patented mining claim near East Pass and three mining claims in the Tule Desert. None of these claims are active.

Table 3-21 BLM-Granted Rights-of-Way near the Project Area

BLM Serial No.	Granted to	Description
N-4790	U.S. Bureau of Reclamation City of Los Angeles Nevada Power	Aerial electric transmission line for a single 500 kV electrical power transmission line extending from the Navajo Generating Plant near Page, Arizona to the McCullough Switching Station near Boulder City, Nevada. Constructed in 1972.
N-10683	Intermountain Power Project	Two 500 kV aerial electric transmission lines originating in Lynndyl, Utah and terminating in Adelanto, California. Constructed in 1981.
N-39815	Nevada Power Company	A single 345 kV aerial electric transmission line originating at the Pecos Substation near north Las Vegas, Nevada to the Harrisburg Junction substation in Utah. The ROW grant parallels the existing 500 kV Navajo McCullough electric transmission line. Constructed in 1984.
N-42581	Kern River Gas Company	36-inch natural gas transmission line and related facilities. Constructed in 1990.
N-62093	Touch America, Inc. (Williams Communications)	FTV System Fiber-Optic Cable. ROW for a buried 0.83-inch diameter fiber optic communication cable. Constructed in 1994.
N-77486	Toquop Energy, Inc.	ROW for overhead powerline within the permanent ROW; Temporary Use Permit (N-77486-01) is 30 feet wide (15 feet on each side of the powerline). Issued 12/03/03; expires 12/02/33
NVN-83110	Lincoln County Water District	ROW for temporary precipitation, spring, surface water, and soil sampling facilities in the Tule Desert. Eighteen sites at 0.23 acre each. Issued 05/04/07; expires 12/31/09.
NVN-66087	Lincoln County Water District	ROW for monitoring wells in the Tule Desert (20 acres). One production well (PW1) and three monitoring well sites (MW1, MW2, MW3) located in the Tule Desert. Issued 04/04/00; expires 04/03/16. Amended ROW on 01/23/02 to add two monitoring well sites (MW4 and MW5) adjacent to MW1.
NVN-80825	Lincoln County Water District	ROW for three monitoring well sites (MW6, MW7, and alternate well) in the south Tule Desert (40 acres). Issued 11/16/05). Amended ROW on 01/26/07 to add five monitoring well sites (TWS-A, TWS-B, TWS-C, TWS-D, and TWS-E). Expires 11/15/35.
NVN-82770	Lincoln County Water District	ROW for two monitoring well sites (TWS-F and TWS-G) in the north Tule Desert (10 acres). Issued 01/26/07; expires 12/31/36.
NVN-78413	Lincoln County Commissioners	ROW for two monitoring wells and access road; access road 10 feet by 3,400 feet; two monitoring well sites are each 100 feet by 100 feet (1.66 acres). Issued 09/08/04.

Source: BLM 2007a
ROW = right-of-way kV = kilovolt FTV = Free Viewpoint Television

3.6.3 Rangelands and Livestock Grazing

The project area lies within the BLM Caliente Resource Area. All federal livestock grazing allotments within the project area are classified as perennial allotments. Term permits authorize grazing use based on perennial vegetation. There are 15 range allotments in or near the project area, all of which are cow/calf operations. These allotments are administered by the BLM Ely District. Information specific to each of these allotments, including their Animal Unit Months (AUMs), is provided in **Table 3-22** (Peterson 2006). An AUM is the amount of forage needed to sustain one 1,000-pound cow and her calf (less than 3 months old), five sheep, or five goats for a month.

Table 3-22 Grazing Allotments in the Project Area

Allotment Name	Lessee	Public AUMs	Allotment Acres
Cottonwood	Wright Trust	3,016	42,172
	Lewis, Robert and Vivian	1,296	62,145
Sheep Flat	Bundy, Ed and Connie	1,977	74,171
	Newby Cattle Co.	1,977	
	Wade, J. Lavar and Kaye S.	1,977	
Barclay	Bowler, Fenton	1,971	79,621
	Hughes, Arlin	1,971	
	Newby Cattle Co.	1,971	
Haypress	National Mustang Association Inc.	154	7,843
Lime Mountain	Hughes, Arlin	6,754	67, 144
Garden Spring	Newby Cattle Co.	2,809	38,823
Summit Spring	Newby Cattle Co.	715	18,035
White Rock	Newby Cattle Co.	2,880	32,916
Snow Springs	Bowler, Fenton	3,567	44,042
	Bowler, John	3,567	
	Covington, Hilton or Mary Ann	3,567	
	Dannelly, Dwight E. and Shauna J.	3,567	
	Preston, Kyle	3,567	
	Staheli Farms	3,567	
Gourd Springs	Bundy, Ed and Connie	3,458	57,700
	Bundy, Ed and Connie	3,458	
	Wade, J. Lavar and Kaye S.	3,458	
	Wade, J. Lavar and Kaye S.	3,458	
Beacon	Closed	-	-
Sand Hollow	Closed	-	-
Flat Top Mesa	Harold Wittwer	No adjudicated AUMs, ephemeral	5,338
Jackrabbit	Closed	-	-
Pulsifer Wash	Closed	-	-

Source: Peterson 2006
AUM = Animal Unit Month

Stocking levels have been reduced over recent years, particularly since 1996, due to drought impacts. Actual use also fluctuates based on economic conditions. On most allotments, the

BLM has required permitees to use less forage than the active use authorized by their term permits. As a result of the 2000 Caliente MFP Amendment for Management of Desert Tortoise Habitat, three entire allotments and portions of six other allotments were closed to livestock grazing. The Beacon and Sand Hollow allotments, which occur in the ROI, were closed. Two allotments administered out of the Las Vegas office, Jackrabbit and Pulsifer Wash, have also been closed to livestock grazing.

3.6.4 Mineral Resources

Federally managed minerals in the public domain are classified into three categories: leasable minerals, locatable minerals, and saleable minerals. Leasable minerals include fluid leasable minerals (oil and gas; geothermal resources and associated by-products; oil shale, native asphalt, oil-impregnated sands, and any other material in which oil is recoverable) and solid leasable minerals such as coal and phosphates. Major locatable minerals in the Ely District include copper, gold, lead, zinc, silver, tungsten, pozzolana (a commodity derived from volcanic ash), and uranium. Saleable minerals include sand and gravel resources, limestone, dolomite, and quartzite rocks quarried for building stone and landscaping (BLM 2005).

3.6.4.1 Solid Minerals

The project area is not located within the boundaries of any historic mining districts. The nearest historic mining district is the Gourd Springs mining district east of the Mormon Mountains. Historic metallic commodities in the Gourd Springs mining district included tungsten and manganese (Tingley 1998). Nonmetallic occurrences in the area include barite and gypsum on the southwestern tip of the East Mormon Mountains. The barite occurrence is associated with tourmaline-bearing pegmatite dikes that cut Precambrian amphibolite schist. Economic deposits of gypsum have been mined in the Muddy Creek Formation (BLM 2005). The gypsum-bearing horizon occurs in a sequence of Permian rocks. At present, there are no active mining claims in the project area.

3.6.4.2 Fluid and Geothermal Minerals

Oil, natural gas, and geothermal energy are classified as "Fluid Minerals" by the BLM. Overall, the BLM Ely District has a high potential for occurrence of hydrocarbons on valley floors (BLM 2007b). Currently, there are no active oil and gas leases in the project area. Exploratory oil and gas drilling projects have been conducted near the project area; however, none of these were pursued beyond the exploratory stage.

The BLM Ely District has low to moderate temperature geothermal resources. Geothermal development potential is considered moderate in the valley areas, including the project area, and low in the mountain areas. There are no active geothermal leases located in or directly adjacent to the project area.

3.6.5 Transportation

3.6.5.1 Regional Transportation

The southern end of the project area is accessible from I-15 via the East Mesa Interchange 13 miles west of Mesquite, Nevada. An existing dirt and gravel road runs north from the East Mesa Interchange to a utility corridor road near the proposed Toquop Energy site. An existing utility corridor road parallels the transmission lines (345 kV and two 500 kV lines) and the Kern River natural gas pipeline. This road provides access to the north end of the LCLA area.

Currently, there are no roadways between the proposed Toquop Energy site and the Toquop Gap. Construction of a railway to serve the Toquop Energy Project is currently under review. It is anticipated that the proposed ROW would parallel this corridor. West of Toquop Gap, Carp Road, a county-maintained dirt and gravel road, provides access north into the Tule Desert. Carp Road connects I-15 with Lyman Crossing at Meadow Valley Wash, a distance of 30 miles. Several unnamed dirt and two-track roads traverse the Tule Desert area crossing both Garden and Sam's Camp Wash as they travel north into the Clover Mountains.

On the south side of the Clover Mountains, Sam's Camp Road/East Pass Road climbs steeply as it switches back from the Tule Desert to East Pass (elevation 6,583 feet). East Pass Road continues north to join numerous dirt and two-track roads that provide access to various areas of the Clover Mountains. East Pass Road is maintained in areas. However, many BLM roads located in the vicinity of the project area are not maintained, and many are not actively used. East Pass Road is closed during the winter. According to the Lincoln County Planning Department, East Pass Road is both a county and a BLM road depending on the section of road (Dixon 2006).

The northern reach of the project area is accessible from Highway 93 and Beaver Dam Road. The turnoff for Beaver Dam Road is approximately 5 miles north of Caliente. Beaver Dam Road is a county-maintained dirt and gravel road that provides public access to Beaver Dam State Park located at the Nevada-Utah border. Access to the upper end of the project area is via an unnamed dirt road that passes the small farming community of Barclay. The road crosses portions of the UPRR in this area.

The northern reach of the project area generally follows East Pass Road from the intersection of Snow Valley Road (located in the Tule Desert) north to where the project splits to continue northwest along East Pass Road and to the northeast along Oak Wells Road. The project area branches again where Oak Wells Road intersects Bunker Peak Road. The project area follows southeast on Bunker Peak Road and then diverts east onto Docs Pass Road.

Transportation use of the BLM and county-maintained dirt roads within the southern and northern reaches of the project area is low. Most dirt and two-track roadways are used primarily by local residents and recreational users including hunters and off-highway vehicle (OHV) users. Road system management by the BLM in the Ely District is variable, and priorities for road maintenance are determined on a case-by-case basis. The BLM Ely District has observed an increase in informal travel route proliferation, due mainly to recreation use, which can be correlated to increases in population and OHV use (BLM 2006d). OHV activities in the Ely

District are managed under the National Management Strategy for Motorized Off-highway Vehicle Use on Public Lands (Executive Orders 11644 and 11989).

The Nevada Department of Transportation (NDOT) operates an automatic traffic recorder (ATR) data site along U.S. Highway 93, north of Caliente (ATR #1721109). Historical Annual Average Daily Traffic (AADT) for this site ranges between 1,135 vehicles in 1996 to 1,370 vehicles in 2005. The percentage of AADT by month ranges from a low of 80 percent in January to a high of above 100 percent in May through September and then drops to just above 80 percent in December.

Lincoln County operates a portable traffic count station on Carp Road. Station number 55 is located between Elgin and Carp on Carp Road south of the terminus of State Road (SR) 317 and 3.2 miles south of the entrance road to Elgin. The most recent available data from 2004 and 2005 show an adjusted or estimated AADT of 20.

In 2004, the AADT for stations along I-15 between the Carp-Elgin interchange and the East Mesa interchange averaged 16,500 vehicles daily. The 2005 AADT levels averaged between 17,700 to 18,000 vehicles daily; about an 8 percent increase. The AADT in this stretch of I-15 will likely increase over the next decade as development continues in the Mesquite area. The Transportation Element of the City of Mesquite Master Plan, guides long-term transportation planning in the local area.

The AADT level along Beaver Dam Road, east of U.S. Highway 93 was 90 vehicles daily in 2004. In 2005, the AADT was 80 vehicles daily. Traffic on Beaver Dam Road is primarily limited to recreational travelers accessing the mountain ranges east of Caliente and visitors to Beaver Dam State Park.

3.6.5.2 Union Pacific Railroad

A section of the UPRR runs from Caliente east to Barclay Siding in the Clover Mountains, to Acoma Siding, and then north to Uvada, Utah. Another section of the southern UPRR line runs from Caliente along SR 317 south to Elgin then continues south paralleling Carp Road to the community of Moapa. The rail service is freight only; no passenger service is available.

3.6.5.3 Airports

The nearest airport to the project area is the Mesquite Airport; a public use airport operated by the Clark County Department of Aviation. The airport is located north of the City of Mesquite, immediately south of the LCLA development area. The airport includes one asphalt runway and one helipad. The St. George Municipal Airport is located approximately 40 miles east of the City of Mesquite. The airport is located one mile west of the City of St. George, Utah and includes two runways. Both airports offer a full array of general aviation services including aircraft maintenance, fueling services, and daily commercial and charter flights.

The Lincoln County Airport, located just west of Panaca along Highway 93, accepts small, two-engine airplanes. This airport is approximately 25 miles north of the Clover Valley project area. There are several dirt airstrips in Lincoln County; however, most of these are not useable or are rarely used (Dixon 2006). The nearest large commercial airport is the McCarran International

Airport, which is approximately 85 miles away in Las Vegas.

Large portions of Lincoln County are located in Military Operations Areas associated with the Nellis Air Force Base. The project area is located in the Desert Military Operations Area, which includes the Elgin and Reveille airspaces. Supersonic aircraft operating from Nellis regularly use the airspace during training operations.

3.7 AREAS OF CRITICAL ENVIRONMENTAL CONCERN, WILDERNESS, AND OTHER SPECIAL USE AREAS

The ROI for ACECs, Wildernesses, and other special use areas includes the portions of the project area immediately within or adjacent to the Mormon Mountain Wilderness, Clover Mountain Wilderness, Mormon Mesa ACEC, and the Beaver Dam Slope ACEC (**Map 3-9**).

3.7.1 Data Collection Methods

Data for characterizing the baseline conditions of ACECs, Wildernesses, and other special use areas within the ROI were obtained from the Proposed RMP and Final EIS for the BLM Ely Field Office, Nevada (2006) and consultation with BLM staff members.

3.7.2 Areas of Critical Environmental Concern

The BLM regulations (43 CFR part 1610) define an ACEC as an area "within the public lands where special management attention is required to protect and prevent irreparable damage to important historic, cultural, or scenic values, fish and wildlife resources, or other natural systems or processes, or to protect life and safety from natural hazards." The FLPMA requires that priority be given to the designation and protection of ACECs. Portions of the project area are located in the Mormon Mesa ACEC and Beaver Dam ACEC (**Map 3-9**).

The Mormon Mesa ACEC occupies 109,700 acres and extends north from the Lincoln/Clark County line and the Cities of Mesquite and Moapa, near the Mormon Mountain range. Portions of the designated LCCRDA utility corridor and various dirt and gravel roads between I-15 and the southern end of the project area are within the Mormon Mesa ACEC. The BLM Las Vegas District is responsible for administering ACEC resource constraints in the Clark County portion, while the BLM Ely District is responsible for the Lincoln County portion.

The Beaver Dam Slope ACEC occupies 36,800 acres and is located east of the Mormon Mesa ACEC and west of the Nevada/Arizona/Utah border. The Beaver Dam Slope ACEC extends north from the Lincoln/Clark County line and northwest of the City of St. George, Utah. Portions of the Proposed Action or Alternative 1 would be located in the Beaver Dam Slope ACEC.

Both ACECs were designated and managed primarily for the recovery of desert tortoise (BLM 1999). Outside of ACECs, habitat for the desert tortoise is also considered in the BLM management decisions, with the goal of maintaining or improving existing habitat conditions to stabilize tortoise populations at existing trend levels, improve habitat, and be consistent with recovery efforts by other agencies (BLM 1999).

3.7.3 Wilderness

The Wilderness Act of 1964 created the National Wilderness Preservation System to allow Congress to designate certain public lands as Wilderness "for preservation and protection in their natural condition." Title II of the LCCRDA designated approximately 769,611 acres as Wilderness Area within Lincoln County. Portions of both the Mormon and Clover Mountain ranges adjacent to the project area were designated as Wildernesses with passage of the LCCRDA.

The Clover Mountain Wilderness occupies 157,938 acres and is located about 20 miles south of Caliente and 90 miles northeast of Las Vegas. Access to the western edge of the Wilderness is via SR 317 east of Caliente, Nevada. The Wilderness is located west of the northern reach of the project area. Portions of the Wilderness are adjacent to East Pass Road between Sheep Flat and East Pass. Signs indicating "Wilderness" and "Closed Road" or "Closed Route" are placed at various intervals along the roadway. Vehicles can be parked outside the wilderness boundary; however, the boundary is set back 100 feet on roads. Mechanized and motorized vehicles are not permitted in a Wilderness area.

The Mormon Mountain Wilderness is located in southern Lincoln County with a portion in northeastern Clark County, approximately 60 miles from Las Vegas. Access to the northern portion of the Mormon Mountain Wilderness is from Glendale, Nevada east 14 miles on I-15 to an unnamed county road northbound. Access to the northern portion of the Wilderness from Caliente, Nevada is achieved via SR 317 through Elgin, Lyman Crossing, and Carp. The Wilderness is located west of the Toquop Gap area.

3.7.4 National Wildlife Refuges and National Recreation Areas

There are no National Wildlife Refuges (NWRs) in the vicinity of the project area. The Pahranagat NWR south of Alamo is located more than 40 miles west of the northern end of the project area. The Pahranagat NWR is located on 5,380 acres along Highway 93 south of Alamo. The refuge is managed by the USFWS to provide habitat for migratory birds, especially waterfowl. Primary public use consists of wildlife observation, hunting, camping, and picnicking.

The Moapa Valley NWR is located northwest of Moapa, south of SR 168 and about 30 miles southwest of the Toquop Gap area. The refuge was established in September 10, 1979 and is managed by the USFWS to secure habitat for the endangered Moapa dace (USFWS 2006d). There are no National Recreation Areas (NRAs) in the vicinity of the project area. The closest NRA is Lake Mead, which is about 25 miles southwest of the LCLA development area.

3.8 RECREATION

The ROI evaluated for effects to recreation resources includes the project area and immediately adjacent areas that may be subject to disturbance from construction and operation of the Proposed Action.

3.8.1 Data Collection Methods

Data for characterizing the baseline conditions of recreational areas and use within the ROI were obtained primarily from the Proposed RMP and Final EIS for the BLM Ely Field Office, Nevada (2006) and personal conversations with BLM recreation staff personnel.

3.8.2 BLM-Administered Recreation Areas

There are no BLM-administered recreation areas in or near the project area. Examples of BLM-administered recreation areas include OHV areas and designated recreation areas such as scenic areas, rock hounding areas, natural areas, natural research areas, and historic trails. The mountains and deserts surrounding the project area offer a variety of dispersed recreational opportunities on BLM-administered public lands. Recreational activities in the project area typically include OHV use on existing roads, trails, and dry washes; big and small game hunting; hiking; mountain biking; horseback riding; camping; snowmobiling and cross-country skiing in the Clover Mountains; target shooting; rock hounding; rock climbing; sightseeing; and photography.

The nearest BLM-administered recreation area is Rainbow Canyon, approximately 6 miles west of the proposed corridor in the Clover Mountains (**Map 3-9**). This primitive recreation area consists of approximately 20 miles of scenic driving from the intersection of Highway 93 and SR 317 in Caliente, and south on SR 317 along the Meadow Valley Wash to Elgin. From Elgin, the route proceeds on unpaved roads recommended for high-clearance vehicles continuing east 38 miles to Highway 93 or south 56 miles to I-15.

The nearest BLM-administered OHV area is the Silver State Off-Highway Vehicle Trail, located west and northwest of Caliente. OHV use in the project area is limited to existing roads, trails, and dry washes and is typically associated with recreational activities such as hunting, fishing, and camping. Management of OHV use on BLM-administered public lands is guided by the National Management Strategy for Motorized Off-Highway Vehicle Use on Public Lands (Executive Orders 11644 [1972] and 11989 [1978], and regulation 43 CFR 8340). Within ACECs, OHVs are allowed only on roads and vehicle trails specifically designated for OHV use, but only for casual use; competitive OHV use is not allowed.

3.8.3 State Parks and State Recreation Areas

There are no state parks or state recreation areas in the project area. The nearest state park is Beaver Dam State Park, located about 5 miles northeast of the project area near Bunker Pass Road. Beaver Dam State Park encompasses 2,393 acres and is managed by the Nevada Division of State Parks. Recreational opportunities include fishing, camping, picnicking, hiking, photography, and nature study. Facilities include two developed campgrounds offering 30 individual campsites, a group use area, a day-use picnic area, and hiking and interpretive trails. Motorists can reach the park by driving 6 miles north of Caliente on Highway 93, then 28 miles east on Beaver Dam Road, a graded gravel road that leads to the park entrance (Nevada Division of State Parks 2006).

Kershaw Ryan State Park is located 2 miles south of Caliente via Highway 93 and SR 317. The park is about 10 miles northwest of the Fife Flat area in the Clover Mountains. The park offers a picnic area, restrooms, and developed hiking trails.

3.8.4 State Wildlife Management Areas

There are no State Wildlife Management Areas (WMAs) in or near the project area. The closest WMA to the project area is the Key Pittman WMA, located approximately 10 miles north of Alamo, off of SR 318. Key Pittman WMA is located in the Pahranagat Valley and includes two small lakes: Nesbitt Lake on the north and Frenchy Lake on the south.

3.9 AIR QUALITY

The ROI evaluated for direct effects to air quality includes the project area and immediately adjacent areas that may be subject to disturbance from Proposed Action construction. Indirect effects are evaluated for air quality in the region as a result of the implementation of the Proposed Action or alternatives.

3.9.1 Data Collection Methods

Data for assessing the existing conditions of the air quality study area were obtained from federal, state, and local air quality regulatory agencies (e.g. EPA, NDEP, and Clark County) and site-specific meteorological and air quality data collected as part of the proposed Toquop Energy Plant project. Meteorological and air quality data for the proposed Toquop Energy Plant project were collected from the period of April 19, 2006 through February 28, 2007 to meet EPA and Nevada monitoring guidance of 90 percent data-capture requirements for project permitting. The project area for the Toquop Energy Project overlaps the southern project area for the Proposed Action, and is applicable to the air quality analysis in this Draft EIS.

3.9.2 Existing Air Quality

All of Lincoln County is in full attainment of ambient air quality standards; that is, existing background concentrations for all criteria air pollutants are lower than the maximum allowable ambient concentrations under State of Nevada and national ambient air quality standards. These criteria pollutants include ozone (O_3), carbon monoxide (CO), oxides of nitrogen (NOx), sulfur dioxide (SO_2), particulate matter with mean aerometric diameter smaller than 10 microns (PM_{10}), particulate matter with mean aerometric diameter smaller than 2.5 microns ($PM_{2.5}$), and lead (Pb). Units of concentration are expressed in parts per million or micrograms per cubic meter (ug/m^3).

Table 3-23 presents maximum monitored ambient concentrations of criteria pollutants for southern Nevada for the year 2005. The data for O_3, NO_2, and PM_{10} were collected in Mesquite near the southern end of the project area.

Table 3-23 Maximum Monitored Ambient Concentrations for the Year 2005

Pollutant	Averaging Period	Maximum Concentration (ug/m^3)	Monitor Location
Ozone	1-hour	207.8	A
	8-hour	180.3	A
NO_2	Annual	13.5	A
PM_{10}	24-Hour	316.0	A
	Annual	25.8	A

Source: EPA 2006
ug/m^3 – micrograms per cubic meter
A - 465 East Old Mill Road, Mesquite, NV (EPA Site 320030023)

The 2005 maximum criteria pollutant concentrations were below the state and federal standards except for the 24-hour PM_{10} concentration, which exceeded the standard of 150 ug/m^3. The next highest 24-hour PM_{10} concentration in Mesquite in 2005 was 89 ug/m^3.

Tables 3-24 and **3-25** presents PM_{10} concentrations collected in Mesquite and at the intersection of Highway 93 and I-15 in Clark County (Apex) for the years 2002 through 2005. These data show that 24-hour concentrations have exceeded the standard several times during this period at both locations. Although the Apex area is more industrial than Mesquite, the data are quite similar, and this suggests that these high 24-hour values are related to natural events. For the Las Vegas area, the Clark County Department of Air Quality Management has identified high wind events as being "largely responsible for exceedances of the 24-hour PM_{10} air quality standard" (Clark County Department of Air Quality 2002). It is likely that these events are also common in the project area.

Table 3-24 Mesquite PM_{10} Concentrations 2002 - 2005

Year	24-Hour PM_{10} (ug/m^3)			Annual PM_{10} (ug/m^3)
	Maximum	Day Maximum Recorded	Second Highest	
2002	413	04/15/02	380	33.0
2003	254	10/30/03	106	26.0
2004	134	04/28/04	130	21.9
2005	316	03/13/05	89	25.8

Source: EPA 2006
ug/m^3 – micrograms per cubic meter PM_{10} – particulate matter smaller than 10 microns in diameter

Table 3-25 Intersection of Hwy 93 and I-15 (Apex) PM_{10} Concentrations 2002 - 2005

Year	24-Hour PM_{10} (ug/m^3)			Annual PM_{10} (ug/m^3)
	Maximum	Day Maximum Recorded	Second Highest	
2002	465	04/15/02	176	26.4
2003	348	10/30/03	105	23.8
2004	150	05/10/04	85	19.1
2005	97	05/16/05	72	18.9

Source: USEPA 2006
ug/m^3 – micrograms per cubic meter PM_{10} – particulate matter smaller than 10 microns in diameter

3.9.3 Areas with Special Air Quality Protection

There are no special air quality protection areas within or near the project area. The closest designated federal Class I air quality area is Zion National Park in Utah, approximately 80 miles east of Mesquite. The Lake Mead NRA, located approximately 25 miles south of the LCLA development area, is a designated federal Class II air quality area.

3.9.4 Existing Stationary Sources of Air Emissions

There are no permitted major sources of air pollutant emission located within the ROI. A major source is categorized as a source that has the potential to emit more than 100 tons per year of a criteria pollutant, more than 10 tons per year of any hazardous air pollutant, or more than 25 tons per year of any combination of hazardous air pollutants. The proposed Toquop Energy Project is currently being reviewed by NDEP for a major source Prevention of Significant Deterioration air quality construction permit. The NDEP is the delegated authority for administering and enforcing the Clean Air Act and federal and state regulations in Lincoln County.

Minor sources include smaller industrial and commercial operations such as rock and construction product industries (e.g., portable crushing and screen plants), hot-mix asphalt plants, and concrete batch plants (BLM 2007b).

3.9.5 Air Quality Regulations

Control of fugitive dust from construction activities is covered in the NAC 445B.22037 - Emissions of Particulate Matter: Fugitive dust. A Class II Air Quality Operating Permit for Stand-Alone Surface Area Disturbance Permit and a dust control plan are required for surface disturbances of more than 5 acres. The plan must consider “best practical methods” to prevent particulate matter from becoming airborne that include, but are not limited to, paving, chemical stabilization, watering, phased construction, and revegetation.

3.10 NOISE

The ROI evaluated for noise includes the project area and those areas immediately adjacent to the project area that may be subject to disturbance from Proposed Action construction and operation.

3.10.1 Data Collection Methods

An assessment of the potential for a project to result in adverse noise effects requires an evaluation of several factors. These factors include a site’s general setting (such as isolated, rural, suburban, or urban); nature of the noise sources or activities occurring in those settings; proximity of the receptor to the noise source or activity; time of day; and various attenuating factors that can mute or interrupt noise waves such as vegetation, topographic features, buildings, and atmospheric conditions.

Noise standards and sound measurement equipment have been designed to account for the sensitivity of human hearing to different frequencies. This is accomplished by applying “A-Weighted” correction factors. This correction de-emphasizes the very low and very high frequencies of sound in a manner similar to the response of the human ear. The primary assumption is that the A-weighted decibel (dBA) is a good correlation to a human's subjective reaction to noise.

Noise is measured in units of decibels (dB) on a logarithmic scale. Because human hearing is not equally sensitive to all frequencies of sound, certain frequencies are given more "weight." The dBA scale corresponds to the sensitivity range for human hearing. Noise levels capable of being heard by humans are measured in dBA. A noise level change of 3 dBA is barely perceptible to average human hearing. A 5-dBA change in noise level, however, is clearly noticeable. A 10-dBA change in noise level is perceived as a doubling or halving of noise loudness, while a 20-dBA change is considered a dramatic change in loudness.

3.10.2 Existing Environment

The entire extent of the project area is located within a rural, uninhabited area. Average noise levels in rural areas are typically in the 35 to 40 dBA range. Ambient noise in rural areas is commonly made up of natural sounds and vehicle and aircraft traffic. Except for vehicle traffic on rural roads, aircraft, and natural sounds, there are few noise-generating sources in the area. The airspace over the project area includes Military Operations Areas associated with the Nellis Air Force Base. Military air traffic generates two types of noise:

- Subsonic flight noise as generated by an aircraft's engines and airframe and
- Sonic booms generated by supersonic flights.

The level of military aircraft sound that is perceived at ground level will depend on the altitude of the aircraft and meteorological conditions. For subsonic flights, the F-22 Force Development Evaluation and Weapons School Beddown, Nellis Air Force Base Environmental Assessment estimated baseline ground-level Onset Rate Adjusted Monthly Day-Night Average Sound Levels (L_{dnmr}) for the Elgin and Reveille airspaces to be 47 and 56 dB, respectively (DOD 1999). These values are based on 300,000 sortie-operations. The L_{dnmr} metric is based on the rapid ambient sound increase (onset rate) related to aircraft operations. This same study estimated that ground level C-Weighted Day-Night Sound Level from sonic booms would be 56 dB for the Elgin airspace (30 booms per month) and less than 45 dB for the Reveille airspace (2 booms per month).

The EPA established a noise level of 55 dBA as a guideline for acceptable environmental noise (EPA 1974). This established EPA environmental noise level is used as a basis of evaluating noise effects when no other local, county, or state standard has been established. The project area is subject to the management guidance included in the Caliente MFP (as amended). The Caliente MFP does not contain noise regulations or standards (BLM 1999). Also, Lincoln County currently does not have noise regulations or standards.

3.11 VISUAL RESOURCES

3.11.1 Data Collection Methods

For lands managed by the BLM, Visual Resource Management (VRM) objectives have been developed to protect the most scenic public lands, especially those lands that receive the greatest amount of public viewing. The VRM system is the basic tool used by the BLM to inventory and manage visual resources on public lands. VRM classes are objectives that outline the amount of disturbance an area can tolerate before it no longer meets the visual quality of that class. VRM classifications range from Class I, the most restrictive, to Class IV, the least restrictive.

Class I Objective: Preserve the existing character of the landscape. The level of change to the characteristic landscape should be low and must not attract attention.

Class II Objective: Retain the existing character of the landscape. The level of change to the characteristic landscape should be low.

Class III Objective: Partially retain the existing character of the landscape. The level of change to the characteristic landscape should be moderate.

Class IV Objective: Provide for management activities that require major modification of the existing character of the landscape. The level of change to the characteristic landscape can be high.

3.11.2 Environmental Setting

The topography of southeast Lincoln County is characterized by high mountain ranges with intervening valleys and canyons featuring broad alluvial fans and bajadas. The project area encompasses diverse desert landscapes that range in elevation from 2,100 feet above sea level along the northern boundary of the LCLA parcel to 6,560 feet above sea level at the East Pass road, and are characterized by vegetation communities that vary with elevation. The LCCRDA and the proposed utility corridor extend to the northwest of the LCLA development area, crossing through the rolling terrain and steep-sided mesas between the Mormon Mesa and Beaver Dam Slope ACECs across the northern end of the East Mormon Mountains to cross the broad, flat expanse of the Tule Desert. The proposed ROW converges with the LCCRDA corridor in the Tule Desert. North of Tule Desert, the LCCRDA corridor climbs up to the East Pass west of the Clover Mountains Wilderness and descends into Clover Valley north of the pass.

Evidence of human modification includes numerous unimproved and two-track roads and utility infrastructure ROWs associated with electric and gas transmission lines. Public use of the landscapes in the ROI is low, consisting of limited OHV use, other dispersed recreational uses (such as hunting), grazing operations, and utility maintenance. Portions of the project area would be visible from the nearby Clover Mountains Wilderness and Mormon Mountains Wilderness. The quality of the visual resource is an important part of the recreational experience for many wilderness users. However, visitation to the wilderness areas is low. Other non-recreational users of the area, including grazing permit holders, may also be affected by changes to the visual landscape.

The LCCRDA corridor and the alternative utility corridor are located on lands managed with VRM Class IV, with some segments located in close proximity to VRM Class III lands. The nearby Clover Mountains and Mormon Mountains Wildernesses are managed with VRM Class 1 objectives.

3.11.3 Key Observation Points

Key Observation Points (KOPs) are critical viewpoints along a travel route, at a use area (or potential use area), or in communities where the view of a management activity would be most revealing. KOPs were selected for roads that provide access to or from locations outside of the project area but continue through the project area. Other selection criteria for the KOPs included those viewpoints with the largest area of unimpeded views of the project area and with the greatest potential for extended viewing times. In general, views from the roads would be from moving vehicles.

KOP 1 is located on Lower Toquop Road about 1 mile north of the road intersection with Phone Cable Road. Lower Toquop Road extends to the northwest from the LCLA parcel located in the southeast corner of Lincoln County. Phone Cable Road is located along the north boundary of the proposed Toquop Energy Project site, and provides access to the existing utility corridor that crosses northeast-southwest through the project area. The view to the west and southwest from the road is of the characteristic desert landscape with a scenic backdrop of the south end of the East Mormon Mountains. The existing electric transmission lines are within the unobstructed viewshed between about 1 to 8 miles from the KOP in the foreground to background distance zone. The steel lattice structures and wood H-frames of the existing electric transmission lines are obvious because the vertical forms and straight lines of the structures provide a strong contrast to the flat, horizontal landform of the desert landscape. The rugged East Mormon Mountains in the middle ground-background distance zone, nearly 5 miles from the KOP, provides some screening for the existing structures.

KOP 2 is on a north-south trending road that connects with several roads that cross through the Virgin River Valley and the Tule Desert, and can be accessed from Mesquite. The KOP is located at the intersection of the road with the LCCRDA corridor. The KOP provides typical views of the existing corridor as seen by motorists on an unimproved road that provides access to the Tule Desert, Mormon Mountains Wilderness to the east, and I-15 to the south. The landscape in the foreground to middle ground distance zones consists of flat to rolling desert that is backdropped by mountain ranges and hills in every direction including the Clover Mountains to the north and the East Mormon Mountains to the southwest. The landscape to the northwest consists of the northernmost low hills of the East Mormon Mountains descending to Toquop Gap, which is located about 1.5 miles northwest of the KOP. Existing human modification is limited to the existing two-track road and bladed surface roads.

The landscapes viewed from the KOPs do not contain any significant scenic vistas, features or landforms and are common to the area; however, the natural setting is an important aspect of the mountainous terrain scattered throughout southeastern Lincoln County. Because there is no significant human modification in parts of the project area, any additional modifications would change the character of the landscape. The quality of the landscape is low to moderate as seen from each KOP depending on the direction of view. Generally, high-quality landscapes are provided by the spectacular mountainous backdrop of the Mormon Mountains Wilderness to the west of the project area.

Viewer exposure (the degree to which viewers are exposed to views of the landscape) to the LCCRDA corridor and the permitted Toquop Corridor is low because public uses of the lands within the corridors are low. In addition, the corridors are isolated from views of sensitive viewing areas, such as residences, recreation sites, and major transportation routes, by both distance and the surrounding mountains.

3.12 SOCIOECONOMICS

3.12.1 Data Collection Methods

This section characterizes the existing social and economic conditions within the ROI. The ROI for the socioeconomic analysis is Lincoln and Clark Counties in Nevada and Washington County in Utah because social and economic effects occur in community and county jurisdictions rather than resource-based areas of influence. Population and labor data were obtained from various federal, state, and local sources, and are provided for communities located closest to the project area, as it is likely that some of the project construction and operation workforce would be based in the nearby communities of Caliente and Mesquite in Nevada and St. George in Utah. However, Mesquite would likely provide the bulk of the lodging for the project. Demographic data for Nevada and Utah are included to set the Proposed Action in a regional context.

3.12.2 Social Characteristics

Most of Nevada's population is located in Clark County (68.8 percent). In 2000, the population of Clark County was 1,375,765. In 2005, the estimated population was 1,710,551, a 24.3 percent increase from 2000. Of this total, 96 percent live within the Las Vegas metropolitan area (U.S. Census Bureau 2007a and 2007b). The city nearest to the southern terminus of the proposed project is Mesquite, located about 2 miles south of the Lincoln/Clark county line in northeast Clark County.

In comparison, Lincoln County's population in 2000 was 4,165. In 2005, the estimated population of Lincoln County was projected at 4,391, an increase of 5.4 percent (U.S. Census Bureau 2007c). The county's population is concentrated in one incorporated city: Caliente, with 1,015 people, and three unincorporated towns: Pioche with 698 people, Panaca with 562 people, and Alamo with 428 people (U.S. Census Bureau 2007c). Together, these four communities account for 61 percent of Lincoln County's estimated 2005 population. The remaining population is located in isolated private residential areas near the four communities mentioned above. At least part of the reason for Lincoln County's sparse population is that 98 percent of the county's land area is administered by the federal government and only 1.43 percent is owned by local government or private interests.

In 2005 4.8 percent (118,885) of Utah's population of 2,469,585 was located in the St. George Metropolitan Statistical Area (MSA; U.S. Census Bureau 2007d). The City of St. George, Utah in Washington County is 119 miles northeast of Las Vegas and 39 miles northeast of Mesquite, Nevada. The St. George MSA, with a 2005 population of 64,201, was the fastest growing MSA in the United States between 1990 and 2000. The MSA's population grew by 31.6 percent in the 5 years between 2000 and 2005. Other nearby towns in Washington County and their 2005 populations are Enterprise (1,419), Hurricane (10,989), Toquerville (1,118), and Washington (11,369) (U.S. Census Bureau 2007e).

As shown in **Table 3-26**, the Cities of Mesquite (44 percent) and North Las Vegas (53 percent) in Clark County, Nevada have seen some of the highest growth rates in the nation (U.S. Census

Bureau 2007e). At the same time, the communities of St. George (29.1 percent), Hurricane (33.2 percent), and Washington (38.8 percent) in Washington County, Utah have experienced high growth rates during recent years. In contrast, the economy of Lincoln County has historically been tied to mining and agriculture, and slow population growth rates have reflected the declines of these economic sectors. The growth rates between 2000 and 2005 of 2.2 percent for Caliente and 5.4 percent for Lincoln County were considerably lower than the growth rates for the communities in Clark County, Nevada and in Washington County, Utah.

Table 3-26 Population Trends in the ROI

Geographic Area	Population (2000)	Population (Estimated 2007)	Percent Change
State of Nevada	1,998,257	2,565,382	20.85%
State of Utah	2,233,169	2,550,063	10.6%
Clark County, NV	1,375,765	1,836,333	24.33%
Las Vegas	478,434	569,753	13.94%
North Las Vegas	115,488	190,291	52.95%
Mesquite	9,389	18,787	44.03%
Lincoln County, NV	4,165	4,759	5.43%
Caliente	1,123	1,089	2.23%
Washington County, UT	90,354	133,791	31.6%
St. George	49,728	70,951	29.1%
Enterprise	1,285	1,419	10.4%
Hurricane	8,250	10,989	33.2%
Toquerville	910	1,118	22.8%
Washington	8,186	11,369	38.8%

Source: U.S. Census Bureau 2007a, 2007b, 2007c, 2007d, and 2007e; Nevada State Demographer's Office 2006a.

The University of Nevada's Center for Economic Development prepared the Analysis of Socio-Economic Data and Trends for Lincoln County to be used for background material for a Comprehensive Economic Development Strategy (CEDS) in Lincoln County and the strategic plan for tourism in Lincoln County (UNR 2004a). According to the analysis, Lincoln County's historic dependency on the mining sector and activities at the Nevada Test Site (NTS) has resulted in unstable population growth rates between 1970 and 2002, indicating the need for economic diversification in the county.

The slow growth rate of the county population between 2000 and 2005 (5.4 percent) relative to the growth rate of 52.9 percent in North Las Vegas for the same period is attributed to declines in mining or NTS activities. The report further indicates that mining activity accounted for much of the population and economic growth in the 1970s, but declined with the shutdown of operations at the Bunker Hill Mine and a reduction of the workforce at the Tempiute Mine. Economic and population growth between the 1980s and 2005 resulted from an increase in government and service sector jobs. In addition to reductions in mining, the reduction in agriculture employment is consistent with national trends, which reflect fewer small family farms and more mechanization and larger corporate farms.

The populations of both Nevada and Utah are projected to increase dramatically during the next 20 years. The Nevada State Demographer's population projections estimate that Nevada's population will increase by nearly 79 percent between 2005 and 2025. The highest rates of growth are anticipated to occur between 2005 and 2010, as shown in **Table 3-27** and **3-28**. The

2005 population is derived from Census 2000 projections, and is not the same as the 2005 estimate provided by the US Census (Nevada State Demographer's Office 2006b and 2007). The Utah Governor's Office of Planning and Budget's population projections indicate that Utah's population will increase by 54 percent between 2005 and 2025. Like Nevada, the highest growth rates are expected between 2005 and 2010 (Utah Governor's Office of Planning & Development 2007).

The population projections are estimated from historic population trends and do not account for future probable and foreseeable developments and events. It is likely that actual population growth would be considerably larger than the population projections for Lincoln County shown in **Table 3-27** and **3-28**. Substantial population growth would result from the development of planned communities in southern Lincoln County, including the LCLA area, over the next two to three decades.

In 2000, the median age of Lincoln County residents was 38.8 years, which was higher than the 2000 median age of 35.0 in Nevada as a whole and the median age of 34.4 in Clark County. Lincoln County median age increased in 2000 from the 1990 median age of 33.4 years and the 1980 median age of 27.8. These shifts to an increased median age in the county are the result of a decrease in the proportionate share of younger age groups in the county's population.

Table 3-27 Population Projections for State of Nevada, Clark County and Lincoln County

Year	Nevada		Clark County		Lincoln County	
	Projected Population	Percent Change	Projected Population	Percent Change	Projected Population	Percent Change
2005*	2,518,869	NA	1,796,380	NA	3,886	NA
2010	3,087,428	22.57%	2,281,997	27.03%	4,754	22.34%
2015	3,605,713	16.79%	2,718,502	19.13%	5,330	12.12%
2020	4,001,520	10.98%	3,045,813	12.04%	5,694	6.83%
2025	4,315,334	7.84%	3,299,623	8.33%	5,875	3.18%

*The 2005 population is derived from Census 2000 projections, and is not the same as the 2005 estimate provided by the US Census. A percent cannot be calculated for the first year in the time series because it is the base year and there is no information to measure an increase from a previous data point.
Source: Nevada State Demographer's Office 2006b and 2007.

Table 3-28 Population Projections for State of Utah and Washington County

Year	Utah		Washington County	
	Projected Population[1]	Percent Change	Projected Population	Percent Change
2005[2]	2,469,585	NA	118,885	NA
2010	2,833,337	14.73%	162,544	36.72%
2015	3,166,498	11.76%	205,025	26.14%
2020	2,486,218	10.10%	251,896	22.86%
2025	3,790,984	8.74%	301,459	19.68%

[1] Utah Governor's Office of Planning and Development 2007
[2] U.S. Census Bureau 2007a

According to an economic development strategy analysis prepared by the University of Nevada, rural counties often lose population in age groups 20 to 24 years and 25 to 34 years because the young people with the best education, health, and the most marketable skills and abilities leave the rural areas to realize their potential in areas with greater economic opportunities.

In addition to the out-migration of young persons, increased rates of retiree in-migration in recent years has raised concerns that the growing elderly population would require greater levels of public services in a narrowing economy characterized by a shrinking revenue base.

The three counties can be further compared by reviewing the social characteristics of their respective populations in 2000 (U.S. Census Bureau 2000). The racial composition of the population of Lincoln County in 2000 was 91.5 percent White, 5.3 percent Hispanic or Latino (of any race), 1.8 percent Black or African, 1.8 percent American or Alaska Native, 0.3 Asian, 2.7 percent some other race, and 1.9 percent two or more races.

The racial composition of the population of Clark County in 2000 was 71.6 percent White, 22.0 percent Hispanic or Latino (of any race), 9.1 percent Black or African, 0.8 percent American or Alaska Native, 5.3 Asian, 8.6 percent some other race, and 4.2 percent two or more races. The racial composition of the population of Washington County, Utah in 2000 was very similar to that of Lincoln County, Nevada. The racial composition was 95.9 percent White, 6.6 percent Hispanic or Latino (of any race), 0.4 percent Black or African, 1.4 percent American or Alaska Native, 0.6 Asian, and 1.1 percent two or more races.

In terms of educational attainment, 83 percent of Lincoln County's population 25 years and older graduated from high school or higher, and 15.1 percent had attained bachelor's degrees or higher. Similarly, in Clark County, 79.5 percent of the population 25 years and older had graduated from high school or higher, and 17.3 had attained a bachelor's degree or higher. In Washington County, only 26.7 percent of the population 25 years and older graduated from high school or higher compared to 83 percent in Lincoln County and 79.5 percent in Clark County. The difference in the number of people that had attained a bachelor's degree or higher was not as large, with 13.9 percent in Washington County compared to 15.1 percent in Lincoln County and 17.3 percent in Clark County (U.S. Census Bureau 2000).

Other selected social characteristics that provide a basis for comparison of the inhabitants of the three counties include the percentage of the population that are veterans, disabled, foreign born, married, use English as the primary language at home, and homes with persons 65 years old or older (U.S. Census Bureau 2000). The percent of the population made up of civilian veterans in each of the counties was 19.6 percent in Lincoln County, 15.6 percent in Clark County, and 15.1 percent in Washington County. The disability status of the population was 24.6 percent in Lincoln County, 21.1 percent in Clark County, and 22.3 in Washington County. Eighteen percent of the Clark County population was foreign-born compared to 3.5 percent in Lincoln County and 4.1 percent in Washington County. The married population made up 52.4 percent of the population older than 15 years in Clark County, 62.6 percent in Lincoln County, and 64.9 percent in Washington County. The percent of the population that speaks a language other than English at home was 26 percent in Clark County, 6.1 percent in Lincoln County, and 7.6 percent in Washington County. Households with persons 65 years or older totaled 31.9 percent for Lincoln County compared to 21.0 percent in Clark County and 32.6 percent in Washington. In summary, Lincoln County in Nevada and Washington County in Utah generally have older populations, fewer foreign-born residents, more married couples, and a much higher percentage of population that speaks English at home than does Clark County in Nevada.

3.12.3 Economic Characteristics

The economy of Lincoln County has historically been supported by mining, agriculture, railroad operations, and federal defense research and development activities. Mining and agriculture have been the dominant economic activities in Lincoln County and continue as a source of income; however, the relative importance of agriculture and mining has decreased in recent decades. Both sectors are still important in the local economy but constitute a smaller share of employment and personal income sources. The historic economy has also been characterized by the “bust and boom” cycles of a mining economy, as shown by periods of high population growth, no population growth, and population declines.

During the latter part of the 1970s and early 1980s, mining accounted for approximately 24 percent of the employment and 32 percent of the personal income in Lincoln County. **Table 3-29** and **3-30** summarizes the labor force characteristics of the State of Nevada and Lincoln and Clark Counties, along with the State of Utah and Washington County. The table includes state labor force data to provide a regional context for the county labor force data. Unemployment rates have steadily declined between 1990 and 2005 for the State of Nevada and Clark and Lincoln Counties and have been relatively stable for the State of Utah and Washington County. The table shows a disproportionately high rate of 7.2 percent for Lincoln County in 1990, which occurred because the county economy had not recovered from the reductions in the mining sector. With the exception of the moderately high unemployment rate in Lincoln County in 1990, unemployment rates in all three counties have been very low.

Table 3-29 Labor Force Characteristics of the State of Nevada, Lincoln County and Clark County - 1990 through 2008

	Nevada			Clark County			Lincoln County		
Year	**1990**	**2000**	**2008**	**1990**	**2000**	**2008**	**1990**	**2000**	**2008**
Labor Force	655,895	1,062,845	1,375,800	407,763	727,521	979,576	1,464	1,655	1,742
Employment	622,516	1,015,221	1,297,000	387,881	693,933	923,850	1,359	1,573	1,637
Unemployment	33,380	47,624	78,800	19,882	33,588	55,726	105	82	105
Unemployment Rate	5.1	4.5	5.5	4.9	4.6	5.7	7.2	5	6.0

Source: Nevada Department of Employment, Training, and Rehabilitation 2008.

According to an economic development strategy analysis prepared by the University of Nevada, rural counties often lose population in age groups 20 to 24 years and 25 to 34 years because the young people with the best education, health, and the most marketable skills and abilities leave the rural areas to realize their potential in areas with greater economic opportunities. In addition to the out-migration of young persons, increased rates of retiree in-migration in recent years has raised concerns that the growing elderly population would require greater levels of public services in a narrowing economy characterized by a shrinking revenue base.

Table 3-30 Labor Force Characteristics of the State of Utah, Washington County - 1990 through 2008

	Utah			Washington County		
Year	**1990**	**2000**	**2008**	**1990**	**2000**	**2008**
Labor Force	820,436	1,136,036	1,382,665	19,176	39,148	64,077
Employment	784,050	1,097,915	1,336,862	17,224	35,646	61,627
Unemployment	36,386	38,121	45,803	870	2,065	2,450
Unemployment Rate	4.4	3.4	3.3	4.5	5.3	3.8

Source: Utah Department of Workforce Services 2008.

While agriculture and mining activity have decreased in Lincoln County, these industries are still important basic industries in that they bring money into the county economy through sales to non-local businesses and individuals. The county's agricultural industry produced total cash receipts of $48.5 million in 2003 (most recent available data). Typically, the manufacturing sector is also a fundamental basic industry, as the sector generally provides significant employment and income for local economies. There is currently no manufacturing sector in Lincoln County.

Table 3-31 and **Table 3-32** summarizes the number of people employed by all economic sectors in the State of Nevada and Lincoln and Clark Counties and the State of Utah and Washington County in 2005. Clark County has 90 percent and Washington County has 87.5 percent of their employment in the private sector, indicating their economies are much more service-based than Lincoln County. Federal, state, and local government employed more than 47 percent of the total employed labor force in Lincoln County. This indicates the strong dependence of the Lincoln County economy on government agencies.

Table 3-31 Employment by Industry for State of Nevada, Lincoln County and Clark County in 2005

	Nevada		Lincoln County		Clark County	
Industry	**Average Employment**	**Percent of All Industries**	**Average Employment**	**Percent of All Industries**	**Average Employment**	**Percent of All Industries**
Total, All Industries	1,215,739	100.0%	1,268	100.0%	865,987	100.0%
Total Private	1,075,042	88.4%	670	52.8%	779,689	90.0%
Agriculture	2,162	0.2%	26	2.1%	157	0.0%
Mining	10,561	0.9%	20	1.6%	378	0.0%
Utilities	5,046	0.4%	0	0.0%	3,280	0.4%
Construction	134,997	11.1%	17	1.3%	101,550	11.7%
Manufacturing	47,810	3.9%	0	0.0%	24920	2.9%
Wholesale Trade	37,411	3.1%	205	16.2%	22,157	2.6%
Retail Trade	131,913	10.9%	189	14.9%	94156	10.9%
Transportation and Warehousing	40,403	3.3%	6	0.5%	28693	3.3%
Information	14,672	1.2%	23	1.8%	10,420	1.2%
Finance and Insurance	40,182	3.3%	99	7.8%	30,048	3.5%
Real Estate and Rental and Leasing	25,038	2.1%	0	0.0%	19,375	2.2%
Prof. and Technical Services	48,291	4.0%	0	0.0%	33,582	3.9%
Company and Enterprise Mgmt.	11,881	1.0%	0	0.0%	8,589	1.0%
Administrative and Waste Services	85,449	7.0%	17	1.3%	62,833	7.3%
Educational Services	5,894	0.5%	20	1.6%	4,308	0.5%
Health Care and Social Assistance	78,328	6.4%	20	1.6%	53,230	6.1%
Arts, Entertainment, Recreation	29,190	2.4%	90	7.1%	18,135	2.1%
Accommodation and Food Services	298,321	24.5%	82	6.5%	244,525	28.2%
Other Services, Ex. Public Admin	26,506	2.2%	0	0.0%	18,725	2.2%
Unknown Industry	986	0.1%	0	0.0%	631	0.1%

Table 3-31 Employment by Industry for State of Nevada, Lincoln County and Clark County in 2005

Industry	Nevada		Lincoln County		Clark County	
	Average Employment	Percent of All Industries	Average Employment	Percent of All Industries	Average Employment	Percent of All Industries
Federal Government	16,785	1.4%	41	3.2%	11,045	1.3%
State Government	31,348	2.6%	134	10.6%	14,208	1.6%
Local Government	92,564	7.6%	424	33.4%	61,045	7.0%

Source: Nevada Department of Employment, Training, and Rehabilitation 2006

Local government employers in Lincoln County include the City of Caliente, Lincoln County government agencies, the Lincoln County School District, various County General/Special Improvement Districts, and the Grover C. Dils Medical Center. State government workers in Lincoln County are employed at the Nevada Division of Forestry's honor camp in Pioche, the Caliente Youth Training Center, the Nevada Division of Parks, and the Nevada Department of Transportation, among others. Federal agencies operating in or near Lincoln County include the U.S. Department of Energy, DOD, and the BLM.

Table 3-32 Employment by Industry for State of Utah and Washington County in 2005

Industry	Utah		Washington County	
	Average Employment	Percent of All Industries	Average Employment	Percent of All Industries
Total, All Industries	1,152,402	100.0%	47,287	100.0%
Total Private	950,086	82.4%	41,373	87.5%
Agriculture	4,406	0.4%	58	0.1%
Mining	8,473	0.7%	167	0.3%
Utilities	3,941	0.4%	81	0.2%
Construction	81,686	7.1%	7,176	15.2%
Manufacturing	117,199	10.2%	3,151	6.7%
Wholesale Trade	43,180	3.7%	1,022	2.1%
Retail Trade	135,365	11.7%	7,202	15.2%
Transportation and Warehousing	43,382	3.8%	2,648	5.6%
Information	32,106	2.8%	884	1.9%
Finance and Insurance	51,145	4.4%	1,244	2.6%
Real Estate and Rental and Leasing	16,435	1.4%	733	1.5%
Prof. and Technical Services	55,062	4.8%	1,622	3.4%
Company and Enterprise Mgmt.	20,947	1.8%	71	.2%
Administrative and Waste Services	70,694	6.1%	1,774	3.8%
Educational Services	28,640	2.5%	204	.4%
Health Care and Social Assistance	99,961	8.7%	6,132	13.0%
Arts, Entertainment, Recreation	16,422	1.4%	734	1.6%
Accommodation and Food Services	87,801	7.6%	5,135	10.9%
Other Services, Ex. Public Admin	33,241	2.9%	1,335	2.8
Unknown Industry	0	0.0%	0	0.0%
Federal Government	35,256	3.1%	480	1.0%
State Government	62,117	5.4%	1,106	2.3%
Local Government	104,943	9.1%	4,328	9.2%

Source: Utah Department of Workforce Services 2005

Many sub-sectors of the service economy in Lincoln County are proportionately small when compared with the service sub-sectors in the State of Nevada and Clark County and the State of Utah and Washington County economies, particularly accommodation and food services, real estate, professional and technical, and health care services. In contrast, employment numbers in the retail trade sectors and the arts, entertainment, and recreation services sub-sector indicate that tourism and recreation play a key role in the Lincoln County economy.

Lincoln County employment in the construction sector was less than 2 percent of total county employment, which contrasts with construction employment of more than 11 percent in Clark County and the State of Nevada, and 15.2 percent in Washington County and 7.1 percent in the State of Utah in 2005. Construction services generally are purchased primarily by local businesses and individuals. The low level of construction activity in Lincoln County relative to the nearby Clark and Washington Counties indicates that the economy in those counties continues to grow, while economic growth in Lincoln County is stagnant.

In 2005, total personal income for Lincoln County was $100 million and for Clark County was $59.8 billion. The total personal income for Nevada was $86.2 billion. Total personal income was $2.7 billion for Washington County and $68.0 billion for the State of Utah in 2005. Personal current transfer receipts include government payments to individuals for retirement and disability insurance benefits, medical payments (mainly Medicare and Medicaid), income maintenance benefits, and veteran's benefits. In Lincoln County, personal current transfer receipts accounted for 24.9 percent of total personal income compared to 10.6 percent in Clark County and 10.7 percent in the State of Nevada or Clark County, which is an indicator of a larger proportion of retirement age population in Lincoln County. Personal current transfer receipts in Washington County and for the State of Utah were 18.6 percent and 11.4 percent, respectively. This indicates that Washington County's population is much more like that of Lincoln County in terms of having a higher proportion of retirement age population than Clark County and the States of Nevada and Utah.

3.12.4 Housing

The estimated total of housing units in Lincoln County in 2005 was 2,231 units, an increase of 2.3 percent from the estimated 2,180 housing units in 2000. The growth rate in Lincoln County was small relative to the growth in housing stock in neighboring Clark and Washington Counties. The number of housing units in Clark County increased by 26.9 percent from 566,107 units in 2000 to 718,358 units in 2005, and the number of housing units in Washington County increased by 33.7 percent from 36,478 units in 2000 to 48,777 in 2005. The slow growth in Lincoln County housing units between 2000 and 2005 indicates that, despite the relatively close proximity of much of Lincoln County to the Las Vegas, Nevada and St George, Utah MSAs, there has been very little overflow of the population growth into Lincoln County. The housing stock in Lincoln County and the communities in the county constituted one of the attributes limiting potential economic development cited in the 1998 Lincoln County Overall Economic Development Plan. The narrowness of the economic base in Lincoln County is exacerbated by the lack of housing, which is one of the primary reasons identified by potential employers as a disincentive to relocate to Lincoln County (Board of Lincoln County Commissioners 1998).

There are no recent data on the availability of rental housing in Lincoln County. However, anecdotal reports indicate that vacant housing of any kind is scarce. In response to the scarce housing stock, Lincoln County has asked the BLM to process the sale of 638 acres near the Town of Alamo for the development for residential uses (Board of Lincoln County Commissioners 2005). This development is described in more detail in Section 4.20. The rental housing market is generally tight in Washington County as well.

Temporary housing in Lincoln County includes approximately 72 motel rooms at four motels in Caliente. There are also two recreational vehicle (RV) parks with 54 hookups. Mesquite, in Clark County, provides more than 2,900 rooms and suites in 11 hotel/motels and 95 hookups in two RV parks (Mesquite Area Chamber of Commerce 2007). In nearby St. George, Utah, there are more than 3,180 rooms and suites in more than 30 hotels/motels and three RV parks with an undetermined number of hookups (St. George Area Chamber of Commerce 2007).

3.12.5 County Services

Lincoln County is largely rural, with most county services located near the population centers of Alamo, Pioche, and Caliente. In Clark County, Nevada, many of the available county services are located in the greater Las Vegas area and, to a smaller extent, in outlying communities such as Mesquite. The same can be said for Washington County, Utah, where many of the available county services are located in the St. George area.

Lincoln County services and utilities are provided by a variety of general- and special-purpose districts and private corporations, which provide services such as water, sewer, and fire protection at the local level. The districts act independently of county and town boards. Lincoln County has established the Toquop Planning Area (also known as the LCLA development area, to address specific policies and fees related to the impacts to the county and benefits of these developments (Lincoln County Planning Commission 2006). Developers of the LCLA parcels would form a GID that would coordinate public services to developments within their planning area. Funds to support the GID would be provided through a property tax levy on private property within the proposed LCLA development. Fire protection services would be provided through fire/ambulance districts in startup facilities provided and staffed through contributions of the developers (Lincoln County Planning Commission 2006).

The Lincoln County Office of Emergency Management is responsible for coordinating emergency response for the entire county. Law enforcement is provided by the Lincoln County Sheriff's Department (Lincoln County Planning Commission 2006).

3.12.6 Lincoln County Master Plan

The current Lincoln County Master Plan, adopted in 2006, guides the county's growth; management of natural resources; provision of public services and facilities; and the protection of the public's health, safety, and welfare. Proposed amendments for the Master Plan were developed in 2006 to address growth pressure in the county stimulated by ongoing growth in the Las Vegas area and by proposed large-scale developments in Lincoln County. The Master Plan is implemented by its policies, which are directly linked to, and consistent with, the zoning and land division ordinances.

The Master Plan identifies goals and policies for the development of public services and utilities to serve population and housing growth in Lincoln County. The goals for public services and utilities identify the need for such services to serve projected population and housing growth while integrating these services with the existing infrastructure. Policies provide a tool for the implementation of the Master Plan goals. Goals and policies that address public services and utilities, including the provision of water for new developments, are summarized below.

GOAL LUD-3: Public services and facilities should be financed and constructed concurrently with and by new development that will use that infrastructure.

Policy LUD-3A: Lincoln County Public Utilities, in coordination with the Lincoln County Planning Commission and other county agencies, should review all new projects to ensure that new public infrastructure costs directly associated with new development are paid by the new development. Future residential growth should be coordinated with local sewer and water providers, along with electrical and natural gas providers, to ensure that there is adequate capacity.

Policy LUD-3B: Address growth corridors, such as the Coyote Spring Valley and the Toquop Planning Area (also known as the LCLA development area), to ensure that adequate public services and facilities can be provided and financed. Coordinate efforts of this Master Plan with the 1998 Lincoln County Overall Economic Development Plan (OEDP) and the 1999 Lincoln County Comprehensive Economic Development Strategy update.

3.12.7 Lincoln County Fiscal Condition

According to the 1998 Lincoln County OEDP, the county government in 1997 was supported primarily by sales and property tax revenues. Intergovernmental revenues accounted for nearly 30 percent of Lincoln County revenues and consisted of Supplemental City/County Relief Tax (SCCRT) revenue distributions. SCCRT is derived from sales in other counties and is distributed to Lincoln County by the state. The 1998 plan analysis of the 1997 budget concluded that the dependence on intergovernmental revenues by Lincoln County posed a risk to the provision of government services. The lack of significant in-county sales tax revenues was believed to be caused by economic/retail leakage and a narrow commercial/industrial economic base in the county.

The Lincoln County revenue and expenditure balances for Fiscal Years 2004 and 2005 are shown in **Table 3-33.** The 2005 budget indicates that the SCCRT revenue distribution of $1.26 million was more than 20 percent of the total 2005 revenues, a decrease of about 10 percent from the 1997 proportion; however, as in 1997, the proportion of intergovernmental resources still accounted for around 60 percent of total revenues in 2005. General fund revenues and expenditures are also presented for Clark County, Nevada and for Washington County, Utah for comparison purposes.

Table 3-33 General Fund Revenues and Expenditures for Lincoln County Fiscal Year Ending 6/30/04 and Fiscal Year Ending 6/30/05

Category	Amount		Percent of Total	
	6/30/04	6/30/05	6/30/04	6/30/05
Revenues				
Property Taxes	1,413,637	1,412,649	15.8%	23.0%
Other Taxes	176,728	37,398	2.0%	0.6%
License & Permits	13,949	11,694	0.2%	0.2%
Intergovernmental Resources	6,327,504	3,645,028	70.7%	59.2%
Charges for services	543,148	495,534	6.1%	8.1%
Fines & Forfeits	340,661	409,741	3.8%	6.7%
Miscellaneous	135,157	133,837	1.5%	2.2%
Total Revenues	**8,950,784**	**6,152,103**	**100.0%**	**100.0%**

Table 3-33 General Fund Revenues and Expenditures for Lincoln County Fiscal Year Ending 6/30/04 and Fiscal Year Ending 6/30/05				
	Amount		**Percent of Total**	
Category	**6/30/04**	**6/30/05**	**6/30/04**	**6/30/05**
Expenditures				
General Government	2,152,689	1,200,344	23.8%	17.6%
Judicial	791,809	742,175	8.7%	10.9%
Public Safety	2,354,503	1,721,225	26.0%	25.2%
Public Works	1,456,842	1,652,272	16.1%	24.2%
Sanitation	421,184	186,500	4.6%	2.7%
Health	148,338	164,633	1.6%	2.4%
Welfare	307,765	299,615	3.4%	4.4%
Culture & Recreation	365,692	128,231	4.0%	1.9%
Community Support	362,187	145,946	4.0%	2.1%
Intergovernmental Expenditures	30,487	45,033	0.3%	0.7%
Capital Projects	156,404	482,363	1.7%	7.1%
Debt Service – Principal	513,111	41,900	5.7%	0.6%
Debt Service - Interest	0	18,156	0.0%	0.3%
Total Expenditures	**9,061,011**	**6,828,393**	**100.0%**	**100.0%**
Excess of Revenues over (under) Expenditures	(110,227)	(682,512)		

Source: Nevada Department of Taxation 2006

The Clark County revenue and expenditure balances for FYs 2004 and 2005 are shown in **Table 3-34**. The 2005 budget indicates that intergovernmental revenues were $319.3 million or about 30.3 percent of the total 2005 revenues, and just slightly more than the percentage in 2004 of 29.5 percent.

The Washington County revenue and expenditure balances for FYs 2004 and 2005 are shown in **Table 3-35**. The 2005 budget indicates that just more than 60 percent of the county's revenues come from taxes, and that intergovernmental revenues accounted for approximately 20 percent of the total revenues during 2004 and 2005.

Table 3-34 General Fund Revenues and Expenditures for Clark County Fiscal Year Ending 6/30/04 and Fiscal Year Ending 6/30/05				
	Amount		**Percent of Total**	
Category	**6/30/04**	**6/30/05**	**6/30/04**	**6/30/05**
Property Taxes	213,130,117	237,128,773	22.9%	22.5%
Other Taxes				
Licenses & Permits	143,686,830	159,868,130	15.5%	15.2%
Intergovernmental Revenue				
CTX	264,091,201	313,642,515	28.4%	29.8%
Other Intergovernmental Revenue	9,934,831	5,683,762	1.1%	0.5%
Total Intergovernmental	**274,026,032**	**319,326,277**		
Charges For Services	73,146,892	88,027,159	7.9%	8.4%
Fines & Forfeits	10,153,620	12,916,684	1.1%	1.2%
Miscellaneous Revenues	8,508,057	14,936,081	0.9%	1.4%
Transfers In	206,594,236	219,794,772	22.2%	20.9%
Other Financing Sources				
Total Revenues	**929,245,784**	**1,051,997,876**	**100%**	**100%**
Beginning Fund Balance	**153,723,193**	**198,691,015**		
Total Available Resources	**1,082,968,977**	**1,250,688,891**		
General Government	108,303,991	119,894,855	12.2%	12.2%
Judicial	95,814,462	102,130,423	10.8%	10.4%
Public Safety	147,890,711	155,264,446	16.7%	15.8%

Table 3-34 General Fund Revenues and Expenditures for Clark County Fiscal Year Ending 6/30/04 and Fiscal Year Ending 6/30/05

Category	Amount		Percent of Total	
	6/30/04	6/30/05	6/30/04	6/30/05
Public Works	14,484,674	13,612,688	1.6%	1.4%
Sanitation				
Health	17,141,009	19,900,651	1.9%	2.0%
Welfare	50,819,946	59,479,322	5.7%	6.0%
Culture and Recreation	29,996,265	30,371,153	3.4%	3.1%
Community Support				
Debt Service				
Intergovernmental Expenditures				
Other General Expenditures	55,499,605	63,596,194	6.3%	6.5%
Operating Transfers Out	364,327,299	420,829,521	41.2%	42.7%
Total Expenditures	**884,277,962**	**985,079,253**	**100%**	**100%**
Ending Fund Balance	**198,691,015**	**265,609,638**		
Total	**1,082,968,977**	**1,250,688,891**		
Fund Balance as a % of Expenditure	22.5%	27.0%		
Population (as of July 1)	1,715,337	1,796,380		
Revenues Per Capita	542	586		
Expenditures Per Capita	516	548		

Source: Nevada Department of Taxation 2007
CTX – Consolidated Tax

Table 3-35 General Fund Revenues and Expenditures for Washington County Fiscal Year Ending 12/31/04 and Fiscal Year Ending 12/31/05

Category	Amount		Percent of Total	
	12/31/04	12/31/05	12/31/04	12/31/05
Revenues				
Taxes	12,511,401	14,163,924	60.4%	61.8%
License & Permits	22,520	26,180	0.1%	0.1%
Intergovernmental Resources	4,333,059	4,286,982	20.9%	18.8%
Charges for Services	1,739,126	2,184,703	8.4%	9.5%
Fines and Forfeitures	1,516,374	1,470,142	7.3%	6.4%
Interest	94,668	164,319	0.5%	0.7%
Sub-lease Revenue				
Miscellaneous Revenue	490,156	619,408	2.4%	2.7%
Total Revenues	**20,707,304**	**22,915,658**	**100.0%**	**100.0%**
Expenditures				
Current:				
General Government	6,736,075	7,182,641	35.0%	32.4%
Judicial	1,308,263	1,229,447	6.8%	5.5%
Public Safety	8,416,984	9,952,590	43.6%	44.8%
Public Works	1,743,494	2,618,745	9.1%	11.8%
Health and Sanitation	689,769	730,802	3.6%	3.3%
Conservation & Economic Development	151,891	157,119	0.8%	0.7%
Culture and Other	177,001	305,961	0.9%	1.4%
Matching Funds & Contributions	37,000	20,250	0.2%	0.1%
Capital Outlay				
Debt Service:				
Principal				
Interest				
Total Expenditures	**19,260,477**	**22,197,555**	**100.0%**	**100.0%**
Excess Revenues Over (Under) Expenditures	1,446,827	718,103		

Source: Washington County Clerk's Office 2007

3.13 ENVIRONMENTAL JUSTICE

The ROI for analysis of environmental justice is the same as that of the socioeconomic analysis: Lincoln and Clark Counties in Nevada and Washington County in Utah.

Executive Order 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations, directs federal agencies to take appropriate and necessary steps to identify and address disproportionately high adverse affects of federal projects on the health or environment of minority or low-income populations to the greatest extent practicable and permitted by law. Population and income statistics relative to the project area are described in Section 3.12 - Socioeconomics.

The project area is located in a rural, uninhabited area between the Clover Mountains on the north and the undeveloped LCLA development area to the south. There are no minority or low-income populations in the project area. The nearest population centers to the project area include the City of Mesquite south of the LCLA development area and the City of Caliente northwest of the northern reach of the project area. The project area is not located near any Tribal lands owned or used for specific cultural practices by Native Americans.

3.14 HAZARDOUS MATERIALS AND SOLID WASTES

The ROI for hazardous materials and solid wastes includes the project area and areas adjacent to the project area that are subject to disturbance by construction and operation of the Proposed Action and alternatives including transportation routes for hazardous materials.

3.14.1 Hazardous Materials

The project area is currently uninhabited, with development limited to a series of BLM and county dirt roads between the Clover Mountains and the LCLA development area, and utility infrastructure corridors along the southern end of the project area. A review of EPA and NDEP databases did not identify any uncontrolled hazardous waste sites on or near the project area (EPA 2006; NDEP 2007b).

3.14.2 Solid Waste

The Lincoln County Waste Management Plan, adopted in September 2000 and approved by the NDEP in August 2001, serves as the basis for solid waste management within Lincoln County.

In the southern part of the project area, the nearest solid waste facility is the City of Mesquite Landfill. The facility is designated as a Class I municipal landfill and is located in Lincoln County, within the northern portion of the LCLA development area. As of 2003, the landfill was averaging 81 tons of solid waste daily.

The nearest solid waste facility in the northern portion of the project area is the Crestline Landfill, located in Lincoln County near Panaca. The facility is privately owned and is currently operating as a Class II landfill. As of 2003, the landfill was averaging 23 tons of solid waste daily. In 2007, the landfill operator obtained a Class I permit (660 acre disposal area) to receive a larger volume of solid waste per day once lined disposal cells were constructed and financial assurance for closure could be demonstrated to the NDEP (NDEP 2007a).

3.15 PALEONTOLOGICAL RESOURCES

Paleontological resources (fossils) are the remains, traces, or imprints of organisms preserved in or on the Earth's crust. Examples of these resources may include fossilized corals, dinosaur bones or eggs, mammoth remains, prehistoric pack rat middens, and associated geologic deposits or formations. Fossils are important scientific and educational resources because of their use in documenting the presence and evolutionary history of particular groups of extinct organisms, reconstructing the environments in which these organisms lived, and in determining the relative ages of the strata in which they occur.

Paleontological resources are classified as non-renewable scientific resources and are protected by federal statutes. Major laws protecting paleontological resources on federal lands are FLPMA (1976), NEPA (1969), as well as various sections of Part 43 of CFR 1508.27. There is absolutely no commercial collection of fossils allowed on federal lands. Permits for non-commercial collection are issued by the BLM, primarily for vertebrate fossil specimens (animals with a backbone). Usually, no permit is required for the small-scale collection of invertebrate specimens (animals without a backbone) as long as collection is not conducted in a special use area, like a Wilderness Study Area or an ACEC.

3.15.1 Existing Conditions

The ROI for paleontological resources includes the area adjacent to the proposed ROW, nearby off-site areas subject to disturbance from the Proposed Action or alternatives, and those areas beneath new facilities that would remain inaccessible for the life of the Proposed Action. Local geological maps and literature were assessed for the potential of paleontological resources in the Clover Mountains, the Tule Desert, and areas north and west of the LCLA area. The Project Areas was not inventoried

The project area of direct effects within the Clover Mountains is located entirely within volcanic rocks associated with the Caliente caldera complex (Ekren et al. 1977). The geology of the area is dominated by rhyolitic ash-flow tuff, andesite, and basalt. Fossils do not typically occur in these formations. Along the intermediate slopes of the Clover Mountains, outcrops of pre-Cenozoic rocks of Mississippian to Triassic limestone, shale, siltstone, and sandstone are evident. These formations may contain sparse fragments of corals, gastropods, and brachiopods (Hintze and Axen 2001). No fossil sites have been documented in the ROI; however, caves formed within similar limestone formations that contain Pleistocene vertebrate remains have been documented north of the ROI in White Pine County at the Snake Creek Burial Cave site (Bell and Mead 1998).

In the vicinity of the LCLA development area north of Mesquite, Nevada, the dissected hills bordering the valley floor are composed of Miocene-Pliocene strata, a characteristic of the Muddy Creek geologic formation (Reynolds and Lindsay 1999). The Muddy Creek Formation consists of sandstone, siltstone, clay, and gypsum. Paleolontological resources have been documented in the Muddy Creek Formation outside of the project ROI towards Moapa, Nevada (Dames & Moore 1992, 1990). The environmental assessment for the Lincoln County Land Act of 2000 reported fossil bearing strata east of the proposed Toquop Energy Project site, particularly in the Badland soil series (BLM 2007b, Livingston 2001).

3.16 CULTURAL AND HISTORIC RESOURCES

The following section presents information on the existing archaeological and historic resources known in the region and expected to occur in the ROI (those watersheds and viewsheds in which the project direct impacts would occur), and the resources and properties identified in the APE.

Intensive investigation has been sparse in southeastern Nevada; however, the situation has recently changed, and the contribution of new data has led to refining the cultural history of the region. Because only a few stratified sites have been identified or excavated in the region, investigators have been forced to rely on a generalized understanding of cultural historical sequences. As such, southeastern Nevada, including Lincoln County, remains an area for continuing research.

3.16.1 Surrounding Regions

The established culture history in the region and associated research domains can be found in the Eastern Nevada, Southern Nevada, and Historic Study Units of the Archaeological Element for the Nevada Historic Preservation Plan (Lyneis 1982). Ezzo (1995) provides a revised cultural history of the Moapa and Virgin Valleys in Nevada. However, the riverine adaptation may have little relevance to the upland Mojave Desert and montane cultural ecological setting of this project. Similarly, the culture history established by Fowler et al. (1973) for the area of upper Meadow Valley Wash may not apply well to the extreme xeric environment of the Tule Desert. To the south, a sequence has been established for the northern margin of the Las Vegas Valley (Ahlstrom and Roberts 2001).

The Nevada Comprehensive Preservation Plan (1989 to present) establishes preservation themes for the historic period in Nevada, many of which are relevant to this region (for example ranching and farming, historic landscapes, the public domain, exploration and early settlements, railroads, and mining). To assess archeological and historic resources in the Ely District, a probability model developed by Drew and Ingbar (2004) was used to establish a baseline for expected site types and frequencies that may occur in the project area. The following chronological sequence descriptions are applicable to the project region and associated artifacts.

3.16.2 Paleoarchaic Period (11,500 through 7500 B.P.)

The Paleoarchaic period combines what have previously been referred to separately as the Paleoindian and Early Archaic periods. In geologic time, this combined period corresponds to the end of the Pleistocene and beginning of the Holocene epochs. Great Basin archaeologists generally distinguish two artifact traditions within the Paleoarchaic period: the Clovis (Paleoindian) tradition and the Stemmed Point tradition (Grayson 1993). Data compiled by Willig and Aikens (1988) suggest that the Clovis tradition predated the Stemmed Point tradition by several centuries.

Research conducted by Jones et al. (2003) suggests that Paleoarchaic foragers living in the Great Basin obtained obsidian toolstone within "conveyance zones" that, in some cases, measured more than 300 miles long by 100 miles wide (one of these obsidian conveyance zones includes the Panaca Summit obsidian source, approximately 25 miles north of the project area). There appears to have been little overlap between these zones, suggesting that they correspond to regions within which particular social groups moved to obtain needed resources rather than areas within which toolstone was exchanged. In other words, the data suggest a high degree of mobility among individual groups of Paleoarchaic foragers. This conclusion supports the casting of a wide net in identifying existing data on the Paleoarchaic that might be relevant to the cultural history of the project area.

3.16.3 Middle Archaic Period (7500 through 5000 B.P.) and Late Archaic Period (5000 through 1650 B.P.)

The Archaic Tradition is characterized by a broad-spectrum adaptation to the faunal and floral resources of a Holocene environment that resembled the Great Basin's historic and modern-day environment. Climate may have been substantially hotter and drier during the Middle Archaic period than at present. Characteristic artifacts of the Middle and Late Archaic periods include large projectile points (that is, relative to later arrow points) that would have been hafted to darts that were propelled with atlatls. Grinding tools appear to be an important part of tool assemblages dating to the Middle Archaic, and they are common in Late Archaic assemblages. These tools imply a greater reliance on hard-seed foods than during the Paleoarchaic period.

The Middle Archaic has also been called the "Pinto period" in reference to the Pinto point, and the Late Archaic has been called the "Gypsum period" in reference to the Gypsum point (Warren and Crabtree 1986). This usage reflects the fact that both Pinto and Gypsum points have been considered by archaeologists as useful Archaic temporal markers.

3.16.4 Late Prehistoric Period (1650 through 200 B.P.)

The post-AD 300 portion of the Prehistoric period has been referred to as the Late Prehistoric period (Buck et al. 1998), the Late Archaic period (Zeanah et al. 2004), and the Saratoga Springs and Shoshonean periods (Warren and Crabtree 1986). The Late Prehistoric period began with the adoption of the bow and arrow, either as a replacement for or alternative to the atlatl and dart. Based on arrow point styles, it is possible to divide the Late Prehistoric period into early and late (pre- and post-AD 1200/1300) sub-periods (Warren and Crabtree 1986). The break between these two periods is equivalent to that between Warren and Crabtree's (1986) Saratoga Springs and Shoshonean periods. The early period is characterized by corner-notched (Rose Spring and Eastgate) points, and the later period by side-notched (Desert Side-notched) points.

Fremont habitation sites and population centers have been identified in Utah in the Snake Valley, located approximately 100 miles north of the project area, and in the Parowan Valley, located some 80 miles northeast of the project area. Settlements in the Parowan Valley that post-date AD 900 incorporate pithouses and coursed adobe storage structures. Ceramics consist primarily of sand-tempered Snake Valley Grayware (Marwitt 1986). The Fremont was originally considered to be a minor, remote branch of the Anasazi culture; however, they are now considered to be a distinct and unique prehistoric culture. "Fremont" is actually a broad term used to describe scattered groups of hunters and farmers and is rather difficult to classify. There is not a clearly defined Fremont lifestyle because some were settled farmers, some were nomads, and others shifted between these lifestyles, either seasonally or over the course of a lifetime. Between AD 1250 and 1500, the Fremont culture vanished, and the exact reasons for this disappearance are not known. There are several possible factors that may have brought about this change including climatic change or displacement by migrating tribes (Madsen 1989). The project area lies just outside the southwestern edge of the area mapped by Madsen and Simms (1998) as representing the maximum extent of the "Fremont Complex." Whereas areas of Fremont occupation are located to the north and east of the project area, a major population center of the Virgin Branch prehistoric Puebloans is located just south of the project area. That center lies in the combined Moapa and Virgin River Valleys of southeastern Nevada.

The project area, particularly its southern portion, would have been well within the range of task groups sent out from settlements in the Moapa and Virgin River Valleys to collect wild resources. Analogous interpretations may apply to two sites, 42Ws2525 and 42Ws1459 (the Springhead site), that are located approximately 20 miles northeast of the project area, between the Beaver Dam Mountains to the south and the Bull Creek Mountains to the north.

The project area is located within Southern Paiute territory; specifically, the territory occupied by the Panaca and Pahranagat sub-groups (Kelly and Fowler 1986). The Southern Paiute practiced a hunting-and-gathering way of life, supplemented to varying degrees from sub-area to sub-area by farming. Local wild subsistence resources procured by the combined Panaca and Pahranagat sub-areas included mountain sheep, antelope, deer, piñon, chuckwalla, and mescal (along the southern edge of the two sub-areas).

3.16.5 Historical Period (AD 1800s – 1950s)

Historical accounts (Holt 1992) suggest that, rather than hunting and gathering, farming was the traditional subsistence focus of the Southern Paiutes prior to the arrival of the Spaniards and other Euroamericans in southern Nevada (Roberts 2000).

Although the Spanish entered the Southwest beginning in the 1540s, sustained contacts did not begin until a century later when the Spanish began to establish permanent missions and settlements in their northern frontiers.

Euroamericans passed through southern Nevada during the first half of the nineteenth century but did not settle there. Many explorers, like Jedediah Smith (in 1826), Antonio Armijo (in 1829), and John C. Frémont (in 1844), used the Virgin River Valley south of the project area as a travel corridor (Sterner and Ezzo 1996).

During the late 1850s, Mormon settlements displaced Southern Paiutes from their traditional agricultural and gathering lands, which then became further depleted by livestock grazing and other ranching and farming activities (Kelly and Fowler 1986). Interaction with Mormons increased to the point that, by the 1870s, most Southern Paiutes had direct contact with Euroamericans and some Paiute groups formed settlements near Mormon towns (Kelly and Fowler 1986).

During the early 1860s, there was a mining boom in the area of Pioche and Panaca. This mining boom started in the fall of 1863 when William Hamblin, one of Brigham Young's missionaries, was shown the location of a source of silver ore by local Indians. However, none of these ore sources occur within the project area.

Due to the region's remote location, transportation of people, supplies, and equipment was a difficult task that included traveling on the Central Pacific Railroad (completed in 1869) to Elko, Nevada, and then by wagon south for more than 270 miles to the Pioche-Panaca region. A branch of the Southern Pacific, Los Angeles, and Salt Lake railroad line was also constructed west of the project area through Meadow Valley in late 1907 (Myrick 1962).

In the mid-nineteenth century, a small logging venture was established in the Clover Mountains away from the main transcontinental transportation corridors. The sawmill supplied lumber and structural timbers to the 1860s to 1870s mining camps in the Pahranagat and Meadow Valley Districts. Bridge timbers and railroad ties were also produced at the sawmill until the early twentieth century.

As a consequence of World War II, there was a need for mineral resources that increased the productivity of the mines and railroads of the region. Mine production waned after the war, and by 1957, the decline of metal prices forced many mines in the region to close.

Ranching and sheep herding likely played an important historic role in the Clover Mountains and the Tule Desert. Several BLM reseeding projects were conducted in 1949 and 1950 in an effort to improve rangeland in the mountains. Hundreds of acres in the Sheep Flats area were cleared of native vegetation and reseeded with crested wheat grass (BLM Clover Mountain Reseeding project number 12-0-198). Activities and features associated with ranching are clearly present in the Tule Desert today, and it is likely that the Tule Desert was a winter range for cattle during the late Historic period, as it is today. Evidence of historic/contemporary sheep herding can be found at the Sheep Springs area in the Clover Mountains, where several corrals and associated water features (e.g., tanks) were constructed.

3.16.6 Region of Influence

There has been little previous inventory and evaluation in the archaeological and historic resources ROI for the project. The BLM is adopting a watershed-based approach for assessing known archaeological resources and historic properties within their management areas (BLM 2007b). Preliminary data from assessments currently underway in the Ely District were used in this analysis.

Two relevant technical reports were prepared for the Ely RMP to assess archaeological resources and historic properties. Drews and Ingbar (2004) prepared a probability model for the occurrence of archaeological resources and historic properties on a watershed basis. This model provides a baseline for establishing expected occurrence of types and frequencies of sites on a watershed basis that needs to be tested by field investigations for any given project. The second relevant technical report completed for the Ely RMP conducts a comprehensive review of American Indian ethnohistoric sites (including informant interviews) and evaluates them under the criteria for qualification to the NRHP as Traditional Cultural Properties (Woods 2003).

The Draft Ely RMP establishes 13 categories of archaeological resources and historic properties (site types) and associated research domains and management direction (BLM 2005). **Table 3-36** lists the site types and evidence that the site type occurs in the project ROI.

Table 3-36 Archaeological and Historic Resources Expected in the ROI

Parameter	Expected in ROI	Not Expected in ROI
Historic roads, trails, railways, highways, and associated sidings and stations	Historic roads and trails from GLOs	Railroad adjacent in Meadow Valley Wash
Rock art sites	Talus slopes, outcrops, or passes, such as East Pass or Toquop Pass	
Historic townsites, mining camps, mining districts, buildings and standing structures, and racetracks - fairgrounds		No historic mining prospects are documented
Cemeteries and isolated gravesites		No cemeteries or graves are documented
Ethnic arboreal narratives, graphics, and bow stave trees	The margins or uplands of the watershed may contain these resources	
Paleoindian sites	Associated with springs	
Archaic	Associated with springs and opportunistic hunting and gathering topographic features, such as Sheep Springs and Sheep Flats	
Prehistoric complex sites, campsites, or specialized activity areas	Associated with perennial water sources	
Rockshelters and cave sites	In the margins or upland portions of the watersheds	
Toolstone sources or quarries	Modena and Kane Springs obsidian toolstone sources	
Ranching and livestock related historic sites, buildings, standing structures, and landscapes	Facilities associated with historic water right applications and facilities (spring developments, water pipelines, corrals, and fences) such as Sheep Springs	
Ethnohistoric sites, sacred sites, traditional use areas, traditional cultural properties		Not identified in American Indian RMP Technical Report (Woods 2003) or American Indian coordination for this project
Other (agave roasting pits, intaglios, geoglyphs, antelope walls, historic debris scatters, non-mining and non-ranching features)	Geoglyphs on watershed margins with commanding views of landscape	

ROI – Region of Influence GLO – General Land Office

3.16.7 Area of Project Direct and Indirect Effects

The literature review for the project area was completed in July 2006. Twenty-nine prehistoric and historic-era sites (25 prehistoric and three historic) were identified. Three of these sites extend into the APE (Jolly 2006).

A Class III inventory was conducted within the 300-foot APE (2,611 acres) in November 2006 and February 2007 (Harper et al. 2008). The inventory resulted in the documentation of 23 sites, (two prehistoric and historic and 21 prehistoric) that were considered eligible, and 17 prehistoric sites considered ineligible, for the NRHP pending a determination by the BLM and the Nevada SHPO. In addition, 129 isolated artifacts were documented. Three of the 40 sites documented in the APE during the Class III inventory were previously recorded sites. These sites were re-evaluated for eligibility to the NRHP.

The survey also documented three NRHP eligible properties, two NRHP non-eligible properties (pending determination by the BLM and the Nevada SHPO), and 12 isolated occurrences near the APE. Additional Class III inventories will be completed in the Sheep Flat area in the Clover Mountains. Data obtained from these inventories will be incorporated into the Final EIS.

In addition to cultural resources identified during the Class III inventory, properties of concern to Native American Tribes will be incorporated into the Final EIS if they are identified as a result of ongoing consultation with interested Tribes (**Section 5.2**).