Lake Powell Pipeline Project

Final Study Report 12
Special Status Plant Species and Noxious Weeds

April 2016

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Special Status Plant Species and Noxious Weeds Study Report
Executive Summary

ES.1 Introduction

This study report describes the results and findings of an analysis to evaluate special status plant species and assess noxious and invasive weeds along the proposed alternative alignments of the Lake Powell Pipeline (LPP) Project, No Lake Powell Water Alternative, and No Action Alternative. The purpose of the analysis, as defined in the 2008 Special Status Plant Species and Noxious Weed Assessment Study Plan prepared for the Federal Energy Regulatory Commission (Commission), is to investigate the occurrence of special status species at locations where they could be affected by project construction, operation, and maintenance activities. Impacts on special status plants caused by indirect or secondary effects from urban development in the St. George metropolitan area are identified based on existing data and assessed to the extent that such development is related to growth made possible by the proposed project.

Special-status plant species include federally listed threatened and endangered species, proposed species, and candidate species under the Endangered Species Act; Bureau of Land Management (BLM) sensitive species; National Park Service (NPS) species of concern; state protected species; Natural Heritage Program watch-list species; and tribal designated species of concern. The plants of cultural concern identified by the Kaibab Band of Paiute Indians include only those species of particular importance and interest to the Kaibab Band of Paiute Indians that are not ubiquitous or abundant. Other plant species of cultural interest may be addressed as part of the vegetation community mapping study or other means as determined in coordination with the Kaibab Band of Paiute Indians. Special status plant species surveys provide baseline information about existing conditions as well as detailed distribution and abundance information on each special status plant species within the proposed project corridor and are used in the effects analyses and identification of potential protection and conservation measures, and to coordinate management activities with various land and resource management agencies. The study report includes a plan to address conservation measures and concepts, standard construction procedures, standard operating procedures, and best management practices that would be used during project construction and operation to protect and conserve listed plant species.

A noxious weed is any plant designated by a federal, state, or county government as injurious to public health, agriculture, recreation, wildlife, or property. The noxious weed and invasive non-native plant study was intended to collect information about weed type, abundance, and general distribution, as well as to evaluate factors that lead to weed invasion, persistence, and spread. The results of field surveys are used as the basis for developing a weed management plan for the project. The study results also are used to identify whether project operation affects weed occurrence on NPS, BLM, or Kaibab-Paiute Indian Reservation, and if so, to coordinate management activities with those entities.

ES.2 Study Area

The study area includes approximately 195 miles of proposed and alternative routes for buried water pipelines and approximately 76 miles of proposed and alternative routes for transmission lines. Land ownership and management throughout most of the study area is federal, state and tribal land, with some private land interspersed between public land parcels. Two main ecological regions—the Colorado Plateau and Mojave Desert—are represented within the project study area. Climatic factors including temperature and precipitation influence germination and phenology of plant species and therefore affect the availability of individual plant species observed in the field. The study area corridors were established based on the pipeline or transmission center line, extending 150 feet on either side for a 300-foot-wide total width, or for areas with greater potential for special plant resources, 300 feet on either side of the center line for a 600-foot-wide total study area corridor. Generally, the 300-foot-wide corridors occurred between Lake Powell and the Cockscomb geological feature, and west of the Hurricane Cliffs. All other linear elements had a 600-foot-wide survey corridor, determined by the presence of soils containing certain minerals influencing the special status plant species growing in those soils.

ES.3 Methodology

Pre-survey preparations for special status species and noxious weed surveys began with the development of a set of project area maps. Pipeline alternatives and alignments were overlaid on aerial and topographic maps using Geographic Information System (GIS) software (ArcGIS 9.2 and 9.3). Aerial maps with a 1:2,500 scale were produced for field use with sufficient scale and clarity to map landscape and vegetative features. Topographic maps from 1:24,000 scale digital raster graphics (DRG) were produced to show elevations, natural features, and cultural features. Reconnaissance-grade geologic mapping was overlaid onto the DRGs from state digital geology maps.

GIS software was used to load the survey area onto Trimble, Juno, and Garmin Global Positioning System (GPS) units, to track surveyor locations while in the field. A data dictionary (electronic data collection template) was created to record pertinent information about special status plant species and noxious weeds identified during the field survey. The data fields within the data dictionary included a sampling unit code (unique identifying number for each plant or grouping of plants); a list of the 14 special status species and 20 noxious weed species most likely to be encountered; and a comment field. The data dictionary was loaded on the Trimble and Juno GPS units. Additional maps including gazetteers and atlases, BLM maps, State of Utah and Arizona maps, and real-time navigation mapping software were utilized to determine access points to the pipeline corridor.

A combination of pedestrian surveys and binocular surveys were performed within the 300-foot wide and 600-foot wide corridors generally centered on the pipeline and transmission line alignments from April through mid-September 2009 and from mid-April through July 2010. Pedestrian surveys were also performed on 50-meter transects systematically placed along the pipeline and transmission line alignments to obtain quantitative plant density data. Transect locations were stratified to cover a wide variety of vegetation communities and geographical locations. Data collected from these transects provided a way to check vegetation associations and alliance and ecological system classifications; quantify noxious and invasive plant densities; and to complement the special status species density data collected during previous field surveys. The 50-meter transects also provided plant cover data used to quantify reconnaissance vegetation classifications along the 300-foot-wide corridor, for areas where field surveys were not conducted.

Various approaches were utilized to capture counts for special status species and noxious weeds. When relatively small numbers of special status species or noxious weeds were encountered, data were collected as single-plant entries. Where localized concentrations of special status species or noxious weeds were encountered, a plant cluster entry approach was utilized. When a large population of a special status species was encountered, a tally approach was utilized.

GPS data collected for the special status species and noxious weeds observed within the LPP study area corridors were mapped using GIS software to show the distribution of each species. The soil type, geological formation, and vegetation communities were overlaid using ArcMap software to aid in identifying patterns or trends in the species' habitat requirements. Characteristics such as soil type, geologic formation, and vegetation community type were used individually or jointly to identify special status species and noxious weed habitats, predict where the plants may occur within private or nonintensively surveyed portions of the corridors, or explain why they were not observed within the project area. Special status species and noxious weed data were analyzed in combination with collected vegetation community field mapping data to identify relationships with ecological systems, plant community alliances, and plant community associations.

ES.4 Special Status Plant Species Results

Fifty-one special status plant species and 72 plants of cultural concern identified by the Kaibab Band of Paiute Indians were targeted in the field surveys. Natural history, survey results and discussion is provided for each targeted special status plant species. Of the 51 special status plant species for which surveys were performed, 7 species were observed and documented, with detailed information provided including location (maps), land ownership and quantity of plants recorded. Thirteen species on the Kaibab Band of Paiute Indians' list of Plants of Cultural Concern were detected during the special status plant and noxious weed surveys. The distribution of

special status species is analyzed according to the vegetation communities in which they occur. The two ecological regions represented within the survey area are Colorado Plateau and Mojave Desert. The ecological regions are further differentiated into ecological systems, which represent recurring groups of biological communities that are found in similar physical environments and are influenced by similar dynamic ecological processes, such as fire or flooding. The next level of vegetation classification within ecological system is alliance. An alliance is a group of plant associations sharing the same growth form and one or more dominant or diagnostic species which, as a rule, are found in the uppermost strata of the vegetation. The association is the finest level of the vegetation community classification hierarchy, and is the basic unit for vegetation classification in North America. An association is a plant community type of definite floristic composition, uniform habitat conditions, and uniform physiognomy.

ES.5 Noxious Weed and Invasive Species Assessment Results

The noxious weed and invasive species assessment surveys confirmed the presence of 16 species within the LPP Project study area. The noxious weeds and invasive species found varied greatly in their distribution within the ecological systems occurring in the LPP Project study area. Three of the 15 Colorado Plateau Region ecological systems contained 13 of the 16 weed species. Two of the 12 Mojave Desert Region ecological systems contained seven of the 16 weed species.

Anthropogenic land areas (affected by human activities) contained neither natural nor semi-natural plant communities. The largest number of noxious and invasive weed species was found in Invasive Upland vegetation communities (14), Agricultural Land (13), Ruderal Vegetation (13), Developed Roads (9), and Developed Lands (9). The greatest concentrations of noxious weeds and invasive species were found along highways and roads and close to population centers.

Noxious weeds and invasive species were found in association with special status plant species. Four weed species occurred as co-dominant species in two plant community associations supporting a special status plant species. The remaining 12 weed species did not occur in sufficient abundance to be considered a dominant member of any vegetation communities supporting special status plant species.

ES.6 Best Management Practices and Effects Analysis

Best Management Practices (BMPs) are identified for implementation during LPP Project construction to minimize effects on special status plant species and to minimize impacts of noxious and invasive weed species. Several categories of BMPs are identified, including: general BMPs applicable to species and habitat protection for the overall project; restoration and rehabilitation BMPs to provide restoration of native species and habitat conditions in ecosystems that have been invaded; riparian corridor, wetland and aquatic habitat BMPs to minimize effects on these areas; special status plant species BMPs to minimize effects on individual plants, groups of plants and their habitats; and noxious and invasive plants BMPs to prevent dispersal, movement and growth.

The highest potential for adverse effects on the highest number of special status plants would occur under the Hydro System Existing Highway Alignment Alternative along Arizona State Highway 389, where three species of special status plants would be affected by the pipeline construction.

Noxious and invasive weed species occur along the entire LPP Project and alternative alignments, especially along highways and around areas of human activity. The disturbance associated with construction activity can lead to weed invasion, persistence, and spread. When the natural ecosystem is disrupted, exotic species, removed from their native ecosystems and un-checked by their natural predators, can invade. A variety of natural adaptations also enable weed species to invade new areas. The production of massive quantities of seed and/or seed that remains viable for long periods of time provides a competitive advantage for weed species. Seed that is dispersed by wind or water mechanisms can spread rapidly, facilitating the invasion of weeds into new areas. Some invasive species have seeds which are specially adapted to transport via humans and/or animals, having

features such as hooked spines. Extensive root systems enable some weedy species to compete with native species for nutrients and space. Some invasive plants also excrete compounds that inhibit the growth of other species.

Chapter 1
Introduction

1.1 Introduction

This chapter presents a summary description of the Lake Powell Pipeline (LPP) Project alignment alternatives, the No Lake Powell Water Alternative, and the No Action Alternative. It introduces the area studied for environmental resources. It provides an overview of the proposed LPP Project, including each alignment alternative and locator maps.

The LPP Project would deliver Utah's Colorado River water from Lake Powell to the service areas of Washington County Water Conservancy District (WCWCD) and Kane County Water Conservancy District (KCWCD). The LPP Project action alternatives studied include various pipeline and penstock system configurations. Each action alternative would deliver 86,249 acre-feet of municipal and industrial (M&I) use water to the following southwest Utah water conservancy district service areas:

- WCWCD would receive 82,249 acre-feet annually.
- KCWCD would receive up to 4,000 acre-feet annually.

One of the LPP systems previously studied included a conveyance system for the Central Iron County Water Conservancy District (CICWCD), which would have delivered approximately 13,249 acre-feet annually to the Cedar Valley area. The various alternatives were under study when the CICWCD decided to withdraw from the LPP Project, and this conveyance system is no longer being considered.

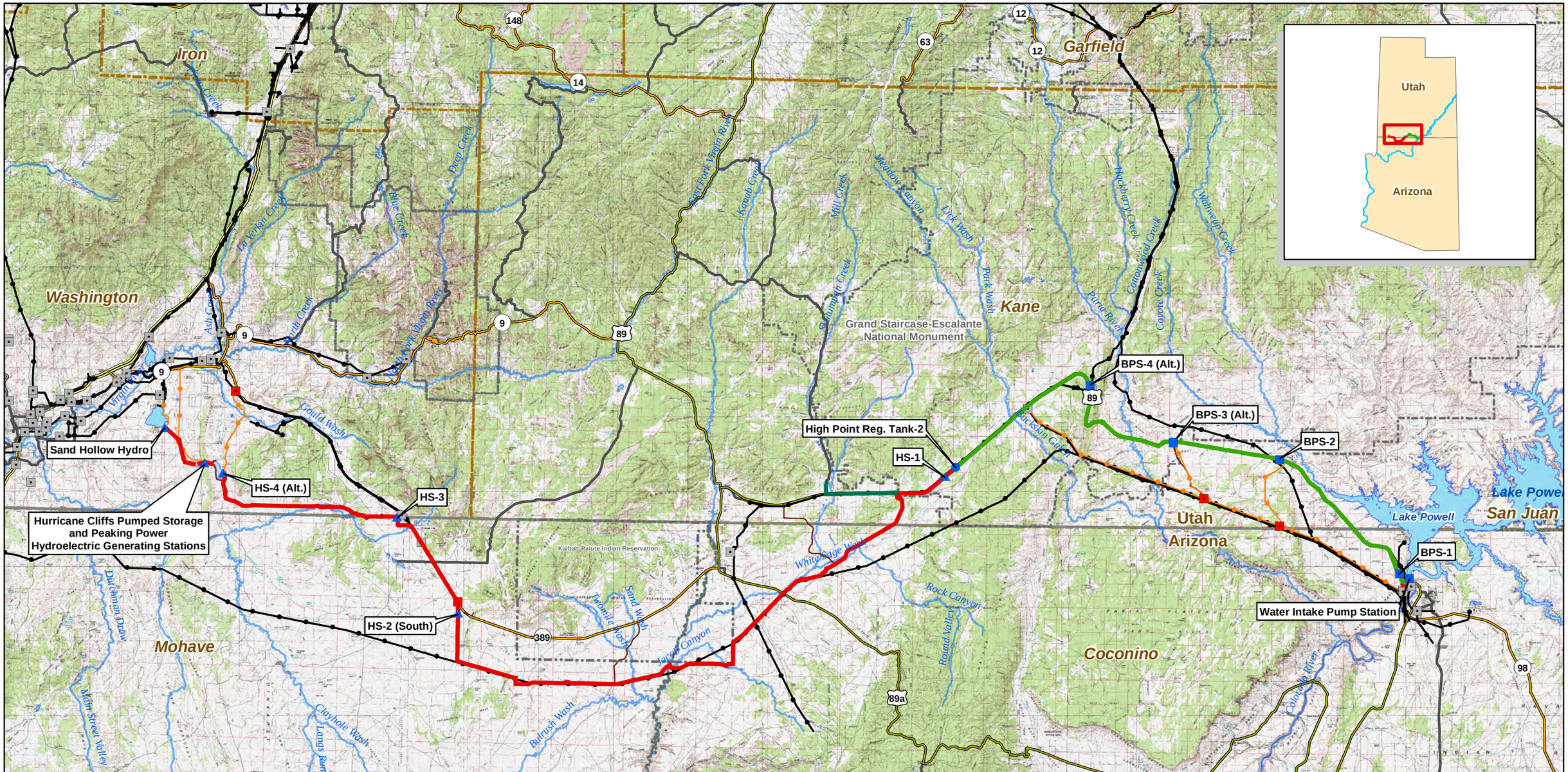
1.2 Summary Description of LPP Project Alignment Alternatives

Three primary pipeline and penstock alignment alternatives are described in this section, along with the electrical power transmission line alignments for providing power to the pump stations and a natural gas supply line alignment alternative. The pipeline and penstock alignment alternatives share common segments between the intake at Lake Powell and delivery at Sand Hollow Reservoir, and they differ spatially in, through and around Kaibab-Paiute Indian Reservation.

The South Alternative (Proposed Action) extends south around Kaibab-Paiute Indian Reservation. The Existing Highway Alternative follows an Arizona state highway through Kaibab-Paiute Indian Reservation. The Southeast Corner Alternative follows the Navajo-McCullough Transmission Line corridor through the southeast corner of Kaibab-Paiute Indian Reservation. The Electric Transmission Line alignments are common to all the pipeline and penstock alignment alternatives. The Natural Gas Supply Line Alignment Alternative is common to all pipeline and penstock alignment alternatives. The natural gas pipeline alignment would be coincident to the buried waterline and would not have a different alignment, as compared to transmission line alignments. Figure 1-1 shows the overall proposed project from Lake Powell near Page, Arizona to Sand Hollow Reservoir, Utah.

1.2.1 South Alternative

The South Alternative consists of four systems: **Water Intake, Water Conveyance, Hydro,** and **KCWCD** (see Figure 1-1).



Project Pump Station
Project Regulating Tank
Project Hydro Station
Substation
Proposed Substation

Water Conveyance System
Hydro System - South Alternative (Penstock Segment)
KCWCD System
Project Transmission Lines
Existing Transmission Lines

Interstate
US Highway
ST Highway
Hwy
Major Road
Access Roads

Hurricane Cliffs Forebay/Afterbay
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Major Rivers & Streams

National Park/Monument
GSENM-Boundary
Tribal Lands
State Boundaries
County Boundaries

FERC Project Number:
12966-001
BLM Serial Numbers:
AZA-34941
UTU-85472

N

0 2.5 5 10 15 20 Miles

Lake Powell Pipeline Project

Spatial Reference: UTM Zone 12N, NAD-83

UDWRe **Figure 1-1** MWH

Lake Powell Pipeline Proposed Action

The **Water Intake System** would pump Lake Powell water via submerged horizontal tunnels and vertical shafts into the LPP. The intake pump station would be constructed and operated adjacent to the west side of Lake Powell, approximately 2,000 feet northwest of Glen Canyon Dam in Coconino County, Arizona. An enclosed pump station building would house vertical turbine pumps with electric motors, electrical controls, and other equipment at a ground level elevation of 3,745 feet above mean sea level (AMSL).

The **Water Conveyance System** would convey water diverted from Lake Powell at the Intake System through a buried 69-inch diameter pipeline for about 51 miles, parallel with Highway 89 in Coconino County, Arizona and Kane County, Utah, to a buried regulating tank (High Point Regulating Tank-2) along Highway 89 at ground level elevation 5,691 feet AMSL. The pipeline would be a line of connected pipes used for carrying water over a long distance. Figure 1-2 shows the LPP Project Water Intake and Water Conveyance systems. The High Point Regulating Tank-2 would be the LPP Project topographic high point (Figure 1-2). The pipeline would be sited within a utility corridor established by Congress in 1998 that extends 500 feet south and 240 feet north of the Highway 89 centerline on public land administered by Bureau of Land Management (BLM) (U.S. Congress 1998). Figure 1-3 shows the typical 100-foot-wide right-of-way and 20-foot-wide temporary construction easement for the water conveyance system pipeline, adjacent to and away from the highway.

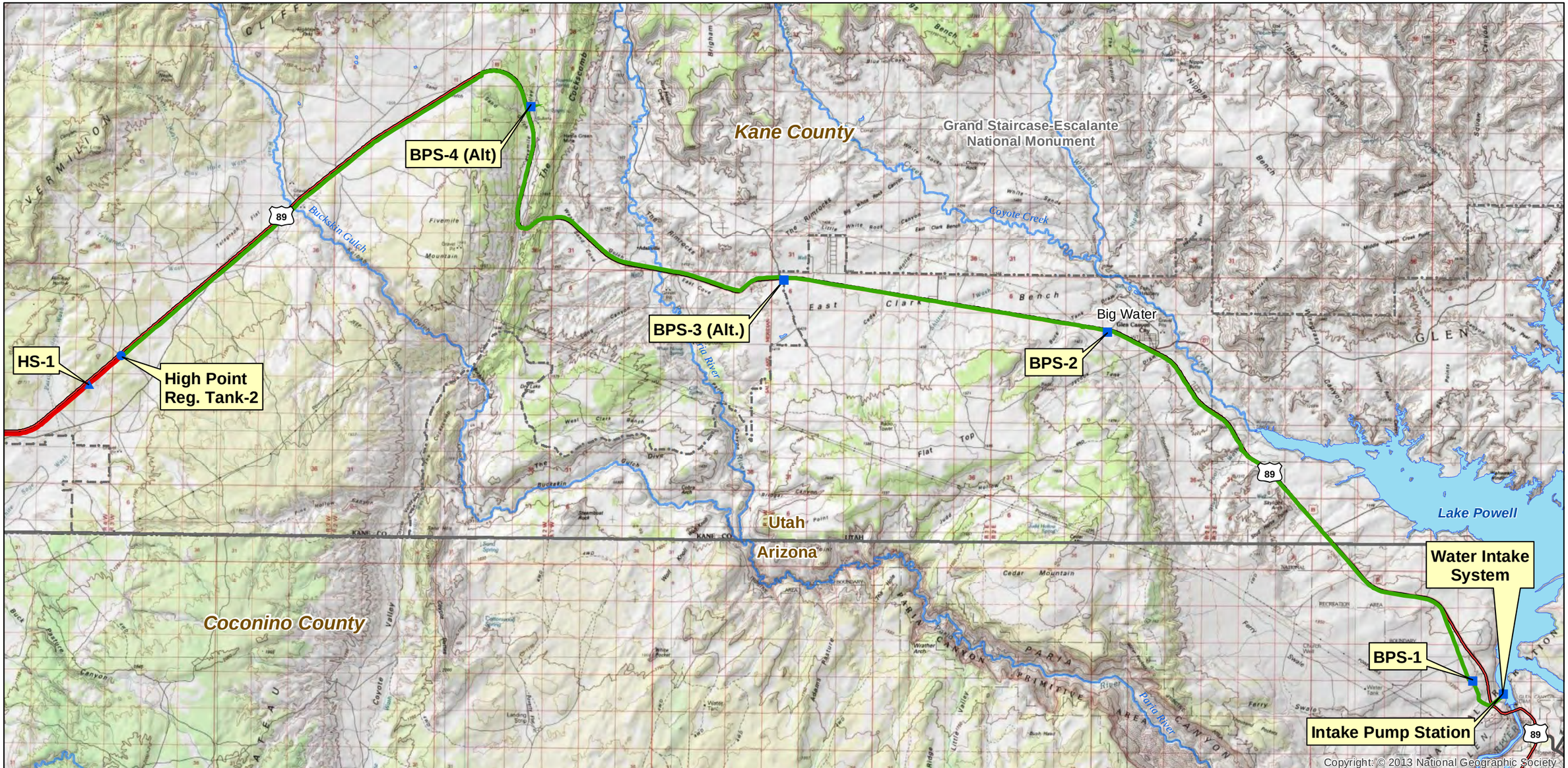
Four booster pump stations (BPS) along the pipeline would pump water to the high point regulating tank. Each BPS would house vertical turbine pumps with electric motors, electrical controls, and other equipment. Additionally, each BPS site would have a buried forebay tank, buried surge tanks, pig retrieval and launching stations, and a surface emergency overflow detention basin. BPS-1 would be located within Glen Canyon National Recreation Area (GCNRA) adjacent to an existing Arizona Department of Transportation maintenance facility, along a segment of abandoned highway, west of Highway 89. The BPS-1 site would cover about six acres and be surrounded by security fencing.

BPS-2 would be on land administered by Utah School and Institutional Trust Lands Administration (SITLA) near Big Water, Utah, on the south side of Highway 89. The BPS-2 site would cover about five acres and be surrounded by security fencing.

BPS-3 (Alt.) would be on land administered by BLM Kanab Field Office, near the east boundary of Grand Staircase-Escalante National Monument (GSENM) on the south side of Highway 89, within the Congressionally-designated utility corridor. The BPS-3 (Alt.) site would cover about five acres and be surrounded by security fencing.

BPS-4 (Alt.) would be located on private land east of Highway 89 and west of the Cockscomb geologic feature (Figure 1-2). The BPS-4 (Alt.) site would cover about six acres and be surrounded by security fencing. The proposed pipeline alignment west of the Cockscomb geologic feature would be situated adjacent to the south boundary of the Congressionally-designated utility corridor.

The proposed pipeline alignment would continue parallel to Highway 89 to the buried High Point Regulating Tank-2 at 5,691 feet AMSL, which would be the topographic high point of the LPP Project (Figure 1-2). The Water Conveyance System would terminate at High Point Regulating Tank-2. The buried High Point Regulating Tank-2 would cover about four acres and be surrounded by security fencing.



- Project Pump Station
- Project Regulating Tank
- Project Hydro Station
- Water Conveyance System
- Hydro System - South Alternative (Penstock Segment)
- KCWCD System
- Interstate
- US Highway
- ST Highway
- Hwy
- Major Road
- Lakes & Reservoirs
- Major Rivers & Streams
- National Park/Monument
- GSENM Boundary
- State Boundaries

FERC Project Number: 12966-001
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N

0 0.5 1 2 3 4 Miles

Lake Powell Pipeline Project

Spatial Reference: UTM Zone 12N, NAD-83

UDWRe **Figure 1-2** MWH

Lake Powell Pipeline Intake and Water Conveyance System

Figure 1-3 shows the typical 100-foot-wide right-of-way and 20-foot-wide temporary construction easement for the hydro system penstock adjacent to, and away from, the highway. Four in-line hydro generating stations (HS-1, HS-2 [South], HS-3, and HS-4 [Alt.]), with substations located along the penstock, would generate electricity and help control water pressure in the penstock. Each in-line hydro station would consist of a building housing the generator units, an afterbay reservoir, retention basin, pig retrieval and launching stations, switchyard, and maintenance parking area, all surrounded by perimeter security fencing.

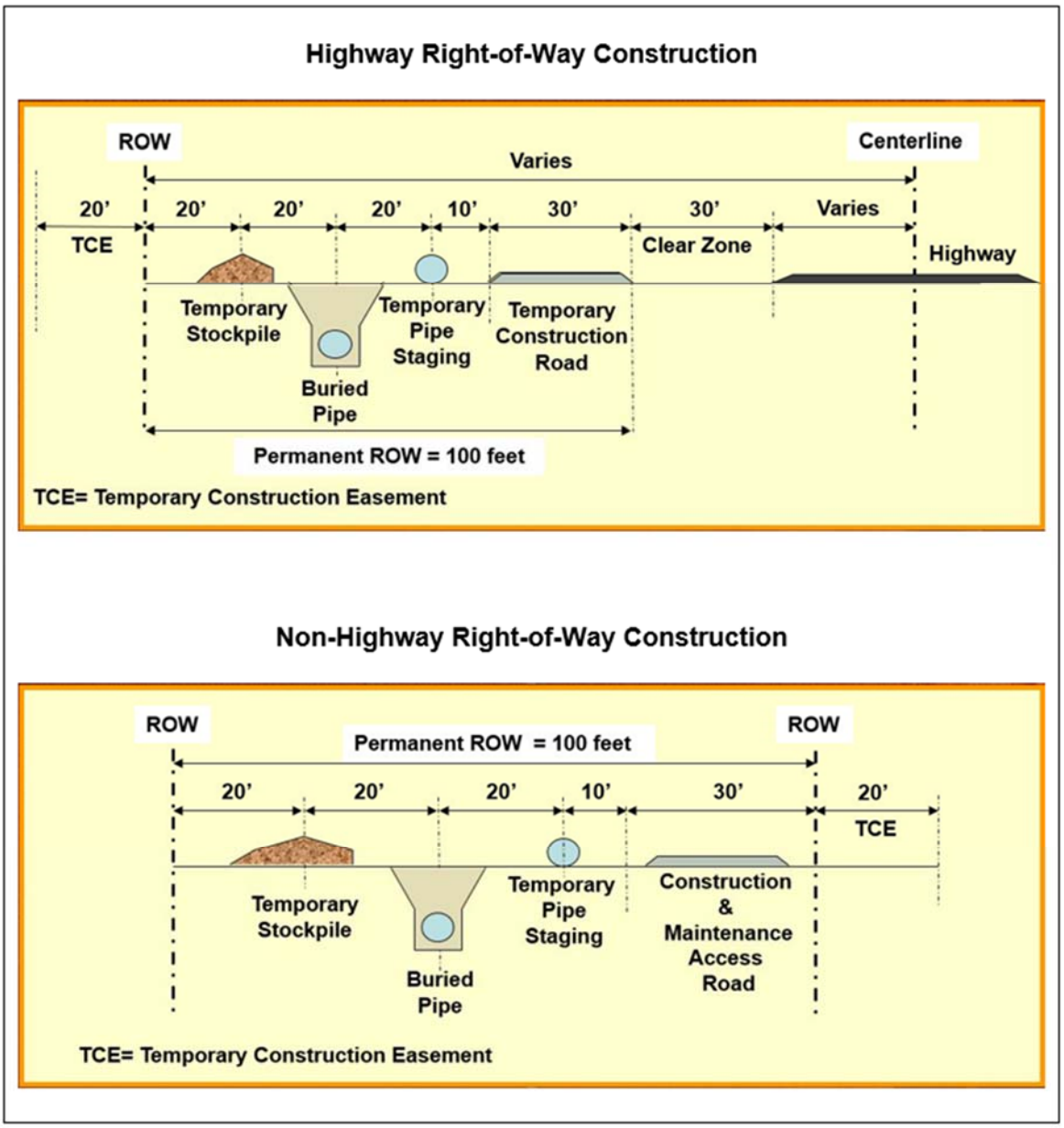


Figure 1-3
Pipeline and Penstock Right-of-Way

The **Hydro System** would convey the water from High Point Regulating Tank-2, at a topographic high point in the LPP Project with ground level elevation 5,691 feet AMSL, for about 87.5 miles through a buried 69-inch diameter penstock in Kane and Washington counties, Utah, and Coconino and Mohave counties, Arizona, to Sand Hollow Reservoir near St. George, Utah (Figure 1-4). A penstock is an enclosed pipe that delivers water to hydroelectric turbines.

A short penstock segment would convey the water to HS-1. This in-line hydro station would generate up to one megawatt (MW) of electricity at a site along Highway 89 within GSENM, and the penstock would continue west along Highway 89 to the GSENM west boundary. The HS-1 site would cover about five acres.

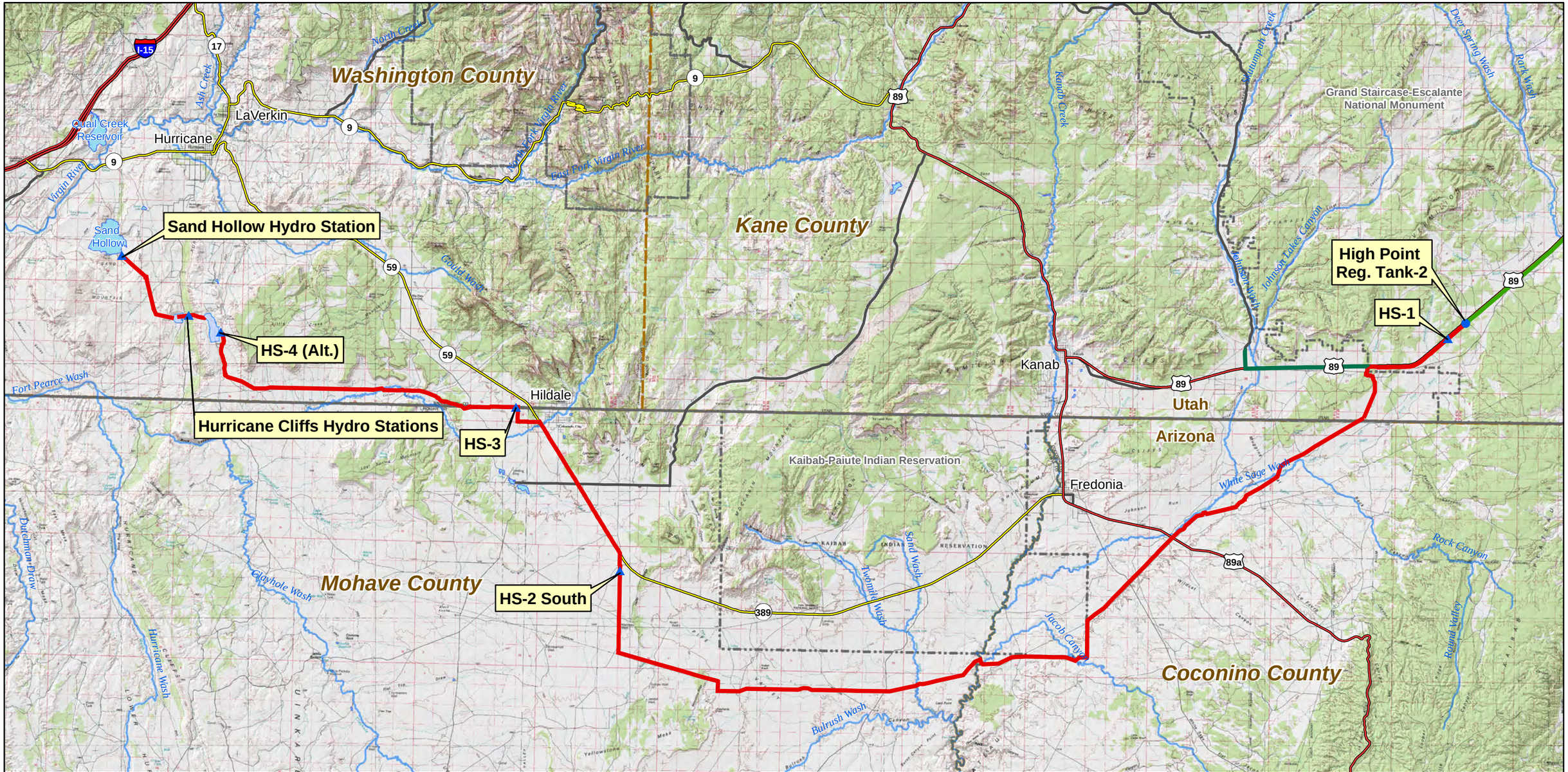
The penstock alignment would turn south from Highway 89 through private land and BLM-administered public lands into White Sage Wash. It would continue across White Sage Wash and then parallel Navajo-McCullough Transmission Line, crossing Highway 89 Alt. and Forest Highway 22 toward the southeast corner of Kaibab-Paiute Indian Reservation. The penstock alignment would run parallel to and south of the Kaibab-Paiute Indian Reservation south boundary, crossing Kanab Creek and Bitter Seeps Wash. It would continue across Moonshine Ridge and Cedar Ridge to Yellowstone Road. At this point, the penstock alignment would run north along Yellowstone Road to Arizona State Route 389 west of Kaibab-Paiute Indian Reservation. HS-2 (South) would be located west of Kaibab-Paiute Indian Reservation on private land east of Yellowstone Road. HS-2 (South) would generate up to one MW of electricity. The HS-2 (South) site would cover about five acres. The penstock alignment would continue northwest along the south side of Arizona State Route 389 past Colorado City to Hildale City, Utah, and HS-3. HS-3 would be located on private land west of Hildale City, Utah, north of and adjacent to Uzona Road. HS-3 would generate up to one MW of electricity. The HS-3 site would cover about five acres. A turnout for future delivery of 13,249 acre-feet of WCWCD's allocation of LPP Project water to Apple Valley would be located immediately west of HS-3.

The penstock alignment would follow Uzona Road west through Canaan Gap and south of Little Creek Mountain, turning north to HS-4 (Alt.) above the proposed Hurricane Cliffs forebay reservoir. HS-4 (Alt.) would be located on about three acres of public land administered by the BLM. HS-4 (Alt.) would generate up to 1.7 MW of electricity and would discharge into the forebay reservoir.

The forebay reservoir would be contained in a valley between two dams (south and north), maintaining active storage of 11,255 acre-feet of water. The forebay reservoir and two dams would cover about 500 acres of public land administered by BLM and would be surrounded by security fencing. A low-pressure tunnel would convey the water to a high-pressure vertical shaft in the bedrock forming the Hurricane Cliffs, connected to a high-pressure tunnel near the bottom of the Hurricane Cliffs. The high-pressure tunnel would connect to a penstock conveying the water to a 35-MW-capacity peaking power hydroelectric generating station and a 300-MW-capacity pumped storage hydroelectric generating station.

The Hurricane Cliffs hydroelectric generating stations and tailrace channel would cover about 50 acres of public land administered by BLM and would be surrounded by security fencing. The tailrace channel would discharge into an afterbay reservoir with 3,551 acre-feet of operating capacity, which is contained by a single dam in the valley below the Hurricane Cliffs. The afterbay reservoir and dam would cover about 200 acres of public land administered by BLM and would be surrounded by security fencing.

Water would be released from the forebay reservoir through the hydro generating system to meet peak power demands. Water would be pumped from the afterbay reservoir into the forebay reservoir during periods of off-peak power demand. The forebay and afterbay reservoirs would not be open to public access because the water levels would fluctuate rapidly during daily operations. A low pressure tunnel would convey the water northwest from the afterbay reservoir to a penstock, continuing to the Sand



Project Pump Station
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Water Conveyance System
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N

0 1 2 4 6 8 Miles

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Spatial Reference: UTM Zone 12N, NAD-83

UDWRe **Figure 1-4** MWH

Lake Powell Pipeline Hydro System South Alternative

Hollow Hydro Station, which would generate up to 4.2 MW of electricity. The Sand Hollow Hydro Station would be located on land owned by WCWCD and cover about five acres adjacent to Sand Hollow Reservoir. The LPP Project water would discharge from the Sand Hollow Hydro Station into the existing Sand Hollow Reservoir.

The **KCWCD System** would convey water diverted from Lake Powell through the LPP at the west GSENM boundary for about eight miles through a buried 24-inch diameter pipeline in Kane County, Utah, near the mouth of Johnson Canyon. The pipeline would parallel the south side of Highway 89 across Johnson Wash and then run north for 5000 feet to the mouth of Johnson Canyon (Figure 1-4).

1.2.2 Existing Highway Alternative

The Existing Highway Alternative consists of four systems: **Water Intake, Water Conveyance, Hydro,** and **KCWCD**. The **Water Intake** and **Water Conveyance** systems would be the same as described for the South Alternative. The **Hydro System** would convey water diverted at Lake Powell from High Point Regulating Tank 2 at the LPP Project topographical high point (5,691 feet AMSL) for about 80.5 miles through a buried 69-inch diameter penstock in Kane and Washington counties, Utah, and Coconino and Mohave counties, Arizona, to Sand Hollow Reservoir near St. George, Utah (Figure 1-5). The alternative alignment parallels Highway 89 to the west and south boundary of GSENM and continues along Highway 89 to Lost Spring Gap. Four in-line hydro generating stations (HS-1, HS-2 [Hwy], HS-3, and HS-4 [Alt.]) located along the penstock would generate electricity and help control water pressure in the penstock. The HS-1, HS-3 and HS-4 (Alt.) hydro stations would be the same as described for the South Alternative.

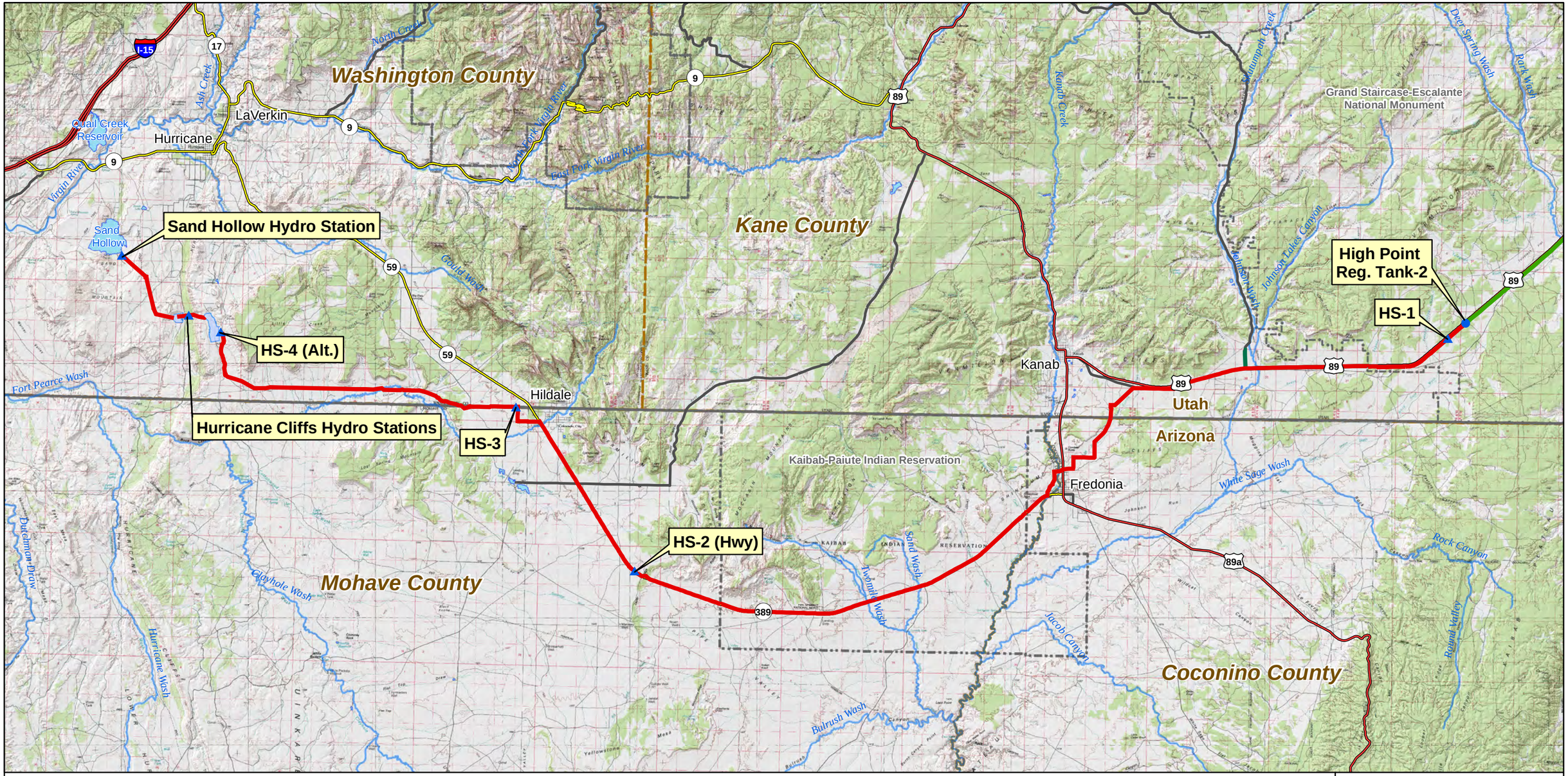
The penstock downstream from the proposed HS-1 would be sited along the south side of Highway 89 within GSENM. The penstock would parallel the south side of Highway 89 west of GSENM, continue past Johnson Wash and follow Lost Spring Gap southwest, crossing Highway 89 Alt. and Kanab Creek in the north end of Fredonia, Arizona. It would continue south, paralleling Kanab Creek to Arizona State Route 389, where it would run west, adjacent to the north side of Route 389 through Kaibab-Paiute Indian Reservation past Pipe Spring National Monument. The penstock would continue along the north side of Arizona State Route 389 through the west half of Kaibab-Paiute Indian Reservation to 1.8 miles west of Cedar Ridge (intersection of Yellowstone Road with Highway 89), where it would then follow the same alignment as the South Alternative to Sand Hollow Reservoir. HS-2 (Hwy) would be sited 0.5 miles west of Cedar Ridge along the north side of Arizona State Route 389. HS-2 (Hwy) would generate approximately 0.8MW of electricity and cover 8.7 acres of private land.

The **KCWCD System** would convey water diverted at Lake Powell from the LPP Project along Highway 89 north along Johnson Canyon Road for 5,000 feet through a buried 24-inch diameter pipeline in Kane County, Utah to the mouth of Johnson Canyon (Figure 1-5).

1.2.3 Southeast Corner Alternative

The Southeast Corner Alternative consists of four systems: **Water Intake, Water Conveyance, Hydro,** and **KCWCD**. The **Water Intake**, **Water Conveyance**, and **KCWCD** systems would be the same as described for the South Alternative.

The **Hydro System** would be the same as described for the South Alternative from High Point Regulating Tank 2 at the LPP Project topographical high point (5,691 feet AMSL) to the east boundary of Kaibab-Paiute Indian Reservation. At the east boundary of Kaibab-Paiute Indian Reservation, the penstock alignment would parallel the north side of the Navajo-McCullough Transmission Line corridor in Coconino County, Arizona, through the southeast corner of the Kaibab-Paiute Indian Reservation for



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N

0 1 2 4 6 8 Miles

Lake Powell Pipeline Project

Spatial Reference: UTM Zone 12N, NAD-83

UDWRe **Figure 1-5** MWH

Lake Powell Pipeline Hydro System Existing Highway Alternative

about 3.8 miles. The penstock would then follow the South Alternative alignment south of the south boundary of the Kaibab-Paiute Indian Reservation, continuing to Sand Hollow Reservoir (Figure 1-6). The Southeast Corner Alternative would be about 85.7 miles long from High Point Regulating Tank-2 to Sand Hollow Reservoir.

1.2.4 Transmission Line Alignments

Transmission line alignments have been identified to transmit electric power to pump stations in the Water Intake and Water Conveyance systems, and to transmit electric power generated by hydroelectric stations in the Hydro System. The transmission lines that would serve the Water Intake and Water Conveyance systems are located in the east half of the LPP Project. The transmission lines that would serve the Hydro System are located in the west half of the LPP Project.

The proposed new **Water Intake Transmission Line** would begin at Glen Canyon Substation and run parallel to Highway 89 for about 2,500 feet to a new switch station, cross Highway 89 at the Intake access road intersection, and continue northeast to a new electrical substation on the Intake Pump Station site. This 69 kV transmission line would be 0.9 mile long in Coconino County, Arizona (Figure 1-7).

The proposed new **BPS-1 Transmission Line** would begin at the new switch station located on the south side of Highway 89 and parallel the LPP Project Water Conveyance System alignment to a new electrical substation on the BPS-1 site west of Highway 89. The 69 kV transmission line would be about one mile long in Coconino County, Arizona (Figure 1-7).

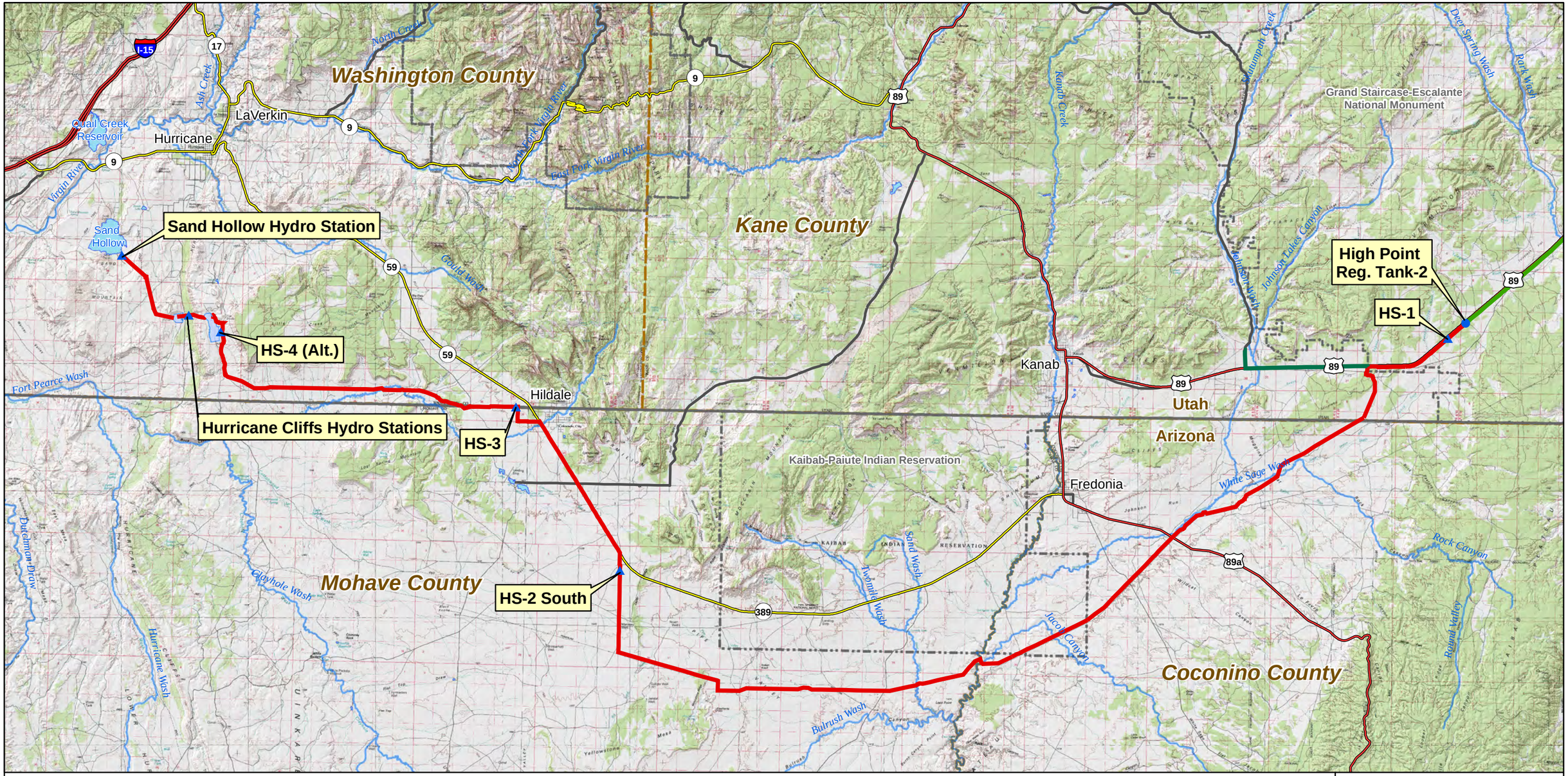
The proposed new **Glen Canyon to Buckskin Transmission Line** would consist of a 230 kV transmission line from the Glen Canyon Substation to the Buckskin Substation, running parallel to the existing 138 kV transmission line. This transmission line upgrade would be about 36 miles long through Coconino County, Arizona, and Kane County, Utah (Figure 1-7).

The existing **Buckskin Substation** would be upgraded as part of the proposed project to accommodate the additional power loads from the new 230 kV Glen Canyon to Buckskin transmission line. The substation upgrade would require an additional five acres of land within GSENM adjacent to the existing substation in Kane County, Utah (Figure 1-7).

The existing **Paria Substation** would be upgraded as part of the proposed project to accommodate the additional power loads to BPS-4 (Alt.). The substation upgrade would require an additional two acres of privately-owned land adjacent to the existing substation in Kane County, Utah (Figure 1-7).

The proposed new **BPS-2 Transmission Line** would consist of a new three-ring switch station along the new 230 kV Glen Canyon to Buckskin Transmission Line, a new transmission line from the switch station to a new substation west of Big Water, and a connection to BPS-2 substation in Kane County, Utah. The new transmission line would parallel an existing distribution line that runs northwest, north, and then northeast to Big Water. This new 138 kV transmission line alignment would be about seven miles long across Utah SITLA-administered land, with a 138 kV connection to a new electrical substation on the BPS-2 site (Figure 1-7).

The proposed new **BPS-3 Alt. Transmission Line South** would consist of a new three-ring switch station along the new 230 kV Glen Canyon to Buckskin Transmission Line, and a new transmission line from the switch station north along an existing BLM road to a new electrical substation on the BPS-3 (Alt.) site near the GSENM east boundary and within the Congressionally-designated utility corridor. This new 138 kV transmission line alignment would be about 5.9 miles long in Kane County, Utah (Figure 1-7).



- Project Pump Station
- Project Regulating Tank
- Project Hydro Station
- Hurricane Cliffs Forebay/Afterbay
- Lakes & Reservoirs
- Water Conveyance System
- Hydro System - Southeast Corner Alternative (Penstock Segment)
- KCWCD System
- Major Rivers & Streams
- Interstate
- US Highway
- ST Highway
- Hwy
- Major Road
- National Park/Monument
- GSENM Boundary
- Tribal Lands
- State Boundaries
- County Boundaries

FERC Project Number:
12966-001
BLM Serial Numbers:
AZA-34941
UTU-85472

N

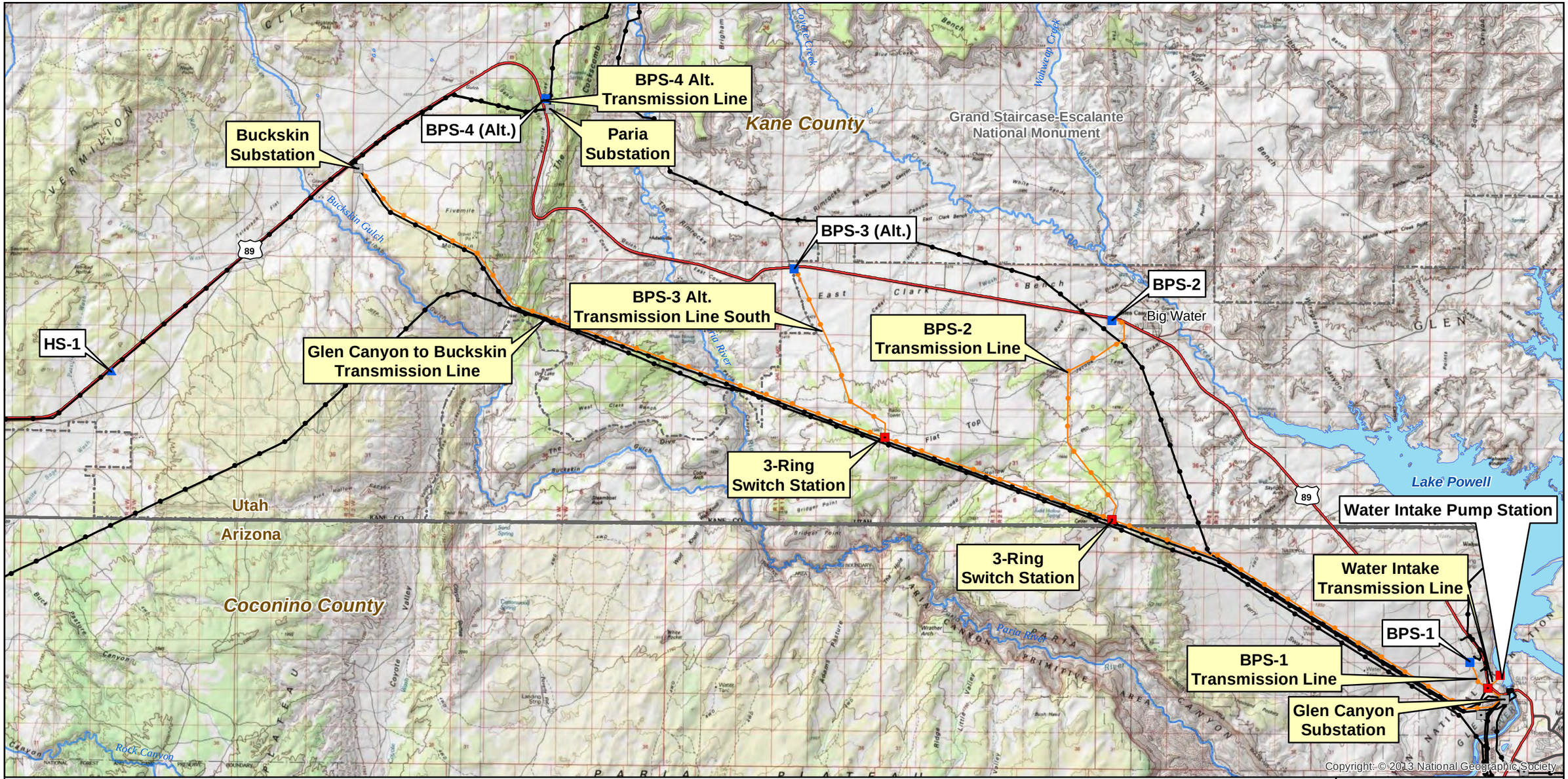
0 1 2 4 6 8 Miles

Lake Powell Pipeline Project

Spatial Reference: UTM Zone 12N, NAD-83

UDWRe **Figure 1-6** MWH

Lake Powell Pipeline
Hydro System
Southeast Corner Alternative



Project Intake Pump Station
Project Pump Station
Project Hydro Station
Substation
Proposed Substation
Project Transmission Lines
Existing Transmission Lines
Interstate
US Highway
ST Highway
Hwy
Major Road
Lakes & Reservoirs
Major Rivers & Streams
National Park/Monument
GSENM Boundary
State Boundaries

FERC Project Number:
12966-001
BLM Serial Numbers:
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UTU-85472

0 0.5 1 2 3 4 Miles

N

Lake Powell Pipeline Project

Spatial Reference: UTM Zone 12N, NAD-83

UDWRe **Figure 1-7** MWH

Lake Powell Pipeline Proposed Transmission Lines East

The proposed new **BPS-4 Alt. Transmission Line** would begin at the upgraded Paria Substation and run north to a new electrical substation on the BPS-4 Alternative site. This 69 kV transmission line would be about 0.4 mile long in Kane County, Utah (Figure 1-7).

The proposed new **HS-1 Transmission Line** would begin at the new HS-1 and tie into the existing 69 kV transmission line along Highway 89 from the Buckskin Substation to the Johnson Substation. The HS-1 69 kV transmission line would be about 400 feet long in Kane County, Utah (Figure 1-8).

The proposed new **HS-2 (South) Transmission Line** would connect the HS-2 hydroelectric station and substation along the South Alternative to an existing 138 kV transmission line paralleling Arizona State Route 389. This new 34.5 kV transmission line would be about 0.9 mile long in Mohave County, Arizona (Figure 1-8).

The new **HS-2 (Highway) Transmission Line** alternative would directly connect the HS-2 hydroelectric station and substation along the Existing Highway Alternative to an existing 138 kV transmission line paralleling Arizona State Route 389. This new 34.5 kV transmission line would be about 200 feet long in Mohave County, Arizona.

The proposed new **HS-3 Transmission Line** would connect the HS-3 hydroelectric station and substation to the existing Twin Cities Substation in Hildale City, Utah. The new 12.47 kV transmission line would be about 0.6 mile long in Washington County, Utah (Figure 1-8).

The proposed new **HS-4 (Alt.) Transmission Line** would connect the HS-4 (Alt.) hydroelectric station and substation to an existing transmission line parallel to Utah State Route 59. The new 69 kV transmission line would be about 7.5 miles long in Washington County, Utah (Figure 1-8).

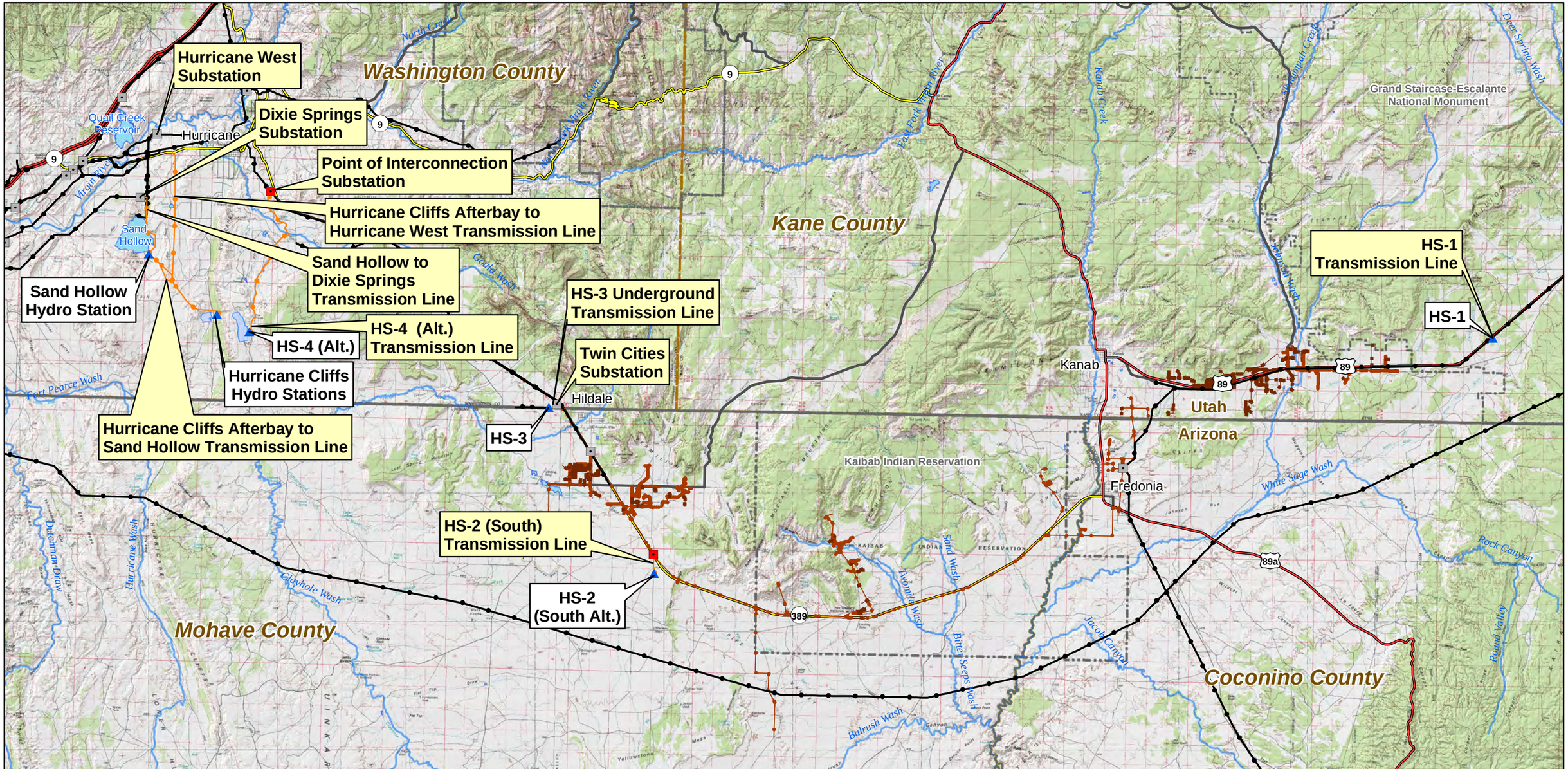
The proposed new **Hurricane Cliffs Afterbay to Sand Hollow Transmission Line** would consist of a new 69 kV transmission line, which would run northwest from the Hurricane Cliffs peaking power plant and substation to the Sand Hollow Hydro substation. This new 69 kV transmission line would be about 4.9 miles long in Washington County, Utah (Figure 1-8).

The proposed new **Hurricane Cliffs Afterbay to Hurricane West Transmission Line** would consist of a new 345 kV transmission line, running from the Hurricane Cliffs pumped storage power plant northwest and then north to the planned Hurricane West 345 kV substation. This new 345 kV transmission line would be about 10.9 miles long in Washington County, Utah (Figure 1-8).

The proposed new **Sand Hollow to Dixie Springs Transmission Line** would consist of a new 69 kV transmission line, running from the Sand Hollow Hydro substation around the east side of Sand Hollow Reservoir and north to the existing Dixie Springs Substation. This new 69 kV transmission line would be about 3.4 miles long in Washington County, Utah (Figure 1-8).

1.2.5 Natural Gas Pipeline and Generators Alternative

Natural gas engine-driven generation systems to power electric pumps would be an alternative to powering the LPP Project pump stations by electricity via transmission lines. Recent discussions with Questar Gas Company (local natural gas supplier) indicated that capacity would be available in the Kern River natural gas pipeline, which is located west of St. George, Utah, to supply natural gas for this alternative. Questar Gas Company indicated the company has future plans to extend a high pressure natural gas pipeline from the Kern River line to Hurricane, Utah. The Questar Gas pipeline would be sized to supply natural gas to the LPP Project if it is determined that a single-purpose, dedicated high pressure gas line would be extended to service the LPP pump stations. Based on the preliminary pump



Project Hydro Station
Substation
Proposed Substation
Project Transmission Lines
Existing Transmission Lines
Existing OH Primary Line
Existing UG Primary Line
Hurricane Cliffs Forebay/Afterbay
Lakes & Reservoirs
Major Rivers & Streams
Interstate
US Highway
ST Highway
Hwy
Major Road
National Park/Monument
GSENM Boundary
Tribal Lands
State Boundaries
County Boundaries

FERC Project Number:
12966-001
BLM Serial Numbers:
AZA-34941
UTU-85472

N

0 1 2 4 6 8 Miles

Lake Powell Pipeline Project

Spatial Reference: UTM Zone 12N, NAD-83

UDWRe **Figure 1-8** MWH

Lake Powell Pipeline Proposed Transmission Lines West

selection and fuel requirements, the natural gas supply pipeline would be 12 inches in diameter to provide natural gas supply for the LPP Project pump stations. The pipeline would likely be successively reduced in size as it delivers gas to each of the pump stations.

1.2.5.1 Natural Gas Transmission Line Connection

The natural gas supply line alternative would connect to the proposed Questar Gas Transmission Line from the existing Kern River line to Hurricane City. The natural gas supply line would connect to the high pressure gas transmission line at a proposed gate station southeast of Sand Hollow Reservoir. The proposed gate station would be located adjacent to the alignment of the extension of the Southern Corridor Highway, which is the existing alignment of Sand Hollow Road east of Sand Hollow Reservoir (Figure 1-9).

1.2.5.2 Natural Gas Supply Line

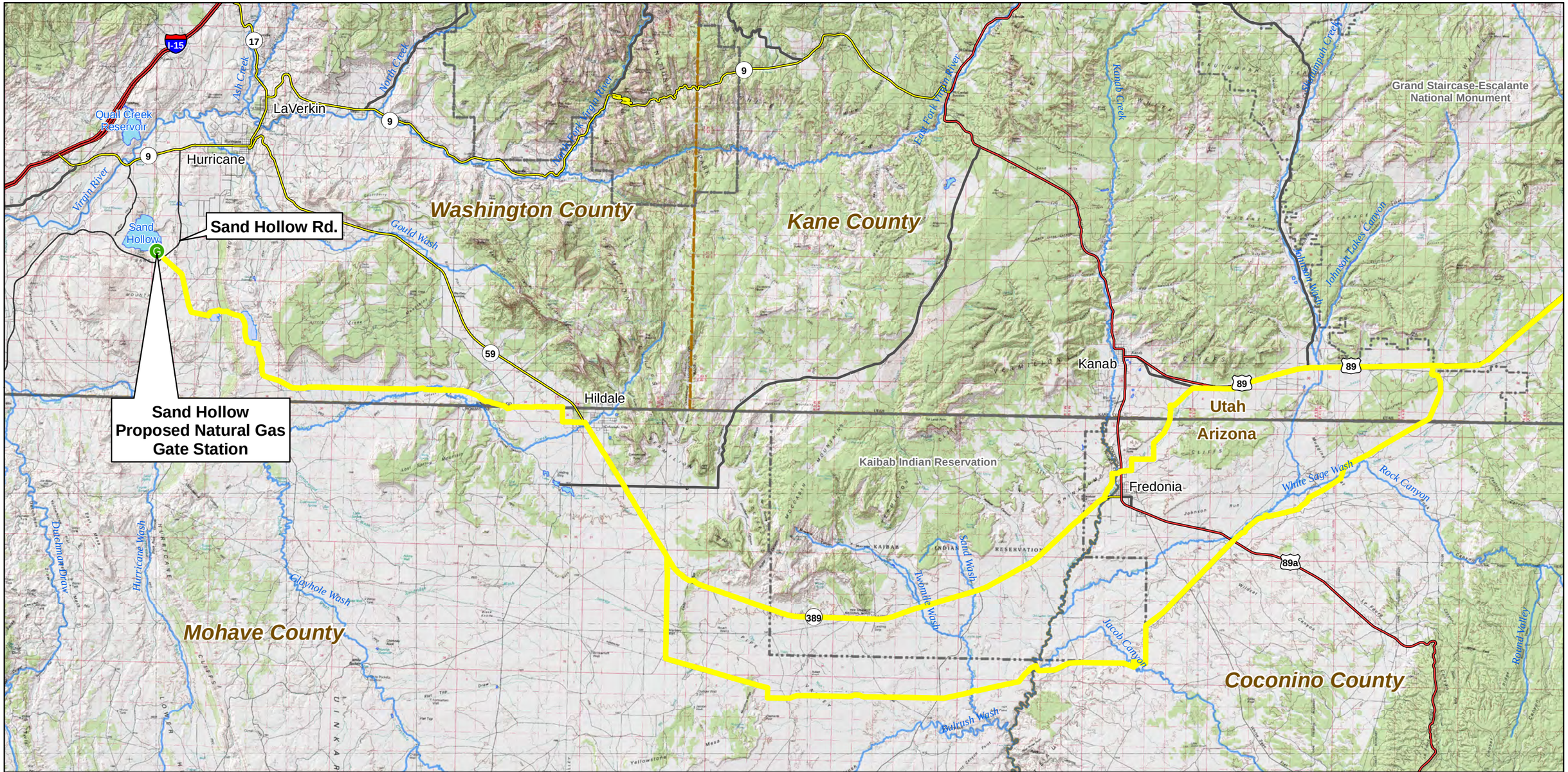
The proposed natural gas supply line would be an intermediate high pressure line and would operate between approximately 250 to 300 psi at the gate station connection. Because of pressure losses in the pipeline it is anticipated that the pressure at each of the LPP pump stations would vary between 50 and 100 psi, which would meet the requirements of the natural gas generators. The pipeline would be constructed of strong carbon steel and have a dielectric coating, such as a fusion bonded epoxy or extruded polyethylene. It would be installed with a minimum four feet of cover and be provided with cathodic protection (a technique that involves inducing an electric current through the pipe to ward off corrosion and rusting). The pipeline would be designed, constructed, tested, and operated at a minimum in accordance with all applicable requirements included in the U.S. DOT regulations in 49 CFR Part 192, “Transportation of Natural Gas and other Gas by Pipeline: Minimum Federal Safety Standards,” and other applicable federal and state regulations.

The natural gas supply line would follow the proposed LPP ROW from the Sand Hollow Gate Station to the intake pump station near Page, Arizona. The line would be about 138.5 miles long and installed a minimum of 10 feet from the edge of the proposed water pipeline in a separately excavated trench within the LPP ROW. Figure 1-9 shows the west alignment of the natural gas supply line as proposed and an alternative alignment along Arizona State Route 389 and through Fredonia, Arizona, parallel to the Existing Highway Alternative alignment, both to the west GSENM boundary. Figure 1-10 shows the east alignment of the natural gas supply line as proposed from the west GSENM boundary to the water intake pump station.

Sectionalizing valves would be required along the natural gas supply line alignment. These valves are safety devices used for emergency shut down or maintenance. The natural gas supply line sectionalizing valves would be required at approximately 20-mile intervals because of the gas line’s remoteness. The main line valve sites would cover a 40-foot by 40-foot area surrounded by a chain link fence within the confines of the permanent LPP pipeline ROW. The valves would be above ground and connected to the buried natural gas supply line. Additionally, pig launching or receiving equipment would be installed within the fenced areas. Pigs are devices that are placed into a natural gas supply line to clean the inside walls or to monitor its internal and external condition. Launching and receiving equipment is connected to the natural gas supply line to enable pigs to be inserted into or removed from the pipeline.

1.2.5.3 Natural Gas Generators

Natural gas generators would be used to supply power to operate the electric pumps at the LPP pump stations. The size of the electric pumps is approximately 18 feet from center to center when configured.



Natural Gas Gate Station
Natural Gas Supply Line Alignment
Hurricane Cliffs Forebay/Afterbay
Lakes & Reservoirs
Major Rivers & Streams
Interstate
US Highway
ST Highway
Hwy
Major Road
National Park/Monument
GSENM Boundary
Tribal Lands
State Boundaries
County Boundaries

FERC Project Number:
12966-001
BLM Serial Numbers:
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UTU-85472

N

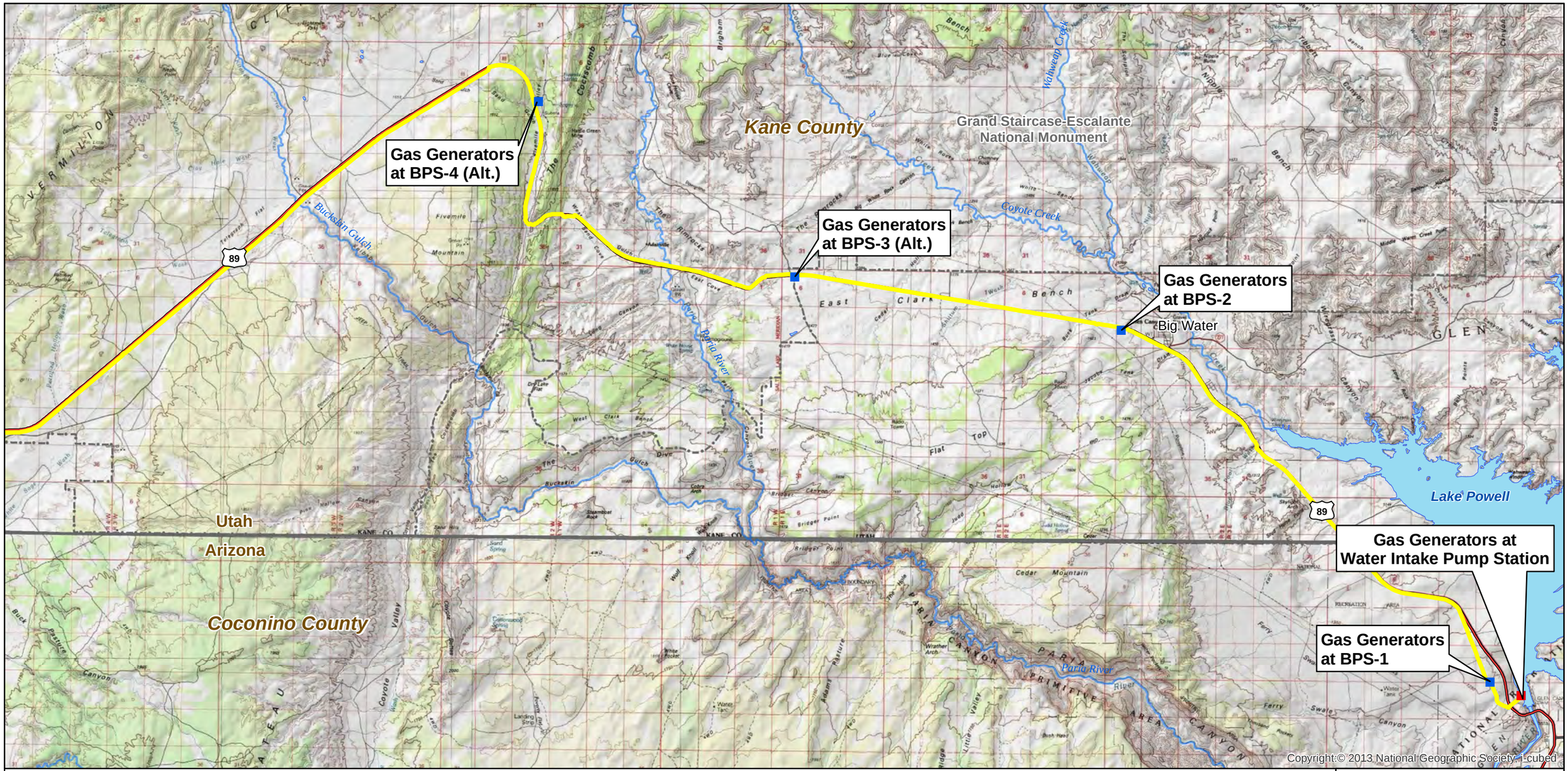
0 2 4 6 8 10 Miles

Lake Powell Pipeline Project

Spatial Reference: UTM Zone 12N, NAD-83

UDWRe **Figure 1-9** MWH

Lake Powell Pipeline
Natural Gas Supply Line and Generators West Alternatives



Project Water Intake Pump Station
Gas Generators at Booster Pump Station
Natural Gas Supply Line Alignment

Interstate
US Highway
ST Highway
Hwy
Major Road

Lakes & Reservoirs
Major Rivers & Streams
National Park/Monument
GSENM Boundary
State Boundaries

FERC Project Number:
12966-001
BLM Serial Numbers:
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UTU-85472

N

0 1 2 3 4 Miles

Lake Powell Pipeline Project

Spatial Reference: UTM Zone 12N, NAD-83

UDWRe **Figure 1-10** MWH

Lake Powell Pipeline Natural Gas Supply Line and Generators East Alternative

The overall pump station building size would be 14 feet wider and 18 feet longer than the pump stations which are powered by electricity from transmission lines.

The natural gas generators would be approximately 35 feet long by eight feet wide by nine feet high. The intake pump station building size for the natural gas generators would be approximately 65 feet wide by 170 feet long by 50 feet high, and located adjacent to the pump station electrical room within the five-acre site designated for each pump station. The booster pump station building size for the natural gas generators would be 65 feet wide and 39 feet high, with lengths ranging from 114 feet to 162 feet long. Each natural gas generator would require a 24-inch diameter stack, with guide wires, extending above the building roof to disperse the exhaust gases. The five stacks (four operating natural gas generators plus one standby natural gas generator) at the intake pump station would extend 20 feet above the top of the 55-foot tall building. The stacks at BPS-1, BPS-2, BPS-3 (Alt.), and BPS-4 (Alt.) would extend 61 feet above the top of the buildings to a total height of 100 feet above the ground surface. The natural gas generators at the intake pump station and BPS-4 (Alt.) would require emission control systems to meet air quality standards.

The natural gas generators alternative at the LPP pump stations would require an annual natural gas supply of 2,855,400 million British thermal units (MMBtu). Table 1-1 shows the annual natural gas consumption at the proposed project intake pump station and booster pump stations 1 through 4.

Table 1-1
Water Conveyance System Natural Gas Generator Annual Fuel Consumption

Pump Station	Site Elevation Feet MSL	Number of Pumps	Motor (HP)	Total Motor (kW)	Natural Gas Generator GE Model	# of Units[1]	Emission Control Required	Generator Total kW[2]	Annual Fuel Consumption (MMbtu)[3]
IPS	3,750	5	3000	11,190	JGS 620 F09	4+1	Yes	12,120	729,000
BPS-1	4,111	5	1500	5,595	JGS 620 F09	2+1	No	5,992	364,500
BPS-2	4,311	5	1750	6,530	JGS 620 F09	3+1	No	8,895	425,400
BPS-3 Alt.	4,657	5	2500	9,325	JGS 620 F09	4+1	No	11,652	607,500
BPS-4 Alt.	5,001	5	3000	11,190	JGS 620 F09	5+1	Yes	14,430	729,000
Total		**25**		**43,830**		**18+5**		**53,089**	**2,855,400**

Notes:
[1] Number of operating units plus standby generator
[2] Total generator capacity without standby generator
[3] The annual fuel consumption is based on all pumps operating at rated motor horsepower, 8400 hours/year operation with generators loaded at 87 percent on the average.

1.3 Summary Description of No Lake Powell Water Alternative

The No Lake Powell Water Alternative would involve a combination of developing remaining available surface water and groundwater supplies, developing reverse osmosis treatment of existing low quality water supplies, and eliminating residential outdoor water use in the WCWCD service area. This alternative could provide a total of 86,249 acre-feet of water annually to WCWCD and KCWCD for M&I use without diverting Utah's water from Lake Powell.

1.3.1 WCWCD No Lake Powell Water Alternative

1.3.1.1 Background

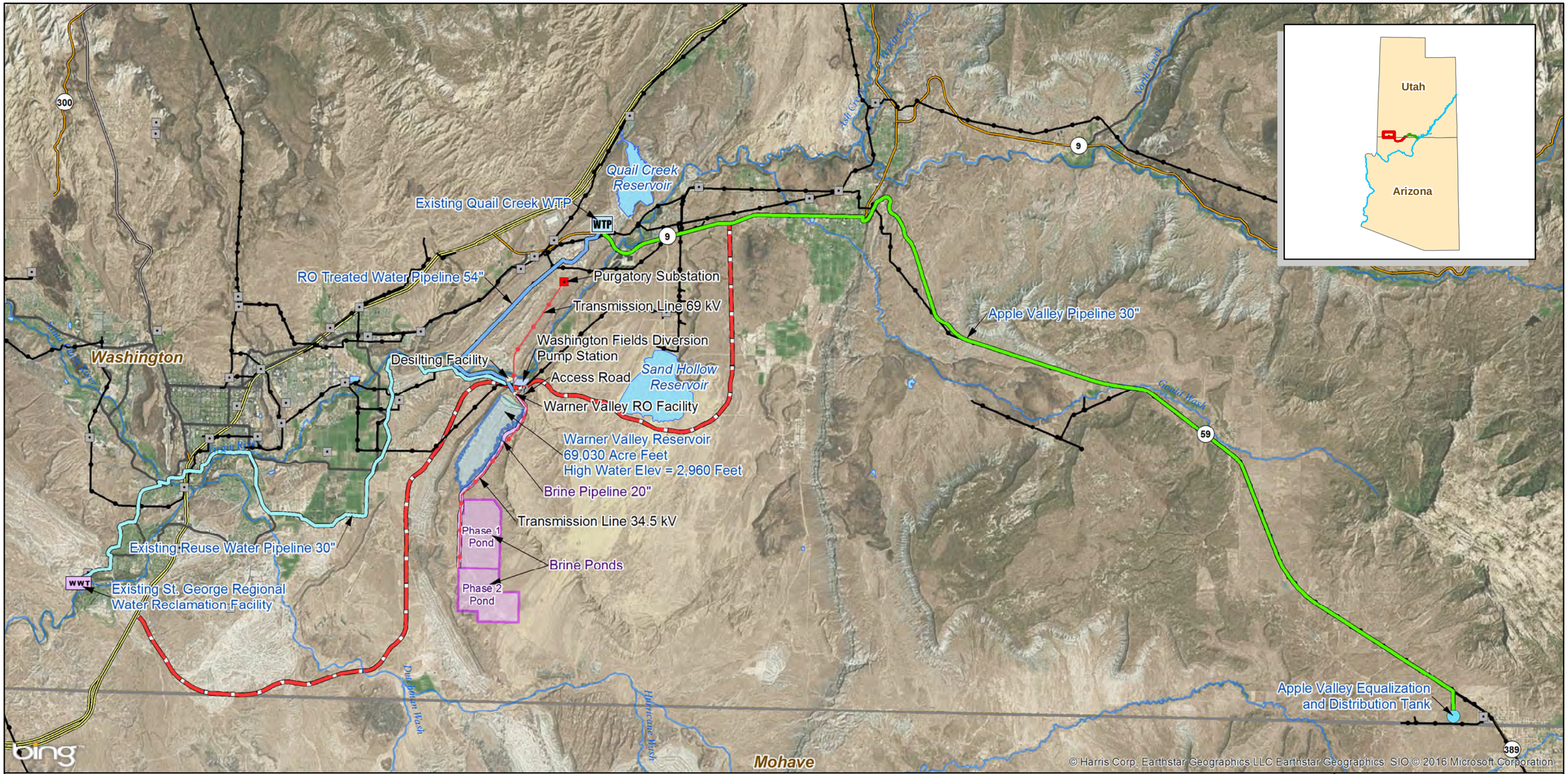
The WCWCD LPP allocation would be 82,249 acre-feet per year, and the WCWCD No Lake Powell Water alternative would need to supply 82,249 acre-feet per year to meet the same future water demands. In addition to the direct supply from Utah's Colorado River water, the water supplied by the LPP Project would provide additional wastewater reuse supply provided that sufficient storage is available.

The No Lake Powell Water Alternative would serve the same population as the LPP Project. WCWCD would implement other future water development projects currently planned by the District, develop additional water reuse/reclamation programs, continue to implement new water conservation measures, and convert additional agricultural water use to M&I use as a result of urban development in agricultural areas through 2028. Remaining planned and future water supply projects include the Ash Creek Pipeline (2,840 acre-feet per year), Sand Hollow recharge/recovery (3,000 acre-feet per year), Westside groundwater wells arsenic treatment (5,000 acre-feet per year), and development/yield increase of existing groundwater wells (2,830 acre-feet per year). Along with existing supplies, these future water supplies would yield an estimated 72,842 acre-feet per year of potable water and 8,505 acre-feet per year secondary water by 2028.

Under the No Lake Powell Water Alternative, actions in addition to the currently planned WCWCD projects would be taken to meet the water demand that would have been supplied by the Lake Powell Pipeline, as described below.

1.3.1.2 WCWCD No Lake Powell Water Alternative Features

Beginning in 2025, Washington County residential outdoor potable water use would be permanently re-purposed to indoor potable water use to help meet increasing indoor potable water demands. The WCWCD would develop a reverse osmosis (RO) advanced water treatment facility near the Washington Fields Diversion in Washington County, Utah, to treat up to 50,000 acre-feet per year of diverted Virgin River water, which has a high total dissolved solids (TDS) concentration, mixed with an additional 19,030 acre-feet per year of reuse water. WCWCD would develop the Warner Valley Reservoir to store the reuse water and diverted Virgin River water prior to RO treatment. A water distribution pump station and pipeline would be constructed to convey 13,249 acre-feet of potable water from Quail Creek Water Treatment Plant to the Apple Valley area of Washington County. Figure 1-11 shows the primary conceptual components of the No Lake Powell Water Alternative. Table 1-2 summarizes available supplies and projected demands under the No Lake Powell Water Alternative and the LPP Project alternatives.



WTP Quail Creek WTP (Existing)
WWT St. George Regional Water Reclamation Facility (Existing)
Substation
Substation (Future)
Warner Valley Transmission Line
Existing Transmission Lines
Desilting Facility
RO WTP
Washington Fields Diversion Pump Station
Lakes & Reservoirs
Brine Evaporation Ponds
Access Road
Apple Valley Pipeline 30"
Brine Pipeline 20"
Existing Reuse Water Pipeline 30"
RO Treated Water Pipeline 54"
Major Rivers & Streams
Interstate
US Highway
ST Highway
Hwy
Major Road
Southern Corridor Highway
State Boundaries
County Boundaries

FERC Project Number:
12966-001
BLM Serial Numbers:
AZA-34941
UTU-85472

N

0 0.75 1.5 3 4.5 6 Miles

Lake Powell Pipeline Project

Spatial Reference: UTM Zone 12N, NAD-83

UDWRe **Figure 1-11** MWH

No Lake Powell Water Alternative Primary Infrastructure

Table 1-2 Available Supplies and Projected Demands Under the No Lake Powell Water and Lake Powell Pipeline Project Alternatives		
	No Lake Powell Water Alternative	**Lake Powell Pipeline Project Alternative**
Existing Supplies	67,677	67,677
Planned Projects	13,670	13,670
Lake Powell Pipeline Project	0	82,249
RO Treatment of Virgin River and Reuse Water	57,883	0
Agricultural Conversion	0[1]	10,080
Reuse	17,100[2]	36,130
2060 Total Supply	156,330	209,806
2060 Total Demand	133,119[3]	185,285
Surplus in 2060	**23,211**	**24,521**

Notes:
[1]Agricultural conversion water included in RO treatment.
[2]19,030 acre-feet per year additional reuse included in RO treatment.
[3]Demand reduced 52,166 acre-feet per year from elimination of residential outdoor watering.

1.3.1.2.1 Re-Purposing Potable Water Use. The No Lake Powell Water Alternative would permanently eliminate residential outdoor potable water use in Washington County, re-purposing the portion of potable water used for residential outdoor watering to indoor potable use. Projections of future water use through 2060 account for population growth, climate change (projected 6 percent reduction of Virgin River flows by 2050 [Reclamation 2014]), and water conservation (35 percent reduction in per capita water use from 2000 to 2060). Potable water in Washington County is consumed for residential indoor and outdoor uses, commercial uses, institutional uses, and industrial uses. These potable water uses would total 130,245 acre-feet per year by 2052, the year the LPP Project water is anticipated to be fully utilized (UDWRe 2015). Gradually eliminating residential outdoor potable water use starting in 2025 would provide the growing population with potable water for indoor use through 2045; however, re-purposing residential outdoor potable water use to indoor use would not increase the water supply and would have to be accompanied by adding another water supply to meet the growing demand. Re-purposing residential outdoor potable water use to indoor potable use would require converting traditional residential outdoor landscapes and uses to either landscaping requiring no irrigation or desert landscapes compatible with the local climate. Residential water users would be responsible for converting their traditional outdoor landscapes to non-irrigated or desert landscapes. If no additional water supply was added in Washington County after 2025 and potable water use continued to meet residential indoor and outdoor purposes, then the projected population would completely utilize the potable water supply of 72,842 acre-feet per year by 2028.

1.3.1.2.2 Reverse Osmosis Water Treatment. Washington County's additional future water supply under the No Lake Powell Water Alternative would be dependent on two water sources: 1) Virgin River water diverted at the Washington Fields Diversion; and 2) reuse water from an expanded St. George Regional Water Reclamation Facility. WCWCD would develop a RO advanced water treatment facility near Washington Fields Diversion in Washington County, Utah. The RO facility would be designed to treat 50,000 acre-feet of de-silted water per year diverted from the Virgin River at Washington Fields Diversion. St. George Regional Wastewater Reclamation Facility would provide an additional 19,030 acre-feet of water per year to be treated at the RO facility. The RO facility would be necessary to remove the high concentrations of TDS present in both the Virgin River and the effluent from the St. George Regional Wastewater Reclamation Facility. The reuse facility has a current capacity of approximately 7,800 acre-feet per year, with a future design capacity of 11,760 acre-feet per year. An additional 7,830 acre-feet per year of future wastewater reclamation capacity would need to be added to meet the

total reuse water requirement of 19,030 acre-feet per year for RO processing inflow. The RO process would separate the TDS from the water, resulting in two products: 1) a treated water product; and 2) a brine product consisting of highly concentrated salts. A two-stage RO process would be applied to the brine solution to recover additional water and reduce the brine volume for enhanced evaporation. The RO-treated water product would be pH-adjusted to neutral pH, dosed with sodium silicate, mixed with conventionally-treated water from the Quail Creek Water Treatment Plant, and disinfected for distribution throughout the WCWCD service area. The RO advanced water treatment facility would process up to 64,313 acre-feet per year and produce up to 57,883 acre-feet per year of water suitable for M&I potable indoor use. The two-stage RO process would remove 90 percent of the TDS. The remaining 10 percent rejection (6,430 acre-feet per year) of brine by-product from the RO treatment process would require evaporation and disposal meeting State of Utah water quality regulations. The RO water treatment plant would process approximately 64,313 acre-feet per year of inflow water from Warner Valley Reservoir storage to meet the 2052 water demand under the No Lake Powell Water Alternative.

The RO water treatment plant processes would consist of pressurized, parallel ultra-filtration units, an influent storage tank with acid added to adjust the pH, pressurized cartridge filtration to remove additional particles from the water, high pressure pumping to pass the water through the parallel RO membrane units, a product water storage tank with saturated lime solution added to adjust the pH of the treated product water prior to disinfection and distribution as potable water, and brine storage tanks in series with the two-stage RO process units for further brine reduction. These water treatment processes would be housed in a water treatment building with electrical, mechanical, chemical storage and metering, heating/air conditioning/ventilation, and SCADA systems. A seven-mile long buried 54-inch diameter pipeline would convey the product water from a pump station at the RO water treatment plant to the Quail Creek Water Treatment Plant. The RO water treatment plant would add RO membrane units in phases as necessary to meet the growing water demand. The RO water treatment plant would be powered by electricity, requiring a 2.8-mile long 69-kV power transmission line from the proposed Purgatory Substation.

The concentrated brine product (6,430 acre-feet per year) would be pumped from the brine tanks through a pipeline to an evaporation apron, spray system and double-lined pond, and then pumped into spray headers over a series of double-lined ponds with leak detection and recovery systems. The enhanced evaporation ponds would be located south of Warner Valley Reservoir and would cover approximately 2,000 acres, developed in two phases. A buried brine conveyance pipeline approximately 4.4 miles long would convey the concentrated brine to the enhanced evaporation ponds. A 4.4-mile long 34.5-kV power transmission line would be extended from the RO water treatment plant to the enhanced evaporation ponds to provide electricity for the pumps spraying the brine solution. The brine solids would be evaporated for approximately 25 years in the Phase 1 ponds, and then dried, collected and disposed in an approved solid waste landfill. The Phase 2 enhanced evaporation ponds would be used during the following 25 years to continue evaporating the brine by-product. Additional infrastructure would be required as part of this alternative, including a de-silting facility, pump stations, pipelines, switch stations and substations, blending and storage tanks, and other associated earthwork.

1.3.1.2.3 Secondary Water Storage in Warner Valley Reservoir. WCWCD would develop the Warner Valley Reservoir to store diverted Virgin River water and reuse water from the St. George Regional Water Reclamation Facility, which would be delivered as inflow to the RO advanced water treatment facility. Warner Valley Reservoir would be located south-southwest of the Washington Fields Diversion. An earth-fill embankment with a clay core and rock-riprap facing would be constructed across the north entrance to the natural valley. The reservoir would have a maximum active storage volume of 69,030 acre-feet and would cover approximately 1,130 acres, including the earth-fill embankment. A large pump station would be constructed at the Washington Fields Diversion to pump the diverted Virgin River water into the Warner Valley Reservoir. The pump station would be powered by electricity via the 69-kV transmission line from the Purgatory Substation to the RO water treatment plant. The reservoir would store Virgin River water diverted at the Washington Fields Diversion (50,000 acre-feet per year) mixed with St. George Regional Water Reclamation Facility effluent (19,030 acre-feet per year), accounting for annual average evaporation (4,717 acre-feet per year), to produce up to 57,883 acre-feet of RO product water (assuming 90 percent recovery). The brine product from RO treatment would total approximately 6,430 acre-feet per year.

1.3.1.2.4 Water Distribution to Apple Valley. The largest remaining contiguous land area available for development in Washington County would be in Apple Valley. WCWCD would develop a pump station and 28-mile long pipeline to deliver 13,249 acre-feet per year of potable water from the Quail Creek Water Treatment Plant near Hurricane City to the Apple Valley area to meet future residential and commercial water demands.

1.3.2 KCWCD No Lake Powell Water Alternative

The KCWCD No Lake Powell Water Alternative would rely on existing water supplies, water conservation measures resulting in reduced water use, and future water development projects consisting of new groundwater production. Reliable water supplies (projected to be 2,170 acre-feet per year in 2035) for the area served by KCWCD (Kanab City and Johnson Canyon), adjusted for projected stream flow reductions (4.2 percent in 2035) resulting from climate change and a planning reserve (10 percent), would be exceeded by projected M&I water demands by 27 acre-feet per year within the KCWCD service area in 2035. KCWCD projected potable water demand in 2060 would be 3,435 acre-feet per year, with a potable water deficit of 1,334 acre-feet per year. Additional groundwater in the Kanab Creek drainage basin could be developed to provide up to 6,615 acre-feet per year of potable water within the aquifer's estimated safe yield. The quality of this water would likely require advanced water treatment. The developed groundwater from the Kanab Creek drainage basin would be pumped and conveyed through an eight-mile long pipeline to the Johnson Canyon drainage basin. The Johnson Canyon drainage basin comprises the potable water supply service area served by KCWCD in the area that could be served by the LPP Project.

1.4 Summary Description of the No Action Alternative

No new intake, water conveyance or hydroelectric features would be constructed or operated under the No Action Alternative. FERC would not issue a license for the LPP Project. The Utah Board of Water Resources' Colorado River water rights consisting of 86,249 acre-feet per year would not be diverted from Lake Powell and would continue to flow into the lake until the water is used for another State of Utah purpose.

1.4.1 WCWCD No Action Alternative

Under the No Action Alternative, WCWCD would complete the Ash Creek Project, planned groundwater development and continue to implement planned conservation programs. Wastewater reuse would be utilized to the maximum extent storage allows. Existing and future water supplies totaling 72,840 acre-feet per year potable and 8,505 acre-feet per year secondary would meet projected M&I water demand within the WCWCD service area through approximately 2028, exhausting all water planning reserves. Each supply source would be phased in to meet the M&I potable and secondary water demand associated with the forecasted population.

The No Action Alternative would not provide WCWCD with any reserve water supply (e.g., water to meet annual shortages because of drought, emergencies, and other losses). The No Action Alternative would not provide adequate water supply to meet projected water demands beyond 2028. There would be a projected water shortage of approximately 102,903 acre-feet per year in 2060 within the WCWCD service area under the No Action Alternative.

1.4.2 KCWCD No Action Alternative

KCWCD would use existing water supplies to meet potable water demands through 2035. Reliable water supplies are projected to be 2,101 acre-feet per year in 2060.

The No Action Alternative would not provide KCWCD with any reserve water supply (e.g., water to meet annual shortages because of drought, emergencies, and other losses). The No Action Alternative would not provide adequate water supply to meet projected water demands beyond 2035. There would be a projected water shortage of approximately 1,334 acre-feet per year in 2060 within the KCWCD service area under the No Action Alternative.

1.5 Identified Issues

The following special status plant species and noxious weed issues were raised during the public and agency scoping and informational process:

- What are the potential direct and indirect effects of the pipeline project construction, operation, and maintenance on federally listed threatened or endangered species and their habitat, including the Welsh's milkweed, Brady pincushion cactus, Siler pincushion cactus, Holmgren milkvetch and its critical habitat, dwarf bear-poppy, Jones cycladenia, Kodachrome bladderpod, Navajo sedge, and sentry milk-vetch?

- What measures would be used to avoid, minimize, or mitigate potential adverse effects?

- What are the potential effects of project-induced land development, urbanization, and population growth on threatened and endangered species?

- What are the potential effects of construction activities and operation on the introduction and spread of invasive and noxious terrestrial plant species?

1.6 Impact Topics

The following impact topics are analyzed in this study report:

- Special status plant species
- Noxious and invasive weed species

Chapter 2
Study Area

2.1 Project Overview

This report characterizes the special status plant species and noxious weeds present in the Lake Powell Pipeline (LPP) survey area based on the results of field surveys conducted in 2008, 2009, and 2010 by Logan Simpson (formerly, Logan Simpson Design). The proposed LPP project is a water conveyance system designed to deliver 86,249 acre-feet of water annually from Lake Powell in the vicinity of Glen Canyon Dam to portions of Washington and Kane counties, Utah. The project includes water intake facilities at Lake Powell; approximately 195 miles of proposed and alternative routes for buried pipeline; a combined conventional peaking and pumped storage hydro station; five conventional in-line hydro stations; hydro-electric generation facilities consisting of a Forebay reservoir, tunnel/shaft facility, and Afterbay reservoir at the Hurricane Cliffs; and transmission lines and associated sub-stations to provide power to the pumping stations. This report is based on the alignment as configured in April 2009 and amended in 2010 and 2015 (see Chapter 1).

2.2 Project Alignment

The proposed pipeline alignment and analyzed alternatives traverse federal, state, county, tribal, municipal, and private lands in Coconino and Mohave counties in Arizona; and Kane and Washington counties in Utah (Figure 2-1). From the project's origin at Lake Powell immediately upstream from Glen Canyon Dam in Coconino County, Arizona, the pipeline alignment follows the U.S. Highway (U.S.) 89 transportation corridor into Kane County, to an area east of Kanab, where several alternative alignments are being considered. The existing highway alternative runs southwest of Kanab, then enters Mohave County, Arizona, passes north of Fredonia, and crosses the Kaibab Indian Reservation within the State Route (SR) 389 transportation corridor. The south alternative crosses U.S. 89A southeast of Fredonia and runs south of the Kaibab-Paiute Indian Reservation, within the Navajo-McCullough Transmission Line corridor. The southeast corner alternative cuts across the southeast corner of the Kaibab Indian Reservation. Approximately seven miles southeast of the communities of Colorado City and Hildale, which straddle the Arizona-Utah state line, the alternatives converge and extend westward to the Forebay facility atop the Hurricane Cliffs, in Washington County, Utah. From the Afterbay facility situated at the base of the Hurricane Cliffs, a portion of the alignment continues north to the Virgin River.

The Glen Canyon to Buckskin Transmission line runs from the Glen Canyon Substation west of Page to the Buckskin Substation at the intersection of U.S. 89 and 5 Mile Mountain Road. Two shorter transmission line alternatives run from the Glen Canyon to Buckskin Transmission Line to pump station locations along U.S. 89. In the Hurricane area, transmission line alternatives run from the Afterbay to Sand Hollow Reservoir and to two pump stations nearby. LPP place names and reaches are illustrated in Appendix A. The reach names are derived from the MWH project reach names.

2.3 Land Ownership

The federal lands along the project alignment are managed and administered by agencies of the U.S. Department of the Interior, including the Bureau of Reclamation (Reclamation), the National Park Service (NPS), and the Bureau of Land Management (BLM). BLM administers the majority of the federal land, which consists primarily of open space used for livestock grazing leases, recreation, wildlife habitat, highway and road corridors, and utility corridors. The Grand Staircase-Escalante National Monument occurs within the BLM lands. The Reclamation land includes about 34 acres adjacent to Lake Powell and immediately north of Glen Canyon Dam; this land is used for construction material storage and controlled access open space. The NPS land is within the Glen Canyon National Recreation Area (GCNRA). State lands include those managed by the Utah School and Institutional Trust Lands Administration (SITLA); Arizona State Land Department; and Utah State Park lands that include Quail Creek State Park and Sand Hollow State Park located near Hurricane, Utah. County lands

occurring near the project alignment are primarily used for county roads and rights-of-way. The tribal lands belong to the Kaibab Band of the Paiute Indians in Arizona. Municipal lands along the proposed project alignment include the communities of Big Water, Kanab, Hildale, Apple Valley, and Hurricane in Utah, and Fredonia and Colorado City in Arizona. Private land within and near the project alignment is used for livestock grazing; agriculture; and residential, commercial, and industrial development.

2.4 Ecological Setting

Two main ecological regions, the Colorado Plateau and Mojave Desert, are represented within the project area (Figure 2-2). The vast majority of the project area, from Lake Powell to Hurricane, occurs within the Colorado Plateau Ecological Region. The Mojave Desert Ecological Region is represented by the area southwest of Hurricane. Diverse landforms, geologic exposures, and elevation gradients present across the project area contribute to the biodiversity and unique character of the vegetation of the ecological regions (see: 2016 Lake Powell Pipeline Project Final Vegetation Communities Study Report).

2.4.1 Colorado Plateau

The Colorado Plateau is a gigantic, uplifted plateau that is generally centered on the “Four Corners” area of the US (Arizona, Utah, Colorado, and New Mexico). Elevations range from 1,200 feet to 12,700 feet, which results in a great diversity of habitats. The more prevalent habitats are pinyon-juniper/juniper savanna, riparian, big sagebrush shrublands, steppe, and grasslands (NMDGF 2006). Within the LPP study area, the Colorado Plateau region extends from Lake Powell on the eastern end, to Hurricane, Utah, and represents 14,487 acres of study area corridor.

2.4.2 Mojave Desert

The Mojave Desert features basin and range topography, with broad valleys separated by rugged mountain ranges. The basins contain several large sand dune complexes, and dry lakes are common. Elevations range from 282 feet below sea level in Death Valley to over 5,280 feet. The Mojave Desert Ecological Region is dominated by shrublands. The Mojave Desert region within the LPP study area totals 1,216 corridor acres south and west of Hurricane.

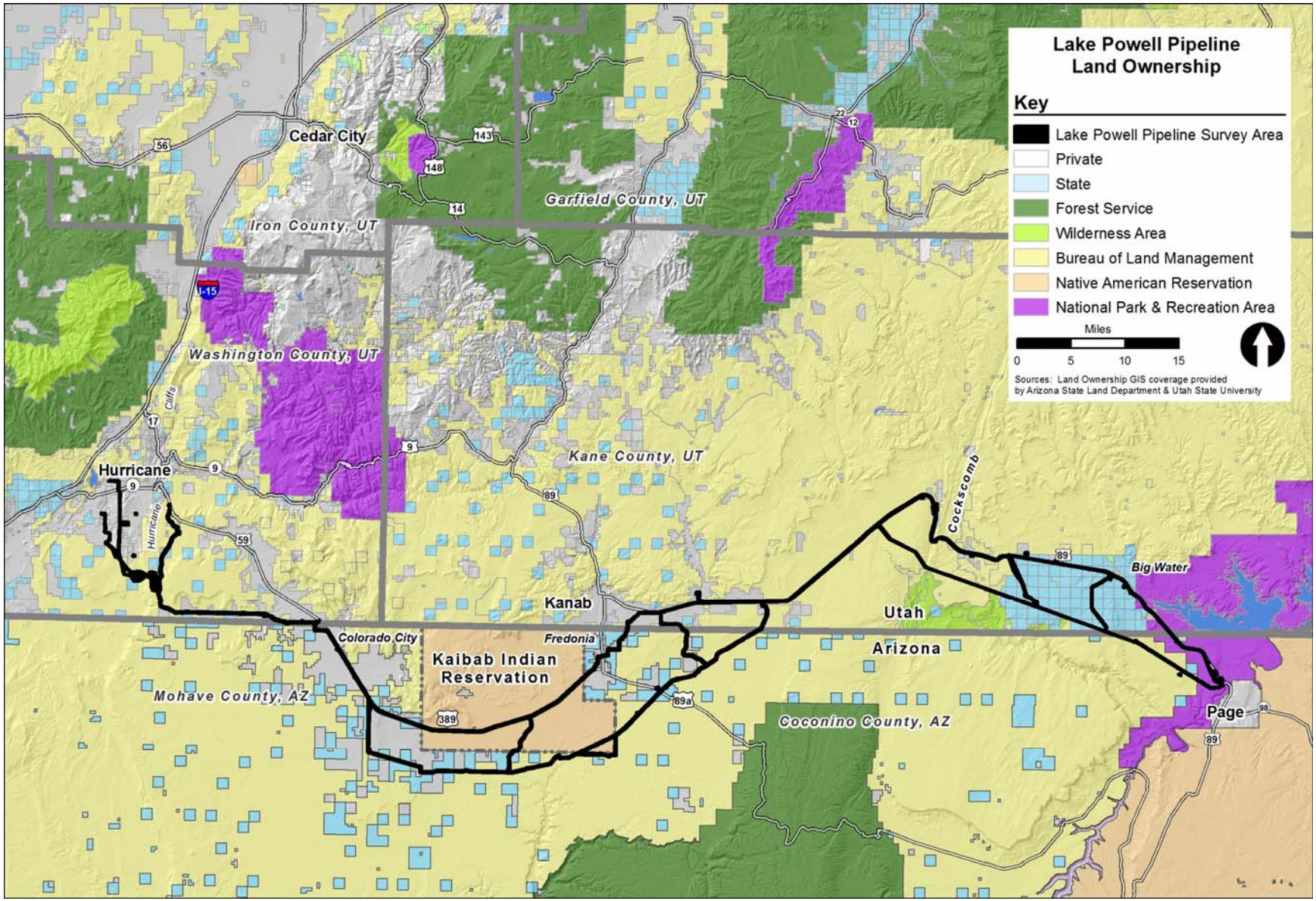


Figure 2-1
Proposed Pipeline Alignment Map

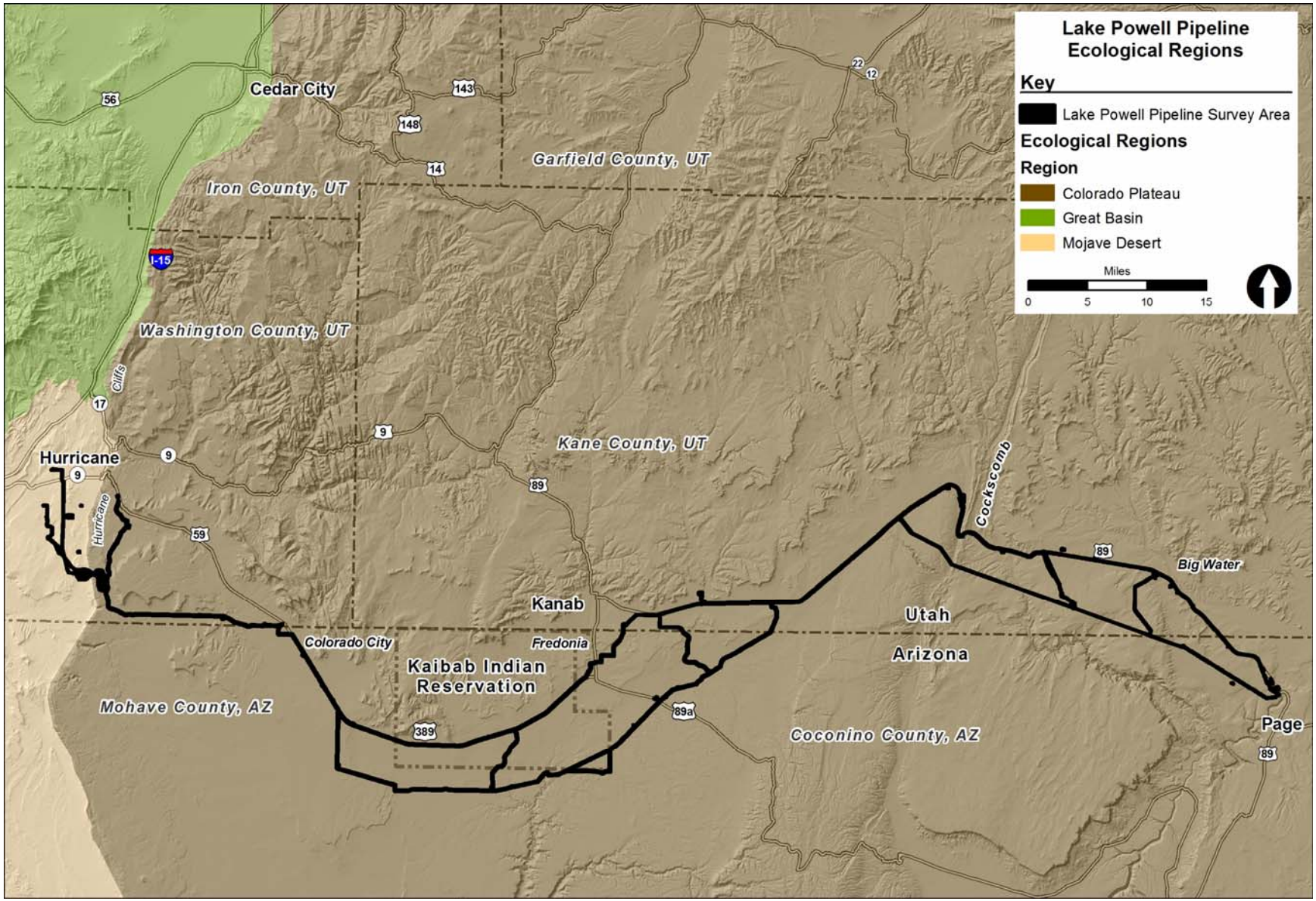


Figure 2-2
Ecological Regions Map

2.5 Climate

The LPP project area experiences hot, dry summers and moderate air temperatures during winter months at the lower elevations, with cooler temperatures and snowfall at the higher elevations. Primary urban centers in the project area are Page, Arizona (elevation 4,300 feet), Kanab, Utah (elevation 4,970 feet), and the City of St. George, Utah (elevation 3,000 feet). Average monthly maximum temperatures for 2008, 2009, and 2010 (through the end of the field season), as compared to 30-year averages, are shown in Figures 2-3, 2-4, and 2-5, respectively (USU 2010; Weather Underground 2010).

Average total precipitation in the communities near the project area ranges from 6.46 inches in Page to 15.43 inches in Kanab annually. The 2008, 2009, and 2010 average annual precipitation for urban centers across the LPP corridor, as compared to 30-year averages, are provided in Figures 2-6, 2-7, and 2-8, respectively (USU 2010; Weather Underground 2010).

2.5.1 Climatic Effects on the Field Survey

Climatic factors affecting the field survey are local temperatures and precipitation throughout 2008, 2009, and 2010. Temperatures and precipitation during, and immediately prior to the 2009 and 2010 field surveys, would be expected to affect the onset of germination and the phenology of plant species occurring within the project corridor, and therefore the availability of individuals to be observed in the field. Temperatures and precipitation during 2008 have also been included in this discussion, as climatic conditions during the 2008 growing season would have influenced the quantity of seeds available for germination, and winter rains in late 2008 (and early 2009) would have affected germination rates. While climatic factors would have affected all targeted species, their effects were likely most pronounced on annuals occurring within the corridor. For instance, many of the targeted annual species depend upon winter precipitation for germination; therefore, winter precipitation is an important factor affecting the field survey. It is also important to note that the properties of the seed bank are not just the result of short-term climatic conditions, but of conditions experienced within the project area over multiple years, and resulting in the accumulation of seed over time. In addition to these variables, the seed bank is affected by non-climatic factors such as seed viability, seed dispersal, and predation.

Temperatures during 2008, 2009, and 2010 were similar to 30-year averages, with some notable differences. In all three cities, during 2008, maximum temperatures in May were lower than the 30-year average, while high temperatures in November were warmer than average. During 2009, maximum temperatures in May were higher than the 30-year average, which was followed by a considerably cooler than average June, with temperatures varying from 30-year averages by more than six and a half degrees Fahrenheit in St. George and Page.

During 2010, May temperatures were lower than the 30-year average, particularly in the area of St. George, where this temperature difference was approximately eight degrees Fahrenheit. Temperatures in Page and Kanab slightly exceeded 30-year averages in June, while St. George continued to see lower-than-average temperatures. By July and August, temperatures in all three cities exceeded 30-year averages.

Precipitation was more variable than temperatures from 30-year averages in 2008, 2009, and 2010. This variation is particularly notable during 2008 in the communities of Page and St. George, where precipitation exceeded the average in the early part of the year and at the end. Throughout 2009, precipitation was lower than the 30-year average in all four communities, with May being the only exception, when precipitation in Page and Kanab exceeded the average considerably. Also of note is the concentration of precipitation from April through September in the Kanab area, with no precipitation recorded prior to April. This contrasts sharply with trends over the 30-year average, in which precipitation is distributed throughout the year, with the highest amounts occurring in winter. A similar trend occurred in the Page area, with the majority of precipitation concentrated from May through September, and extremely high precipitation in May. Early 2010 saw higher than average precipitation levels in all cities but Kanab, with much higher levels in January in the vicinity of St. George. At the end of the 2010 survey, lower than average precipitation was experienced in Kanab, while higher than average precipitation occurred in Page and St. George.

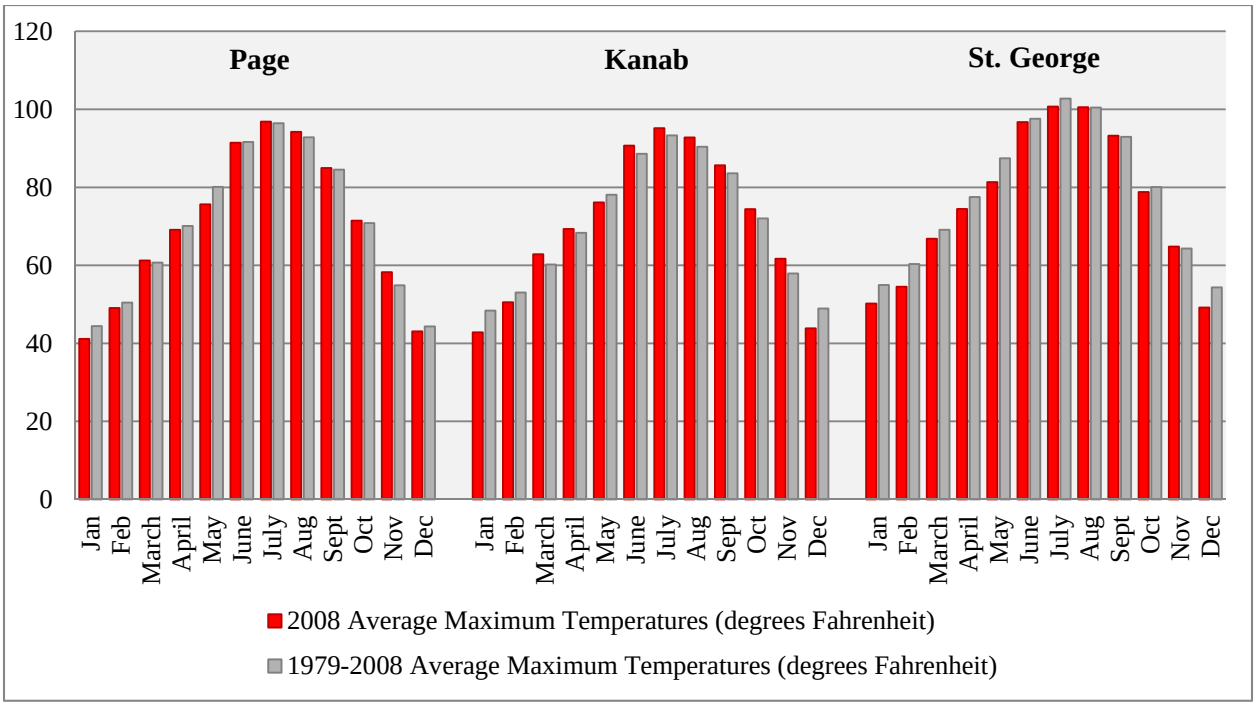


Figure 2-3
2008 Average Monthly Maximum Temperatures, as Compared to 30-year Averages

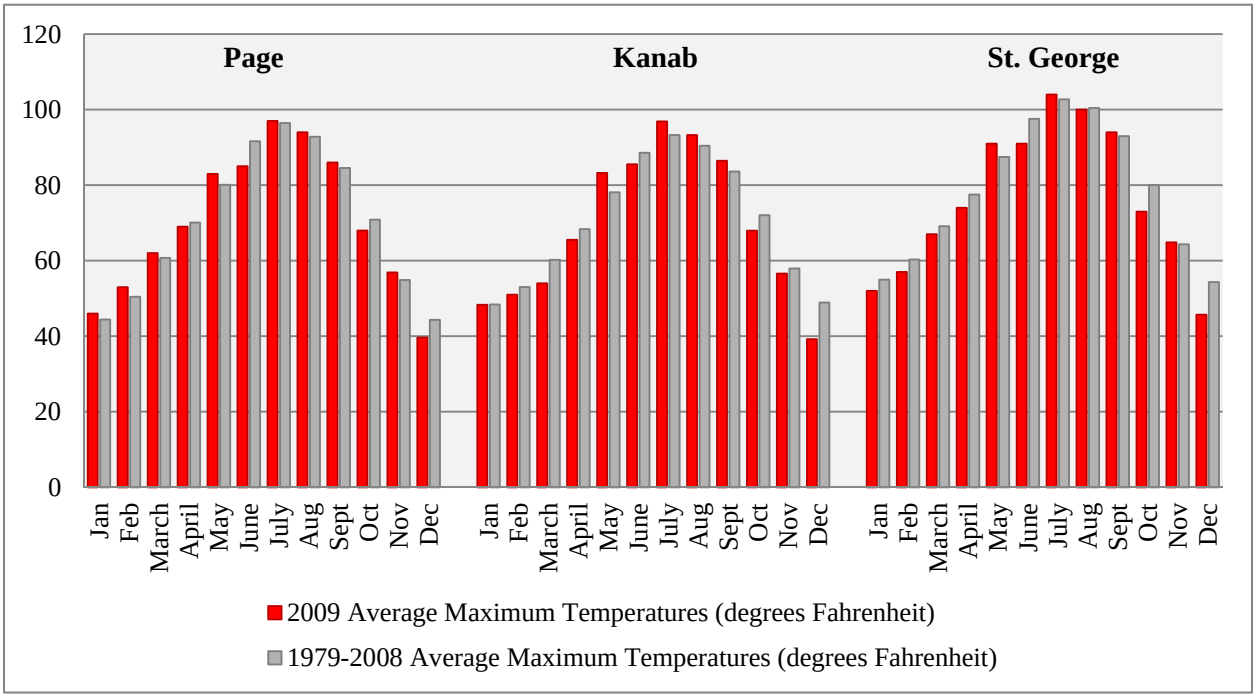


Figure 2-4
2009 Average Monthly Maximum Temperatures, as Compared to 30-year Averages

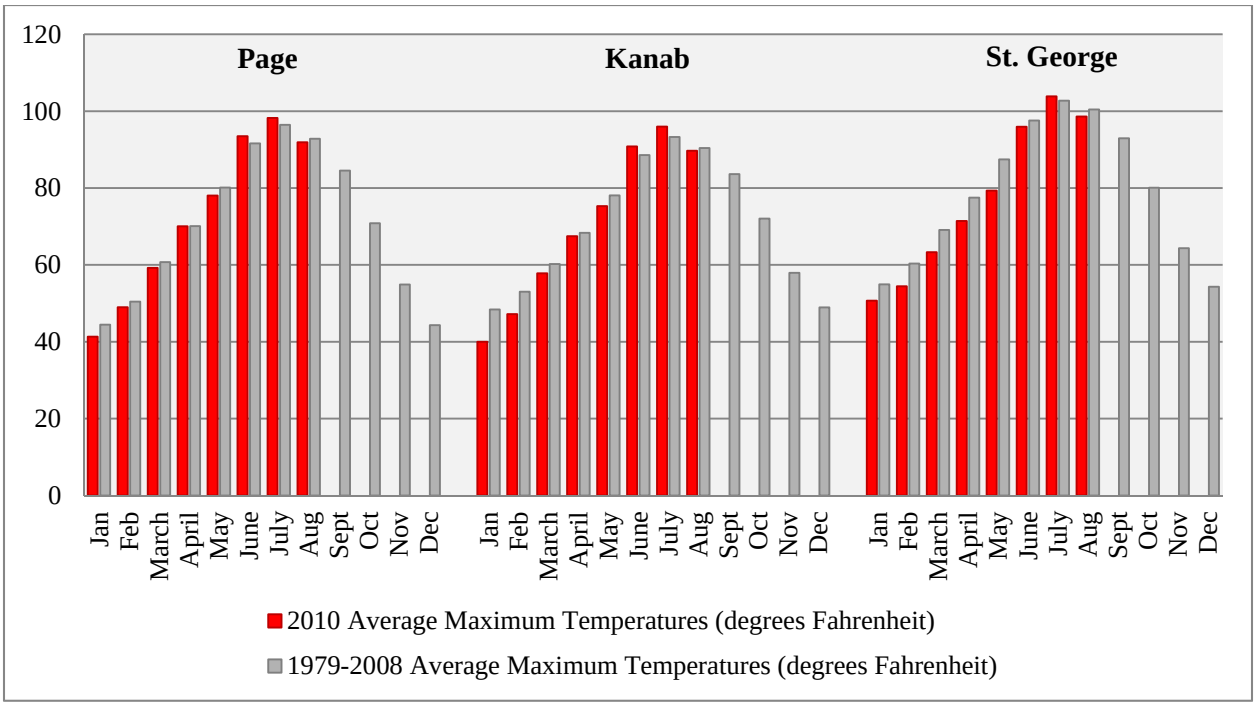


Figure 2-5
2010 Average Monthly Maximum Temperatures, as Compared to 30-year Averages

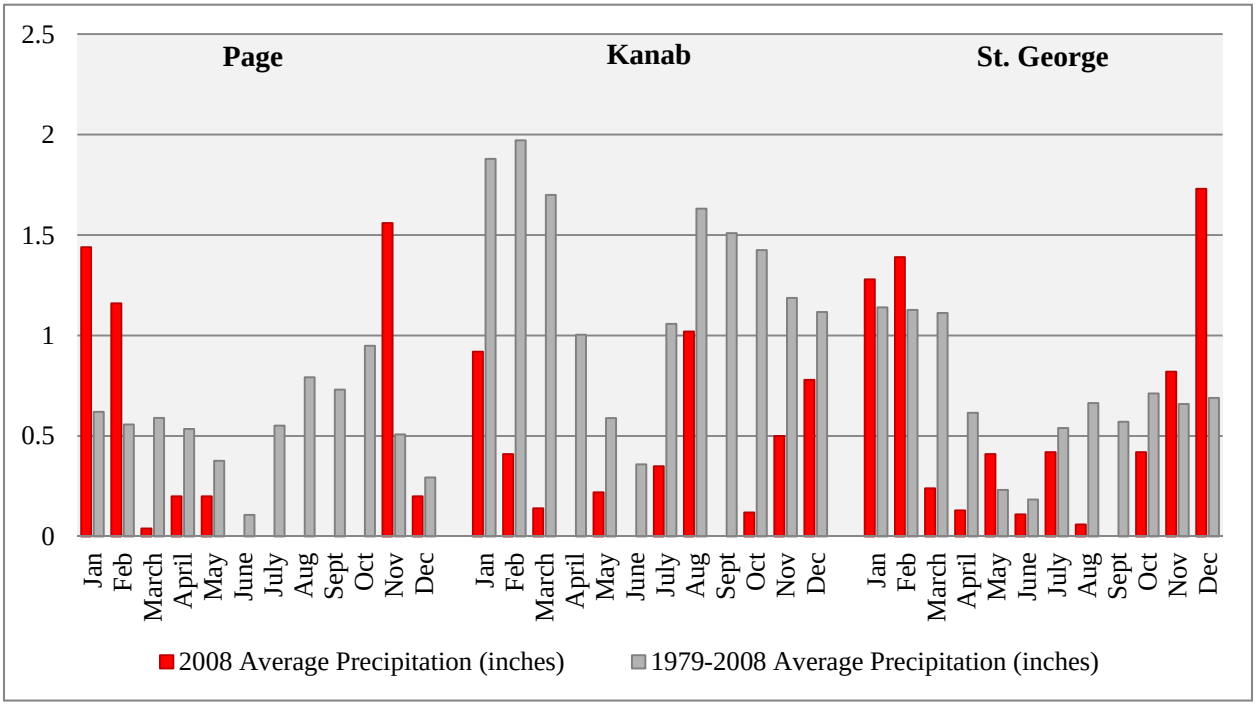


Figure 2-6
2008 Average Monthly Precipitation, as Compared to 30-year Averages

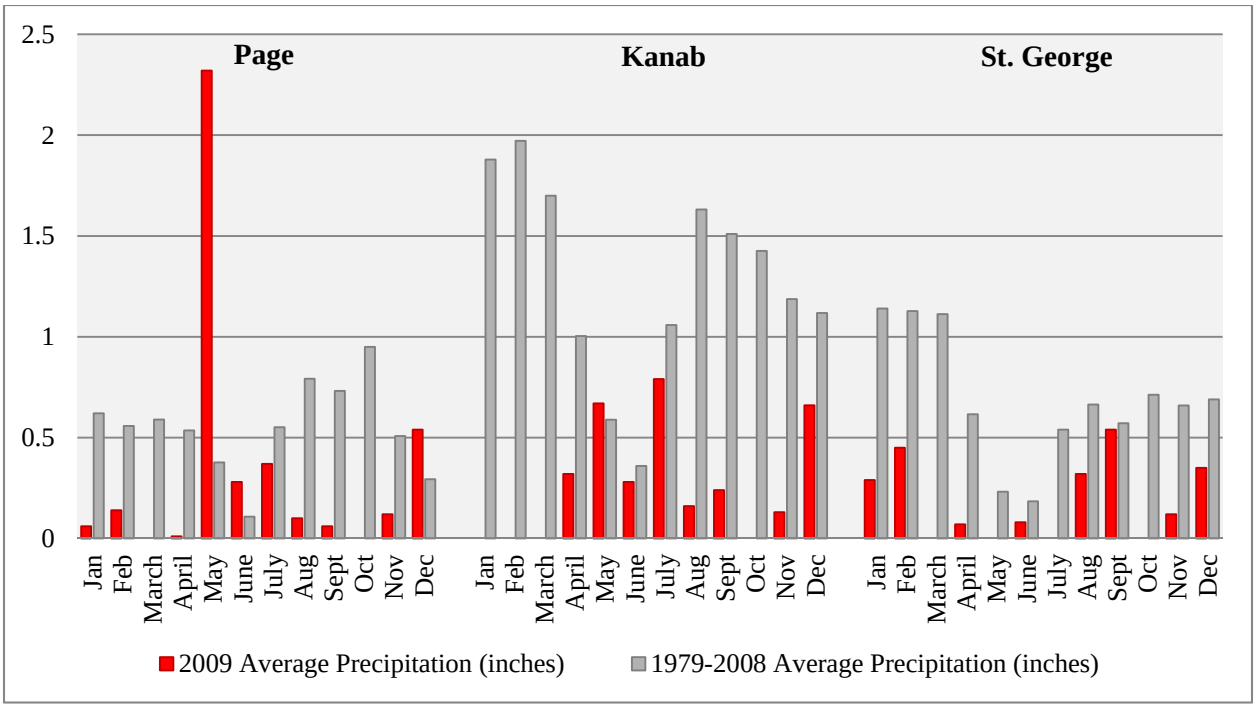


Figure 2-7
2009 Average Monthly Precipitation, as Compared to 30-year Averages

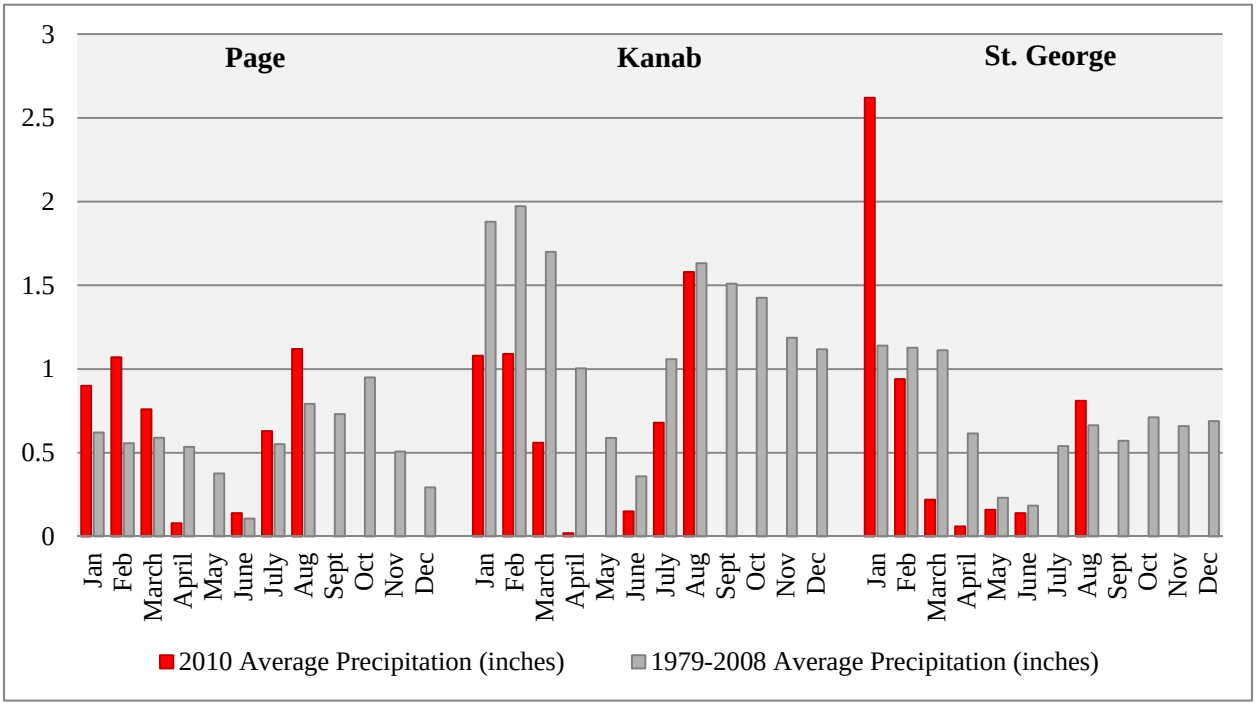


Figure 2-8
2010 Average Monthly Precipitation, as Compared to 30-year Averages

In 2008, lower than average high temperatures in May, and higher than average temperatures as late as November, would have created a long growing season, resulting in a high seed set. Additionally, high amounts of precipitation recorded in November and December of 2008, and in early 2009, particularly in Page and St. George, likely resulted in a high rate of germination of the annuals within the project area, in turn increasing the overall quantity of seed available in the seed bank for the 2009 season. Higher than average temperatures in early 2009 likely induced early germination, while late rains, particularly in Kanab and Page, extended the blooming period outside of that historically observed. The resulting effect was a wide field survey window in 2009, allowing surveys to begin early in the year and to extend late into the summer. The 2010 survey would have benefited from higher than average precipitation over the winter of 2009-2010. While lower than average temperatures in the early part of the 2010 field season, particularly around St. George, may have delayed the phenological period of spring flowering plants, the abundance of annuals, particularly *Phacelia pulchella* var. *atwoodii*, observed during the survey suggests that this effect was minimal. In order to optimize the probability of encountering target annual species, field work was adjusted to accommodate for climatic conditions wherever possible.

2.6 Survey Area

For purposes of the LPP special status plant species and noxious weed surveys, the survey area is defined as the alignment of the buried pipeline alternatives; other facilities associated with the pipeline such as hydro stations and reservoirs; transmission lines; and construction staging areas (Figure 2-9). The width of the study area for the linear elements was determined by the U.S. Fish and Wildlife Service (USFWS) based on a general evaluation of the geologic origin of soils, with larger survey corridors in areas with greater potential for occurrence of sensitive plant species. The survey corridors were established based on the pipeline or transmission center line: 150 feet on either side for a 300-foot-wide total width, or 300 feet on either side of the center line for a 600-foot-wide total width for areas with greater potential for special plant resources. Generally, the 300-foot wide corridors occurred between Lake Powell and the Cockscomb, and west of the Hurricane Cliffs. All other linear elements had a 600-foot wide survey corridor. The survey for special status plant species was undertaken concurrently with the noxious weed survey and vegetation community mapping.

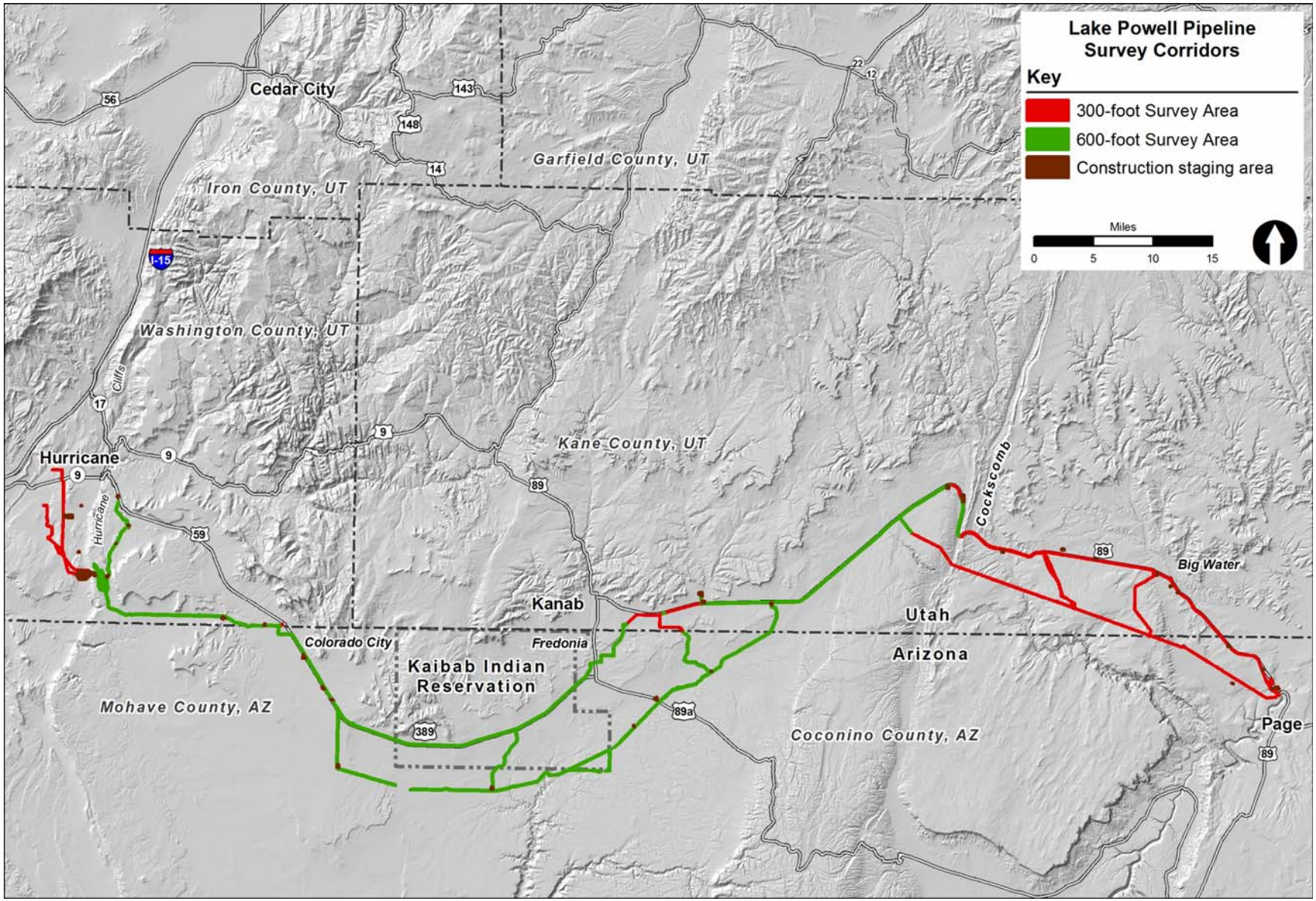


Figure 2-9
Survey Area and Construction Staging Areas Map

Chapter 3
Methodology

3.1 Pre-survey Preparations, Field Equipment, and Materials

Prior to conducting surveys for special status species and noxious weeds, the survey team performed a variety of activities to focus the field work, maximize efficiency and thoroughness in the field, and identify ways to facilitate post-survey data analysis and the interpretation of results.

In 2008, the pipeline design team led by MWH with representatives from USFWS, BLM, Arizona Game and Fish Department (AGFD) met to discuss an accelerated schedule for special status plant surveys within the pipeline right-of-way. Abundant rainfall during the winter of 2007 to 2008 was expected to promote germination of annual species resulting in increased flowering, making the likelihood of detecting these species during surveys higher. Logan Simpson was directed to conduct preliminary surveys targeting portions of the pipeline with the highest potentially suitable habitat for special status plants.

Pre-survey preparations for special status species and noxious weed surveys began with the development of a set of project area maps. Pipeline alternatives and alignments were overlaid on aerial and topographic maps using Geographic Information System (GIS) software (ArcGIS 9.2 and 9.3). Aerial maps with a 1:2,500 scale were produced for field use with sufficient scale and clarity to map landscape and vegetative features. In 2009, ecological systems predicted by the Southwest Regional Gap Analysis Project (SWReGAP) program were color coded as a dissolve onto the maps. Following the 2009 field season, it was determined that this color coding did not aid in vegetation community mapping and was removed for the 2010 field season. Topographic maps from 1:24,000 scale digital raster graphics (DRG) were produced to show elevations, natural features, and cultural features. Reconnaissance grade geologic mapping was overlaid onto the DRGs from state digital geology maps.

GIS software was also used to load the survey area onto Trimble, Juno, and Garmin Global Positioning System (GPS) units, in order to track surveyor locations while in the field. A data dictionary (electronic data collection template) was created to record pertinent information about special status species and noxious weeds identified during the field survey. The data fields within the data dictionary included a sampling unit code (unique identifying number for each plant or grouping of plants); a list of the 14 special status species and 20 noxious weed species most likely to be encountered; and a comment field. The data dictionary was loaded on the Trimble and Juno GPS units. Additional maps including gazetteers and atlases, BLM maps, State of Utah and Arizona maps, and real-time navigation mapping software were utilized to determine access points to the pipeline corridor.

Pre-survey activities for special status species surveys continued with the compilation of lists from appropriate federal and state land and resource management agencies. A list of threatened, endangered, proposed, candidate, and conservation agreement plant species with the potential to occur within Coconino and Mohave counties, Arizona, and Kane and Washington counties, Utah was obtained from the USFWS. A Sensitive Plant Species List was obtained from the BLM and a list of special status plants was provided for Glen Canyon National Recreation Area by the NPS.

The Kaibab Band of Paiute Indians provided a list of Plants of Cultural Concern to UDWRe. UDWRe consulted with the Kaibab Band of Paiute Indians during LPP Project scoping prior to developing the study plan in July 2008, and UDWRe consulted with Kaibab Band of Paiute Indians representatives regarding the draft study plan in October 2008. Comments received from the Kaibab Band of Paiute Indians were incorporated into the approved study plan. UDWRe requested permission from the Kaibab Band of Paiute Indians to perform field studies on the Kaibab-Paiute Indian Reservation in May 2009 and received permission from the Kaibab Band of Paiute Indians in May 2009. UDWRe initiated field studies in June 2009 with Tribal monitors observing the field work each day. UDWRe provided a Powerpoint presentation summarizing the field study results to the Kaibab Band of Paiute Indians on June 18, 2009. Additional follow-up field studies were performed on the Kaibab-Paiute Indian

Reservation in August and September 2009. Tribal monitors observed the August and September 2009 field studies,

These lists were used to compile an exclusion table containing 101 species of rare plants (Table 3-1). A literature review was then initiated for each species. Habitat preferences and the known and potential distribution of each species were compared to the habitats represented across the LPP project area. Key factors used to evaluate this potential included geographic range, elevation, vegetation community, and geologic formations. If the identified habitat preferences of special status species did not occur within the project area, those species were excluded from further evaluation (if information was inconclusive, the species was considered for surveys). Several species that currently do not have special status designations, but were recommended by resource agency botanists to be of concern, were also added to the table. The exclusion table was reviewed and approved by USFWS and BLM each year of the project. Hand-sized field information cards describing important habitat components and aids to identification were prepared for each special status plant. During the 2009 season, a total of 68 species were determined to have the potential to fall within the pipeline corridor; therefore, surveys focused on these 68 species. After the 2009 survey season was completed, 18 of these species were excluded from further evaluation because no suitable habitat was found. In 2010, with the addition of new pipeline and transmission line alignments, 8 new species were added to the exclusion table, for a total of 58 special status plant species for which surveys were conducted during the 2010 survey season. Seven of these species were previously identified as sensitive species or species of concern by agency biologists, though they do not currently have any recognized special status. Only the 51 species that currently have a recognized special status are addressed in this report. The Kaibab Band of Paiute Indians' list of Plants of Cultural Concern included a total of 72 species. These plants were surveyed for along with the other special status species identified by the BLM, NPS, and USFWS.

Table 3-1
Special Status Plant Species Exclusion List for the Lake Powell Pipeline Project Area

Page 1 of 11

Species Name	**Status[1]**	**Habitat Requirements**	**Potential for Presence in Project Area**
Acer glabrum (Rocky Mountain maple) Aceraceae	GCNRA G5	Found in pinyon-juniper, mountain brush, sagebrush, ponderosa pine, Douglas fir, lodgepole pine, and spruce-fir communities at 5,500 to 10,400 feet in all UT counties. Range also includes Coconino, Navajo, Apache, Pima, Cochise, and Graham counties, (AZ, and Alaska south to California, New Mexico, and Nebraska.	No (No suitable habitat)
Acer grandidentatum (Bigtooth maple) Aceraceae	GCNRA G5	Found in oak, oak-maple, sagebrush, Douglas fir, and white fir communities. In Utah between 4,200 and 9,220 feet. In all UT counties except Daggett, Emery, and Wayne; from Idaho and Wyoming, south into Nevada, Mexico, Oklahoma, and AZ including Mohave and Coconino counties.	No (No suitable habitat)
Aquilegia loriae (Lori's columbine) Ranunculaceae	BLM UT	Found in hanging gardens, wash bottoms, and sand-seeps on moist canyon walls in Moenave, Navajo, and possibly Kaiparowits sandstone formations; near ponderosa pine and oak communities. In the Straight Cliffs of Kane County, UT at elevations between 5,840 and 6,283 feet. Also in adjacent Coconino County, AZ.	No (Outside elevation range)
Aralia racemosa (American spikenard) Araliaceae	GCNRA G5	Found in crevices in sandstone and on sandy detritus, including shaded defiles of Zion Canyon. At 4,000 feet in Washington County, UT. Known in Coconino, Navajo, Apache, Yavapai, Gila, Graham, Pima and Cochise counties, AZ and eastward into NM.	Yes

Table 3-1
Special Status Plant Species Exclusion List for the Lake Powell Pipeline Project Area

Species Name	Status[1]	Habitat Requirements	Potential for Presence in Project Area
Arctomecon humilis (Dwarf bear-poppy) Papaveraceae	ESA LE	Restricted to the Schnabkaib, Middle Red, and Shinarump members of the Moenkopi Formation on rolling hills and bluffs in mixed warm desert shrub communities. From 2,590 and 3,000 feet in Washington County, UT.	Yes
Asclepias welshii (Welsh's milkweed) Asclepiadaceae	ESA LT, ESA CH	Found on open, sparsely vegetated, semi-stabilized sand on active dunes, in sagebrush, juniper and pine communities of the Great Basin. Occupies both the crest and lee slopes of dunes derived from Navajo Sandstone from 5,500 to 6,300 feet in elevation. Found from the Coral Pink Sand Dunes and Sand Hills in Kane County, UT and in Coconino, Apache, and, historically, Navajo and Counties, AZ.	Yes
Astragalus ampullarioides (Shivwits milkvetch) Fabaceae	ESA LE, ESA CH	Found in warm desert shrub, creosote bush, and juniper communities on gypsiferous substrates in the Chinle Formation and Moenave between 3,400 and 3,800 feet in Washington County, UT. Occupied critical habitat exists at Pahcoon Spring Wash, east of St. George in Coral Canyon, Quail Creek Reservoir, Silver Reef, and Zion National Park.	Yes
Astragalus ampullarius (Gumbo milkvetch) Fabaceae	BLM UT	Found in clay soils of the Triassic Chinle and Tropic Shale formations between 3,180 and 5,415 feet. In Mohave and Coconino counties, AZ; and in east Washington, and Kane counties, UT (including the Cockscomb area).	Yes
Astragalus cremnophylax var. *cremnophylax* (Sentry milkvetch) Fabaceae	ESA LE	Found in unshaded openings of pinyon-juniper-cliffrose and ponderosa pine communities on a white layer of exposed Kaibab limestone in cracks and pockets with little soil. Found on north and south rims of Grand Canyon National Park, Coconino County, AZ.	No (Outside geographical range; however, there is a possibility of a similar "*cremnophylax*" on Kaibab limestone benches at the Kanab Creek)
Astragalus cremnophylax var. *hevronii* (Marble Canyon milkvetch) Fabaceae	BLM AZ	Found on rim-rock benches in crevices and depressions with shallow soil on exposed Kaibab Limestone outcrops. In Great Basin desert scrub at 5,420 feet. Known only on the east rim of Marble Canyon, Coconino County, AZ.	
Astragalus cremn phylax var. *myriorraphus* (Cliff milkvetch) Fabaceae	BLM AZ	Found on rim-rock benches of gray-white Kaibab Limestone in crevices and depressions with shallow soil. Found in Great Basin conifer woodland; pinyon-juniper woodland at 6,200 feet, and may be found up to 7,900 feet. Typically on points, which extend out from vertical canyon/cliff edge escarpment beyond the rocky talus that sloughs from adjacent slopes. Known in the Buckskin Mountains (northern edge of the Kaibab Plateau), Coconino County, AZ.	
Astragalus cutleri syn. *A. preussii* var. *cutleri* (Cutler milkvetch) Fabaceae	GCNRA G1	Found in saltbush and blackbrush communities on Permian Formations (and on Triassic Chinle and its Mossback member and Moenkopi formations) from 3,800 to 4,100 feet in San Juan County, UT. Navajo Nation reports habitat limited to warm desert shrub communities on sandy, seleniferous soils with level to moderate slopes on the Shinarump and Chinle formations from 3,700 feet to 4,700 feet in elevation. Known in canyons subsequent to the San Juan Arm of Lake Powell and Copper Canyon on Navajo Nation Tribal Lands. May also occur in Northern AZ. Blooms April to May.	No (Outside geographic range)

Table 3-1
Special Status Plant Species Exclusion List for the Lake Powell Pipeline Project Area

Species Name	Status[1]	Habitat Requirements	Potential for Presence in Project Area
Astragalus geyeri var. *triquetrus* (Three-cornered milkvetch) Fabaceae	BLM AZ	In creosote bush scrub community where it is limited to washes, small pockets of wind-deposited sand, and low lying, open flat surfaces on stabilized sand . From 1,100 to 2,400 feet; adjacent to Lake Mead and its tributary valleys; in Sand Hollow Wash, Horsethief Canyon, and Beaver Dam Wash in Mohave County, AZ.	No (Outside elevation range)
Astragalus holmgreniorum (Paradox [Holmgren] milkvetch) Fabaceae	ESA LE, ESA CH	Found in Great Basin desert scrub communities at approximately 2,690 to 2,800 feet; in well drained, shallow, gravelly sandy loam soils on alluvial fans and just below limestone rock outcrops. Restricted to the Santa Clara and Virgin River drainages from Washington County, UT extending into Mohave County, AZ.	Yes
Astragalus monumentalis (Monument milkvetch) Fabaceae	GCNRA G2	Found in pinyon-juniper and Great Basin desert scrub communities in crevices and shallow depressions in rimrock and other slickrock sites on Cutler, White Rim, and Cedar Mesa Sandstone formations between 3,970 and 6,200 feet. Known from Garfield and San Juan, New Mexico. Blooms late April-June.	No (Outside geographic range)
Astragalus oophorus var. *lonchocalyx* (Pink egg milkvetch) Fabaceae	BLM UT	Found in sandy substrates in pinyon-juniper, sagebrush, and mixed Great Basin desert scrub communities at 5,800 to 7,550 feet. Known from Beaver, Iron, and Washington counties, UT; and west into Lincoln County, Nevada.	No (Outside elevation range)
Astragalus striatiflorus (Escarpment milkvetch) Fabaceae	BLM UT	Found in inter-dune valleys, sandy depressions on ledges, and on bars and terraces in stream channels. In pinyon-juniper, ponderosa pine, and sandy desert shrub communities; between 4,920 and 6,562 feet. In eastern Washington, and Kane counties, UT; and Coconino County, AZ.	Yes
Astragalus toanus var. *scidulus* (Diamond Butte milkvetch) Fabaceae	BLM AZ	Associated with seleniferous, red Moenkopi soils around the base of buttes in Great Basin desert scrub, with scattered juniper and pinyon; between 4,900 and 5,000 feet. Known from the bases of Diamond Butte and Twin Butte at the north end of Upper Hurricane Valley in Mohave County, AZ (northwest of Mount Trumbull). Grows only in years with sufficient rainfall; blooms late September to November.	No (Outside geographic range)
Camissonia atwoodii (Atwood's camissonia) Onagraceae	GCNRA G2	Found in Great Basin desert scrub communities on slopes and talus in clay soils of the Tropic Shale and Carmel formations. Between 3,800 and 5,000 feet. Endemic to the Last Chance drainage, at Straight Cliffs, and Smokey Mountain in east Kane County, UT. Grows only in years with sufficient rainfall; blooms late September to November.	No (Outside geographic range)
Camissonia bairdii (Baird camissonia) Onagraceae	BLM UT	Found in blackbrush, and pinyon-juniper communities. Found in Washington County, UT between 3,900 and 4,300 and in Apache County, AZ. A UT type was described between Manganese Wash and Miner's Canyon, approximately 2 miles east of Gunlock. Blooms late April-May.	Yes
Camissonia gouldii (Diamond Valley suncup) Onagraceae	BLM UT	Collected in UT at 3,500 feet in volcanic ash, or sandy pockets in basalt, with *Phacelia palmeri*, in Washington and Millard counties. Restricted to volcanic ash deposits from 3,440 feet to 5,410 feet in Mohave and east-central Coconino counties, AZ.	Yes

Table 3-1
Special Status Plant Species Exclusion List for the Lake Powell Pipeline Project Area

Species Name	Status[1]	Habitat Requirements	Potential for Presence in Project Area
Carex specuicola (Navajo sedge) Cyperaceae	ESA LT ESA CH	Found in pockets of silty soils at shaded seeps and springs on vertical cliffs and alcoves of pink-red Navajo Sandstone; from 5,700 to 6,000 feet elevation. Endemic to the Navajo Nation, Coconino, Navajo, Apache counties, AZ and San Juan County and potentially Kane County, UT.	No (Outside geographic range)
Ceanothus greggii var. *vestitus* (Mohave ceanothus) Rhamnaceae	GCNRA G5	Found in mixed desert shrub, pinyon-juniper, and mountain brush communities from 4,000 to 9,415 feet in UT and 3,445 to 8,040 feet in AZ. Known from CA to southwest UT (Iron and Washington counties) and Mohave County, AZ.	Yes
Cimicifuga arizonica (Arizona bugbane) Ranunculaceae	CA	Associated with moist, loamy, fertile, rich soils high in humus content; in canyons and crevices with deep shade and high humidity; between 5,000 and 7,000 feet. From Coconino and Gila counties, AZ.	No (Outside geographic range)
Cirsium virginense (Virgin thistle) Asteraceae	BLM UT	Associated with saline seeps and stream terraces; sandy or gravelly (often alluvial) moist, alkaline slopes; between 1,650-1,895 feet in Mohave County, AZ and 2,800-3,100 feet in Washington County, UT. Also known from Nevada.	No (No suitable habitat present)
Cladium californicum (California sawgrass) Cyperaceae	GCNRA G4	Found in alkaline freshwater marshes, swamps, hanging gardens, and springs; between 3,690 and 3,775 feet. In hanging gardens above the high water line at Lake Powell. Known from Mohave County, AZ; Kane and San Juan counties, UT; California and Nevada to Texas. Fruiting and flowering late-spring to summer.	Yes
Cornus sericea (Red-osier dogwood) Cornaceae	GCNRA G5	Associated with streambanks and other moist sites; in UT between 4,495 and 10,000 feet. Found in all Utah counties, and in AZ including Coconino, Navajo, and Apache counties; widespread in North America.	Yes
Cryptantha semiglabra (Smooth catseye) Boraginaceae	BLM UT	Associated with arid red detrital clay soils and gray shales of the Moenkopi Formation. In Great Basin desert scrub, sagebrush, and pinyon-juniper communities. Elevation range from 4,900 to 5,675 feet in Washington County, UT; and 4,600 to 4,900 feet in extreme northern Coconino County, AZ; and adjacent Mohave County, AZ.	Yes
Cycladenia humilis var. *jonesii* (Jones cycladenia) Apocynaceae	ESA LT	Found in Great Basin desert scrub and associated with juniper, buckwheat, and Mormon tea; on gypsiferous, saline soils of the Cutler, Summerville, and Chinle formations. Elevation range from 4,390 to 6,000 feet. Known in Garfield, Grand, Emery, and Kane counties, UT and Coconino and Mohave counties, AZ.	Yes
Cymopterus acaulis var. *higginsii* syn. *C. higginsii* (Higgins biscuitroot) Apicaceae	GCNRA G1	Found in Great Basin desert scrub communities; often on sandy alluvium, shale members of the Straight Cliffs Formation, and xeric saline soils of the Tropic Shale Formation. Elevation range between 5,000 and 5,740 feet. Endemic to Kane County, UT. Purple flowers, blooming in late March-May.	No (Outside geographic range)

Table 3-1
Special Status Plant Species Exclusion List for the Lake Powell Pipeline Project Area

Species Name	Status[1]	Habitat Requirements	Potential for Presence in Project Area
Cystopteris utahensis syn. *C. fragilis* (Utah brittle-fern) Polypodiaceae	GCNRA G3	Found on the calcareous cliffs of the Weber Formation, particularly on sandy ledges and in crevices in AZ. Found from 4,200 to 11,515 feet in UT; and from 4,262 to 8,852 feet in Coconino, Yavapai, and Apache counties, AZ. Range includes Colorado, New Mexico, and disjunct areas in western Texas.	Yes
Dalea flavescens var. *epica* (Hole-in-the-Rock prairie-clover) Fabaceae	GCNRA G2	Associated with sandstone bedrock and sandy areas in blackbrush and Great Basin desert scrub communities. Elevation range from 4,700 to 5,000 feet. Limited to east Garfield and southwest San Juan counties, UT.	No (Outside geographic range)
Dodecatheon pulchellum var. *zionense* (Zion shooting star) Primulaceae	GCNRA G5	Associated with seeps and hanging gardens at an elevation range between 3,700 and 4,200 feet. Endemic to Kane, Washington and possibly San Juan counties, UT. Blooms April to May.	No (No suitable habitat present)
Echinocactus polycephalus var. *xeranthemoides* (Kanab barrel cactus) Cactaceae	GCNRA G5	Found in Mojave desert scrub, Great Basin desert scrub and pinyon- juniper communities on rocky hills, slopes, and ledges of canyons, derived from igneous and calcareous substrates. Elevation range from 1,800 to 6,480 feet. Known from Mohave and Coconino counties, AZ (including Lee's Ferry in the GCNRA); and Kane County, UT. Flowering June-August.	Yes
Enceliopsis argophylla (Silverleaf sunray) Asteraceae	BLM AZ	Found from clay and gypsum cliffs to gravelly slopes and sandy washes. Collected on limestone substrates, dry northeast slopes (10 percent+/-) and sandy washes in Mohave County, AZ from about 705 – 3,400 feet. Known on the Schnabkaib member of the Moenkopi Formation in Washington County, UT at 4,100 feet, and known in Clark County, Nevada at 1,800 feet.	Yes
Epilobium nevadense (Nevada willowherb) Onogarceae	BLM UT	Found in pinyon-juniper and oak-mountain mahogany communities; on limestone or quartzite. Between 4,921 and 8,800 feet. Iron, Washington, and Millard counties, UT; and into Nevada.	No (No suitable habitat present)
Erigeron kachinensis (Kachina daisy) Asteraceae	GCNRA G1	Distribution is divided between: a) seeps, springs, and hanging gardens between 5,519 to 6,201 feet in White Canyon, Dark Canyon, and Elk Ridge of the Abajo Mtns (near Monticello, UT); and b) montane sites with pinyon-juniper, ponderosa pine, and Douglas fir communities between 5,249 and 8,000 feet. In Garfield and San Juan counties, UT; and Montrose County, Colorado.	No (Outside geographic range)
Erigeron zothecinus syn. *E. pumilus* ssp. *Concinnoides* (Alcove daisy) Asteraceae	GCNRA G2	Found in saline seeps and hanging gardens on vertical walls of alcove, bench lands, and along drainages with oak, skunkbush, golden aster, and less commonly, with ponderosa pine; between 3,700 feet and 7,300 feet. Known from east Kane, Garfield, Grand, and San Juan counties, UT. Blooms late May to June.	No (No suitable habitat present)

Table 3-1
Special Status Plant Species Exclusion List for the Lake Powell Pipeline Project Area

Species Name	Status[1]	Habitat Requirements	Potential for Presence in Project Area
Eriogonum viscidulum (Sticky wild buckwheat) Polygonaceae	BLM AZ	Found in low dunes, washes, and areas of loose sandy soils within Mojave desert scrub. Elevation range from 1,500 feet to 2,500 feet. Known in extreme northwest Mohave County, AZ and into Nevada.	No (Outside geographic range)
Euphorbia aaron-rossii (Ross's spurge) Euphorbiaceae	GCNRA G4	Found in river canyons, usually in relatively loose, sandy soils of river bars and sand dunes of the Coconino Sandstone Formation; and occasionally on talus slopes, rock ledges, and boulders of the Redwall Limestone Formation. Elevation range from 2,160 to 4,200 feet. Known in Marble Canyon, along the east side of Grand Canyon and the canyon of the Little Colorado River; Coconino County, AZ.	No (Outside geographic range)
Euphorbia nephradenia (Utah spurge) Euphorbiaceae	BLM UT	Found in mat-saltbush, blackbrush, Mormon tea, and mixed sandy desert shrub communities on Tropic Shale and Entrada formations. Between 3,790 and 4,800 feet; in Emery, Garfield, Kane, and Wayne counties, UT.	Yes
Gilia latifolia var. *imperialis* syn. *G. imperialis* (Cataract gilia) Polemoniaceae	BLM UT, GCNRA G5	Found in shadscale and other mixed desert shrub communities, especially in wash bottoms and at the bases of ledges; from 3,800 to 5,220 feet. Known from Emery, Garfield, Kane, San Juan, and Wayne counties, UT. Flowers June through October.	Yes
Habenaria zothecina syn. *Platanthera zothecina* (Alcove bog-orchid) Orchidaceae	GCNRA G2	Found in seeps and hanging gardens, and on moist stream banks in mixed desert shrub, pinyon-juniper, and oakbrush communities. Known from Emery, Garfield, Grand, San Juan, and Uintah counties, UT from 4,000 to 6,220 feet; and Coconino, Apache, and Navajo counties, AZ from 3,950 to 6,400 feet; and from northwest Colorado.	Yes
Haplopappus crispus (Pine Valley goldenbush) Asteraceae	BLM UT	Found in ponderosa pine, spruce-fir, mountain mahogany, and aspen communities; between 8,100 and 10,000 feet. Endemic to the Pine Valley Mountains of Washington County, UT. Blooms August- October.	No (Outside elevation range)
Haplopappus zionis (Cedar Breaks goldenbush) Asteraceae	BLM UT	Found in spruce-fir and ponderosa pine communities; mostly on limestone members of the Cedar Breaks (Claron limestone) Formation. Elevation range between 8,000 and 10,121 feet. Found in Garfield, Iron, and Kane counties, UT. Blooms mid July-August.	No (Outside elevation range)
Imperata brevifolia (Satintail grass) Poaceae	GCNRA G5	Found along stream sides and other moist places. Known from 1,200 to 6,000 feet in AZ (including Mohave and Coconino counties and at Grand Canyon, Lake Havasu Canyon, Parker Canyon Lake, Sonoita Creek, and the Pajarito Mountains), and from 3,700 to 3,800 feet in UT (including San Juan County at 3,700 feet), California, Texas, and Mexico.	Yes
Jamesia americana var. *zionis* (Zion jamesia) Saxifragaceae	BLM UT	Found in hanging gardens, sandstone crevices, and cliff sides and bases in pinyon-juniper, oak, and ponderosa pine communities from 4,200 to 6,000 feet. Known from Zion Canyon NP and South Fork Indian Canyon, 7 miles west of Kanab in Washington and Kane counties, UT.	Yes

Table 3-1
Special Status Plant Species Exclusion List for the Lake Powell Pipeline Project Area

Species Name	Status[1]	Habitat Requirements	Potential for Presence in Project Area
Leersia oryzoides (Rice cutgrass) Poaceae	GCNRA G5	Found in wet, heavily vegetated sites along waterways or in marshes. Found below 4,600 feet in Davis and Weber counties, UT; and from Canada, throughout the United States, and into Mexico	No (Outside geographic range)
Lepidium montanum var.*claronense* (Claron pepperplant) Brassicaceae	BLM UT	Found in sagebrush, pinyon-juniper, and ponderosa pine/bristlecone pine communities on the Claron Member of the Wasatch Limestone Formation and other fine-textured substrates. Between 6,400 and 8,000 feet in the Paunsaugunt and Table Cliff Plateaus in Garfield, Kane, and Piute counties, UT.	No (Outside geographic range)
Lesquerella tumulosa syn. *Physaria rubicundula* var. *tumulosa* (Kodachrome bladderpod) Brassicaceae	ESA LE	Found on white, semi-barren shale knolls of the Winsor Member of the Carmel Formation, among scattered juniper in Bouteloua grasslands. Elevation range between 6,594 and 8,000 feet; Kane County, UT.	No (Outside elevation range)
Lomatium graveolens var. *clarkia* (Clark's lomatium) Apiaceae	BLM UT	Found in oak, serviceberry, and ponderosa pine communities on Carmel Limestone and Navajo Sandstone. Elevation between 6,000 and 7,000 feet; Washington County, UT.	No (Outside of elevation range)
Lycopus americanus (American bugleweed) Laminaceae	GCNRA G5	Found in marshes, wetlands, and other wet sites in palustrine and riparian habitats. In Utah between 4,000 and 7,612 feet; in Box Elder, Cache, Duchesne, Grand, Salt Lake, Uintah, and Utah counties; and Navajo and Apache counties, AZ. Also known from Newfoundland to British Columbia, south to Florida, Texas, New Mexico, and California.	No (Outside geographic range)
Lupinus caudatus var. *cutleri* (Cutler's spurred lupine) Fabaceae	BLM UT	Found in pinyon-juniper woodlands at 5,150 feet along the Cockscomb in Kane County, and from Garfield, Grand, and San Juan counties, UT. Also known from Defiance in Apache County, AZ, Colorado and New Mexico.	Yes
Mentzelia memorabalis (September 11 stickleaf) Loasaceae	BLM AZ	Grows on dry, sparsely vegetated, gypsum-clay outcrops from 4,689 to 5,197 feet in elevation. Endemic to northern Mohave County, AZ, in the Clayhole Wash drainage between Colorado City and Mount Trumbull.	Yes
Oenothera murdockii (Chinle evening primrose) Onagraceae	BLM UT	Found in pinyon-juniper communities on red-purple or gray clay silty barrens of the Chinle, and possibly the adjacent Moenkopi formations. Between 4,429 and 5,740 feet; in Kane and Washington counties, UT. Blooms April-May.	Yes
Ostrya knowltonii (Western hophornbeam) Betulaceae	GCNRA G3	Found at the bases of monoliths, shaded defiles, and hanging gardens in sandstone areas. In Utah between 4,019 and 5,610 feet. Found in Garfield, Grand, Kane, and San Juan counties, UT; Mohave and Coconino counties, AZ; New Mexico; and Texas.	Yes
Packera franciscana syn. *Senecio franciscanus* (San Franscisco Peaks ragwort) Asteraceae	ESA LT, ESA CH	Found above spruce-fir and pine forests on talus slopes above 10,900 feet on the San Francisco Peaks; Coconino County, AZ. Designated critical habitat is San Francisco Peaks.	No (Outside geographic range)

Table 3-1
Special Status Plant Species Exclusion List for the Lake Powell Pipeline Project Area

Species Name	Status[1]	Habitat Requirements	Potential for Presence in Project Area
Pediocactus bradyi (Brady pincushion cactus) Cactaceae	ESA LE	Found on benches and terraces in Navajo desert near Marble Canyon in Kaibab limestone chips; from 3,850 to 4,500 feet. Found up to three miles from Marble Canyon rims, Coconino County, AZ.	No (Outside geographic range)
Pediocactus paradinei (Kaibab or Paradine pincushion cactus) Cactaceae	CA, BLM AZ	Found on fairly open, mostly level sites on alluvial fans, valley bottoms, and ridge tops on gravelly Kaibab limestone soils. In grassland, desert scrub, pinyon-juniper woodland, and lower ponderosa pine stringers, from 5,000 to 7,200 feet. Only on the east side of the Kaibab Plateau (the East Kaibab Monocline) to the western edge of House Rock Valley; Coconino County, AZ.	No (Outside geographic range)
Pediocactus peeblesianus var. *fickeiseniae* (Fickeisen plains cactus) Cactaceae	ESA C	Found on exposed layers of gravelly Kaibab limestone and Moenkopi Formation on canyon margins or hills in grassland and desert scrub communities; from 4,000 to 5,940 feet; Coconino, Navajo, and Mohave counties, AZ.	Yes
Pediocactus sileri (Siler pincushion cactus) Cactaceae	ESA LT	Found in desert shrub communities on gypsiferous clay and sandy soils of the Moenkopi Formation, and sometimes Chile and Kaibab Formations. Elevation range from 2,800 to 5,625 feet as reported by USFWS and from 2,950 to 5,220 feet in UT. In Kane and Washington counties, UT and Coconino and Mohave counties, AZ.	Yes
Pediomelum aromaticum var. *barnebyi* (Indian breadroot) Fabaceae	BLM UT	Found in pinyon-juniper and silver buffaloberry communities on fine- textured substrates of the Triassic Chinle Formation at 4,430 feet in Kane and Washington County, UT and Mohave County, AZ (from Short Creek east to Moccasin to Kanab).	Yes
Pediomelum epipsilum (Kane breadroot) Fabaceae	BLM UT	Found in pinyon-juniper woodland communities. In Utah from 4,000 to 5,500 feet on the Chinle and Moenkopi formations in Kane County, UT and adjacent Mohave County, AZ.	Yes
Penstemon ammophilus (Sandloving penstemon) Scrophulariaceae	BLM UT	Found in blowsand derived from Navajo Sandstone (where long-lived clumps act as sand stabilizers) and in ponderosa pine and mixed shrub communities; between 5,900 and 7,220 feet. Found in Garfield, Kane and Washington counties, UT.	Yes
Penstemon distans (Mt. Trumbull beardtongue) Scrophulariaceae	BLM AZ	Found in gravelly Kaibab limestone on mesa tops in pinyon-juniper woodlands and steep north-facing canyon slopes of the Supai Formation in Mojave desert scrub. Elevation range from 3,900 to 5,200 feet. Known from the southeastern edge of the Shivwitz Plateau and in Whitmore, Parashaunt, and Andrus canyons of Mohave County, AZ.	No (Outside geographic range)
Penstemon franklinii (Franklin's penstemon) Scrophulariaceae	BLM UT	Found in needlegrass, matchweed, and black sagebrush communities. From 5,400 to 5,910 feet; in Cedar Valley, Iron County, UT.	No (Outside geographic range)
Penstemon petiolatus (Sheep Range or crevice beardtongue) Scrophulariaceae	BLM AZ	Found on limestone cliffs, ledges, boulders, and in crevices in Joshua tree, blackbrush, creosote bush, indigo bush, and pinyon-juniper communities. From 2,000 to 4,525 feet. Known from the Virgin Mountains and Beaver Dam Mountains of Mohave County, AZ; and in adjacent Washington County, UT and into Nevada.	No (Outside geographic range)

Table 3-1
Special Status Plant Species Exclusion List for the Lake Powell Pipeline Project Area

Species Name	Status[1]	Habitat Requirements	Potential for Presence in Project Area
Penstemon pinorum (Pinyon penstemon) Scrophulariaceae	BLM UT	Found in pinyon-juniper, mountain mahogany, Mormon tea, oak, sagebrush, and less commonly greasewood communities; often on Claron Limestone or its gravels. Between 5,575 and 6,515 feet. Endemic to Pine Valley Mountains, Iron County, UT.	No (Outside geographic range)
Pertiyle specuicola (Alcove rock daisy) Asteraceae	GCNRA G1	Found in hanging garden communities in narrow canyons, alcoves, and at cliff bases in Navajo Sandstone, and Cedar Mesa Sandstone formations. From 3,700 to 4,200 feet. Grand and San Juan counties, UT.	No (Outside geographic range)
Petalonyx parryi (Parry petalonyx) Loasaceae	BLM UT	Found in shadscale, indigo bush, creosote bush, and bursage communities on Chinle and Moenkopi outcrops from 2,550 to 4,000 feet in Washington County, UT. Range extends into northern Mohave and western Coconino counties, AZ; also Nevada and California.	Yes
Phacelia cronquistiana (Cronquist phacelia) Hydrophyllaceae	BLM UT	Found on clay outcrops in pinyon-juniper-sagebrush and ponderosa pine communities. From 6,300 to 6,900 feet in western Kane County, UT. Range extends into Navajo and Apache counties, AZ.	No (Outside elevation range)
Phacelia howelliana (Howell's phacelia) Hydrophyllaceae	GCNRA G3	Found in warm desert shrub and pinyon-juniper communities on clay and basalt hills. In Utah from 3,700 to 5,000 feet. Found in Grand, San Juan, and Wayne counties, UT. Range extends into northern portions of Navajo and Apache counties, AZ.	Yes
Phacelia mammalariensis (Nipple phacelia) Hydrophyllaceae	GCNRA G2	Found in mixed desert shrub communities. Elevation range from 4,000 to 6,000 feet. Known from eastern Kane and Garfield counties, UT.	Yes
Phacelia pulchella var. *atwoodii* (Atwood's pretty phacelia) Hydrophyllaceae	BLM UT	Occurs in duff under junipers on gypsiferous strata from the Moenkopi Formation in pinyon-juniper, oak, sagebrush, single-leaf ash, and serviceberry communities. Elevation range from 5,085 to 5,510 feet. Known from western Kane County, UT.	Yes
Pinus ponderosa (Ponderosa pine) Pinaceae	GCNRA G5	Found in mountain brush, ponderosa pine, and aspen communities, less commonly with spruce-fir and lodgepole pine. In Utah from 5,200 to 8,810 feet. Found in all Utah counties except Box Elder, Cache, Davis, Morgan, Rich, Salt Lake, and Wasatch. Found in all Arizona counties except La Paz, Yuma, Pinal, and Greenlee. Found from British Columbia, south to California and New Mexico.	No (Outside elevation range)
Potamogeton natans (Floating pondweed) Potamogetonaceae	GCNRA G5	In shallow pools, lakes or slow moving streams. In Utah from 4,910 to 10,075 feet in Rich, Uintah, Duchesne, and Utah counties, UT. In Yavapai, Apache and Coconino counties, AZ. From Alaska to Newfoundland, south to California, AZ, New Mexico and the northeastern United States.	No (Outside geographic range)
Pseudotsuga menziesii (Douglas fir) Pinaceae	GCNRA G5	Found in white fir, mountain brush, aspen, and spruce-fir communities. In Utah from 5,000 to 10,000 feet. Found in all Utah counties and all Arizona counties except La Paz, Yuma, Maricopa, and Greenlee. Known from British Columbia south to California, New Mexico, Texas, and Mexico.	No (Outside elevation range/no suitable habitat)

Table 3-1
Special Status Plant Species Exclusion List for the Lake Powell Pipeline Project Area

Species Name	Status[1]	Habitat Requirements	Potential for Presence in Project Area
Psorothamnus thompsoniae var. *whitingii* (Whiteing's indigo-bush) Fabaceae	GCNRA G5	Associated with sandy-clay banks and talus, and gravelly or sandy washes; in mixed desert shrub communities. From 3,800 to 5,020 feet in San Juan County, UT and Coconino, Apache, and Navajo counties, AZ. A Navajo Basin endemic.	No (Outside geographic range)
Ptelea trifoliata ssp. *pallida* (Hoptree) Rutaceae	GCNRA G5	Found along canyons in Garfield, Kane, and Washington counties; possibly near town of Kanab and the shores of Lake Powell in UT. Known in Mohave County, AZ, where locally plentiful on limestone.	Yes
Purshia subintegra (Arizona cliffrose) Rosaceae	ESA LE	Associated with white limestone soils derived from tertiary lakebed deposits at less than 4,000 feet within Maricopa, Yavapai ,and Graham counties; and near Burro Creek in Mohave County, AZ.	No (Outside geographic range)
Rosa stellata var. *abyssa* (Grand Canyon rose) Rosaceae	BLM AZ	Found on or near canyon rims or the tops of cliffs at the edges of mesas or plateaus, along low ledges at depressions caused by breccias pipes in Great Basin conifer woodland or scrub communities from 4,500 to 7,500 feet. Known from the Arizona strip, rims of Grand Canyon and Kanab Canyon, and junction of Little Colorado River and Big Canyon; Mohave and Coconino counties, AZ.	Yes
Rhus glabra (Smooth sumac) Anacardiaceae	GCNRA G5	Found in desert shrub, riparian, juniper, and mountain brush communities, often in dry sites in scattered stands. In Utah from 3,590 feet to 7,515 feet in Box Elder, Cache, Davis, Grand, Kane, Millard, Salt Lake, San Juan, Tooele, Utah, Wasatch, and Washington counties; and adjacent Coconino, Navajo and Apache counties, AZ; widespread in North America.	No (No suitable habitat present)
Rubus neomexicanus (New Mexico raspberry) Rosaceae	GCNRA G5	In hanging gardens with *Ostrya knowltonii.* In Ribbons, Knowles, and Cataract canyons of San Juan County, UT; at 3,700 to 3,800 feet. Known in Coconino and Yavapai counties, AZ and east into New Mexico from 5,000 to 9,000 feet.	No (No suitable habitat present)
Salvia columbariae var. *argillacea* (Chinle chia) Laminaceae	BLM UT	Found on sparsely vegetated pinyon-juniper woodlands on fine textured saline-clay silts and 'gypsum boils' of the Chinle Formation. Elevation from 4,250 to 5,600 feet. In western Kane and eastern Washington counties, UT.	Yes
Sclerocactus sileri (Paria Plateau fishhook cactus) Cactaceae	BLM AZ	In pinyon-juniper communities on mesa tops in sandstone to sandy soils derived from Moenave, Chinle, and Navajo formations. Elevation from 5,000 feet to 6,300 feet. Known in House Rock Valley and Paria Plateau, Coconino County, AZ; and Washington and Kane counties, UT.	Yes
Sisyrinchium demissum (Blue-eyed grass) Iridaceae	GCNRA G5	In seeps, springs, wet meadows, and stream banks, often where saline. In UT from 2,789 to 7,808 feet. Found in Beaver, Carbon, Duchesne, Garfield, Iron, Juab, Kane, Millard, Piute, San Juan, Sevier, Tooele, Uintah, Utah, Washington, and Wayne counties, UT; and Mohave, Coconino, Navajo, and Apache counties, AZ; into New Mexico, Texas and Mexico.	No (No suitable habitat present)

Table 3-1
Special Status Plant Species Exclusion List for the Lake Powell Pipeline Project Area

Species Name	Status[1]	Habitat Requirements	Potential for Presence in Project Area
Sphaeralcea fumariensis syn. *Sphaeralcea grossulariifolia fumariensis* (Smoky Mountain mallow) Malvaceae	BLM UT	Found in matchweed, ephedra, blackbrush, galleta, shadescale, and juniper communities of the Straight Cliffs and Smoky Mountains; Found on Tropic Shale and Dakota formations and alluvium from those formations. Elevation range between 4,400 and 5,400 feet. Endemic to eastern Kane County, UT.	No (Outside geographic range)
Sphaeralcea gierischii (Gierisch globemallow) Malvaceae	ESA C	In Great Basin desert scrub community, mainly on gypsiferous outcrops of the Harrisburg Member of the Kaibab Formation and Moenkopi Formation. Elevation range between 2,560 and 3,580 feet in UT and from 3,000 to 4,300 feet in AZ. Found at Black Rock Gulch, Black Knolls, and Pigeon Canyon in Mohave County, AZ and western Washington County, UT.	Yes
Spiranthes diluvialis syn. *S. romanzoffiana* var. *diluvialis* (Ute ladies'-tresses)	N/A	Found in wet meadows, stream banks, abandoned oxbow meanders, marshes, lakeshores, and raised bogs. Elevation range in UT between 4,495 and 6,841 feet. Found in Daggett, Duchesne, Garfield, Salt Lake, Tooele, Uintah, Utah, Wasatch, Wayne, and Weber counties, UT; into Nevada and Colorado.	No (Outside geographic range)
Thelypodiopsis ambigua var. *erecta* (Kanab thelypody) Brassicaceae	BLM UT	Found in pinyon-juniper woodland and desert shrub communities on clay soils derived from purple Chinle shale. Elevation range from 5,000 to 5,400 feet. Found in Kane and possibly Washington counties, UT; and Mohave County, AZ.	Yes
Townsendia smithii (Black Rock daisy) Asteraceae	BLM AZ	Found on basaltic red clay substrate in ponderosa pine and pinyon- juniper communities at elevations from 6,700 feet to 7,000 feet. Endemic to the Black Rock and Wolf Hole Mountains, Mohave County, AZ.	No (Outside geographic range)
Viguiera soliceps syn. *Heliomeris soliceps* (Tropic goldeneye) Asteraceae	BLM UT, GCNRA G3	Found within the mat-saltbush community on clay knolls and bluffs of the Tropic Shale Formation. Elevation range between 4,600 and 4,825 feet. Known from Cottonwood Canyon in Kane County, UT.	Yes
Zigadenus vaginatus (Alcove or sheathed death camas) Liliaceae	GCNRA G3	Found in hanging garden communities in seeps and alcoves. Between 3,700 and 6,200 feet in Grand, Kane, San Juan, and Washington counties, UT; and into Colorado. Blooms in late August through October.	No (No suitable habitat present)

Sources:
U.S. Fish and Wildlife Service list of threatened, endangered, proposed, candidate, and conservation agreement species potentially occurring in Mohave County and Coconino County, AZ, and Kane and Washington counties, UT, https://ecos.fws.gov/ipac/, accessed April 14, 2016; the Bureau of Land Management Sensitive Plant Species Lists for Utah dated February 2011; the Bureau of Land Management Sensitive Plant Species Lists for Arizona dated December 22, 2010; Special-Status Terrestrial Species and Communities of Glen Canyon National Recreation Area dated February 2011, and the list of Plants of Cultural Concern to the Kaibab Band of Paiute Indians of northern Arizona.

Notes:
[1] Status Definitions: ESA=Endangered Species Act, LE=Listed Endangered, LT=Listed Threatened, C=Candidate, CA=Conservation Agreement, CH=Designated Critical Habitat; BLM AZ=Bureau of Land Management Arizona Sensitive Species; BLM UT=Bureau of Land Management Utah Sensitive Species; GCNRA=Glen Canyon National Recreation Area, G1=Critically imperiled globally, G2=Imperiled globally, G3=Either vary rare and local throughout its range or found locally in a restricted range, G4=Apparently secure globally, and G5=Demonstrably secure globally.

Similar to the pre-survey preparations for special status species, preparation for noxious weeds continued with the compilation of noxious and invasive weed lists provided by the federal and state land and resource management agencies having jurisdiction over the LPP project area. The designation of noxious is given to weed species pursuant to state and federal laws. Plants are generally considered to be noxious if they are non-native and negatively impact agriculture, navigation, fish, wildlife, or public health. Invasive weeds are non-indigenous species that adversely affect the habitats they invade, economically, environmentally, or ecologically. The USFWS provided a list of invasive weed species whose occurrence was to be noted if observed in association with threatened, endangered, proposed, candidate, and conservation agreement species. The BLM provided lists for the Arizona Strip, St. George, Kanab, and Grand Staircase-Escalante areas. The list of federally-designated noxious weeds was obtained from the U.S. Department of Agriculture (USDA). A list of invasive weeds was provided by John Spence, ecologist with Glen Canyon National Recreation Area. Noxious weed lists were obtained for Arizona and Utah, as well as for Kane County and Washington County, Utah. *Salsola tragus* (Russian thistle), while not listed as noxious or invasive by any of the federal or state agencies, was included on the list of weeds because it is non-native and of considerable concern to land managers. From these lists, all noxious weed species deemed as having the potential to occur within the project area were compiled into a table containing 82 species (Table 3-2). To facilitate field identification of noxious weeds, information cards were created and formatted to 5 ½" by 8 ½" (for ease of field use). The cards contained photographs, descriptions of vegetative characteristics and similarities to other taxa, and discussions of habitat in which the species was likely to be found. Additionally, cards from the "Field Identification Cards for Invasive Non-native Plant Species Known to Threaten Arizona Wildlands" published by the Sonoran Institute were utilized.

Each surveyor was given copies of the special status species and noxious weed identification cards to carry in the field in order to provide a search image of the species and its unique habitat characteristics, and to aid in field identification. To further gain familiarity with target plant species, surveyors had the opportunity to review and photograph herbarium samples at the BLM St. George interagency office at the beginning of the 2009 field season, and at the BLM Kanab field office during the 2010 field season. Surveyors were also able to observe several rare plants in their natural settings at previously known locations, including *Echinocactus polycephalus* var. *xeranthemoides*, *Pediocactus sileri*, and *Pediomelum epipsilum*. Follow-up visits were made to the herbaria at University of Nevada – Las Vegas and Lake Mead National Recreation Area to verify voucher samples of some of the more difficult to identify species found.

Field surveys for special status species and noxious weeds, as well as for vegetation communities, were planned to occur simultaneously. Field data sheets were created for recording the results of these surveys, and included the following information: date; beginning and ending time of the survey; the names of all surveyors; location of the survey segment; topographic and aerial maps used; GPS file name; Universal Transverse Mercator (UTM) coordinates and elevation at the four corners of the survey segment; photo log; soils information; vertebrate species observed; special status species potentially occurring within the area and species observed; noxious weed species observed; apparent land use; and vegetation community information (Appendix B). Fifty-meter belt transect surveys, aimed at collecting quantitative density data for both special status species and noxious weeds, were conducted separately. A separate data sheet was created for the 50-meter belt transects, and included many of the same data fields used for the larger survey segments, with the addition of a list of the plants most likely to be encountered (Appendix C).

Table 3-2
Noxious and Invasive Weed Species for the Lake Powell Pipeline Project Area

Species											
Scientific Name	**Common Name**	**USDA[1]**	**USFWS[2]**	**State of Arizona[3]**	**State of Utah[4]**	**Washington Co., UT**	**BLM (Arizona Strip)**	**BLM (St. George)**	**BLM (Kanab)**	**BLM (Grand Staircase-Escalante)**	**Glen Canyon N.R.A**
Acroptilon repens (Syn. *Centaurea repens*)	Russian knapweed			PNW, RNW			N				
Aegilops cylindrica	Jointed goatgrass			PNW, RNW							
Agropyron repens (syn. *Elytrigia repens*)	Quackgrass				NC						
Alhagi pseudalhagi (syn. *Alhagi maurorum*)	Camelthorn			PNW, RNW			N				N
Alternanthera philoxeroides	Alligator weed			PNW							
Asclepias subverticillata	Poison milkweed					N		N		N	
Brassica tournefortii	African mustard, Sahara mustard		I								I
Bromus rubens	Red brome		I				I				
Bromus tectorum	Cheatgrass		I				I		I		
Cardaria spp.	Hoary cress				NB						
Cardaria chalepensis	Lens podded hoary cress			PNW							
Cardaria draba	Hoary cress			PNW, RNW			N	N	N	N	
Cardaria pubescens	Hairy whitetop			PNW							
Carduus acanthoides	Plumeless thistle			PNW							
Carduus nutans	Musk thistle				NB				N		
Cenchrus echinatus	Southern sandbur			PNW, RGNW							
Cenchrus incertus (syn. *C. spinifex*, *C. pauciflorus*)	Field sandbur			PNW, RGNW							
Centaurea calcitrapa	Purple starthistle			PNW							
Centaurea diffusa	Diffuse knapweed			PNW, RNW	NA		N		N		
Centaurea iberica	Iberian starthistle			PNW							
Centaurea maculosa (syn. *C. biebersteinii*)	Spotted knapweed			PNW, RNW	NA		N		N		
Centaurea melitensis	Malta starthistle						I	I			

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Centaurea repens (syn. *Acroptilon repens*)	Russian knapweed				NB			N	N	N	N
Centaurea solstitialis	Yellow starthistle			PNW, RNW	NA			N	N		
Centaurea squarrosa (syn. *C. virgata*)	Squarrose knapweed			PNW					N		
Centaurea sulphurea	Sicilian starthistle			PNW							
Centaurea virgate (syn. *C. squarrosa*)	Squarrose knapweed				NB						
Chondrilla juncea	Rush skeletonweed			PNW							
Chrysanthemum leucanthemum	Oxeye daisy				NA						
Cirsium arvense	Canada thistle			PNW NC					N		
Cirsium vulgare	Bull thistle							N			
Conium maculatum	Poison hemlock				NB						
Convolvulus arvensis	Field bindweed			PNW, RGNW	NC			N	N	N	
Coronopus squamatus	Creeping wartcress			PNW							
Cucumis melo var. *dudaim*	Dudaim melon			PNW							
Cuscuta spp.	Dodder			PNW, RNW							
Cynodon dactylon	Bermudagrass (Except for Washington County)				NB				N	N	
Cynoglossum officianale	Houndstongue				NC						
Drymaria arenarioides	Alfombrilla, lightning weed	N		PNW							
Eichhornia azurea	Anchored water hyacinth	N		PNW							
Eichhornia crassipes	Floating water hyacinth			PNW, RGNW, RNW							
Elaeagnus angustifolia	Russian olive						I				I

Table 3-2
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Scientific Name	**Common Name**	**USDA[1]**	**USFWS[2]**	**State of Arizona[3]**	**State of Utah[4]**	**Washington Co., UT**	**BLM (Arizona Strip)**	**BLM (St. George)**	**BLM (Kanab)**	**BLM (Grand Staircase-Escalante)**	**Glen Canyon N.R.A**
Elytrigia repens (syn. *Agropyron repens*)	Quackgrass			PNW, RNW					N	N	
Erodium cicutarium	Red stem filaree, Stork's bill		I								
Euphorbia esula	Leafy spurge			PNW	NA				N		
Euryops subcarnosus ssp. *vulgaris*	Sweet resinbush			RNW							
Halogeton glomeratus	Halogeton			PNW, RNW			N				
Helianthus ciliaris	Texas blueweed			PNW, RNW							
Hydrilla verticillata	Hydrilla	N		PNW							
Hyoscyamus niger	Black henbane				NA						
Hypericum perforatum	St. Johnsworts				NA						
Ipomoea spp.	Morning glory (Except Ipomoea carnea and Ipomoea arborescens)			PNW							
Ipomoea triloba	Three-lobed morning glory			PNW, RNW			N				
Isatis tinctoria	Dyers woad			PNW	NB				N		
Lepidium latifolium	Broad-leaved peppergrass				NB		N	N	N		N
Linaria dalmatica (syn. *Linaria genistifolia* var. *dalmatica*)	Dalmation toadflax				NB						
Linaria genistifolia var. *dalmatica* (syn. *Linaria dalmatica*)	Dalmation toadflax			PNW, RNW							
Linaria vulgaris	Yellow toadflax				NA						
Lythrum salicaria	Purple loosestrife			PNW	NA				N		
Malcolmia africana	African mustard		I								
Medicago polymorpha	Burclover			PNW, RGNW							
Nassella trichotoma	Serrated tussock	N		PNW							
Onopordum acanthium	Scotch thistle			PNW, RNW	NB		N	N	N	N	

Table 3-2
Noxious and Invasive Weed Species for the Lake Powell Pipeline Project Area

Species											
Scientific Name	**Common Name**	**USDA[1]**	**USFWS[2]**	**State of Arizona[3]**	**State of Utah[4]**	**Washington Co., UT**	**BLM (Arizona Strip)**	**BLM (St. George)**	**BLM (Kanab)**	**BLM (Grand Staircase-Escalante)**	**Glen Canyon N.R.A**
Orobanche ramosa	Branched broomrape	N		PNW							
Panicum repens	Torpedo grass			PNW							
Peganum harmala	African rue			PNW							
Pennisetum ciliare	Buffelgrass			PNW, RGNW							
Portulaca oleracea	Common purslane			PNW, RGNW							
Potentilla recta	Sulfur cinquefoil				NA						
Rorippa austriaca	Austrian fieldcress			PNW							
Saccharum ravennae	Ravenna grass										I
Salsola tragus[5]	Russian thistle										
Salvinia molesta	Giant salvina	N		PNW, RGNW							
Senecio jacobaea	Tansy ragwort			PNW							
Solanum carolinense	Carolina horsenettle			PNW							
Solanum elaegnifolium	Silverleaf nightshade					N		N			
Solanum viarum	Tropical soda apple	N		PNW							
Sonchus arvensis	Perennial sow thistle			PNW							
Sorghum spp.	Perennial sorghum spp. (includes but is not limited to Sorghum almum and Sorghum halepense)				NA						
Sorghum almum	Perennial sorghum				NA						
Sorghum halepense	Johnson grass				NA				N	N	

Table 3-2
Noxious and Invasive Weed Species for the Lake Powell Pipeline Project Area

Species											
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Stipa brachychaeta	Puna grass	N		PNW							
Striga spp.	Witchweed	N		PNW							
Taeniatherum caput-medusae	Medusahead				NA		N		N		
Tamarix spp.	Tamarisk						N				
Tamarix chinensis	Tamarisk, Saltcedar										N
Tamarix ramosissima	Saltcedar				NC			N			
Trapa natans	Water-chestnut			PNW							
Tribulus terrestris	Puncturevine			PNW, RGNW			N				
Ulmus pumila	Siberian elm										I

Notes:
Shading indicates weed species found during the survey
[1] N = Noxious Weed Designation
[2] I = Invasive Species
[3] PNW = Prohibited Noxious Weed; RGNW = Regulated Noxious Weed; RNW = Restricted Noxious Weed (State of Arizona Department of Agriculture Noxious Weed List)
[4] NA = Noxious Class A (Early Detection Rapid Response); NB = Noxious Class B (Control); NC = Noxious Class C (Containment) (State of Utah Noxious Weed List)
[5] Not listed as noxious or invasive by any agencies, but of concern to land managers

3.2 Survey

In 2008, a preliminary survey in high priority habitat was conducted over 14 miles of proposed pipeline right-of-way. Lands with the highest potential to support special status plants were targeted, including lands south and west of the Kaibab Indian Reservation in Arizona and lands east of Kanab, Utah. The Logan Simpson field team conducted surveys on foot, covering the entire 250-foot width with 12 transects walked parallel to the pipeline alignment and spaced 20 feet apart.

In 2009, surveys commenced in the vicinity of Hurricane, Utah and generally moved east (increasing in elevation) toward Page, Arizona. The 300-foot-wide and 600-foot-wide alignments, plus associated facilities, construction staging areas, and transmission line corridors comprised the survey area. Surveys began in mid-April 2009 and were mostly complete by early August 2009. Areas along the pipeline were revisited as late as mid-September 2009 if private land access was granted or to verify and collect target plant species during their blooming period. Surveys in 2010 were conducted in areas where the project footprint had been modified since the previous summer; primarily adjacent to the forebay and afterbay facilities, as well as the Hydro System High Point

Alignment Alternative. Surveys during the 2010 field season began in mid-April and were completed by the end of July.

Total coverage of the 600-foot-wide corridor (157.4 miles) was achieved using a combination of pedestrian surveys (77 percent) and windshield/binocular surveys (23 percent) (Figure 3-1). Approximately 94 percent of the 300-foot-wide corridor (110.9 miles) was surveyed either on foot (76 percent) or by windshield/binocular surveys (18 percent), with six percent of the area interpreted via aerial images. Lands that were not surveyed on foot included private property, areas with impassible terrain, or areas where special status plants were not expected to be encountered based on geology and habitat requirements, or along roadsides where ruderal vegetation was dominant. Areas where surveys were not conducted on foot were assessed to rule out the potential presence of special status species habitat (using aerial maps, soil maps, and general visual assessments). Windshield surveys were conducted with a driver plus one to three observers. The surveys were generally conducted at low speeds, with frequent stops to examine vegetation on foot. Binocular surveys were conducted from vantage points, such as the summit of Cedar Mountain and the western edge of Judd Hollow, as well as other high points within the survey area that were accessible by a four-wheel-drive vehicle or all-terrain vehicle (ATV). In some areas where windshield surveys were conducted, the strategic placement of 50-meter transects (along right-of-ways where private property was the limiting factor) served to increase survey coverage in those areas.

Each survey day began with a pre-survey crew meeting. In these brief meetings, surveyors were assigned to teams and individuals were given job assignments by the field manager. Survey site locations were disclosed and sensitive landscape features, private property, and site access were discussed. A list of special status species with a potential to occur within the survey area was created by researching the survey area's elevation ranges and soil types. The targeted special status species were presented to the surveyors by the lead field botanist, with focus on identifying characteristics and unique habitat requirements. Each surveyor was given plant identification cards for all target special status species, as well as noxious weed species.

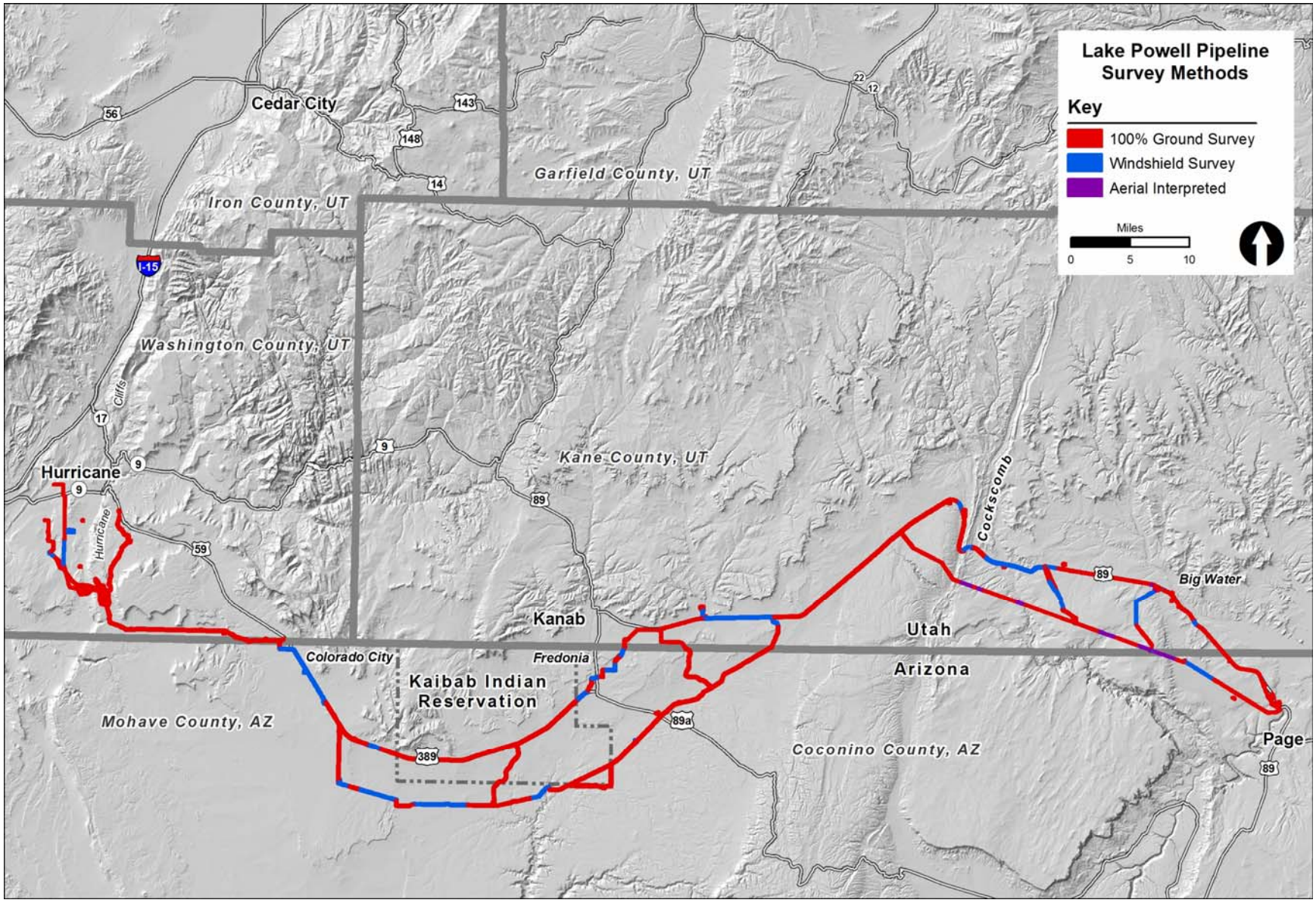

Figure 3-1
Survey Corridors Map

Surveys began by using the Trimble or Juno GPS unit to log the start positions of the survey. Crew members lined up to walk parallel transects along the length of the 300-foot or 600-foot-wide corridor (Figure 3-2). On a 300-foot-wide corridor, seven to 12 crew members were spaced 25 to 40 feet apart. On a 600-foot-wide corridor, 10 to 24 crew members were spaced 15 to 30 feet apart. In some segments, the 600-foot-wide corridor was treated as two 300-foot-wide corridors and covered by a crew suitable for a 300-foot-wide corridor by walking down one half of the corridor and returning on the other half. When this approach was used, the Garmin tracking feature was used to mark the inside edge of the first band surveyed (the centerline of the 600-foot-wide corridor) so that the second band did not overlap the first. The spacing of surveyors was based on the complexity of the terrain and presence of sensitive landscape features (rock outcrops, gypsum outcrops or soils, unique vegetation communities, and known occurrences of special status species). When sensitive landscape characteristics were present, surveyors were spaced closer together (15 feet or less) and moved at a slower pace. Often, the field manager roamed across the transects, mapping and typing vegetation communities and compiling a list of plants and their relative abundances. A typical transect length was two to four miles, and the survey crew covered six to twelve miles per day.

Figure 3-2
Crew Members Approximately 20 Feet Apart,
Walking Parallel Transects across Survey Area

Upon encountering a suspected special status species or noxious weed during the survey, the surveyor would compare the species to the identifying characteristics represented in the appropriate prepared plant identification cards. If the plant could not be positively identified based on the information presented in the card, the surveyor contacted the field botanist via a two-way hand-held radio. Care was taken by the field biologist to carry primary source references in the field based on recent study of herbarium specimens to minimize potential problems using a dated species characterization abstract when the herbarium specimens may have been subsequently renamed, or new specimens collected. For example, field determinations to confirm special status plant occurrences for difficult to determine or disjunct occurrences were often made by checking morphology and habitat descriptions in the Intermountain Flora, or the extensively edited 2008 edition of A Utah Flora. In the case of special status species confirmation, surveyors observed the plant in its natural habitat and circled out from the individual in an intensive search effort to locate additional individuals (Figure 3-3). In the case of a newly-encountered noxious weed, surveyors observed the plant in order to increase familiarity with the species.

Various approaches were utilized to capture counts for special status species and noxious weeds. When relatively small numbers of special status species or noxious weeds were encountered, data were collected as single-plant entries. Species documented using the single plant entry method include *Echinocactus polycephalus* var. *xeranthemoides*, *Lupinus caudatus* var. *cutleri*, *Pediocactus sileri*, and *Petalonyx parryi*. In this case, a separate GPS point and photograph was collected for individual occurrences. Data including the species name, a unique number, location, and comments on the plant size, condition (live or dead), and habitat was recorded in the Trimble or Juno GPS unit's data dictionary, and duplicated on the field data sheet (Figure 3-4). In the case of encountering localized concentrations of special status species or noxious weeds, a plant cluster entry approach was utilized. Species documented using the cluster entry method include *Cryptantha semiglabra* and *Pediomelum epipsilum*. This approach involved flagging individuals within the cluster, then counting the total number of individuals within the area. The center of the cluster was recorded using a GPS unit, and the data for the center of the cluster was treated as a single plant entry. A reference to the cluster and the total number of plants was noted in the comment field. Once the outer boundary of the cluster was identified, a polygon was created using a Trimble or Juno GPS unit. The boundary was walked while the unit collected GPS data, and a reference to the associated center point was made in the comment field. Photographs were taken of the cluster and a minimum of one representative individual. Any pin flags used for capturing species data were removed after the data were recorded.

When a large population of a special status species was encountered, a tally approach was utilized. Species documented using the tally method include *Pediocactus sileri*, *Pediomelum epipsilum*, and *Phacelia mammalariensis*. At the start of each tally, two points (one at each side of the pipeline corridor) were recorded using a Trimble or Juno GPS unit. Each crew member kept individual tallies while walking parallel transects, and continued to count until crew members ceased to observe the plant. The two end points and a reference to the total number of individuals tallied were recorded with Trimble or Juno GPS units. One or more photographs were taken of the area in which plants were tallied. This approach was necessary on occasion, such as when very large populations were encountered (*Pediomelum epipsilum*, *Phacelia mammalariensis*). Plant counts for the large or dense populations of *Phacelia pulchella* var. *atwoodii* were obtained by recording the species' relative abundance within the transect and then extrapolating from the data obtained by placing 50-meter transects in representative areas.

Figure 3-3
Crew Members Observing *Cryptantha semiglabra* in Its Natural Habitat

Figure 3-4
Collecting and Recording *Pediocactus sileri* Data

3.3 50-meter Transects

Quantitative plant density data was obtained by placing 50-meter transects systematically throughout the pipeline and transmission line corridor areas (Appendix D). Transect locations were stratified to cover a wide variety of vegetation communities and geographical locations. Data collected from these transects provided a way to check vegetation associations and alliance and ecological system classifications; quantify noxious and invasive plant densities; and to complement the special status species density data collected during previous field surveys. The 50-meter transects also provided plant cover data used to quantify reconnaissance vegetation classifications along the 300-foot-wide corridor, for areas where field surveys were not conducted. During 2009, transect surveys were conducted from late August to mid-September, and during 2010, from May to mid-July.

In 2009 the 50-meter transects were placed by visually assessing changes in the vegetative community along the corridor, or by identifying apparent landform changes on aerial maps. When this occurred, teams would stop and randomly orient the 50-meter transect. In 2010 the transect locations were pre-determined by viewing aerial maps and selecting locations to represent different vegetation associations based on the previous year's field data. At the transect locations, teams measured out 50 meters with a tape and took GPS coordinates and photographs at the start and end of each transect. Individual plants within a 1 meter wide belt (measured with a meter stick) along the 50-meter transect line were identified and tallied on a data sheet (Appendix C). Occasionally, plant densities were too high to efficiently or accurately count (e.g., some grass and herbaceous species) and a relative abundance was recorded instead. A relative abundance refers to a descriptive word representing the number of individuals of a taxon in a given area, and acts as a measure of plant cover. Relative abundances included dominant, abundant, common, occasional, and rare. To calculate total vegetation cover along the 50-meter transect, living plants were tallied when intersected at each 1 meter point, and then the total was multiplied by two to obtain percent plant cover. Additional data collected along each transect included: slope and aspect, community type, hydrology, land use, distance from the nearest road, and the amount and type of disturbance present (Figure 3-5).

Figure 3-5
Biologists Conducting a 50-meter Transect

3.4 Analysis

GPS data collected for the special status species and noxious weeds observed within the LPP corridor were mapped using GIS software to show the distribution of each species. The soil type, geological formation, and vegetation communities were overlaid using ArcMap software to aid in identifying patterns or trends in the species' habitat requirements. Characteristics such as soil type, geologic formation, and vegetation community type were used individually or jointly to identify special status species and noxious weed habitats, predict where the plants may occur within private or non-intensively surveyed portions of the corridors, or explain why they were not observed within the project area. Special status species and noxious weed data were analyzed in combination with collected vegetation community field mapping data in order to identify relationships with vegetation community alliances, associations, and ecological systems.

The highest resolution of GIS data was represented by the individual special status species waypoint locations. This method was utilized to the extent possible. The survey technique of circumscribing a boundary around a group of plants and counting the individuals also yielded high-resolution data. When plant concentrations were too dense to count individuals, the tally and plant cluster method was used. This method yielded accurate plant counts but less precise information about the location of individual plants. Thus, the vegetation association(s) in which the tally polygons were located could be identified, but the occurrence of special status species on individual geologic formations or specific soil types could not be confirmed.

For 2009, the 50-meter transect data sheets were individually reviewed and a U.S. National Vegetation Classification (NVC) compliant vegetation association assigned. For 2010 data, only the 50-meter transects taken in areas that were not surveyed on foot were analyzed and a vegetation association assigned. These data were considered as a secondary source for classification purposes, since the one meter transect width was insufficient to accurately determine tree cover. Transects were often displayed in ArcMap against recent aerial imagery and the vegetation classification was modified, if necessary, to reflect the surrounding cover classes for trees, shrubs and understory species. The cover cut points needed to determine physiognomic class for the U.S. NVC were: 0-10 percent, 10-25 percent, 25-60 percent and over 60 percent. The 50-meter transect data was also utilized to support and enhance the analysis of the collected noxious weed and special species data.

Chapter 4
Special Status Species

4.1 Introduction

This chapter presents information on the 51 plant species that potentially occur in the survey area, based on habitat requirements. The list of species was derived from an overall list of 101 species, including plants listed by the USFWS as threatened, endangered, proposed, candidate, and conservation agreement species potentially occurring in Mohave and Coconino counties, Arizona, and Washington and Kane counties, Utah; the Glen Canyon National Recreation Area (GCNRA) Special Status Plant Species list; and the BLM Sensitive Plant Species List for the Arizona Strip, and for Kane and Washington counties Utah (Table 4-1). The Kaibab Band of Paiute Indians also provided a list of plants of cultural concern that included a total of 72 species. These plants were surveyed for along with the other special status species identified by the BLM, NPS, and USFWS.

Table 4-1
Special Status Plant Species with the Potential to Occur within Lake Powell Pipeline Survey Area

Page 1 of 2

Species Name	**Status[1]**	**Found? (Yes/No)**
Acer glabrum (Rocky Mountain maple) Aceraceae	GCNRA G5	No
Acer grandidentatum (Bigtooth maple) Aceraceae	GCNRA G5	No
Aralia racemosa (American spikenard) Araliaceae	GCNRA G5	No
Arctomecon humilis (Dwarf bear-poppy) Papaveraceae	ESA LE	No
Asclepias welshii (Welsh's milkweed) Asclepidaceae	ESA LT, CH	No
Astragalus ampullarioides (Shivwits milkvetch) Fabaceae	ESA LE, CH	No
Astragalus ampullarius (Gumbo milkvetch) Fabaceae	BLM UT	No
Astragalus holmgreniorum (Paradox [Holmgren] milkvetch) Fabaceae	ESA LE, CH	No
Astragalus striatiflorus (Escarpment milkvetch) Fabaceae	BLM UT	No
Camissonia bairdii (Baird camissonia) Onagraceae	BLM UT	No
Camissonia gouldii (Diamond Valley suncup) Onagraceae	BLM UT	No
Ceanothus greggii var. *vestitus* (Mohave ceanothus) Rhamnaceae	GCNRA G5	No
Cladium californicum (California sawgrass) Cyperaceae	GCNRA G4	No
Cornus sericea (Red-osier dogwood) Cornaceae	GCNRA G5	No
Cryptantha semiglabra (Smooth catseye) Boraginaceae	BLM UT	Yes
Cycladenia humilis var. *jonesii* (Jones cycladenia) Apocynaceae	ESA LT	No
Cystopteris utahensis Syn. *C. fragilis* (Utah brittle-fern) Polypodiaceae	GCNRA G3	No
Echinocactus polycephalus var. *xeranthemoides* (Kanab barrel cactus) Cactaceae	GCNRA G5	Yes
Enceliopsis argophylla (Silverleaf sunray) Asteraceae	BLM AZ	No
Epilobium nevadense (Nevada willowherb) Onogarceae	BLM UT	No
Euphorbia nephradenia (Utah spurge) Euphorbiaceae	BLM UT	No

Table 4-1
Special Status Plant Species with the Potential to Occur within Lake Powell Pipeline Survey Area

Species Name	Status[1]	Found? (Yes/No)
Gilia latifolia var. *imperialis* Syn. *G. imperialis* (Cataract gilia) Polemoniaceae	BLM UT, GCNRA G5	No
Habenaria zothecina Syn. *Platanthera zothecina* (Alcove bog orchid) Orchidaceae	GCNRA G2	No
Imperata brevifolia (Satintail grass) Poaceae	GCNRA G5	No
Iris pariensis (Paria iris) Iridaceae	BLM UT	No
Jamesia americana var. *zionis* (Zion jamesia) Saxifragaceae	BLM UT	No
Lepidium montanum var. *claronense* (Claron pepperplant) Brassicaceae	BLM UT	No
Lupinus caudatus var. *cutleri* (Cutler's spurred lupine) Fabaceae	BLM UT	Yes
Mentzelia memorabalis (September 11 stickleaf) Loasaceae	BLM AZ	No
Oenothera murdockii (Chinle evening primrose) Onograceae	BLM UT	No
Ostrya knowltonii (Western hophornbeam) Betulaceae	GCNRA G3	No
Pediocactus peeblesianus var. *fickeiseniae* (Fickeisen plains cactus) Cactaceae	ESA C	No
Pediocactus sileri (Siler pincushion cactus) Cactaceae	ESA LT	Yes
Pediomelum aromaticum var. *barnebyi* (Indian breadroot) Fabaceae	BLM UT	No
Pediomelum epipsilum (Kane breadroot) Fabaceae	BLM UT	Yes
Penstemon ammophilus (Sandloving penstemon) Scrophulariaceae	BLM UT	No
Petalonyx parryi (Parry petalonyx) Loasaceae	BLM UT	No
Phacelia howelliana (Howell's phacelia) Hydrophyllaceae	GCNRA G3	No
Phacelia mammalariensis (Nipple phacelia) Hydrophyllaceae	GCNRA G2	Yes
Phacelia pulchella var. *atwoodii* (Atwood's pretty phacelia) Hydrophyllaceae	BLM UT	Yes
Pinus ponderosa (Ponderosa pine) Pinaceae	GCNRA G5	No
Pseudotsuga menziesii (Douglas fir) Pinaceae	GCNRA G5	No
Psorothamnus thompsoniae var. *whitingii* (Whiteing's indigo-bush) Fabaceae	GCNRA G5	No
Ptelea trifoliate ssp. *pallid* (Hoptree) Rutaceae	GCNRA G5	No
Rosa stellata var. *abyssa* (Grand Canyon rose) Rosaceae	BLM AZ	No
Salvia columbariae var. *argillacea* (Chinle chia) Laminaceae	BLM UT	No
Sclerocactus sileri (Paria Plateau fishhook cactus) Cactaceae	BLM AZ	No
Sisyrinchium demissum (Blue-eyed grass) Iridaceae	GCNRA G5	No
Sphaeralcea gierischii (Gierisch globemallow) Malvaceae	ESA C	No
Spiranthes diluvialis Syn. *S. romanzoffiana* var. *diluvialis* (Ute ladies'- tresses) Orchidaceae	N/A	No
Thelypodiopsis ambigua var. *erecta* (Kanab thelypody) Polypodiaceae	BLM UT	No
Viguiera soliceps Syn. *Heliomeris soliceps* (Tropic goldeneye) Asteraceae	BLM UT, GCNRA G3	No

Note:
[1] Status Definitions: ESA=Endangered Species Act, LE=Listed Endangered, LT=Listed Threatened, C=Candidate, CA=Conservation Agreement, CH=Designated Critical Habitat; BLM AZ=Bureau of Land Management Arizona Sensitive Species; BLM UT=Bureau of Land Management Utah Sensitive Species; GCNRA=Glen Canyon National Recreation Area, G1=Critically imperiled globally, G2=Imperiled globally, G3=Either vary rare and local throughout its range or found locally in a restricted range, G4=Apparently secure globally, and G5=Demonstrably secure globally.

4.2 Results of Special Status Species Survey

The following section provides species accounts organized alphabetically by botanical (Latin) name for the 51 special status plant species targeted for surveys. Nomenclature follows the United States Department of Agriculture (USDA) Plants Database, except where noted. Physical descriptions, habitat abstracts, and distribution information are from Arizona or Utah sources, as cited.

The species accounts include natural history, survey results, and discussion. Of the 51 special status plant species for which surveys were conducted, seven were observed; detailed information on those species is provided. The locations at which the plants were observed are described, ordered from east to west, and listed by reach name (see Appendix A for an overview of reaches). The specific location of each occurrence is provided, as well as the land ownership and the quantity of plants observed. The locations of plants of cultural concern identified by the Kaibab Band of Paiute Indians were not mapped in the field but were recorded by vegetation community and their relative rarity ranked within each community type.

The distribution of special status plant species is noted according to the vegetation communities in which they occur. The two ecological regions represented within the survey area are Colorado Plateau and Mojave Desert. The ecological regions are further differentiated into ecological systems, which represent recurring groups of biological communities that are found in similar physical environments and are influenced by similar dynamic ecological processes, such as fire or flooding. The next level of vegetation classification within ecological system is alliance. An alliance is a group of plant associations sharing the same growth form and one or more dominant or diagnostic species which, as a rule, are found in the uppermost strata of the vegetation. Plant species that are dominant (cover the greatest area) and diagnostic (found consistently in some vegetation types but not others) are the foundation of both alliance and association names. At least one species from the dominant and/or uppermost stratum is included in each name. Alliance names include the growth form class (e.g., “Forest”, “Woodland”, “Herbaceous”) in which they are classified, followed by the word “alliance” to distinguish them from associations. The lowest possible number of species is used for an alliance name, up to a maximum of four. The association is the finest level of the vegetation community classification hierarchy, and is the basic unit for vegetation classification in North America. It is a plant community type of definite floristic composition, uniform habitat conditions, and uniform physiognomy. Additional information on vegetation communities can be found in the Lake Powell Pipeline Vegetation Community Report, where more detailed descriptions of the vegetation communities are provided based on the framework used in the U.S. National Vegetation Classification (NVC) system (Logan Simpson 2016).

Further information on the habitats in which special status species occur is provided by an analysis of plant distribution by geologic formation and soil type. Geologic formation and soil names were determined in ArcMap from digitized data or georeferenced maps obtained from the USDA Geospatial Data Gateway, the Utah Geological Survey, and the U.S. Geological Survey.

The discussion for each taxon summarizes the results focusing on the effectiveness of the sampling methodology for discovering special status species, land use as it coincides to plant occurrences, potential effects of nonnative plant species introduction in the survey area, impacts from pipeline or transmission line construction to the species within the survey area, and recommendations to minimize potential impacts to the species. For any taxa which may still have potential for presence in the survey area, recommendations are provided on optimal sampling dates. Where practical, the discussion also includes conflicts with past occurrence data and an estimate of the probability (high, medium, or low) that the plant might be found in a follow-up survey.

Distribution and detailed maps for each species observed within the survey area are included following each species account. The distribution maps show the occurrence of each observed species throughout the entire length of the survey area. The detailed maps show species occurrences at a larger scale where they occur in the survey area. A marked occurrence on the distribution and detailed maps may represent one individual or multiple individuals in one small area. Refer to the results table for exact numbers of individuals represented on each detailed map.

4.3 Species Accounts

4.3.1 *Acer glabrum* (Rocky Mountain maple)

4.3.1.1 Natural History

Acer glabrum is a perennial multi-stemmed shrub or tree (NPIN 2010) of the Aceraceae (Maple Family) reaching 6.5 feet to 26 feet (2 to 8 meters) tall (Welsh et al. 2008). The simple, opposite leaves are lobed, serrated, hairless, and 0.8 to 3.1 inches (2 to 8 centimeters) long, green above with light colored veins and lighter below (NPIN 2010). Inconspicuous, early spring flowers are fragrant and greenish, with uni- and bisexual flowers found on a single plant (Welsh et al. 2008). Fruits of *A. glabrum* are winged and reddish. Flowering occurs from April to May Utah (NPIN 2010).

A. glabrum is the northern most maple in North America, from Alaska south to California, Arizona, New Mexico, and Nebraska (NPIN 2010). It is common on moist sites within oak and coniferous forests of the western mountains (Sibley 2009). In Utah *A. glabrum* occurs in pinyon-juniper, mountain brush, sagebrush, ponderosa pine, Douglas fir, lodgepole pine, and spruce-fir communities at elevations between 5,500 feet (1,675 meters) and 10,420 feet (3,175 meters) (Welsh et al. 2008). In Arizona, it is found in white fir, white fir-Douglas fir, and Engelmann spruce communities at elevations from 5,000 feet (1,524 meters) to 12,000 feet (3,658 meters) (Anderson 2001).

4.3.1.2 Survey Results

A. glabrum was not encountered during project surveys.

4.3.1.3 Discussion

The survey area does not support potentially suitable habitat for *A. glabrum*. Moist oak and coniferous forests did not occur along the project route. Juniper dominated sparse woodlands and pinyon-juniper woodlands were present but provided a more exposed habitat than the moist environment preferred by *A. glabrum*. No further surveys are warranted within the survey area for this plant.

4.3.2 *Acer grandidentatum* (Bigtooth maple)

4.3.2.1 Natural history

Acer grandidentatum is a small, deciduous tree or shrub in the Aceraceae (Maple Family) reaching up to 40 feet (12 meters) tall. Leaves are 1 to 4 inches (2.5 to 10 centimeters) wide with three to five lobes that extend from a midpoint, with leaf edges that are coarsely toothed to almost entire (Welsh et al. 1993). Lower leaf surfaces are covered in fine soft hairs. The flowers of *A. grandidentatum* occur as a flat-topped cluster, with the outer flowers growing taller than inner flowers. Sepals are 0.12 to 0.20 inches (3 to 5 millimeters) long and are a greenish color with a broadly rounded shape. No petals are present in the flowers of A. grandidentatum; flowering occurs between April and May. Fruits are dry, wing-shaped, and covered in long hairs.

A. grandidentatum occurs from southeastern Idaho to Arizona, New Mexico, south-central Texas, and northern Mexico. The species is uncommon and local; inhabiting soils near streams in canyon bottoms (Sibley 2009) or the slopes of dry canyons (Tollefson 2006). In Utah, the species occurs in oak, oak-maple, sagebrush, Douglas fir, and white fir communities (Welsh et al. 1993). *A. grandidentatum* occurs in Douglas-fir, ponderosa pine, and white fir communities in Arizona (Tollefson 2006). Elevation ranges from 4,200 to 9,220 feet (1,280 to 2,810 meters) in Utah and 4,500 to 7,000 feet (1,370 to 2,130 meters) in Arizona.

4.3.2.2 Survey Results

A. gradidentatum was not encountered during project surveys.

4.3.2.3 Discussion

The survey area does not support potentially suitable habitat for *A. gradidentatum*. Oak, oak-maple, Douglas fir, and white fir forests did not occur along the project route. Sagebrush communities were present but were not observed along streams in canyon bottoms as preferred by *A. gradidentatum*. No further surveys are warranted within the survey area for this plant.

4.3.3 *Aralia racemosa* (American spikenard)

4.3.3.1 Natural History

Aralia racemosa is a very large perennial herb in the Araliaceae (Ginseng Family). *A. racemosa* can grow from 2 to 5 feet (0.6 to 1.5 meters) tall. The foliage lacks spines and is composed of large compound leaves that can grow up to 3.2 feet (1 meter) long. Each compound leaf has toothed leaflets that superficially resemble regular leaves and average about 4 inches (10 centimeters) in length (NatureServe 2010). The flowers of *A. racemosa* consist of large tapered clusters containing many tiny white flowers, each with a tinge of yellow or green. They grow upright above the large compound foliage on heavy, leafy stems and bloom during mid-summer. The flowers produce showy clusters of small red to purple berries that ripen in the fall, that are not considered edible, and are 0.15 to 0.25 inches (4 to 6 millimeters) thick.

There are 18 genera in Araliaceae family and nine species of Aralia. This species is common in the center of its extensive range in eastern and central North America, ranging from Ontario Canada south through the United States to Mississippi and Alabama. Two subspecies of *A. racemosa* are currently recognized (USDA-NRCS 1999) which includes the subspecies *bicrenata*, found in Texas, New Mexico, Arizona, Colorado, and Utah; and the subspecies racemosa, found in the remainder of the species' extensive range in eastern North America (USDA-NRCS 1999, NatureServe 2010). The number of *A. racemosa* county records declines greatly in the western and southwestern states of this species' range, and the population center for this species appears to occur roughly at the Great Lakes (USDA-NRCS 1999).

A. racemosa is most often found on rich soils and ravines of woodland vegetation communities (NatureServe 2010). However, outside of its primarily range in northeastern United States, it locally occupies habitat such as sandstone crevices and sandy soils consisting of decomposing vegetation, known as detritus, in the shaded narrow gorges of Zion Canyon, at elevations from 4,000 feet (1,220 meters) to 5,741 feet (1,750 meters) in Washington County, Utah (Welsh et al. 2008). Natural heritage records of *A. racemosa* also exist for Kane County, Utah (NatureServe 2010). Its range extends into Arizona where *A. racemosa* is found on rich soil in coniferous forests, preferring shaded areas from 5,000 (1,515 meters) to 9,500 feet (2,895 meters) (Kearney and Peebles 1951). The species is found in eight Arizona counties, including Coconino (USDA-NRCS 2009).

A. racemosa shows some tendency to be intolerant of habitat decline or damage, and information on the species abundance is sparse. Although numerous groups are documented in protected areas, threats associated with habitat decline and collection of plants from wild populations for use in the herb trade are likely to increase in the future. *A. racemosa* is a close relative of Sarsaparilla whose large roots are aromatic and spicy and were once used as one of the ingredients in root beer and as a remedy for respiratory ailments in man and domesticated animals.

4.3.3.2 Survey Results

A. racemosa was not encountered during project surveys.

4.3.3.3 Discussion

The survey area does not support potentially suitable habitat for *A. racemosa*. Rich forest soils on steep slopes and bluffs did not occur along the project route. Juniper dominated sparse woodlands and pinyon-juniper woodlands were present but provided a more exposed habitat than the rich shaded environment preferred by *A. racemosa*. No further surveys are warranted within the survey area for this plant.

4.3.4 *Arctomecon humilis* (Dwarf bear-poppy)

4.3.4.1 Natural History

Arctomecon humilis is an herbaceous perennial herb of the Papaveracea (Poppy Family). *A. humilis* is a taprooted perennial herb producing stout, waxy stems that grow from 4 inches (10 centimeters) to 10 inches (25 centimeters) tall. The leaves of *A. humilis* are blue-green and waxy with rounded teeth that are located around the base of the plant (eFlora.org 2009). The stems of *A. humilis* have one or two ivory-white flowers that have orange-yellow stamens that bloom from mid-April through May. The flowers are showy by being next to the red soils in which the plant grows. *A. humilis* flowers are pollinated by the rare solitary bee species, *Perdita meconits* (Buchmann et al. 1996). The oval, egg shaped fruits produce up to 30 or sometimes more, shiny black seeds.

A. humilis is a gypsum loving herb, only found growing on barren, clay soils composed predominately of gypsum, in southern Utah. These specific soils include the Moenkopi Formation, specifically the upper three members: Shnabkaib (the white gypsiferous member), Middle Red and Upper Red, where it occurs at elevations from 2,590 (790 meters) to 3,000 feet (915 meters) (Welsh et al. 2008). The species is found on rolling hills and bluffs in mixed warm desert shrub communities whose dominant plant species include Fremont indigo bush (*Psorothamnus fremontii*), cheesebush (*Hymenoclea salsola*), Nevada Mormon tea (*Ephedra nevadensis*), saltbush (*Atriplex* sp.), shrubby buckwheat (*Eriogonum corymbosum*), and Fremont pepperweed (*Lepidium fremontii*) (USFWS 1985). *A. humilis* occurs along the eastern edge of the Mojave Desert in Washington County, Utah, in a 7 mile radius to the east, south and west of St. George, with the exception of Beehive Dome, which is 9 miles southeast of St. George (USFWS 1985).

A. humilis was proposed endangered (along with approximately 1,700 other plants) on June 16, 1976 and was determined endangered on November 6, 1979 by the U.S. Fish and Wildlife Service. *A. humilis* is restricted in distribution to the immediate vicinity of St. George, Utah. “Known from 11 traditionally accepted concentrations of plants (with some human-made obstacles, some unoccupied habitat, or widely scattered individuals that form the separation between them; there are perhaps 7 or 9 distinct locations). The species' habitat is in an area of rapid human population growth and expansion. The low, barren hills on which it grows are sought after by off-road vehicle users. Gypsum mining is also a threat” (NatureServe 2010).

4.3.4.2 Survey Results

A. humilis was not encountered during project surveys.

4.3.4.3 Discussion

A. humilis has only been found within a strict altitudinal range in Utah, despite extensive searching for this distinctive plant. Geologically suitable habitat was found during the 2009 survey season below the southern dike of Quail Creek Reservoir, where Shnabkaib and Upper Red Members of the Moenkopi Formation occur at elevations from 2,950 (900 meters) to 3,400 feet (1,036 meters), and in the Nephi Twist where the Middle Red Member of the of the Moenkopi Formation occurs from 3,200 (975 meters) to 3,450 feet (1,050 meters). However, both locations are at or above the known elevation limit for this plant, and surveys fully covered the area. No further surveys are warranted within the survey area for this plant.

4.3.5 *Asclepias welshii* (Welsh's milkweed)

4.3.5.1 Natural History

Asclepias welshii is an herbaceous perennial of the Asclepiadaceae (Milkweed Family) that produces milky juice. *A. welshii* is a distinct species with no close relatives (UNPS 2003-2008). It is recognized by having stems that are 10 inches (25 centimeters) to 40 inches (100 centimeters) tall, and are arranged in clusters. This species does produce seeds but propagates primarily by root stock. *A. welshii* has a root system composed of horizontal and vertical taproots (AGFD 2005). The leaves are displayed in opposite pairs along the stems, with the upper side of the leaves broadly oval on a short leaf stem of approximately 3 inches (7.7 centimeters) long and 2 inches (5 centimeters) wide. The lower leaves are smaller, with tips that taper gradually to a sharp point that are borne directly on the stem without a stalk attaching the leaf blade to the stem. The leaves and stems have a dense covering of white, wooly, fine, soft hairs (USFWS 1992, ARPC 2001). Flowers are borne in a circular pattern on the stems with the petals that constitutes the inner whorl of the flower are approximately 0.2 inches (5 millimeters) long and cream colored, with a rose-tinged center. *A. welshii* produces a globular clusters of flowers that is cream-colored with pink-tinged centers that appears from May to June, with few fruits developing from the flowers (ARPC 2001).

A. welshii is known from three groups on the Coral Pink Sand Dunes (7 miles [11km] west of Kanab, Utah), the Sand Hills 8 miles [13 km] north of Kanab, Utah), and Sand Cove (on the Arizona-Utah border, 28 miles [45 km] east of Kanab, Utah) (USFWS 1992). In Arizona its range includes from the Paria Plateau and U.S. Highway 160 north of Wildrose Spring in Coconino County, Arizona to most recently, the Little Capitan Valley in Navajo County, Arizona and east into Apache County, Arizona (AGFD 2005). Welsh et al. only reports locations in Kane County, Utah and Apache and Coconino counties, Arizona (2008). *A. welshii* is found on open, sparsely vegetated semi-stabilized coral pink colored sand dunes, in sagebrush, juniper, pine, and oak communities of the Great Basin desert scrub at elevations from 5,500 feet (1,700 meters) to 6,300 feet (1,900 meters) in Utah (Welsh et al. 2008) and on active dunes in Great Basin desert scrub from 4,700 to 6,250 feet in Arizona. It occupies both the crest and on the down-wind slopes of dunes, adjusting readily to changes in sand depth (ARPC 2001).

A. welshii was proposed threatened on June 6, 1984, and determined threatened on October 28, 1987, by the U.S. Fish and Wildlife Service. It was originally known from only four locations with a total of approximately 20,000 above-ground stems (the number of genetic individuals is unknown). The two Utah occurrences face the greatest threats, with the species' very fragile sand dune habitat being impacted primarily by off-road vehicle activity. The two Navajo Nation occurrences are smaller, but are relatively remote and are believed to have well to excellent viability. In Utah, thousands of people visit the Coral Pink Sand Dunes State Park and adjacent areas for ORV, camping, hiking, and other outdoor recreation. Livestock grazing has also been suggested as a threat to *A. welshii*. In the Navajo Nation, the current main threat is grazing, although no immediate impacts have been observed and there are no issues with ORV traffic at this time (NatureServe 2010).

4.3.5.2 Survey Results

A. welshii was not encountered during project surveys.

4.3.5.3 Discussion

There is a moderate probability of finding *A. welshii* outside of the survey area on sand dune habitat located west of Page, Arizona. Specifically, this would be in remote dunelands classified as the Colorado Plateau Active and Stabilized Dune Ecological System (see Vegetation Communities Report). Potentially suitable habitat may be present outside the survey area on Flat Top, West Clark Bench, and East Clark Bench north of Cedar Mountain. This is a distinctive plant on the landscape, but surveys would have to be conducted prior to livestock being grazed within suitable habitat. No further surveys are warranted within the survey area for this plant.

4.3.6 *Astragalus ampullarioides* (Shivwits milkvetch)

4.3.6.1 Natural History

Astragalus ampullarioides is a perennial upright herbaceous plant of the Fabaceae (Legume Family) with an underground branching woody base. Stems are hollow and may grow along the ground or to a height of 8 to 20 inches (20.3 to 50.8 centimeters) (Welsh et al. 2008). Each plant produces approximately 45 small cream-colored flowers about 0.8 inches (2.0 centimeters) long on a single stalk. Flowering occurs between March and April (USFWS 2006). The fruit is a short broad pod between 0.3 to 0.6 inches (0.8 to 1.5 centimeters) long and only 0.2 to 0.5 inches (0.6 to 1.2 centimeters) wide.

A. ampullarioides species has a distinct leaf structure; a defining characteristic when comparing to a resembling species, the Astragalus ampullarius (UNPS 2003 – 2008).

Remaining groups of *A. ampullarioides* only occur in Washington County, Utah; three are 10 to 15 miles east of St. George, Utah (Coral Canyon, the Harrisburg Bench and Cottonwood location and Silver Reef) and two are 15 to 20 miles west of St. George (Shivwits and Pahcoon Spring Wash; USFWS 2006). An additional disjunct group occurs within the Petrified Forest section of Zion National Park (Van Buren and Harper 2003, Welsh et al. 2008). *A. ampullarioides* is found on soils with a high content of gypsum primarily associated with the Triassic Chinle Formation, and occasionally the Dinosaur Canyon Member of the of the Moenave Formation, between 3,400 feet and 3,800 feet (1,036 meters and 1,158 meters) in elevation (USFWS 2006, Welsh et al. 2008). The fine-grained textured soils of the Upper Red Member of the Moenkopi Formation may provide potentially suitable habitat. The species is found in warm desert shrub, creosote bush and juniper communities, with dense patches of individual *A. ampullarioides* in an otherwise sparsely vegetated area (USFWS 2006).

4.3.6.2 Survey Results

A. ampullarioides was not encountered during project surveys.

4.3.6.3 Discussion

No *Astragalus* of any species was observed during project surveys. No further surveys are warranted within the survey area for this plant.

4.3.7 *Astragalus ampullarius* (Gumbo milkvetch)

4.3.7.1 Natural History

Astragalus ampullarius is an herbaceous perennial of the Fabaceae (Legume Family) with short, well-developed above-ground stems that arise from a deep, stout underground woody base; stems are between 0.8 to 11.2 inches tall, grow along the ground and radiate out from a central base (Welsh et al. 1993). Stems appear white due to the presence of short fine hairs (AGFD 2005). Unlike other *Astragalus* species in Utah, the underground woody base and stems persist with the previous year's bleached and skeleton-like stems and pods (Welsh et al. 1993). Leaves are 1.2 to 5.5 inches long with 7 to 15 oblong, rounded or notched leaflets that are 0.2 to 0.6 inches (0.6 to 1.5 centimeters) long and 0.1 to 0.5 inches (0.4 to 1.2 centimeters) wide (Welsh et al. 1993). Plants have 5 to 30 flowers, with flowers opening upward towards the top of the stem when fully open. Flowers appear from April to June (NatureServe 2009). The fruit is an oblong pod 0.5 to 0.8 inches (1.2 to 2.0 centimeters) long on an elongated stalk (UNPS 2003 – 2008).

A. ampullarius is found in western Kane (west of the Cockscomb) and Washington counties, Utah (Welsh et al. 2008) and has been collected along the Cockscomb (UNHP) and 1 mile east of Kanab (UAH 2009b), and near Fredonia (Mohave County) and House Rock Valley, North Canyon (Coconino County) in Arizona (AGFD 2005)

and has been collected in the vicinity of Cedar Ridge (UAH 2009a). *A. ampullarius* is found on clay soils of the Chinle and Tropic Shale formations at elevations between 3,200 feet (970 meters) and 5,400 feet (1,650 meters) in Utah (Welsh et al. 2008). In Arizona, this species occupies pinyon-juniper, mixed desert shrubland communities on clay-silt, shale, saline, seleniferous to very sandy soils on northeast and southeast facing slopes (AGFD 2005). *A. ampullarius* is associated with other *Astragalus* species, saltbush, wild buckwheat, sunflower, and virgin phacelia in Arizona (AGFD 2005). Additionally, several museum records indicate that historic locations of *A. ampullarius* are known in the vicinity of Cedar Ridge, the Cockscomb, and Fivemile Mountain to West Clark Bench on Chinle and Moenave formations.

4.3.7.2 Survey Results

A. ampullarius was not encountered during project surveys.

4.3.7.3 Discussion

Although no *A. ampullarius* was found during the survey seasons, there are unsurveyed lands within the survey area that could support additional suitable habitat for this species on two privately owned sites at 5.5 miles east of Kanab and in the vicinity of Cedar Ridge. Geologic mapping shows the Petrified Forest Member of the and the Shinarump Member of the of the Chinle Formation (Billingsley et al. 2008) cross the survey area at the Kanab site between 4,650 feet (1,417 meters) and 4,900 feet (1,494 meters) in elevation. Vegetation communities at the Kanab site include *Juniperus osteosperma* woodlands, *Amelanchia utahensis* shrubland, and *Sarcobatus vermiculatus* shrubland. Geologic mapping shows the Petrified Forest Member of the of the Chinle Formation (Billingsley et al. 2008) crosses the survey area at the Cedar Ridge site between 5,000 feet (1,524 meters) and 5,200 feet (1,585 meters) in elevation. Vegetation communities at the Cedar Ridge site include mixed desert shrublands dominated by *Artemisa filifolia* and *Atriplex canenses*. These lands are privately owned and access was not granted at the time of the surveys. If access to these sites is granted, follow-up surveys would have a high potential of locating this plant on Chinle clay knolls as both sites fall within the elevation and expected vegetation community of *A. ampullarius*. Potentially suitable habitat for *A. ampullarius* indicated by museum records and within the survey areas at the Cockscomb and Fivemile Mountain to West Clark Bench were all surveyed. No further surveys are warranted within the survey area for this plant except for the private property east of Kanab and in the vicinity of Cedar Ridge.

4.3.8 *Astragalus holmgreniorum* (Paradox milkvetch)

4.3.8.1 Natural History

Astragalus holmgreniorum is a dwarf, tufted, stemless herbaceous perennial from the Fabaceae (Legume Family) that produces leaves and flowers in the spring and dies back to its roots after the flowering season (USFWS 2006). This species only reaches 1.6 to 4.9 inches (centimeters) in height and spreads across the ground with leaves and flower stalks arising from the root crown (AGFD 2006). The compound leaves are displayed as opposite pairs, measuring 1.5 to 5.1 inches (4.0 to 13.0 centimeters) in length; leaves have 5 to 23 oval shaped leaflets that are 0.3 to 0.6 inches long (0.8 to 1.6 centimeters) (Welsh et al. 2008). Flowers are pink-purple with white wing-tips on a stalk in groups of 6 to 16. Flowers appear from March to April (ARPC 2001), though the Utah Native Plant Society reports flowering April to May (AGFD 2006). The fruits are pods 1 to 2 inches (3 to 5 centimeters) long, and 0.2 to 0.4 inches (0.6 to 0.9 centimeters) across (AGFD 2006).

A. holmgreniorum is found in areas that drain into the Santa Clara and Virgin Rivers on the skirt edges of hill and plateau formations slightly above the edge of drainage areas, where plant cover averages less than 15 percent of the landscape (USFWS 2006). This species occurs in warm desert shrub communities on gravelly clay hills from 2,690 feet (820 meters) to 2,790 feet (850 meters) in elevation (NatureServe 2009), where it is associated with southwestern slopes of the Virgin Limestone and Upper Red Members of the Moenkopi Formation, and to a lesser extent, Chinle Shale (Petrified Forest member) with a thin gravel stratum from the Shinarump Conglomerate

Member of the (USFWS 2006). Six extant *A. holmgreniorum* groups occur in Utah and Arizona (all within 10 miles of St. George), five of which are in Washington County, Utah (consisting of two groups south of Santa Clara and one isolated group east of St. George) and one group extending into Mohave County, Arizona (comprising three subgroups extending from the Atkinville Wash area eastward across I-15 to the Arizona Strip Highway; USFWS 2006).

4.3.8.2 Survey Results

A. holmgreniorum was not encountered during project surveys.

4.3.8.3 Discussion

This species is found at elevations lower than the elevations observed within the survey area.

4.3.9 *Astragalus striatiflorus* (Escarpment milkvetch)

4.3.9.1 Natural History

Astragalus striatiflorus is an herbaceous perennial of the Fabaceae (Legume Family), 0.6 to 2.4 inches (1.5 to 6 centimeters) tall that is partially above ground with an underground woody base (Welsh et al. 1993). Stems are up to 2 inches (up to 5 centimeters) long with only the stem tips emerging above ground (UNPS 2003 – 2008). Leaves are 0.4 to 1.6 inches (1 to 4 centimeters) long with 5 to 13 leaflets up to 0.3 inches (0.1 to 0.7 centimeters) long and oblong with a sharp point or notch at the tip and slightly narrower at the stem (Welsh et al. 1993). Plants have 2 to 5 flowers; flowers face upwards when fully open and are pink-purple or whitish and commonly suffused with a gradually narrowing purple keel-tip, and a head-shaped stigma protruding (Welsh et al. 2008). The pods of this species are inflated, spreading and attached at the base of the stem, 0.5 to 0.7 inches (1.2 to 1.8 centimeters) in length (UNPS 2003 – 2008). Flowers appear from May to June.

A. striatiflorus is endemic to the Colorado Plateau, in scattered stations along the Zion Escarpment between the Virgin and Paria rivers westward to the vicinity of the Coral Pink Dunes in eastern Washington and Kane counties, Utah (Cronquist et al. 1989, Welsh et al. 2008). *A. striatiflorus* is also known from Coconino County, Arizona (Welsh et al. 2008). This species grows in the valleys between sand dunes, sand depressions on ledges, and on bars and terraces in stream channels within pinyon-juniper, ponderosa pine, and sandy desert shrub communities at 4,920 feet (1,500 meters) to 6,560 feet (2,000 meters) in elevation (Welsh et al. 2008). According to University of Arizona Herbarium records, *A. striatiflorus* has been collected from the Paria Plateau are in a variety of habitats including: red sand - sandstone crevices at 7,000 feet (2,134 meters) elevation within a pinyon-juniper woodland with *Amelanchier*, *Artemisia* and *Opuntia* (R.K. Gierisch [#4303] 1978); in rocky sandy soil at 5,600 feet elevation within a pinyon-juniper woodland with *Purshia mexicana*, *Yucca* and *Cercocarpus* (R.K. Gierisch [#4651] 1979); and in sandy soils at 6,040 feet (1,841 meters) elevation with pinyon, juniper, and sagebrush (Larry Higgins [#26615] 2005).

4.3.9.2 Survey Results

A. striatiflorus was not encountered during project surveys.

4.3.9.3 Discussion

The combination of elevation, associated vegetation, and sandy soils reported from Paria Plateau locations are not present within the survey area. No further surveys are warranted within the survey area for this plant.

4.3.10 *Camissonia bairdii* (Baird camissonia)

4.3.10.1 Natural History

Camissonia bairdii is an herbaceous annual in the Onagraceae (Evening Primrose Family) that grown derived 1.8 to 4.8 inches (4.5 to 12 centimeters) tall. It grows from a taproot and produces simple leaves found mostly near the base of the stem. Stems and leaves are covered in glands with minute, downy, soft hairs that are characteristically the same length and size (UNPS 2010). Leaves form at the base, are simple in shape, and measure 0.3 to 1.2 inches (0.8 to 3 centimeters) long (Welsh et al. 1993). Flowers are borne on a leafless stalk with yellow petals that often have red spots near the base (NatureServe 2009). Seeds are released from a dry fruit, which ranges from 1.3 inches to 1.9 inches (33 to 50 millimeters) in length. These plants flower between in May and June (NatureServe 2009).

This species may be confused with *Camissonia scapoidea* and *C. chamaeneriodies*. All three species produce a long, dry fruit, but *C. bairdii* has a longer fruit than *C. scapoidea* and a thicker fruit than *C. chamaeneriodies*. Although *C. scapoidea* and *C. bairdii* are similar in appearance, they are found in separate geographic ranges (Welsh et al. 1993).

This species is endemic to Utah. Its entire range is restricted to Washington County, Utah where its habitat is comprised of blackbrush and pinyon-juniper communities. *Camissonia bairdii* is found within a small elevation range of 3,900 feet (1,189 meters) to 4,300 feet (1,311 meters) in elevation. Type localities have been described from between Manganese Wash and Miner's Canyon (Welsh et al. 1993).

4.3.10.2 Survey Results

C. bairdii was not encountered during project surveys.

4.3.10.3 Discussion

This cryptic species was intensively searched for in gypsum barrens on the Colorado Plateau. Only *Camissonia parryi* was found in potentially suitable habitat for *C. bairdii*. No further surveys are warranted within the survey area for this plant.

4.3.11 *Camissonia gouldii* (Diamond Valley suncup)

4.3.11.1 Natural History

Camissonia gouldii is an annual in the Onagraceae (Evening Primrose Family). This plant is leafy with a simple or branching stem reaching 2.4 inches to 7.9inches (6 to 20 centimeters) tall (Welsh et al. 1993). Leaves are 0.4 to 0.6 inches (1 -1.5 centimeters) long, minutely toothed and oval shaped. The flowers are white, fading to pink, bent to one side, and characteristically tiny, reaching less than 0.1 inches (1.5 to 3 millimeters) long (Welsh et al. 1993). Flowers are self-pollinating and bloom from mid-May to early June (UNPS 2003 to 2008).

C. gouldii is allied to *Camissonia boothiii* var. *cillosa*, but is easily distinguished by the placement of its dried fruit which is attached directly to *C. gouldii's* stem. *C. gouldii* is also recognized by its tiny flowers (Welsh et al. 1993).

C. gouldii is known from the volcanic cones north of St. George in Washington County, Utah, (UNPS 2003 – 2008), northwest of Flowell in Millard County, Utah, and from Mohave and east–central Coconino counties, Arizona (AGFD 2005). This plant is found in pinyon-juniper and big sagebrush communities in volcanic ash with *Phacelia palmeri* at 3,500 feet (1,067 meters) in elevation in Utah (Welsh et al. 2008) and volcanic cones on steep slopes, volcanic scree slopes or cinder flats from 3,400 to 5,400 feet (1,036 to 1,646 meters) in Arizona (AGFD

2005). In Arizona, *C. gouldii* is associated with *Eriogonum* spp., *Gaura coccinea*, *Mentzelia pterosperma*, *Nicotiana trigonophylla*, and *Phacelia* spp. (AGFD 2005).

4.3.11.2 Survey Results

C. gouldii was not encountered during project surveys.

4.3.11.3 Discussion

Potential suitable habitat for *C. gouldii* was surveyed in the unburned volcanic soils between the Divide and Gould's Wash, and within the Forebay. No occurrences of *C. gouldii* were documented. No further surveys are warranted within the survey area for this plant.

4.3.12 *Ceanothus greggii* var. *vestitus* (Mohave ceanothus)

4.3.12.1 Natural History

Ceanothus greggii var. *vestitus* is an erect or low rounded shrub of the Rhamnaceae (Buckthorn Family), growing 8 inches to 7 feet (0.2 to 2 meters) tall. Branches, not intricately displayed, are covered with short, densely matted, soft white wool, and are spineless (Welsh et al. 1993). Leaves are evergreen and opposite, thick and leathery, oblong shaped, and hairy on both sides. Flowering occurs in the spring, with the appearance of white flowers that dry to white.

The range of *C. g.* var. *vestitus* extends into Nevada, California, New Mexico, Texas, and Mexico (Welsh et al. 2008). The species is known to occur in Iron and Washington counties, Utah, and Mohave County, Arizona. *C. g.* var. *vestitus* is described as occurring in montane chaparral, desert chaparral, sagebrush scrub, and Joshua tree and pinyon-juniper woodlands. In Utah and Arizona it is found in mixed desert shrub, pinyon-juniper and mountain brush communities. *C. g.* var. *vestitus* occurs at 4,000 feet (1,219 meters) to 9,415 feet (2,870 meters) elevation in Utah (Welsh et al. 2008); in Arizona the species is found in elevations ranging from 3,445 feet (1,050 meters) to 8,038 feet (2,450 meters) (USDA Plants 2009; Zouhar 2000).

4.3.12.2 Survey Results

C. g. var. *vestitus* was not encountered during project surveys.

4.3.12.3 Discussion

C. g. var. *vestitus* was not encountered during the project surveys. All potentially suitable habitat occurring within the survey area was surveyed during the survey seasons. No further surveys are warranted within the survey area for this plant.

4.3.13 *Cladium californicum* (California sawgrass)

4.3.13.1 Natural History

Cladium californicum is a perennial grass of the Cyperaceae (Sedge Family) spreading from robust scaly underground stems. Hollow, leafy stems are 3.3 to 6.6 feet (1 to 2 meters) tall and almost circular to triangular shaped. Leaves are flat and slightly serrated with hard teeth. Flowers are clustered, made up of 3 to 10 or more few-flowered umbels with numerous spikelets (Welsh et al. 2008). Fruiting and flowering occurs in late spring to summer (efloras.org 2009).

C. californicum is found throughout the southwestern United States (efloras.org 2009). In Utah it is known from spring runs in Lake Mead National Recreational Area. This species is one of the rarest and most unusual plant species in Utah only occurring just above the high water mark of Lake Powell in Kane and San Juan counties (Welsh et al. 2008). The grass is locally dominant in the creek flowing from Rogers Spring, Clark County, Nevada. Throughout its range *C. californicum* is found in alkaline freshwater marshes and springs up to 6,561 feet (efloras.org 2009). In Utah the species ranges from 3,690 feet (1125 meters) to 3,775 feet (1150 meters) in elevation in hanging gardens (Welsh et al. 2008).

4.3.13.2 Survey Results

C. californicum was not encountered during project surveys.

4.3.13.3 Discussion

No seeps or hanging gardens were encountered in field surveyed survey areas. *C. californicum* was not encountered during the project surveys, and all potentially suitable springs were investigated during the 2010 survey season. No further surveys are warranted within the survey area for this plant.

4.3.14 *Cornus sericea* (Red-osier dogwood)

4.3.14.1 Natural History

Cornus sericea is a perennial clump-forming, woody shrub of the Cornaceae (Dogwood Family) between 5 to 20 feet (1.4 to 6 meters) tall. Red to purplish branches have some fine hairs, with older stems appearing grayish green and mostly hairless (Welsh et al. 1993). The simple, opposite leaves are 0.4 to 2.4 inches (1 to 12 centimeters) long, dark green above and hairy and pale beneath, with smooth margins, rounded bases, pointed tips, and falsely parallel veins. The plant has numerous flowers with white to cream-colored petals. Flowering occurs from May to July in Utah (Crane 1989).

C. sericea is known to occur throughout the northeastern, northwestern, and western United States. It can be found throughout Utah and within Coconino, Navajo, and Apache counties, Arizona (Crane 1989). In the northeastern and midwestern United States it is common in previously glaciated areas; south of these areas it occurs locally where site conditions are favorable. In Utah and Arizona it primarily occurs along streambanks and other moist sites in woodland-riparian areas. Throughout its range *C. sericea* can occur up to 10,000 feet (3,048 meters) elevation; it occurs between 4,495 feet (1,370 meters) and 10,000 feet (3,048 meters) elevation in Utah (Welsh et al. 2008) and 5,000 feet (1,524 meters) to 9,000 feet (2,743 meters) elevation in Arizona (Crane 1989).

4.3.14.2 Survey Results

C. sericea was not encountered during project surveys.

4.3.14.3 Discussion

C. sericea was not encountered during the project surveys, and all potentially suitable springs were investigated during the 2010 survey season. No further surveys are warranted within the survey area for this plant.

4.3.15 *Cryptantha semiglabra* (Smooth catseye)

4.3.15.1 Natural History

Cryptantha semiglabra is an herbaceous perennial in the Boraginaceae (Borage Family) that grows 8 to 12 inches (2 to 3 decimeters) in height. Its woody root system produces single to multiple herbaceous stems covered in stiff, sharp hairs which are characteristically bent downward. Short, soft hairs cover the lower surface of the leaf, although an important identifying feature is the lack of hairs on the upper leaf surface. The margins of the lanceolate leaves may be fringed with hairs. The foliage is shiny green in color. The inflorescence of *C. semiglabra* is a scorpioid raceme up to 5 inches (12 centimeters) in length, and contains few individual white flowers with yellow appendages located in the throat (Figure 4-1). The tube of each flower is 0.35 to .50 inches (9 to 12 millimeters) long, and surpasses the calyx considerably in length. Seeds are contained within smooth and shiny nutlets, which are dispersed closely to the parent plant. Nutlets are broadly ovate in shape. The plants flower and set seed from May to June (UNPS 2003-08, AGFD 2004).

Figure 4-1
Close-up View of *Cryptantha semiglabra*

C. semiglabra may be confused with *C. flava* or *C. capitata*. While all three species produce white flowers with yellow appendages, *C. semiglabra* is easily distinguished by nutlet shape, the amount of hair present on the leaves, and the inflorescence. In contrast to *C. semiglabra*, both the top and bottom of the leaves of *C. flava* and *C. capitata* are hairy. *C. capitata* produces capitate inflorescences, rather than the racemes found on *C. semiglabra*. While *C. semiglabra* produces broadly ovate nutlets, those of *C. flava* are lanceolate to narrowly ovate (AGFD 2004).

C. semiglabra is endemic to Utah and Arizona. Its entire range is restricted to southeast Washington County, Utah, and Coconino and Mohave counties, Arizona. In Utah, it is identified as inhabiting clay soils in Great Basin Desert scrub and Great Basin Conifer Woodland (pinyon-juniper) communities, from 4,900 feet (1,494 meters) to 5,675 feet (1,730 meters) in elevation (Welsh et al. 2008). In Arizona, the species is associated with *Artemisia bigelovii*, *Atriplex confertifolia*, *Ephedra torreyana*, *Gutierrezia sarothrae*, *Oryzopsis hymenoides*, *Pediocactus sileri*, and *Yucca angustissima* within the Great Basin Desert scrub community, where it inhabits red clay soils of the Moenkopi Formation, at elevations ranging from 4,600 feet (1,402 meters) to 4,900 feet (1,494 meters) (AGFD 2004).

4.3.15.2 Survey Results

Within the survey area, *C. semiglabra* was only recorded in Mohave County, Arizona, within the Hydro System Existing Highway Alternative Reach. A total of 3,314 individuals were encountered, which were scattered along Arizona State Route 389, west of Fredonia and extending to Pipe Springs National Monument. Some occurrences were located on private and State Trust Lands, although the majority (2,243 individuals) was found on the Kaibab Indian Reservation between Cottonwood Wash and Twomile Wash. A second substantial group (968 individuals) was encountered southwest of Kanab Creek along State Route 389. The fewest number of individuals were encountered adjacent to Twomile Wash, where 103 individuals were identified (Table 4-2). The distribution of *C. semiglabra* across the survey area is shown in Figure 2-2 through Figure 4-6.

Table 4-2
A Summary of *Cryptantha semiglabra* Survey Results by Location

Reach	Location	Land Ownership	# of Plants
Hydro System Existing Highway Alternative	0.75 miles southwest of Kanab Creek along Arizona State Route 389	Private and State Trust	968
Hydro System Existing Highway Alternative	Cottonwood Wash to Twomile Wash	Kaibab Indian Reservation	2,243
Hydro System Existing Highway Alternative	3 miles east and 0.4 miles west of Twomile Wash	Kaibab Indian Reservation	103
		Total	**3,314**

All 3,314 *C. semiglabra* individuals were found growing between 4,550 feet (1,387 meters) and 4,718 feet (1,438 meters) in elevation within the Colorado Plateau Ecological Region. Individuals were observed in three ecological systems, seven alliances, and 10 associations. *C. semiglabra* was found primarily within the Colorado Plateau Gypsum Badlands Ecological System within the *Eriogonum* (*corymbosum*, *mortonianum*, *thompsoniae*) Gypsum Badlands Sparse Shrubland and *Artemisia bigelovii – Ephedra torreyana* / Crytobiotic Gypsum Badlands Sparse Shrubland associations. *Cryptantha semiglabra* was mostly found in areas that were sparsely vegetated; however, those species most commonly present included Artemisia bigelovii, *Ephedra torreyana*, *Eriogonum corymbosum*, *Pleuraphis jamesii*, and *Atriplex confertifolia*, the occurrence of *C. semiglabra* often coincided with other rare plants with an affinity for red, gypsum soils, including *Eriogonum corymbosum nilesii*, *E. thompsoniae atwoodii*, *E. mortonianum*, and *Pediocactus sileri*. All vegetation communities supporting *C. semiglabra* are shown in Table 4-3.

The relative abundances of *C. semiglabra* individuals varied across microhabitats with Gypsum Badlands. Its abundance was documented as locally common on mud washes, as locally abundant at the base of red hills, and on the slopes below gypsum outcrops. On gypsum outcrops it was occasional, and within arroyos occurrences it was rare (see the Vegetation Community Report for information relating to the Gypsum Badlands Ecological System). The absence of the species was noted from non-cryptobiotic soils on crests and benches, from cryptobiotic soils atop benches and knolls, and from bajadas. *C. semiglabra* appears to benefit from the process of mud wash creation through enhanced seed dispersal.

C. semiglabra was found on four geologic formations within the survey area. It was primarily found on Undivided Moenkopi Formation and the Shnabkaib Member of the Moenkopi Formation within the Colorado Plateau Gypsum Badlands Ecological System. The Undivided Moenkopi Formation is a light-red and dark-red, slope-forming siltstone and sandstone with minor gray gypsum. It is often exposed as isolated outcrops and is similar to the Lower Red and Middle Red Members. The Shnabkaib Member alternates between beds of white to light-gray fine grained dolomite and light-gray, calcareous siltstone and silty gypsum (Billingsley et al. 2008). All geologic formations supporting *C. semiglabra* are given in Table 4-4.

Table 4-3 A Summary of *Cryptantha semiglabra* Survey Results by Alliance and Association		
Alliance	**Association**	**# of Plants**
COLORADO PLATEAU GRASSLAND ECOLOGICAL SYSTEM		
Pleuraphis jamesii Herbaceous	*Pleuraphis jamesii* Herbaceous Vegetation	28
COLORADO PLATEAU GYPSUM BADLANDS ECOLOGICAL SYSTEM		
Artemisia bigelovii Shrubland	*Artemisia bigelovii – Ephedra torreyana* / Crytobiotic Gypsum Badlands Sparse Shrubland	830
Atriplex confertifolia Shrubland	*Atriplex confertifolia* Gypsum Badlands Dwarf- shrubland	15
Atriplex confertifolia Shrubland	*Atriplex confertifolia* Gypsum Badlands Sparse Dwarf- shrubland	100
Ephedra (*nevadensis*, *torreyana*) Shrubland	*Ephedra* (*nevadensis*, *torreyana*) Gypsum Badlands Sparse Shrubland	398
Eriogonum (*corymbosum*, *mortonianum*, *thompsoniae*) Shrubland	*Eriogonum* (*corymbosum*, *mortonianum*, *thompsoniae*) Gypsum Badlands Shrubland	573
Eriogonum (*corymbosum*, *mortonianum*, thompsoniae) Shrubland	*Eriogonum* (*corymbosum*, *mortonianum*, *thompsoniae*) Gypsum Badlands Sparse Shrubland	1345
Eriogonum (*corymbosum*, *mortonianum*, *thompsoniae*) Shrubland	*Eriogonum* (*corymbosum*, *mortonianum*, *thompsoniae*) Gypsum Badlands Sparse Dwarf-shrubland	22
Eriogonum thompsoniae var. *atwoodii* Sparsely Vegetated	*Eriogonum thompsoniae* var. *atwoodii* Gypsum Badlands Sparse Vegetation	2
COLORADO PLATEAU MIXED DESERT SCRUB ECOLOGICAL SYSTEM		
Krascheninnikovia lanata Shrubland	*Krascheninnikovia lanata* Dwarf-shrubland	1
	Total	**3,314**

Table 4-4 A Summary of *Cryptantha semiglabra* Survey Results by Geologic Formation	
Geologic Formation	**# of Plants**
COLORADO PLATEAU GRASSLAND ECOLOGICAL SYSTEM	
Undivided Moenkopi Formation	28
COLORADO PLATEAU GYPSUM BADLANDS ECOLOGICAL SYSTEM	
Qah	100
Undivided Moenkopi Formation	2,214
Middle Red Member of the Moenkopi Formation	3
Shnabkaib Member of the Moenkopi Formation	968
COLORADO PLATEAU MIXED DESERT SCRUB ECOLOGICAL SYSTEM	
Undivided Moenkopi Formation	1
Total	**3,314**

C. semiglabra was documented it growing on red, clay or gypsum soils, and red mud flats believed to have derived from the erosion of gypsum outcrops . The majority of plants were found on Gypsiorthids- Gypsiorthids, shallow complex soils. All soils supporting *C. semiglabra* are given in Table 4-5.

Table 4-5 A Summary of *Cryptantha semiglabra* Survey Results by Soil Type	
Soil Type	**# of Plants**
Clayhole loam	226
Gypsiorthids-Gypsiorthids, shallow complex	3,088
Total	**3,314**

Note:
*Due to the resolution of the plant data and the geologic layer data, this species may occur in any of the geologic formations listed for each ecological system.

4.3.15.3 Discussion

The survey identified a total of 3,314 individuals of *C. semiglabra* within the survey area, occurring entirely within Mohave County, Arizona; within the Hydro System Existing Highway Alternative Reach. These individuals were documented mostly within the Colorado Plateau Gypsum Badlands Ecological System (Figure 3-5). *C. semiglabra* was observed most often on Gypsiorthids-Gypsiorthids soils of the Undivided Moenkopi Formation. Nearly all individuals were located on the Kaibab-Paiute Indian Reservation, although some were found on private and State Trust Lands to the east of the Reservation. Note that *C. semiglabra* is a Utah BLM sensitive species found outside BLM jurisdiction; this species is not considered a sensitive species by the BLM in Arizona.

Figure 4-2
***Cryptantha semiglabra* in Habitat within the Survey Area**

C. semiglabra was encountered in habitats mostly consistent with published data; it was observed within the Colorado Plateau Gypsum Badland, Colorado Plateau Grassland, and the Colorado Plateau Mixed Desert Scrub ecological systems. The lowest elevation where the species was encountered during the survey was slightly lower than that documented in Arizona by AGFD (4,550 feet [1,387 meters] versus 4,600 feet [1,402 meters] in elevation).

The AGFD reports that *C. semiglabra* seems to be tolerant of disturbance; however, important management factors include habitat disturbance due to off-road vehicle recreation, trampling, and garbage dumping. Although speculative, survey findings suggest that the presence of *C. semiglabra* is associated with erosional processes, particularly mud flows. Also, *C. semiglabra* was found primarily on un-grazed or lightly grazed lands in areas otherwise minimally disturbed by human activities. These findings suggest that while *C. semiglabra* may be tolerant of some types of natural disturbance, the impacts of human-caused disturbances are unclear. Field observations suggest that the species occurs with sparse vegetation cover and so the spread of invasive weeds could occupy *C. semiglabra* habitat due to ground disturbance. The dense monotypical growth habit of many invasive weeds may pose a potential threat to *C. semiglabra* through competition for resources and shading effects due to crowding.

As *C. semiglabra* reproduces from seed, the number of individuals identified during the survey may represent relative distribution of the plant at various locations where *C. semiglabra* is present within the seed bank. Additionally, it is likely that seed is present within adjacent habitats containing saline soils or clay soils derived from the Moenkopi Formation, where localized climactic conditions may not have been conducive to germination prior to, or during the survey periods. Project construction activities could therefore include salvage and replanting of topsoil from habitats with the potential to contain viable *C. semiglabra* seed.

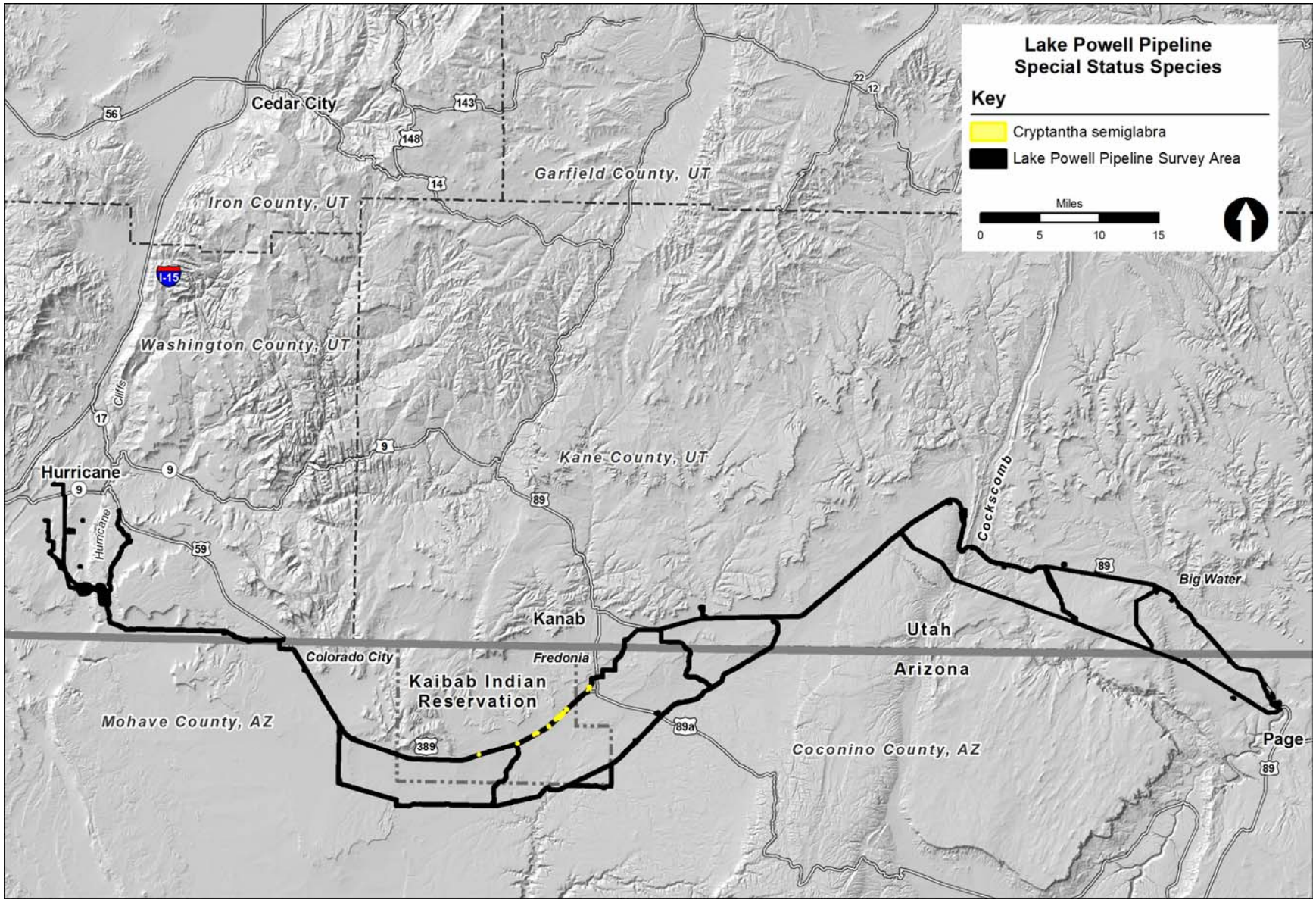

Figure 4-3
***Cryptantha semiglabra* Overview Map**

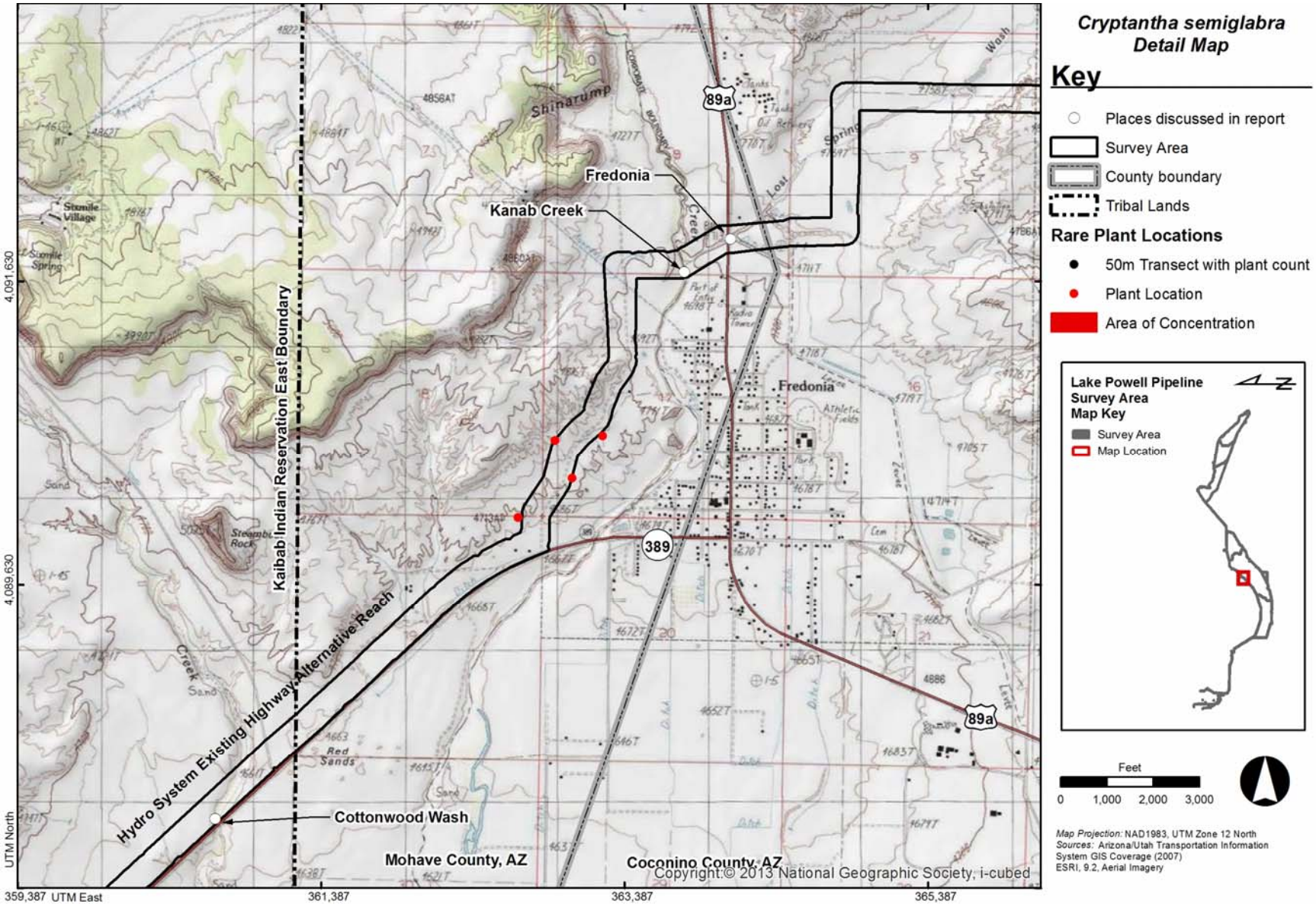

Figure 4-4
***Cryptantha semiglabra* Detail Map 1**

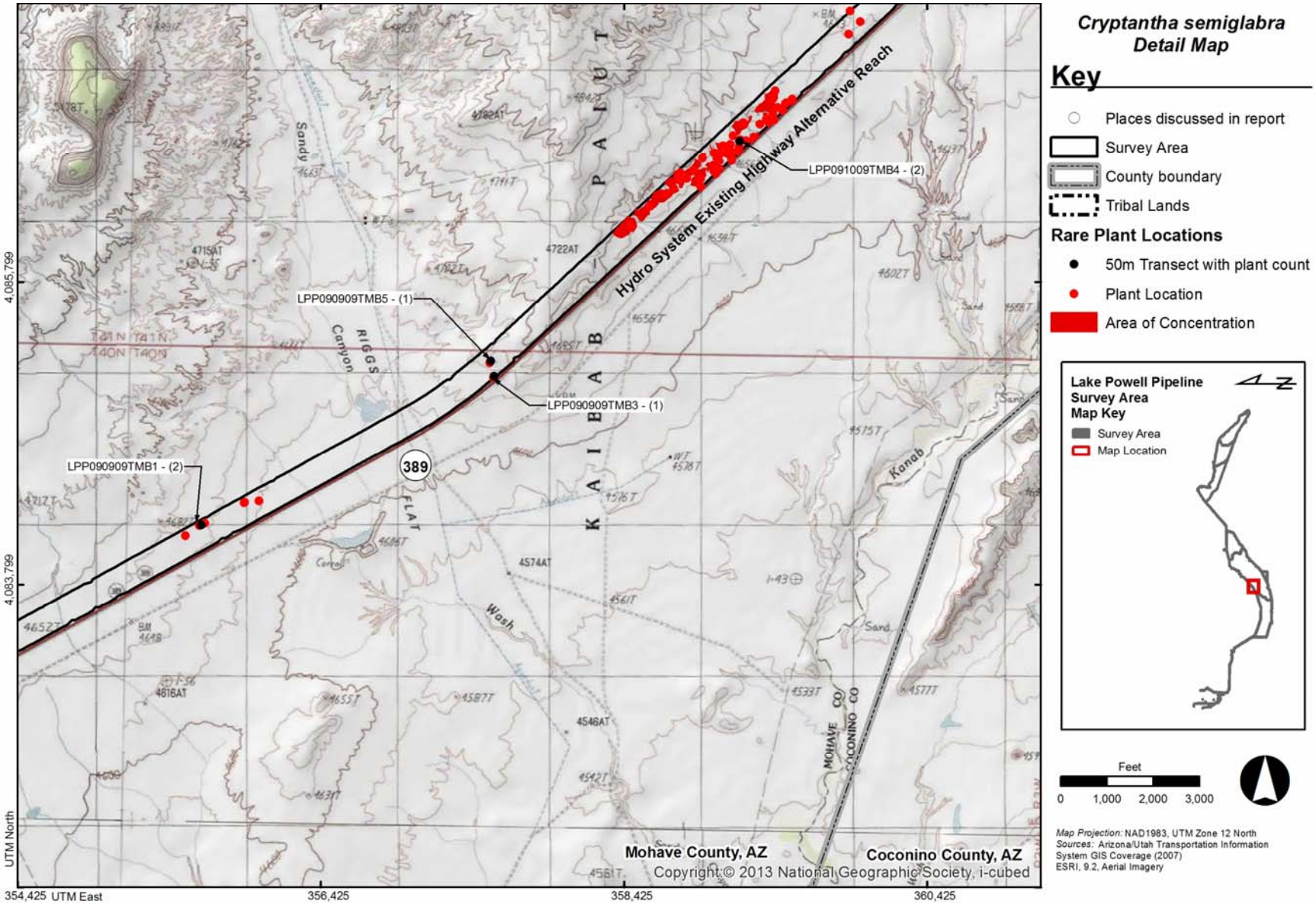

Figure 4-5
***Cryptantha semiglabra* Detail Map 2**

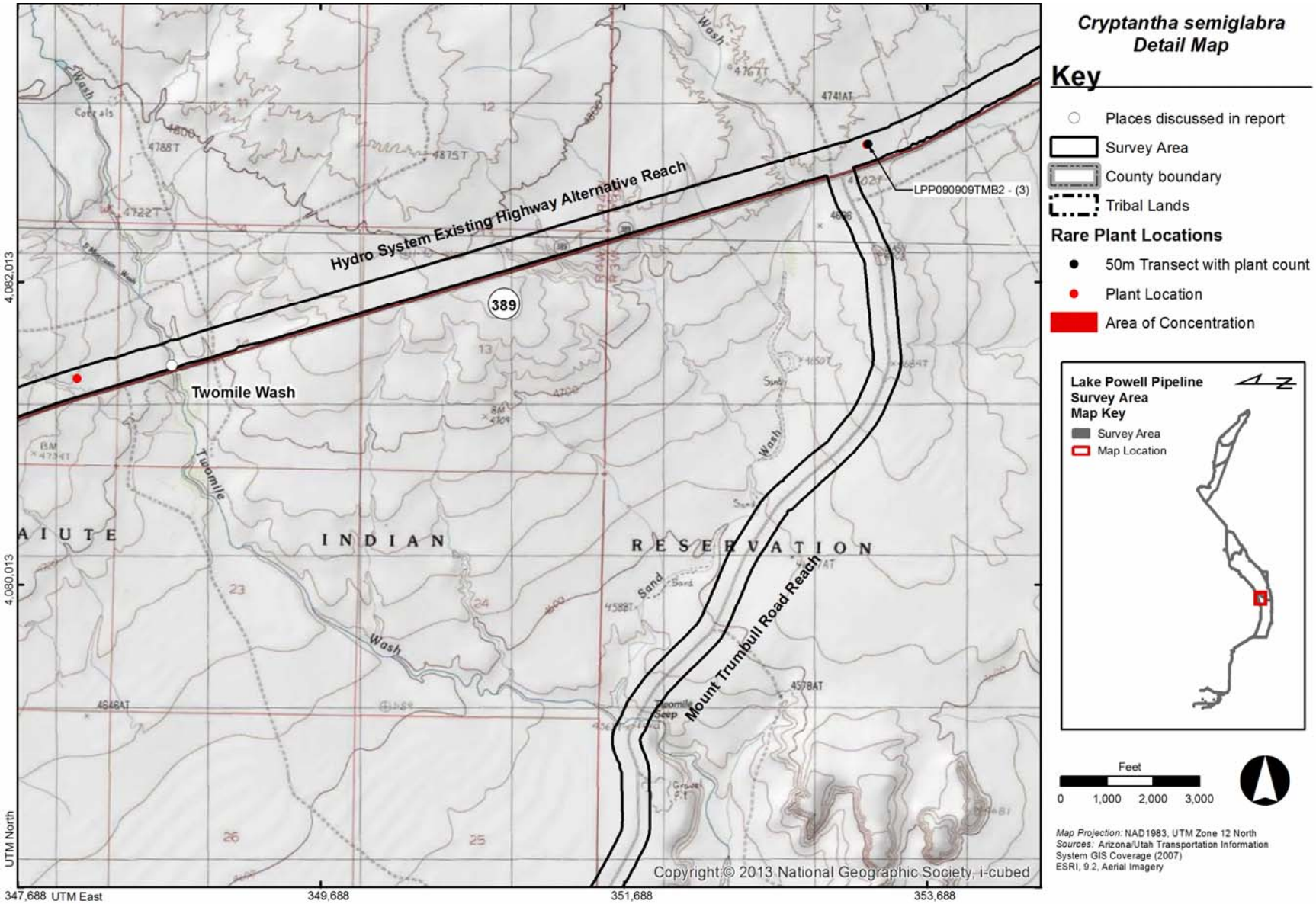

Figure 4-6
***Cryptantha semiglabra* Detail Map 3**

4.3.16 *Cycladenia humilis* var. *jonesii* (Jones cycladenia)

4.3.16.1 Natural History

Cycladenia humilis var. *jonesii* is a long-lived perennial herb of the Apocynaceae (Dogbane Family). The roots of the plant allow it to survive the winter and re-sprout in the spring. The blue-gray to green stems are erect, reaching from 4 to 16 inches (10 to 40 centimeters) in height. Main foliage leaves are arranged oppositely and are pale green, and smooth. Lower leaves appear to wrap around the stem, and enlarge moving upwards along the stem. Funnel-shaped flowers have two forms differing slightly in length and width (UNPS 2201-2008), and are clustered on smooth leafless stalks, each with 5 pink to rose-purple petals. Flowers appear in May and June. Individual *C. h.* var. *jonesii* grow in clumps and reproduce by shared rhizomes underground (NatureServe 2009).

C. h. var. *jonesii* is on found in and around the Canyonlands region of southeastern Utah in Kane, Emery, Garfield, and Grand counties and in Arizona from the Vermillion Cliffs, Moccasin Mountains, and east of Colorado City in Mohave County (AGFD 2005, Welsh et al. 2008). In Utah, this *C. h.* var. *jonesii* inhabits barren soils of the Cutler, Summerville, and Chinle formations on semi-barren lands of *Eriogonum- Ephedra*, mixed desert shrub, and juniper communities at 4,390 feet (1340 meters) to 6,000 feet (1830 meters) (Welsh et al. 2008). In Arizona, this plant inhabits gypsiferous, sandy, silty, saline clay soils of the Chinle Formation steep sides and lower slopes of mesas in Great Basin desert scrub (AGFD 2005).

4.3.16.2 Survey Results

C. h. var. *jonesii* was not encountered during project surveys.

4.3.16.3 Discussion

Although *C. h.* var. *jonesii* was not found during project surveys, the plant could occur within the survey area on private lands near Cedar Ridge as discussed for *Astragalus ampullarius*. Lands near Cedar Ridge meet the geologic, vegetative, and elevational requirements for *C. humilis*, and there is a high probability of *C. h.* var. *jonesii* being located within these private lands. If access can be obtained, surveys should be conducted in May or June in the vicinity of Cedar Ridge where habitat conditions are favorable.

4.3.17 *Cystopteris utahensis* (Utah brittle-fern)

4.3.17.1 Natural History

Cystopteris utahensis is a hybrid, with chromosomes derived from different species, of the Dryopteridaceae (Wood Fern Family). *C. utahensis* is a loosely tufted perennial herb originating from short, creeping underground stems. The stem is hairless, and the leaves are elongated and triangular; clustered at the stem; up to 18 inches (45 centimeters) long; and almost all bearing clusters of spores on the underside. The leaf stalk is green to straw-colored, or darker near the base. The leaf blade is longer than the stalk in the *C. utahensis*, and is elongated, paired, and widest at the base. The main stem is unicellular with gland-tipped hairs and small, misshapen bulbs that may or may not be present. Spores of this species are spiny (AGFD 2005). *C. utahensis* produces spores from June to November (AGFD 2005, Welsh et al. 2008).

C. utahensis ranges from Utah, Arizona, Colorado, and disjunct in western Texas, and New Mexico (AGFD 2005). In Utah, the species is known from Grand, Kane, Utah and Washington counties; and in Arizona, primarily from Canyon del Muerto in Canyon de Chelly National Monument in Apache County. It has also been collected from Coconino and Yavapai counties, Arizona (AGFD 2005, Welsh et al. 2008). *C. utahensis* grows on sandy ledges and in crevices on partially shaded to shaded west- to north-facing cliffs. It is found in association with *Aquilegia chrysantha*, *Berberis repens*, *Heuchera* spp., and *Cystopteris fragilis*. *C. utahensis* is found on crevices, talus, and in other damp shady places at elevations from 4,200 feet (1,280 meters) to 11,515 feet (3,510 meters) in

Utah (Welsh et al. 2008) and on calcareous cliffs, including limestone, sandstone, and some volcanic rock, of the Weber Formation from 4,262 feet (1,300 meters) to 8,852 feet (2,700 meters) in Arizona (AGFD 2005).

4.3.17.2 Survey Results

C. utahensis was not encountered during project surveys.

4.3.17.3 Discussion

No seeps or hanging gardens were encountered within surveyed areas. *C. utahensis* was not encountered during the project surveys, and all potentially suitable springs were investigated during the 2010 survey season. No further surveys are warranted within the survey area for this plant.

4.3.18 *Echinocactus polycephalus* var. *xeranthemoides* (Kanab barrel cactus)

4.3.18.1 Natural History

Echinocactus polycephalus var. *xeranthemoides* is a perennial stem succulent shrub of the Cactaceae (Cactus Family), branching from the base to form compact mounds of 2 to 50 heads. Stems of this barrel are gray-green to yellow-green, spherical to short cylindrical in shape with 11 to 25 vertical ribs. The spines are straight to curved, but never hooked, red to straw in color, smooth or sparsely hairy, and in clusters of 10 to 19 spines per areole (Figure 4-7). Flowers are yellow and set within the spines, restricting the flower from fully opening. *E. p.* var. *xeranthemoides* is slow-growing and probably long-lived. Flowers bloom from June to August, and are pollinated by bees. Spiny, armored seeds are eaten and dispersed by birds and packrats. Bighorn sheep and javelina eat the whole plant, and may be responsible for long-distance seed dispersal (AGFD 2006). This species is not a BLM sensitive species.

Figure 4-7
Close-up View of *Echinocactus polycephalus* var. *xeranthemoides* within the Survey Area

E. p. var. *xeranthemoides* is found near Kanab in Kane County, Utah, Coconino and Mohave counties in Arizona (Welsh et al. 2008) and has been reported from and Clark County in Nevada (AGFD 2006). This species is found in pinyon-juniper and desert shrub communities on rocky hills, slopes, and ledges (AGFD 2006). *E. p.* var. *xeranthemoides* is most often found on south-facing ledges and cliffs and southeast and west-facing slopes on igneous and calcareous soils, including limestone ledges and boulders and sandstone. Range wide this species is known to occur at elevations from 1,803 feet (550 meters) to 6,479 feet (1,975 meters) (AGFD 2006).

E. p. var. *xeranthemoides* can be identified from *E. p.* var. *polycephalus* by having spines that are either smooth or with scattered hairs and smooth, shiny seeds while *E. p.* var. *polycephalus* spines are felty and the seeds have soft glands (Welsh et al. 2008).

4.3.18.2 Survey Results

E. p. var. *xeranthemoides* was encountered only in the Hydro System South Alternative Reach (Table 4-6), where it occurred on BLM lands south of the Kaibab Indian Reservation on the cliffs above Kanab Creek. Surveys produced nine individual plants between 4,324 feet (1,318 meters) and 4,735 feet (1,443 meters) in elevation. The distribution of *E. p.* var. *xeranthemoides* is shown in the distribution and detailed maps provided in Figure 4-9 and Figure 4-10.

Table 4-6
A Summary of *Echinocactus polycephalus* var. *xeranthemoides* Survey Results by Location

Reach	Location	Land Ownership	# of Plants
Hydro System South Alternative	0.12 miles north, east, and south of Kanab Creek Canyon	BLM	9
		Total	**9**

E. p. var. *xeranthemoides* was found within the Colorado Plateau Ecoregion in three Ecological Systems, three alliances, and three associations. *E. p.* var. *xeranthemoides* was observed within the Colorado Plateau Mixed Bedrock Canyon and Tableland, Colorado Plateau Shrub Steppe, and the Colorado Plateau Mixed Desert Scrub ecological systems. The Colorado Plateau Shrub-Steppe Ecological System supported the largest quantity of individuals (6 of 9), all of which occurred within the *Eriogonum corymbosum – Gutierrezia sarothrae*/*Pleuraphis jamesii* Sparse Shrubland Association. A summary of *E. p.* var. *xeranthemoides* occurrences is provided in Table 4-7.

Table 4-7
A Summary of *Echinocactus polycephalus* var. *xeranthemoides* Survey Results by Alliance and Association

Alliance	Association	# of Plants
COLORADO PLATEAU MIXED BEDROCK CANYON AND TABLELAND ECOLOGICAL SYSTEM		
Ephedra nevadensis Sparsely Vegetated	*Ephedra nevadensis* Sparse Vegetation	2
COLORADO PLATEAU MIXED DESERT SCRUB ECOLOGICAL SYSTEM		
Artemisia filifolia Shrubland	*Artemisia filifolia* Sparse Shrubland	1
COLORADO PLATEAU SHRUB-STEPPE ECOLOGICAL SYSTEM		
Eriogonum corymbosum Shrubland	*Eriogonum corymbosum – Gutierrezia sarothrae*/*Pleuraphis jamesii* Sparse Shrubland	6
	Total	**9**

Based on GIS data, *E. p.* var. *xeranthemoides* was found on one geologic formation within the survey area, the Undivided Moenkopi Formation. However, the geology data is only available in poor resolution, and field observations of the area where *E. p.* var. *xeranthemoides* was found discount the GIS data in this instance. In the field, *E. p.* var. *xeranthemoides* was found on exposed Kaibab limestone at Kanab Creek. All GIS data on geologic formations supporting *E. p.* var. *xeranthemoides* are given in Table 4-8.

Table 4-8
A Summary of *Echinocactus polycephalus* var. *xeranthemoides* Survey Results by Geologic Formation

Geologic Formation	# of Plants
COLORADO PLATEAU MIXED BEDROCK CANYON AND TABLELAND ECOLOGICAL SYSTEM	
Undivided Moenkopi Formation	2
COLORADO PLATEAU MIXED DESERT SCRUB ECOLOGICAL SYSTEM	
Undivided Moenkopi Formation	1
COLORADO PLATEAU SHRUB-STEPPE ECOLOGICAL SYSTEM	
Undivided Moenkopi Formation	6
Total	**9**

E. p. var. *xeranthemoides* were found on multiple soil types within the survey area, with the majority of plants found on Torriorthents – Rock outcrop complex soils on 30 to 70 percent slopes. Table 4-9 provides a complete list of soils supporting *E. p.* var. *xeranthemoides*.

E. p. var. *xeranthemoides* individuals were generally found growing on cliffs with southern and western exposures. Often, the species was found in small openings on the cliff face, growing in small pockets of soil exposed amongst the bedrock.

Table 4-9
A Summary of *Echinocactus polycephalus* var. *xeranthemoides* Survey Results by Soil Type

Soil Type	# of Plants
Pennell gravelly loam	1
Rock outcrop-Torriorthents complex, warm, 25 to 65 percent slopes	1
Torriorthents – Rock outcrop complex, warm, 30 to 70 percent slopes	7
Total	**9**

4.3.18.3 Discussion

E. p. var. *xeranthemoides* was only identified in the Hydro System South Alternative Reach, where it was found on the cliffs above Kanab Creek. Each cactus was observed on gravelly, rock outcrops, with southern or western exposures (Figure 4-8). Accompanying vegetation was sparse, but included *Eriogonum corymbosum*, *Artemisia tridentata*, *Gutierrezia sarothrae*, *Pleuraphis jamesii*, *Ephedra nevadensis*, and *Artemisia filifolia*. *E. p.*var. *Xeranthemoides* is a GCNRA species of concern; however, no plants were located within GCNRA. This species is not a BLM sensitive species.

Figure 4-8
View of *Echinocactus polycephalus* var. *xeranthemoides* within the Survey Area

E. p. var. *xeranthemoides* is subject to horticultural collecting, like most cacti (AGFD 2006). Public access and knowledge of *E. p.* var. *xeranthemoides* may increase as access roads are created for the construction of the pipeline or associated facilities. The species was found in a highly localized area within the survey area. Individuals growing within or immediately adjacent to the survey area may be at-risk from habitat loss, disturbance, or damage by mechanized equipment. Individuals to be avoided should be flagged and protected in place. Individuals that cannot be avoided could be salvaged and relocated outside of the affected area, but within similar habitat. Plants should be transplanted to sites with the same exposure, and replanted at the same depth as found prior to salvage. Invasive weeds are not considered a current threat to the species, as they were not found in high densities in association with *E. p.* var. *xeranthemoides*. Additionally, invasion of non-native plants as a result of project construction is unlikely to pose a significant threat to the species, as the sheer cliff habitat in which the species is found is not conducive to invasion by invasive weeds.

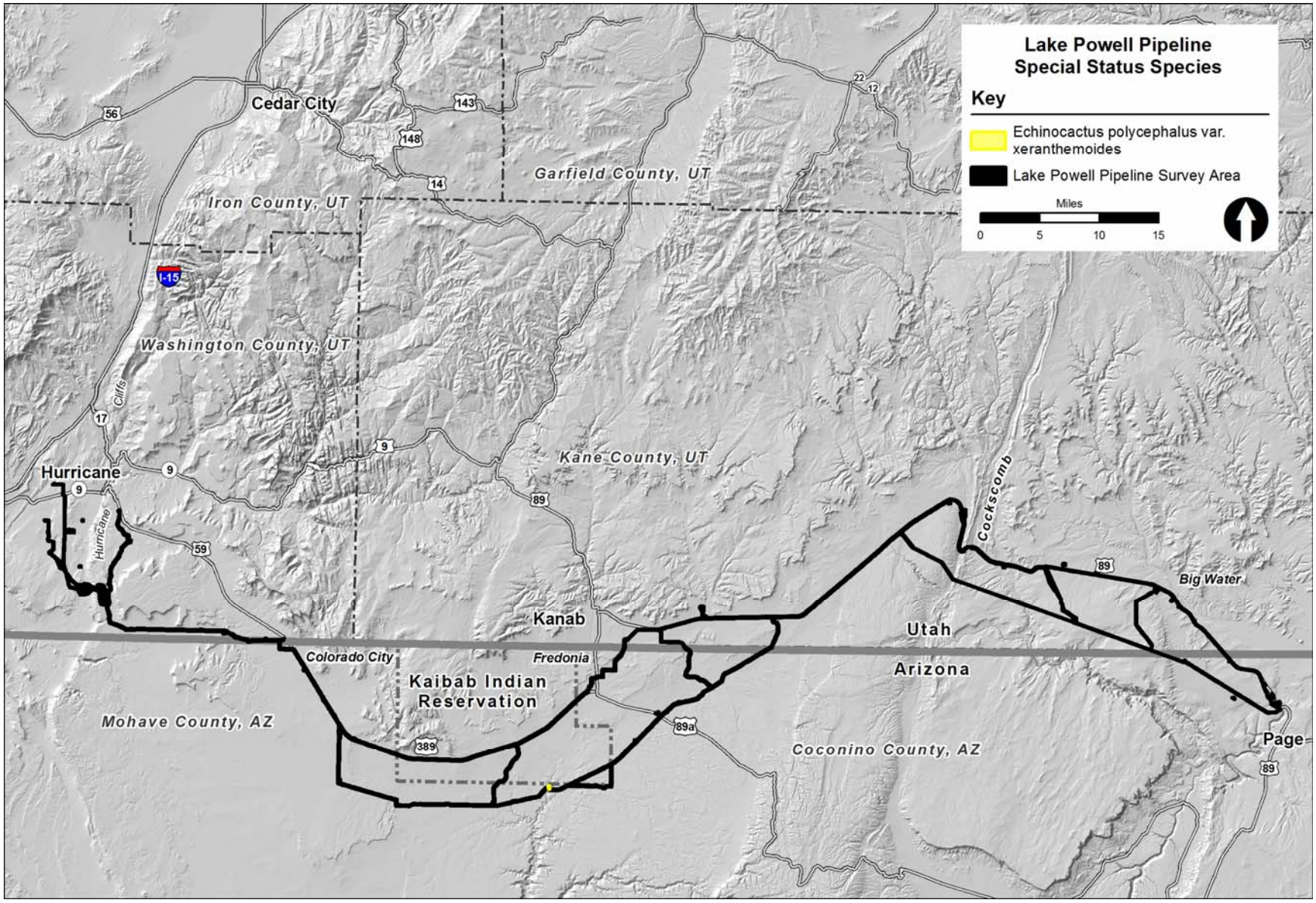

Figure 4-9
***Echinocactus polycephalus var. xeranthemoides* Overview Map**

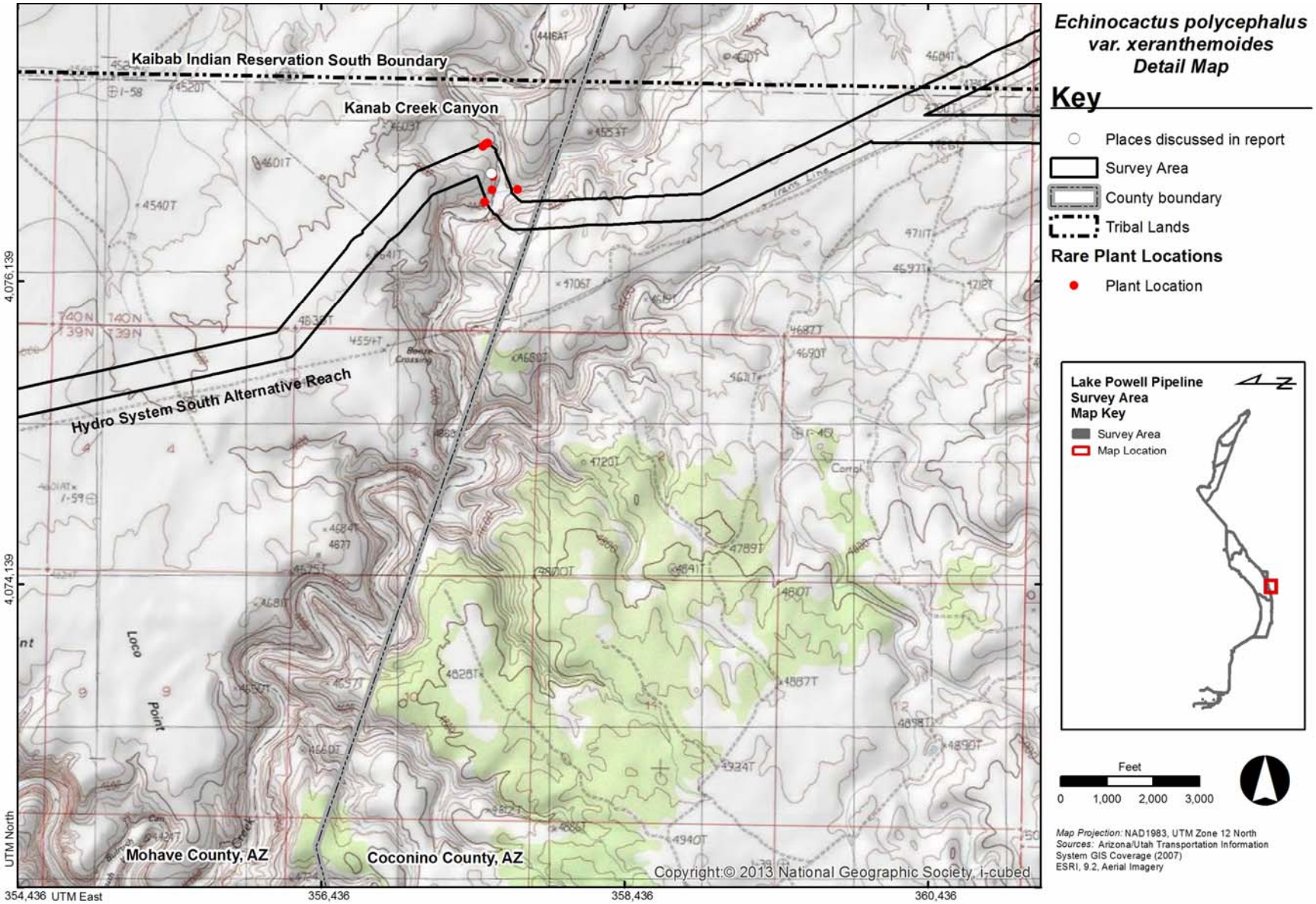

Figure 4-10
***Echinocactus polycephalus var. xeranthemoides* Detail Map**

4.3.19 *Enceliopsis argophylla* (Silverleaf sunray)

4.3.19.1 Natural History

Enceliopsis argophylla is a perennial of the Asteraceae (Composite Family) that grows in dense tufts from a superficially branching underground woody base. Stems and leaves of this species are covered in "cobwebby" hairs and silvery white. Leaves are broad, reaching 1.5 to 5 inches (4 to 12 centimeters) in length, tapering to the stem. The flower is a disk up to 2 inches (5 centimeters) in diameter and yellow rays up to 1.5 inches (4 centimeters) in length on a stalk rising from the ground (AGFD 2005). *E. argophylla* flowers continually from April through June (AGFD 2005 and NNHP 2001).

This species is almost entirely confined to Clark County, Nevada, though locations extend into Utah and Arizona, and near Wildrose Charcoal Kilns in Death Valley, California. In Utah *E. argophylla* is known from Beaver Dam Mountains in Washington County. In Arizona it is known from the vicinity of Lake Mead, Grapevine Mesa area, below Hurricane Cliffs, south of Hoover Dam, Boulder Dam area, Gyp Hills area; and east of Littlefield in Mohave County and near the Navajo Bridge in Coconino County. *E. argophylla* is found on the Schnabkaib Member of the Moenkopi Formation in warm desert shrub communities at (1,250 meters) in Utah (Welsh et al. 1993). In Arizona, *E. argophylla* can be found in warm desert shrub communities on clay and gypsum cliffs to gravelly slopes, and sandy washes from 705 feet (215 meters) to 3,400 feet (1036 meters) in elevation (AGFD 2005).

4.3.19.2 Survey Results

E. argophylla was not encountered during project surveys.

4.3.19.3 Discussion

E. argophylla is very visible on the landscape and was clearly not found within the survey areas. No further surveys are warranted within the survey area for this plant.

4.3.20 *Epilobium nevadense* (Nevada willowherb)

4.3.20.1 Natural History

Epilobium nevadense is a shrubby, slightly woody, perennial herb of the Onagraceae (Evening Primrose Family) reaching 6 to 16 inches (15 to 40 centimeters) tall (NNHP 2001). The leaves are up to 0.2 inches (0.1 to 0.6 centimeters) wide, entire or minimally toothed, and hairless to sparsely cover in short, soft hairs. Small pink-purple flowers are up to 0.3 inches (0.5 to 0.75 centimeters) long and bloom from June or July through September (NNHP 2001 and UNPS 2003-08).

Epilobium nevadense is known in southwestern and west-central Utah in Iron, Millard, and Washington counties, and in the Charleston Mountains in southern Nevada. This species is not known to occur in Arizona. This species is found in pinyon-juniper and oak/mountain mahogany communities from 5,100 feet (1,500 meters) to 8,800 feet (2,700 meters) in Utah. Within these communities, *E. nevadense* grows on arid talus slopes and rocky limestone or quartzite outcrops (UNPS 2003-08).

4.3.20.2 Survey Results

Epilobium nevadense was not encountered during project surveys.

4.3.20.3 Discussion

Epilobium nevadense was not found during surveys. Familiarity with location that this plant has been found in Nevada supports the conclusion that suitable habitat was not present in the project area. Limestone and quartzite substrates were not present within the survey area, but are locate upslope from the project area within the boundaries of Zion National Park's Kolob Canyon section. No further surveys are warranted within the survey area for this plant.

4.3.21 *Euphorbia nephradenia* (Utah spurge)

4.3.21.1 Natural History

Euphorbia nephradenia is an annual herb from a slender taproot. Herbage is covered in straight, soft to stiff hairs. The leaves are opposite and dimorphic, with the upper leaves 10 to 40 millimeters long and 1 to 2.5 millimeters wide, and the lower leaves 10 to 33 millimeters long and 4 to 9 millimeters wide. The cyathia is solitary with 5 greenish glands and found in the stem forks or leaf axils. Cyathiums appear in June through August (UNPS 2003-08, Welsh et al. 2008).

E. nephradenia is found in mixed, sandy desert shrub and grassland communities on dark clay hills, blow sand, and stabilized dunes (UNPS 2003-08). It is found with mat-saltbush, blackbrush, Mormon tea, and mixed sandy desert shrub communities derived from the Tropic Shale and Entrada formations from 3,790 feet (1,155 meters) to 4,805 feet (1,465 meters) in elevation. *E. nephradenia* is endemic to the Colorado Plateau. It is known from Emery, Garfield, Kane, and Wayne counties, Utah, and also in Colorado (Welsh et al. 2008).

4.3.21.2 Survey Results

E. nephradenia was not found during the survey season.

4.3.21.3 Discussion

Tropic Shale and the Entrada Formation are well to the north of the survey area along U.S. Highway 89 in Kane County, Utah. No potentially suitable habitat for *E. nephradenia* is present within the survey area. No further surveys are warranted within the survey area for this plant.

4.3.22 *Gilia latifolia* var. *imperialis* (Cataract gilia)

4.3.22.1 Natural History

Gilia latifolia var. *imperialis* is an annual herb from taproot, usually over 9.8 inches (25 centimeters) tall. Oval leaf blades have coarsely dentate and reach up to 1.8 inches (4.5 centimeters) long and 4 to 30 millimeters wide. Flowers are clustered in racemose inflorescence, with the central flowers opening first. The calyx is 2.8 to 4.8 millimeters long with teeth 1 to 2 millimeters long, smaller than those of similar species. Corollas are pink to purplish (Welsh et al. 2008).

G. l. var. *imperialis* is found on shadscale and other mixed desert shrub communities at elevations from 3,805 feet (1,160 meters) to 5,220 feet (1,591 meters). It is endemic to Utah, known only in Emery, Garfield, Kane, San Juan, and Wayne counties. Flowering is from June through October (Welsh et al 2008).

4.3.22.2 Survey Results

G. l. var. *imperialis* was not found during the survey season.

4.3.22.3 Discussion

This is a geographically narrow endemic whose known range is outside of the survey area. All potentially suitable occurring with the survey area was surveyed during the survey seasons. No further surveys are warranted within the survey area for this plant.

4.3.23 *Habenaria zothecina* (Alcove bog orchid)

4.3.23.1 Natural History

Habenaria zothecina is an erect, glabrous, herbaceous perennial growing to 13.8 inches (35 centimeters) tall and few, thick roots. Four to five leaves measuring 2 inches (5 centimeters) to 9.8 inches (25 centimeters) long and 0.3 inches (0.8 centimeters) to 2.4 inches (6 centimeters) wide, oblong-elliptic, mostly basal leaves appear in late April to early May (ARPC 2001). Plants develop 5 to 30 yellowish green flowers from mid-June to July. Capsules mature one month later (AGFD 2004). *H. zothecina* is distinguished from *Platanthera sparsiflora* by a spur that is 1.5 to 3 times as long as the lip, more rounded basal leaves, and a more elliptic lip (ARPC 2001).

H. zothecina is found along moist stream banks, seeps, and hanging gardens from 5,000 feet (1,524 meters) to 9,000 feet (2,743 meters) on Navajo Sandstone Formations (AGFD 2004). Orchids require constant moisture and full to partial sun (ARPC 2001). Specific microhabitats for this species include: bases of alcove face-walls with a flowing drip-line or with seepage down the wall; protected by dense vegetation or under rock debris of alcove foot slopes; shaded sites along a stream; and shaded seeps at elevations from 3,950 feet (1,204 meters) to 6,400 feet (1,951 meters) (AGFD 2004).

H. zothecina is widely scattered and nowhere in great numbers, though groups appear stable (ARPC 2001). The range includes the Colorado and Green rivers and their tributaries in Utah, adjacent northwest Colorado, and northern Arizona (AGFD 2004).

4.3.23.2 Survey Results

H. zothecina was not encountered during project surveys.

4.3.23.3 Discussion

H. zothecina was not encountered during the surveys: no hanging gardens were located. All potentially suitable springs were investigated during the 2010 survey season. No further surveys are warranted within the survey area for this plant.

4.3.24 *Imperata brevifolia* (Satintail grass)

4.3.24.1 Natural History

Imperata brevifolia is a perennial herb growing from scaly rhizomes and reaching 2.3 (0.7 meters) to 5 feet (1.5 meters) tall. The sheaths are hairless, and leaf blades are flat, 0.2 inches (4 millimeters) to 0.7 inches to (18 millimeters) wide and up to 19.7 inches (50 centimeters long), and hairless except for long hairs at the base of the blades. Spikelets are soft, long, largely obscured by white, silky hairs, and rise 5.9 inches (15 centimeters) to 7.9 inches (20 centimeters) above the blade clump (Welsh et al. 1993, Verrier 2008). Satintail grass blooms from May to October (Brain 2000).

I. brevifolia is found growing along streamsides and other moist areas in sandstone canyons at elevations from 3,700 feet (1,128 meters) to 3,800 feet (1,158 meters) in Utah (Welsh et al. 2008). In Arizona, it is reportedly found in rocky canyons near streambeds or pools in shady, lush canyon bottoms at elevations from 1,200 feet (366 meters) to 6,000 feet (1,829 meters) (Brain 2000, Verrier 2008). However, online herbarium records for Arizona limit its range to Grand Canyon National Park, at elevations between 2,400 feet (732 meters) and 4,120 feet (1,256 meters) (SEINet 2010). I brevifolia ranges from California east to New Mexico, Texas, and Mexico. In Arizona, it is known from Mohave, Yavapai, Santa Cruz, and Pima Counties, Arizona (Brain 2000). In Utah, it is known from the San Juan Arm of Lake Powell in San Juan County (Welsh et al. 2008, Brian 2000).

4.3.24.2 Survey Results

I. brevifolia was not encountered during project surveys.

4.3.24.3 Discussion

The survey area crosses the Paria River between the Cockscomb and Cedar Mountain at 4,300 feet (1,311 meters) elevation; 500 feet above and 100 miles away from the only documented collection of *I. brevifolia* in Utah. *I. brevifolia* was not encountered during the survey seasons; all potentially suitable springs were investigated during the 2010 survey season. No further surveys are warranted within the survey area for this plant.

4.3.25 *Jamesia Americana* var. *zionis* (Zion jamesia)

4.3.25.1 Natural History

Jamesia americana var. *zionis* is a perennial shrub reaching 1 foot (3 decimeters) to 4.9 feet (15 decimeters) tall. Leaf blades are ovate or elliptic and serrate or dentate. This variety can be distinguished from macrocalyx by its longer and wider leaves, reaching 1.2 inches (3 centimeters) to 2.2 inches 5.5 centimeters) long and 0.8 inches (2 centimeters) to 1.6 inches (4.5 centimeters) wide. Flowers bloom in small clusters from June to early August. Flower petals are white or sometimes tinged with pink, and somewhat covered in short hairs (Welsh et al. 2008, UNPS 2003-08).

In addition to its longer and wider leaf blades, *J. a.* var. *zionis* differs from var. *macrocalyx* in its habitat preference. *J. a.* var. *zionis* is known only in Zion Canyon and adjacent areas near Kanab that includes South Fork Indian Canyon in Kane and Washington counties, Utah (Welsh et al. 2008). It grows in pinyon- juniper, oak, and ponderosa pine communities in hanging gardens at elevations from 4,200 feet (1,280 meters) to 6,000 feet (1,829 meters). *J. a.* var. *zionis* prefers sandstone crevices and cliff sides (UNPS 2003-08).

4.3.25.2 Survey Results

J. a. var. *zionis* was not encountered during project surveys.

4.3.25.3 Discussion

No seeps or hanging gardens were encountered in field surveys of the project area; all potentially suitable springs were investigated during the 2010 survey season. No further surveys are warranted within the survey area for this plant.

4.3.26 *Lepidium montanum* var. *claronense* (Claron pepperplant)

4.3.26.1 Natural History

Lepidium montanum var. *claronense* is a rounded shrubby perennial herb in the Cruciferae (Mustard Family) with several stems arising from a thick underground base. Leaves occur on the upper and lower portions of the stem and are between 0.10 inches (3 millimeters) and 1 inch (25 millimeters) wide. Flowers are on stalks that are green or slight variations of green. Petals are white and egg-shaped to spatula-shaped (Welsh et al. 1993). Cylindrical fruits are 0.10 inches (2.5 millimeters) to 0.16 inches (4 millimeters) long. *L. m.* var. *claronense* flowers between May and June (UNPS 2003-2008).

L. m. var. *claronense* is endemic to the Paunsaugunt and Table Cliff plateaus in Garfield, Kane, and Piute counties, Utah (UNPS 2003-2008). *L. m.* var. *claronense* occurs on Claron Limestone and other fine substrates in sagebrush, pinyon-juniper, and ponderosa pine communities. Elevation ranges from 6,590 feet (2,010 meters) to 7,510 feet (2,290 meters) (Welsh et al. 1993).

L. m. var. *claronense* is one of 12 accepted varieties in *Lepidium montanum* (eFlora 2010). In *L. m.* var. *claronense*, perennial, basal leaves wither but do not fall off the plant. It is also recognized by its long inflorescences reaching over half the plant length and its hairless stem (UNPS 2003-2008).

4.3.26.2 Survey Results

L. m. var. *claronense* was not encountered during project surveys.

4.3.26.3 Discussion

Potentially suitable habitat for *L. m.* var. *claronense* was surveyed at the Henrieville substation and resulted in no observations of *L. m.* var. *claronense*. No further surveys are warranted within the survey area for this plant.

4.3.27 *Lupinus caudatus* var. *cutleri* (Cutler lupine)

4.3.27.1 Natural History

Lupinus caudatus var. *cutleri* is a perennial herb reaching 0.7 feet (21 centimeters) to 2.6 feet (80 centimeters) tall, originating from a woody caudex. Leaflets are broadly oblanceolate, a key characteristic when identifying *L.c.* var. *cutleri* from the two similar varieties, var. *argophyllus* and var. *utahensis* (Figure 4-11). Flowers are blue purple and reach 0.3 inches (8 millimeters) to 0.5 inches (12.5 millimeters) long. The banner of the flower is reflexed at the midpoint versus reflexed beyond the midpoint, as in var. *argophyllus* and var. *utahensis*. Flowers appear in mid-April through May (Welsh et al. 2008, UNPS 2003-08).

L. c. var. *cutleri* is known from Defiance in Apache County, Arizona (Welsh et al. 1993). It is also known from the Cockscomb in Kane County; and east Garfield, Grand, and San Juan counties, Utah. *L. c.* var. *cutleri* is found in pinyon-juniper woodlands and at 5,150 feet (203 meters) in Utah. It has been synonymized under *Lupinus caudatus* Kellogg in Welsh et al (2008).

Figure 4-11
Close-up View of *Lupinus caudatus* var. *cutleri* within the Survey Area

4.3.27.2 Survey Results

A total of 54 *L. c.* var. *cutleri* plants were found, one of which was encountered near Fivemile Valley in the Water Conveyance System Reach, 20 individuals were found near the Paria Townsite Road Junction in the Water Conveyance System Reach, and 33 plants were identified near Long Valley Road within the Glen Canyon to Buckskin Transmission Line North Reach. All individuals encountered were tentatively identified, as none of the *L. c.* var. *cutleri* encountered were flowering or producing fruits, making a positive identification impossible. Potential *L. c.* var. *cutleri* locations are provided in Table 4-10 and shown in the distribution and detailed maps included in Figure 4-12 to Figure 4-14.

Table 4-10
A Summary of *Lupinus caudatus* var. *cutleri* Survey Results by Location

Reach	Location	Land Ownership	# of Plants
Water Conveyance System	0.15 miles north of Fivemile Valley	Private	1
Water Conveyance System	1 mile southwest of the Paria Townsite Road Junction	BLM	20
Glen Canyon to Buckskin Transmission Line North	0.85 miles east of Long Valley Road	BLM	33
		Total	**54**

All *L. c.* var. *cutleri* individuals were encountered in the Colorado Plateau Ecological Region, where it occurred in the Mixed Bedrock Canyon and Tableland, and Colorado Plateau Wash ecological systems. The species was identified in a total of three alliances and three associations in vegetation communities dominated by *Artemisia* spp., *Juniperus osteosperma*, and/or *Purshia glandulosa*. The majority of individuals occurred in the *Juniperus osteosperma* Woodland Alliance, in the *Juniperus osteosperma*/*Artemisia filifolia* Sparse Woodland Association (Table 4-11). Plants were encountered between 4,760 feet (1,451 meters) and 5,000 feet (1,524 meters) in elevation.

Table 4-11 A Summary of *Lupinus caudatus* var. *cutleri* Survey Results by Alliance and Association		
Alliance	**Association**	**# of Plants**
COLORADO PLATEAU MIXED BEDROCK CANYON AND TABLELAND ECOLOGICAL SYSTEM		
Juniperus osteosperma Woodland	*Juniperus osteosperma* / *Artemisia filifolia* Sparse Woodland	33
COLORADO PLATEAU WASH ECOLOGICAL SYSTEM		
Artemisia tridentata ssp. *tridentata* Shrubland	*Artemisia tridentata* ssp. *tridentata* Shrubland	20
Purshia (*stansburiana, glandulosa, mexicana*) Shrubland	*Juniperus osteosperma* / *Purshia glandulosa* Wooded Shrubland	1
	Total	**54**

L. c. var. *cutleri* was encountered on four geologic formations (Table 4-12). The majority of individuals (33) were found on the Carmel Formation composed of medium to dark-red-brown to brown, slope forming silty sandstone or siltstone on the upper parts and mostly dark-red-brown siltstone or silty sandstone below (Doelling and Willis 2006); while the second largest group was identified on the Timpoweap Member of the Moenkopi Formation, a formation consisting of an upper part characterized by gray to yellow-gray sandy limestone, and a lower part characterized as gray, dark-gray, white and reddish-brown chert conglomerate in a gray gravel sandstone matrix (Biek at al. 2007).

Table 4-12 A Summary of *Lupinus caudatus* var. *cutleri* Survey Results by Geologic Formation	
Geologic Formation	**# of Plants**
COLORADO PLATEAU MIXED BEDROCK CANYON AND TABLELAND ECOLOGICAL SYSTEM	
Carmel Formation	33
COLORADO PLATEAU WASH ECOLOGICAL SYSTEM	
Kaibab Formation, Lower member Moenkopi Formation	1
Timpoweap Member Moenkopi Formation	20
Total	**54**

The majority of individuals were found on Mido-Kenzo-Rock outcrop soils, with 2 to 30 percent slopes, while the second largest group occurred in Mellenthin, moist-Rock outcrop soils with 25 to 60 percent slopes (Table 4-13).

Table 4-13 A Summary of *Lupinus caudatus* var. *cutleri* Survey Results by Soil Type	
Soil Type	**# of Plants**
Mellenthin, moist-Rock outcrop, Moenkopi Formation, complex, 25 to 60 percent slopes	20
Mido-Kenzo-Rock outcrop, Carmel Formation, complex, 2 to 30 percent slopes	33
Simel-Strych, moist-Kenzo complex, 2 to 20 percent slopes	1
Total	**54**

4.3.27.3 Discussion

A total of 54 plants were found in the Buckskin to Paria Transmission Line, the Water Conveyance System, and the Glen Canyon to Buckskin Transmission Line North reaches. All *L. c.* var. *cutleri* individuals were encountered on the Colorado Plateau, where it occurred in the Mixed Bedrock Canyon and Tableland and Colorado Plateau Wash ecological systems. The species was identified in vegetation communities dominated by *Artemisia* spp., *Juniperus osteosperma*, and/or *Purshia glandulosa*. *L. c.* var. *cutleri* was encountered on 4 geologic formations, the majority of which occurred in the Carmel Formation. Most individuals were found on Mido-Kenzo-Rock outcrop soils and in Mellenthin, moist-Rock outcrop soils.

Because positive confirmation of the variety is dependent upon key floral features, and none of the individuals encountered during the survey were in flower or fruit, a positive identification was not possible. However, the individuals identified by the survey as *L. c.* var. *cutleri* displayed vegetative morphological characteristics that are consistent with the variety, and individuals were encountered in habitat consistent with published literature; therefore, identification of the species as *L. c.* var. *cutleri* was warranted.

Threats to the identified potential *L. c.* var. *cutleri* individuals resulting from the project could possibly include introduction of invasive weeds. Although the woody caudex of the species would likely enable it to reach soil moisture depths greater than many invasive weeds encountered within the survey area, the dense monotypical growth habit of many invasive weed species may result in a shading effect if introduced into habitat supporting L. c. var. cutleri.

If avoidance of *L. c.* var. *cutleri* is not possible, it is recommended that the identified locations be re- visited prior to project construction. These visits should begin in April in order to observe individuals in flower, and positively identify the species. If the identified groups are indeed *L. c.* var. *cutleri*, follow-up visits could be scheduled in order to collect seed from at-risk individuals. Seed could be re-distributed following completion of construction. Consideration could also be given to growing individuals from collected seed in order to supplement revegetation efforts. Project construction activities could also include salvage and utilization of topsoil from habitats with the potential to contain viable seed.

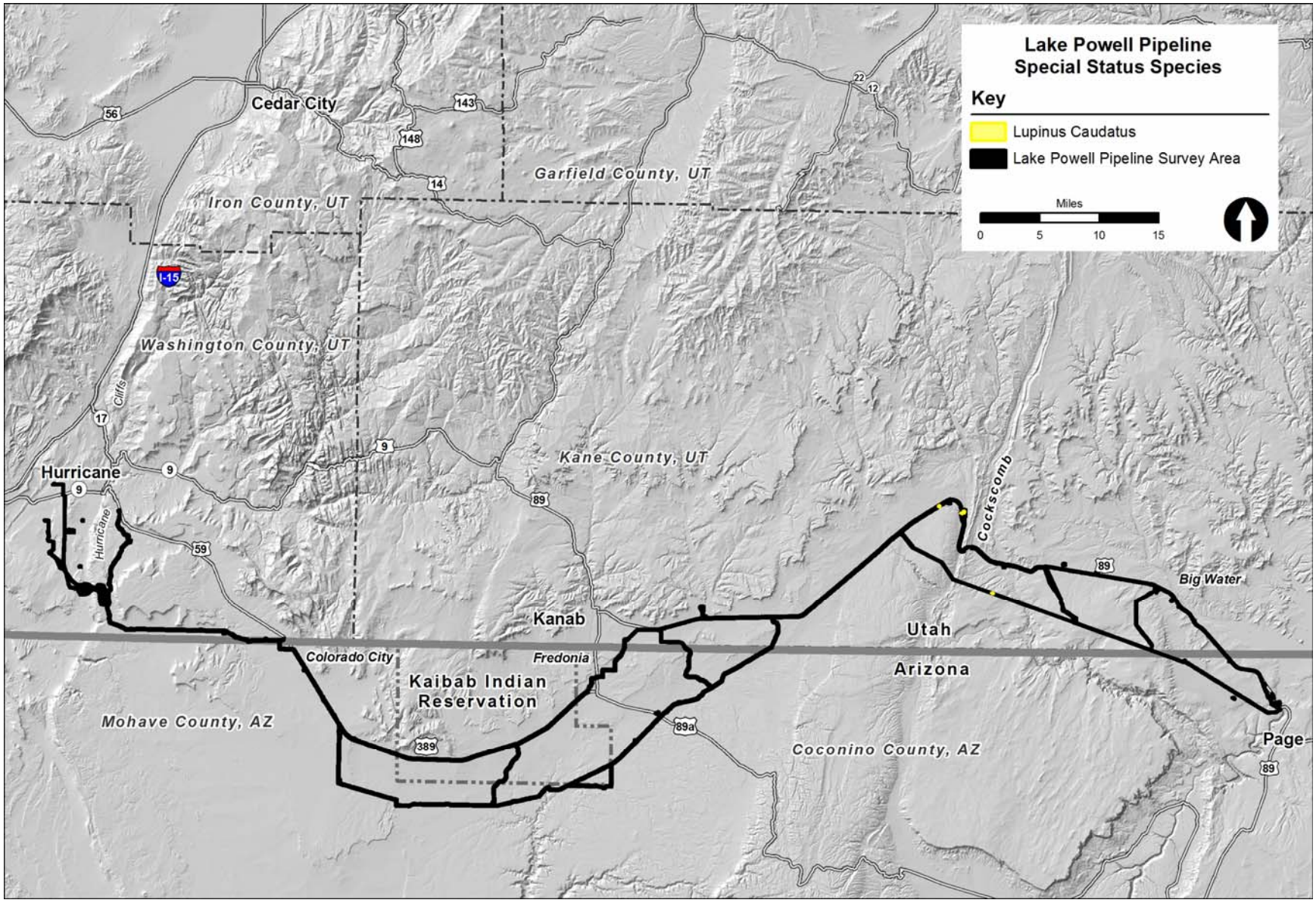

Figure 4-12
***Lupinus caudatus* var. *cutleri* Overview Map**

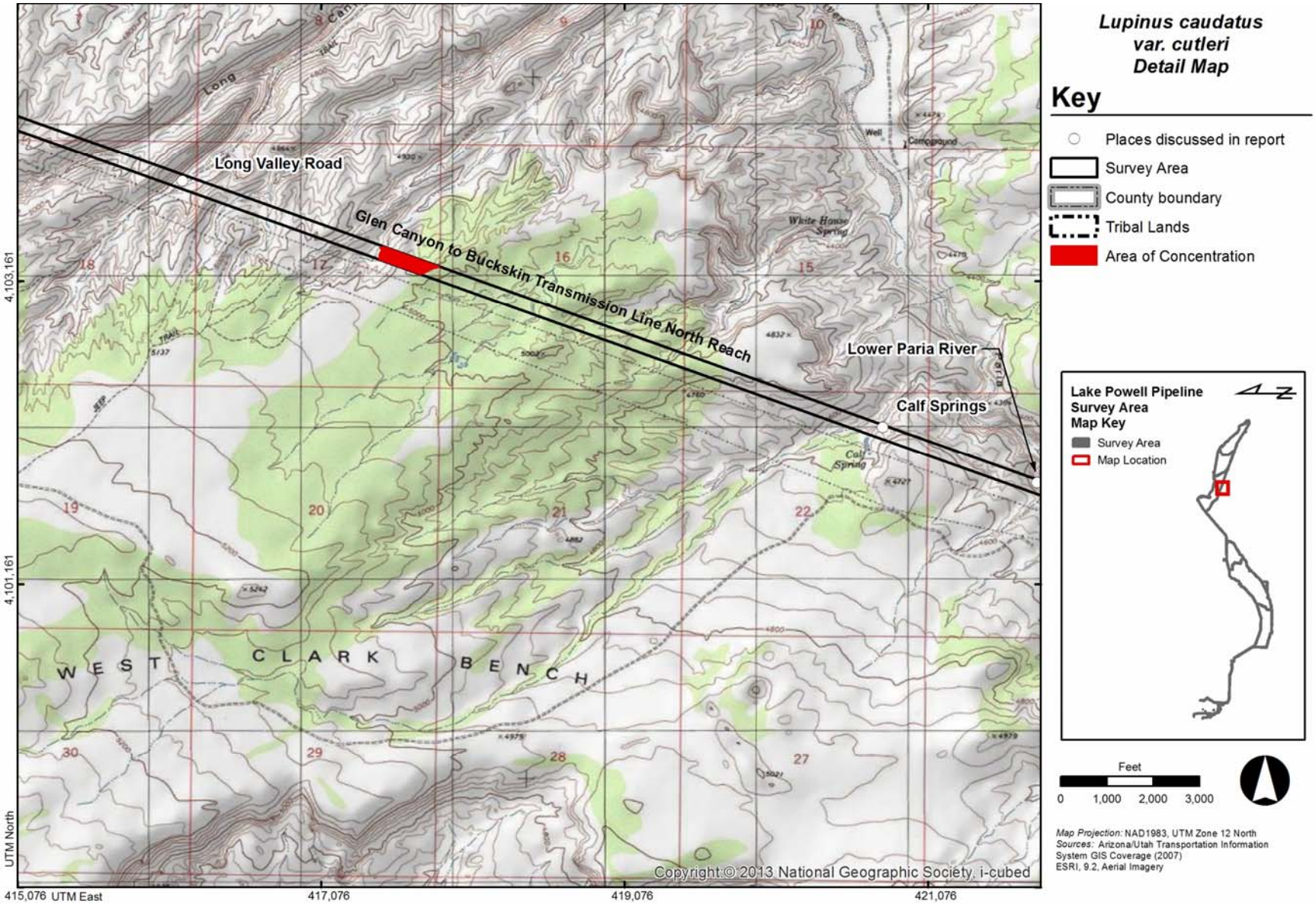

Figure 4-13
***Lupinus caudatus* var. *cutleri* Detail Map 1**

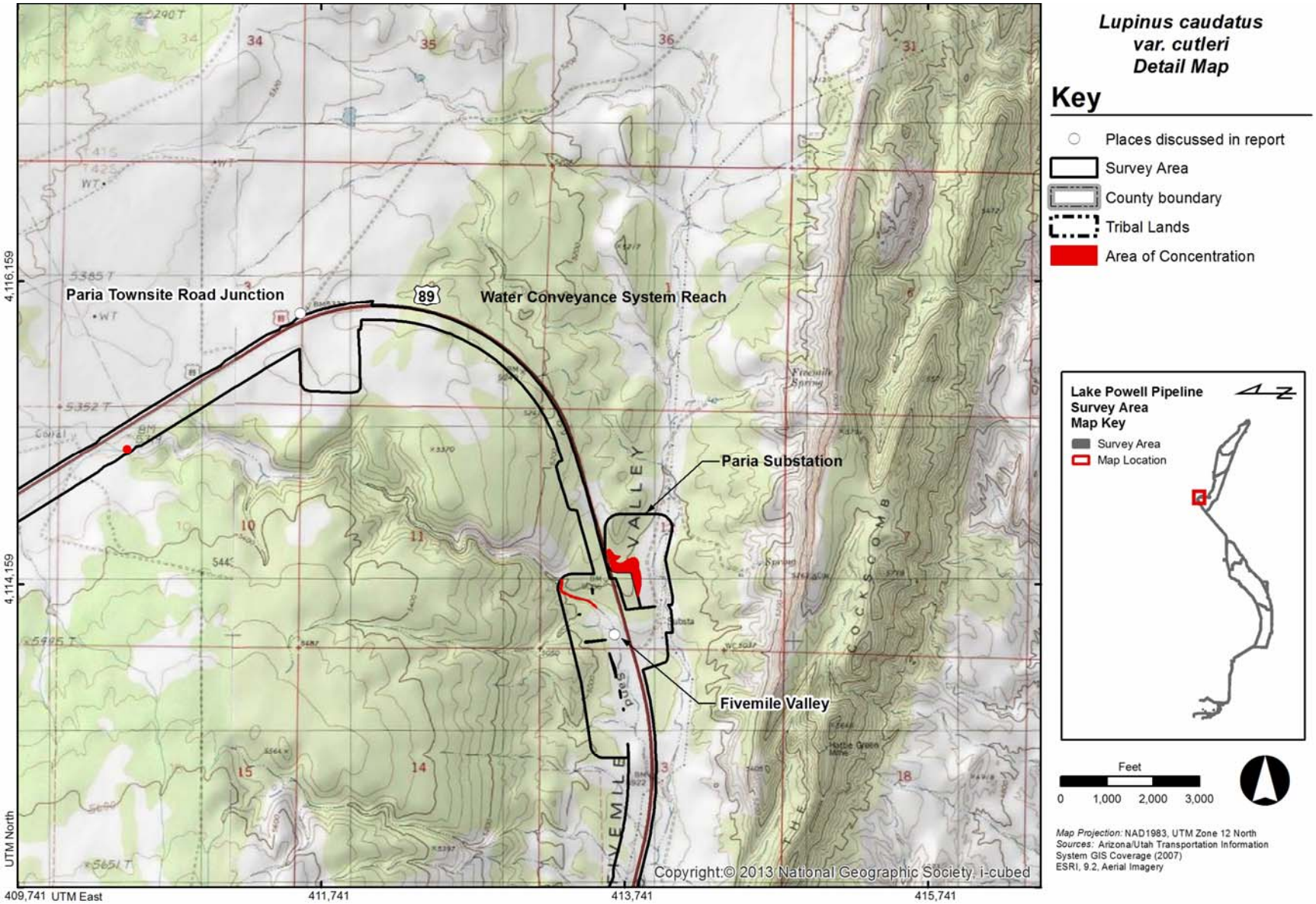

Figure 4-14
***Lupinus caudatus* var. *cutleri* Detail Map 2**

4.3.28 *Mentzelia memorabalis* (September 11 stickleaf)

4.3.28.1 Natural History

Mentzelia memorabalis is a perennial, multi-stemmed shrub originating from a subterranean, woody, branched caudex. This plant reaches 5.9 to 17.7 inches (1.5 to 4.5 decimeters) tall. Herbage is covered with small, ascending-appressed hairs. Leaves are distributed along the stems, and are often curved upwards. The pale yellow flowers are arranged two to four loose, terminal, corymbosely branched clusters. Flowers bloom from late June to September and open one hour before sunset (AGFD 2006).

M. memorabalis is endemic to northern Mohave County, Arizona from Clayhole Wash between Colorado City and Mount Trumball. This species is found only on gypsum-clay outcrops at elevations from 4,689 feet (1,429 meters) to 5,197 feet (1,584 meters). *M. memorabalis* grows with sparse vegetation including *Atriplex canescens*, *Chrysothamnus greenei*, *Eriogonum wrightii*, and *Tetradymia canescens* (AGFD 2006).

4.3.28.2 Survey Results

M. memorabalis was not encountered during project surveys.

4.3.28.3 Discussion

M. memorabalis is known only from Claypole Wash, which occurs outside of the survey area. All collections of perennial *Mentzelia* from gypsum habitat within the survey area appear to be *M. laevicaulis*, which is vegetatively distinct from *M. memorabalis*. Since species determinations generally require flowers, which were seldom available at the time of sampling, this "somewhat difficult to place with certainty" genus (Welsh et al. 2008) would require precisely timed field surveys to distinguish it among any other perennial *Mentzelia* species (other than *M. laevicaulis*). It might be found within Moenkopi Formations near Honeymoon Trail, Washington County, Utah. However, the probability of finding it is low, and no further surveys are warranted within the survey area for this plant.

4.3.29 *Oenothera murdockii* (Chinle evening primrose)

4.3.29.1 Natural History

Oenothera murdockii is an annual herb with no stem and a heavily lignified taproot. Leaves are basal and nearly entire, toothed, or pinnatified. Leaves may also be slightly hairy. *O.murdockii* is distinguished from other annual *Oenothera* species by its yellow flower. Other perennial *Oenothera* species, including *O. flava* and *O. howardii*, have yellow flowers, but *O. murdockii* petals are shorter, being only 0.4 inches (9 millimeters) to 0.8 inches (12 millimeters) long and producing capsules only 0.5 inches (1.3 centimeters) to 1 inch (2.5 centimeters) long. O. murdockii blooms from April to May (UNPS 2003-08).

O. murdockii is endemic to Kane and Washington counties, Utah. It is found on red-purple or gray clay silty barrens derived from Chinle and possibly Moenkopi Formations. It is found growing in pinyon-juniper communities at elevations from 4,400 feet (173 meters) to 5,600 feet (220 meters) (UNPS 2003-08).

4.3.29.2 Survey Results

Oenothera murdockii was not encountered during project surveys.

4.3.29.3 Discussion

O. species encountered during spring surveys were either without flowers or white flowered; yellow primroses were observed in bloom in Washington County only during a late summer field session. As *O. murdockii* blooms in April to May, not fall, it is possible the yellow primrose was one of two similar species such as *Oenothera* flava that blooms in June or later, or *Oenothera howardii* that blooms from June through August. Potential habitat for *O. murdockii* may occur on private lands east of Kanab with expressions of the Chinle Formation as described for *Astragalus ampullarius*. The elevation range and the vegetative components of the Kanab site meet the habitat requirements for *O. murdockii*, thus there is a high probability of finding this species if access is granted for surveys in the future.

4.3.30 *Ostrya knowltonii* (Western hophornbeam)

4.3.30.1 Natural History

Ostrya knowltonii is a perennial tree reaching 6.5 feet (2 meters) to 19.7 feet (6 meters) tall, but may reach up to 26.4 feet (8 meters) tall in the Grand Canyon and 32.8 feet (10 meters) tall in New Mexico. The tree bark is scaly and grayish brown. Twigs and leaf petioles are glandular. The leaves are simple, alternate, doubly toothed, and reach 0.3 to 3.1 inches (0.8 to 8 centimeters) long and 0.3 inches (0.8 centimeters) to 2 inches (5 centimeters) wide. Fruiting catkins are greenish white to brownish in color, and are present from April to May. This species can be distinguished from a similar species, water birch (*Betula occidentalis*), by having wingless nutlets that are covered by an enlarged, inflated involucres or sac (Welsh et al. 1993, NMRPTC 1999, Brian 2000).

O. knowltonii is known from Texas, New Mexico, Utah, and Arizona. It is found in canyons along the pine belt, the bases of monoliths, shaded defiles or narrow gorges, and hanging gardens. It is known in sandstone, desert areas at elevations from 4,900 feet (1,494 meters) to 8,900 feet (2,713 meters) (Brian 2000) in Garfield, Grand, Kane, and San Juan counties of Utah (Welsh et al 2008).

4.3.30.2 Survey Results

O. knowltonii was not encountered during the survey seasons.

4.3.30.3 Discussion

O. knowltonii was not encountered during the survey seasons, and all potentially suitable springs were investigated during the 2010 survey season. No further surveys are warranted within the survey area for this plant.

4.3.31 *Pediocactus peeblesianus* var. *fickeiseniae* (Fickeisen pincushion cactus)

4.3.31.1 Natural History

Pediocactus peeblesianus var. *fickeiseniae* is a small, globose, perennial succulent that reaches 2.4 inches (6 centimeters) tall and 2.2 inches (5.5 centimeters) in diameter. The areoles are circular with corky or spongy, white to pale gray spines. The central spines are 0.2 inches (5 millimeters) to 0.3 inches (18 millimeters) long and ascending while the radial spines number from three to seven, reach 0.4 inches (2 to 9 millimeters) long, and recurve. Cream, yellow, or yellowish-green flowers appear in late April and produce fruits from May to June. During periods of drought, this species retracts into the soil (USFWS 2001, AGFD 2004).

P. p. var. *fickeiseniae* is known from Coconino, Mohave, and Navajo counties in Arizona. Locations in Coconino County are scattered from House Rock Valley and near Gray Mountain and along the canyons of the Little Colorado and Colorado rivers. Locations in Mohave County have been found in Hurricane and Main Street Valleys, and near Clayhole and Sunshine ridges (AGFD 2004). *P. p.* var. *fickeiseniae* may also occur near Joseph City in Navajo County (USFS 2001).

P. p. var. *fickeiseniae* occurs at elevations from 4,000 feet (1,219 meters) to 5,940 feet (1,811 meters) on flat ridge-tops and benches, well-drained hills, and canyon margins within Great Basin Desert scrub, Great Basin Grassland, and Plains Grassland communities. This species is found on shallow, gravelly limestone loam derived from Kaibab limestone and Moenkopi Formations. In Navajo County, it may occur on gravels derived from the Shinarump Conglomerate. Fickeisen pincushion cactus may be found growing with *Artemisia tridentata, Atriplex canescens, Bouteloua eriopoda, Bouteloua gracilis, Bromus* sp., *Chrysothamnus* spp., *Gutierrezia sarothrae*, and *Pleuraphis jamesii*.

4.3.31.2 Survey Results

P. p. var. *fickeiseniae* was not encountered during project surveys.

4.3.31.3 Discussion

Members of the Moenkopi Formation are present throughout the survey area; however, limestone soils derived from the Moenkopi Formation were not observed. Kaibab Formation limestone has limited occurrence within the survey area. Focused searches were conducted for this cryptic, small cactus on exposed limestone benches at the Kanab Creek crossing south of the Kaibab Indian Reservation, and at the base of the Hurricane Cliffs (based on a known location along the cliffs south of the survey area). No *P. p.* var. *fickeiseniae* were found during surveys. No further surveys are warranted within the survey area for this plant.

4.3.32 *Pediocactus sileri* (Siler's pincushion cactus)

4.3.32.1 Natural History

Pediocactus sileri is a perennial succulent in the Cactaceae (Cactus Family). It is globose in shape and occasionally with clustered heads, reaching 4 inches (10 centimeters) tall and 3 inches (7.6 centimeters) to 4 inches (10 centimeters) in diameter. As the cactus matures, it tends to elongate. Tubercles are 0.35 inches (9 millimeters) to 0.59 inches (15 millimeters) long and 0.24 inches (6 millimeters) to 0.43 inches (11 millimeters) wide. Circular areoles contain three to seven brownish-black central spines reaching 1 inch (2.5 centimeters) in length. Central spines are straight and turn pale gray or white with age (Figure 4-15). Areoles also contain 11 to 16 whitish radial spines, slightly smaller than the central spines. Flowers are yellowish in color with purple veins, 0.7 inches (18 millimeters) to 0.9 inches (22 millimeters) long, and 0.8 inches (20 millimeters) to 1.2 inches (30 millimeters) wide. Fruit is dry, greenish-yellow in color, 0.5 inches (1.2 centimeters) to 0.6 inches (1.5 centimeters) long, and contain gray to black seeds. The flowers of *P. sileri* open from April to mid-May in Arizona and from March through April in Utah (AGFD 2004).

Figure 4-15
Close-up View of *Pediocactus sileri* Observed within the Survey Area

P. sileri is restricted to gypsum and salt-rich soils found in southwestern Utah and northwestern Arizona. It is known from the Fredonia area in northwestern Coconino County, Arizona, west into north-central Mohave County, Arizona (USFWS 1986). The range extends into Washington and Kane counties in Utah (Welsh et al. 2008). *P. sileri* is habitat specific and found only on low red or gray gypsiferous soils derived from the Moenkopi Formation, and sometimes similar Chinle and Kaibab Formations. It is known mostly from the Great Basin Desert scrub biotic community, but also from the Great Basin Conifer Woodland and Plains, Great Basin Grassland, and Mojave Desert scrub biotic communities (USFWS 1986). The USFWS reports the elevation across this species range from 2,800 feet (853 meters) to 5,400 feet (1,646 meters) (1986). In Utah, the range is reported from 2,950 feet (899 meters) to 5,220 feet (1,591 meters) in elevation (Welsh et al. 2008). The cactus is often found in rolling hills that have a "badlands" appearance with sparse vegetation. It is found in association with *Atriplex canescens*, *Artemisia tridentata*, *Artemisia bigelovii*, *Chrysothamnus* spp., *Salvia dorrii*, *Eriogonum corymbosum*, *Eriogonum mortonianum*, *Eriogonum thompsoniae* var. *atwoodii*, and *Gutierrezia sarothrae* (USFWS 1986).

P. sileri appears similar to *Coryphantha vivipara* var. *rosea*, but the taxa can be distinguished by their flowers and spines. The yellow flowers with maroon veins are characteristic of mature *P. sileri* cacti, and differ from the pink flowers found on *C. v.* var. *rosea*. While *P. sileri* bares black central spines and curved spines mixed with straight spines, *C. v.* var. *rosea* bares spines that are white and always straight (eFloras 2010).

P. sileri was listed as endangered under the ESA in 1979 and down-listed to threatened in 1993 (USFWS 1993).

4.3.32.2 Survey Results

P. sileri was encountered within the Hydro System, the Hydro System South Alternative, and the Hydro System Existing Highway Alternative reaches (Table 4-34). The species was encountered predominantly southwest of Fredonia (13 individuals) and within the Kaibab-Paiute Indian Reservation (2,925 individuals); with two additional sites from White Sage Wash to Seaman Wash (one individual) and from west of Short Creek at Canaan Gap (seven individuals). Surveys located a total of 952 live and 2,000 dead cacti. The majority of individuals were found on the Kaibab-Paiute Indian Reservation, scattered along Arizona State Route 389 from west of Fredonia to the intersection of State Route 389 and the road to Pipe Springs National Monument. *P. sileri* locations are shown in Table 4-14 and in the distribution and detailed maps provided in Figure 4-18 through Figure 4-24.

Table 4-14
A Summary of *Pediocactus sileri* Survey Results by Location

Reach	Location	Land Ownership	# of Plants
Hydro System South Alternative	2 miles northeast of White Sage Wash	BLM	1
Hydro System Existing Highway Alternative	0.70 to 1.1 miles southwest of Kanab Creek	State Trust	13
Hydro System Existing Highway Alternative	1 mile to 4 miles southwest of Cottonwood Wash	Kaibab Indian Reservation	773
Hydro System Existing Highway Alternative	0.70 miles to 2 miles northeast of Twomile Wash	Kaibab Indian Reservation	1,589
Hydro System Existing Highway Alternative	Twomile Wash to Pipe Springs National Monument	Kaibab Indian Reservation	563
Hydro System	2.5 miles west of Short Creek at Canaan Gap	Private	7
		Total	**2,946**

P. sileri individuals were found growing entirely within the Colorado Plateau ecological region, where individuals were encountered primarily in the Gypsum Badland Ecological System. There were two exceptions to this, the Colorado Plateau Shrub-Steppe Ecological System and the Colorado Plateau Grassland Ecological System. Within the Colorado Plateau Gypsum Badlands Ecological System, cacti were found occurring in 11 alliances and 17 associations, the majority of which (1,324 individuals) were found within the *Chrysothamnus viscidiflorus* Shrubland Alliance and the *Chrysothamnus viscidiflorus* Gypsum Badlands Sparse Dwarf-shrubland Association. Individuals were found in three alliances and the corresponding three associations within the Colorado Plateau Shrub-Steppe Ecological System, and just one alliance and association within the Colorado Plateau Grassland Ecological System (Table 4-15). All plants were found between 4,462 feet (1,360 meters) and 5,020 feet (1,530 meters) in elevation.

P. sileri occurred predominantly on Gypsiorthids-Gypsiorthids soils in association with the Middle Red Member of the Moenkopi Formation. This formation appears reddish-brown and is found on slope-forming gypsiferous siltstone and sandstone and includes abundant thin veinlets and stringers of gypsum deposited in fractures and cracks throughout, mud cracks and ripple marks are common. A summary of *P. sileri* occurrences are provided in Table 4-16 and Table 4-17.

The vast majority of *P. sileri* individuals were found on Gypsiorthids-Gypsiorthids, shallow complex soils. Plants were often encountered in association with well-established cryptobiotic crusts, often occurring in, or adjacent to this microhabitat.

Much of the area occupied by *P. sileri* has been used for cattle grazing; however, on the Reservation, minimal grazing was observed in the localized areas around encountered individuals. Most of the individuals encountered were observed growing in the open, with full sun exposure, but were also found on occasion growing adjacent to shade-providing shrubs. The majority of plants (2,000 individuals) were found dead.

Table 4-15
A summary of *Pediocactus sileri* Survey Results by Alliance and Association

Alliance	Association	# of Plants
COLORADO PLATEAU GRASSLAND ECOLOGICAL SYSTEM		
Pleuraphis jamesii Herbaceous	*Pleuraphis jamesii* Herbaceous Vegetation	1
COLORADO PLATEAU GYPSUM BADLANDS ECOLOGICAL SYSTEM		
Artemisia bigelovii Shrubland	*Artemisia bigelovii – Ephedra torreyana* / Crytobiotic Gypsum Badlands Sparse Shrubland	367
Artemisia bigelovii Shrubland	*Artemisia bigelovii - Chrysothamnus greenei* Gypsum Badlands Sparse Dwarf-shrubland	114
Atriplex confertifolia Shrubland	*Atriplex confertifolia* Gypsum Badlands Dwarf-shrubland	133
Atriplex confertifolia Shrubland	*Atriplex confertifolia* Gypsum Badlands Sparse Dwarf-shrubland	70
Chrysothamnus viscidiflorus Shrubland	*Chrysothamnus viscidiflorus* Gypsum Badlands Sparse Dwarf- shrubland	1,326
Ephedra (*nevadensis, torreyana*) Shrubland	*Ephedra* (*nevadensis, torreyana*) Gypsum Badlands Sparse Shrubland	8
Eriogonum (*corymbosum, mortonianum, thompsoniae*) Shrubland	*Eriogonum* (*corymbosum, mortonianum, thompsoniae*) / Cryptobiotic / Sparse Understory Gypsum Badlands Shrubland	104
Eriogonum (*corymbosum, mortonianum, thompsoniae*) Shrubland	*Eriogonum* (*corymbosum, mortonianum, thompsoniae*) Gypsum Badlands Shrubland	8
Eriogonum (*corymbosum, mortonianum, thompsoniae*) Shrubland	*Eriogonum* (*corymbosum, mortonianum, thompsoniae*) Gypsum Badlands Sparse Shrubland	256
Eriogonum (*corymbosum, mortonianum, thompsoniae*) Shrubland	*Eriogonum* (*corymbosum, mortonianum, thompsoniae*) Gypsum Badlands Sparse Dwarf-shrubland	18
Eriogonum thompsoniae var. *atwoodii* Sparsely Vegetated	*Eriogonum thompsoniae* var. *atwoodii* Gypsum Badlands Sparse Vegetation	16
Mixed Desert Shrub Shrubland	*Ephedra torreyana* - (*Atriplex* spp.) / Cryptobiotic Gypsum Badlands Sparse Shrubland	488
Mixed Desert Shrub Shrubland	Mixed Desert Shrub Gypsum Badlands Shrubland	26
COLORADO PLATEAU SHRUB-STEPPE ECOLOGICAL SYSTEM		
Atriplex confertifolia Shrubland	*Atriplex confertifolia* / *Pleuraphis jamesii* Dwarf-shrubland	7
Gutierrezia sarothrae Shrubland	*Gutierrezia sarothrae* - (*Opuntia* spp.) / *Pleuraphis jamesii* Sparse Dwarf-shrubland	1
Mixed Desert Shrub Shrubland	Mixed Desert Scrub / Pleuraphis jamesii Shrubland	3
	Total	**2,946**

The abundance of *P. sileri* varied notably across the variety of microhabitats within the gypsum badlands landscape. In thinly bedded gypsum exposures the species occurred commonly, while at the base of slopes adjacent to these gypsum exposures individuals were encountered occasionally. In mud washes below these slopes the abundance was locally occasional; and on thin, red clay soils with microbiotic crusts the species was rare. The absence of *P. sileri* on non-cryptobiotic soils of crests and ridges was also noted. This diverse badlands topography supports other rare, endemic plants such as *Cryptantha semiglabra*, which share an affinity for soils with alternating layers of red mudstone and gypsum.

Table 4-16 A Summary of *Pediocactus sileri* Survey Results by Geologic Formation	
Geologic Formation	**# of Plants**
COLORADO PLATEAU GRASSLAND ECOLOGICAL SYSTEM	
Undivided Moenkopi Formation	1
COLORADO PLATEAU GYPSUM BADLANDS ECOLOGICAL SYSTEM	
Young alluvial deposits	79
Intermediate alluvial deposits	7
Undivided Moenkopi Formation	772
Middle Red Member Moenkopi Formation	2,063
Shnabkaib Member Moenkopi Formation	13
COLORADO PLATEAU SHRUB-STEPPE ECOLOGICAL SYSTEM	
Alluvial and eolian deposits	7
Undivided Moenkopi Formation	1
Middle Red Member Moenkopi Formation	3
Total	**2,946**

Table 4-17 A Summary of *Pediocactus sileri* Survey Results by Soil Type	
Soil Type	**# of Plants**
Clayhole loam	76
Gypsiorthids-Gypsiorthids, shallow complex	2,862
Schmutz loam	7
Torriorthents	1
Total	**2,946**

4.3.32.3 Discussion

The survey identified an estimated 2,946 individuals of *P. sileri* within the survey area. All cacti were located within the Hydro System, the Hydro System South Alternative, and the Hydro System Existing Highway Alternative reaches, with the majority of individuals occurring within the Hydro System Existing Highway Alternative Reach. The vast majority (2,925 of 2,946) of plants were found on the Kaibab Indian Reservation. The remaining 21 individuals were encountered on BLM land, State Trust land and private land. *P. sileri* was documented entirely in the Colorado Plateau Ecological Region, primarily within the Gypsum Badland Ecological System, and most often within *Chrysothamnus viscidiflorus* Shrubland, Mixed Desert Shrub Shrubland, *Artemisia bigelovii* Shrubland, and *Eriogonum* (*corymbosum*, *mortonianum*, *thompsoniae*) Shrubland associations. *P. sileri* occurred predominantly on Gypsiorthids-Gypsiorthids soils in association with the Middle Red Member of the Moenkopi Formation, and individuals were often encountered in conjunction with gypsum outcrops (Figure 4-16), often growing in full sun. Many of the lands supporting *P. sileri* were disturbed, although localized disturbance around individuals was generally minimal, particularly on the Reservation.

P. sileri observations were consistent with published data regarding habitat preferences, and the observed variation in relative abundance across the landscape points to an affinity of the species for highly specific microhabitats. Surveys between Riggs Flat and Cottonwood Wash provided data on habitat preference within the microhabitats of the Gypsum Badlands Ecological System. *P. sileri* was more common on gypsum outcrops and toe slopes below the outcrops than on cryptobiotic soils of ridges and knolls. On toe slopes it was heavily subjected to mud caking. On cryptobiotic soils of ridges and knolls, *P. sileri* only occupied areas with minimal disturbances, including grazing and disturbance from animal burrows. The survey also observed a high proportion of mortality amongst the majority of encountered individuals, 2,000 out of the total 2,946 that were found. At least some of this mortality is thought to be due to sediment deposition over the surface of these low-growing plants. Many of the dead individuals were covered in soil at the time of the survey, thought to be the result of runoff associated with intense rainfall events (Figure 4-17). Extended periods of time without subsequent precipitation to wash off this sediment could result in retardation of photosynthesis, and ultimately mortality. However, monitoring studies conducted by the BLM since 1985 have documented that the primary causes of mortality among *Pediocactus sileri* are rabbit/rodent predation and natural causes including drought or age-related mortality (BLM 2006).

Figure 4-16
Red Clay and Gypsum Soils Representing *Pediocactus sileri* Habitat within the Survey Area

Figure 4-17
***Pediocactus sileri* Caked in Mud**

P. sileri was predominantly found within gypsum badlands of the Colorado Plateau supporting diverse plant communities that included other rare, endemic plants, including *Cryptantha semiglabra*, *Eriogonum mortonianum*, and *Eriogonum thompsoniae* var. *atwoodii*. The cryptobiotic soils that provide microhabitats for these species cannot be artificially created, and may take decades to re-establish. Therefore, pipeline and transmission line access road routing through gypsum badlands with known special status plant locations and cryptobiotic soils should be avoided when an alternative is available. The two known occurrences of Siler pincushion cactus along the South Alternative alignment would be avoided. If additional Siler pincushion cacti were discovered within the South Alternative alignment, the primary conservation measure would be avoidance. The known occurrences of Siler pincushion cactus along the Existing Highway Alternative alignment could not be avoided. Additional conservation measures for *P. sileri* would be developed in consultation with the USFWS.

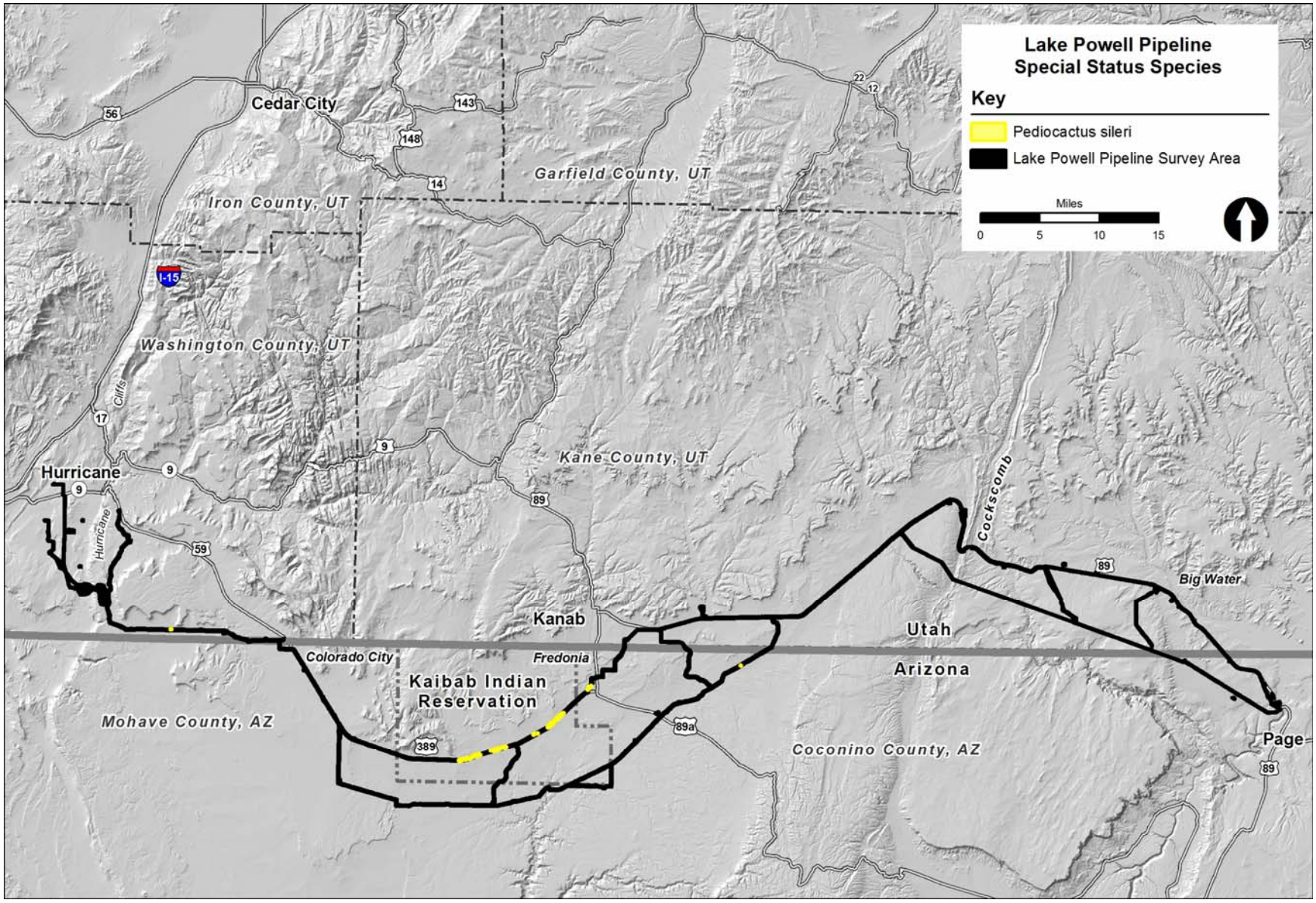

Figure 4-18
***Pediocactus sileri* Overview Map**

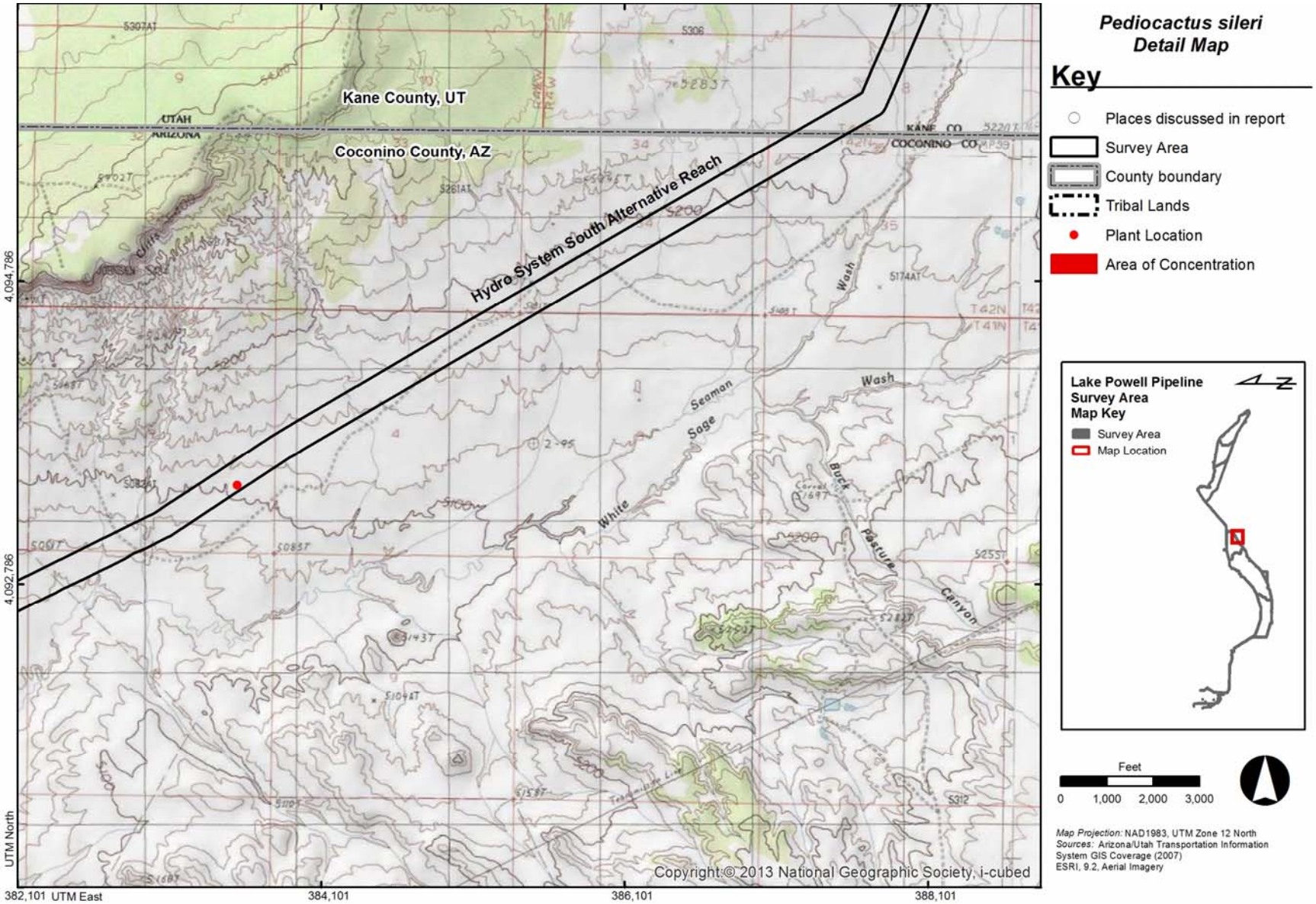

Figure 4-19
***Pediocactus sileri* Detail Map 1**

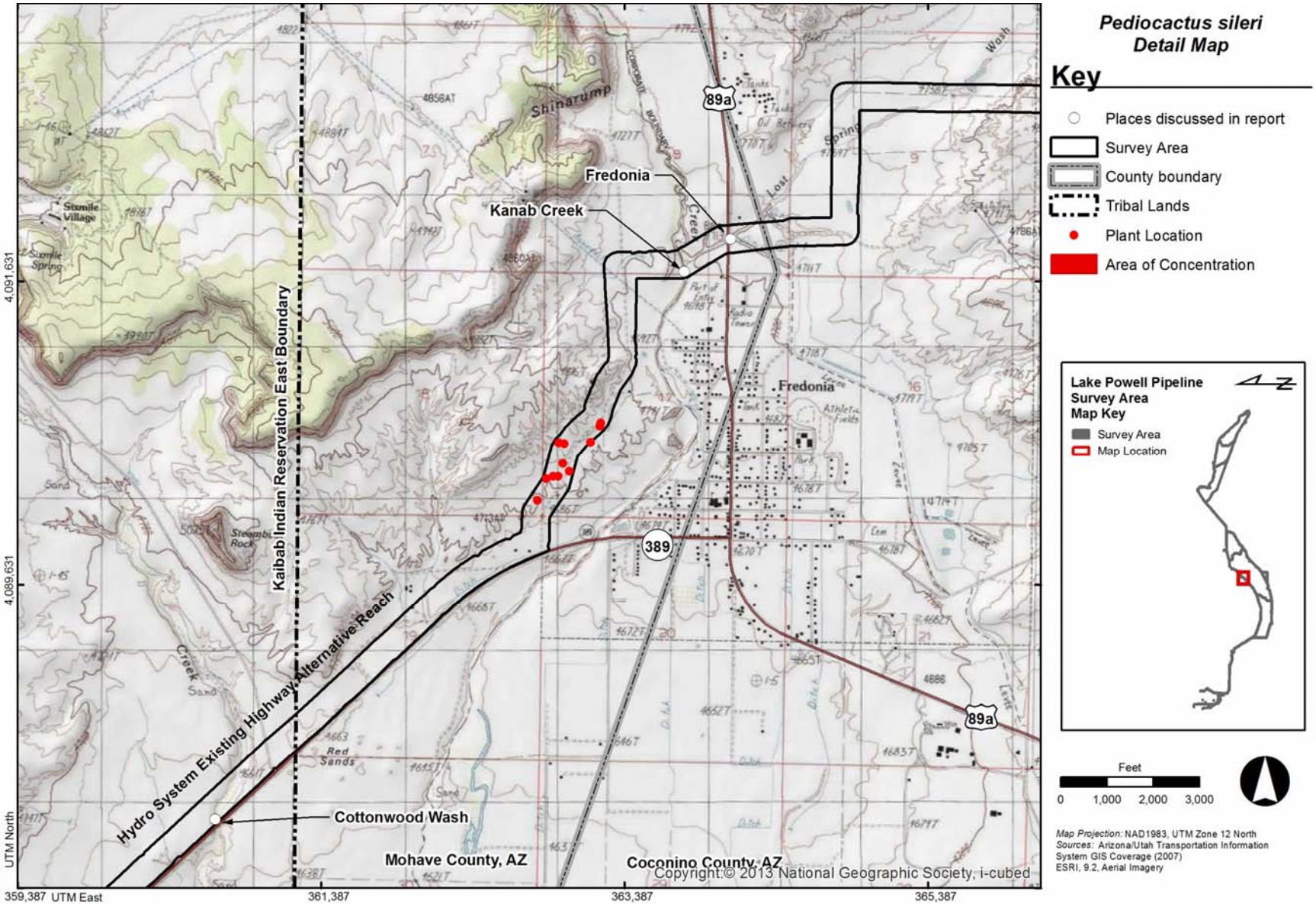

Figure 4-20
***Pediocactus sileri* Detail Map 2**

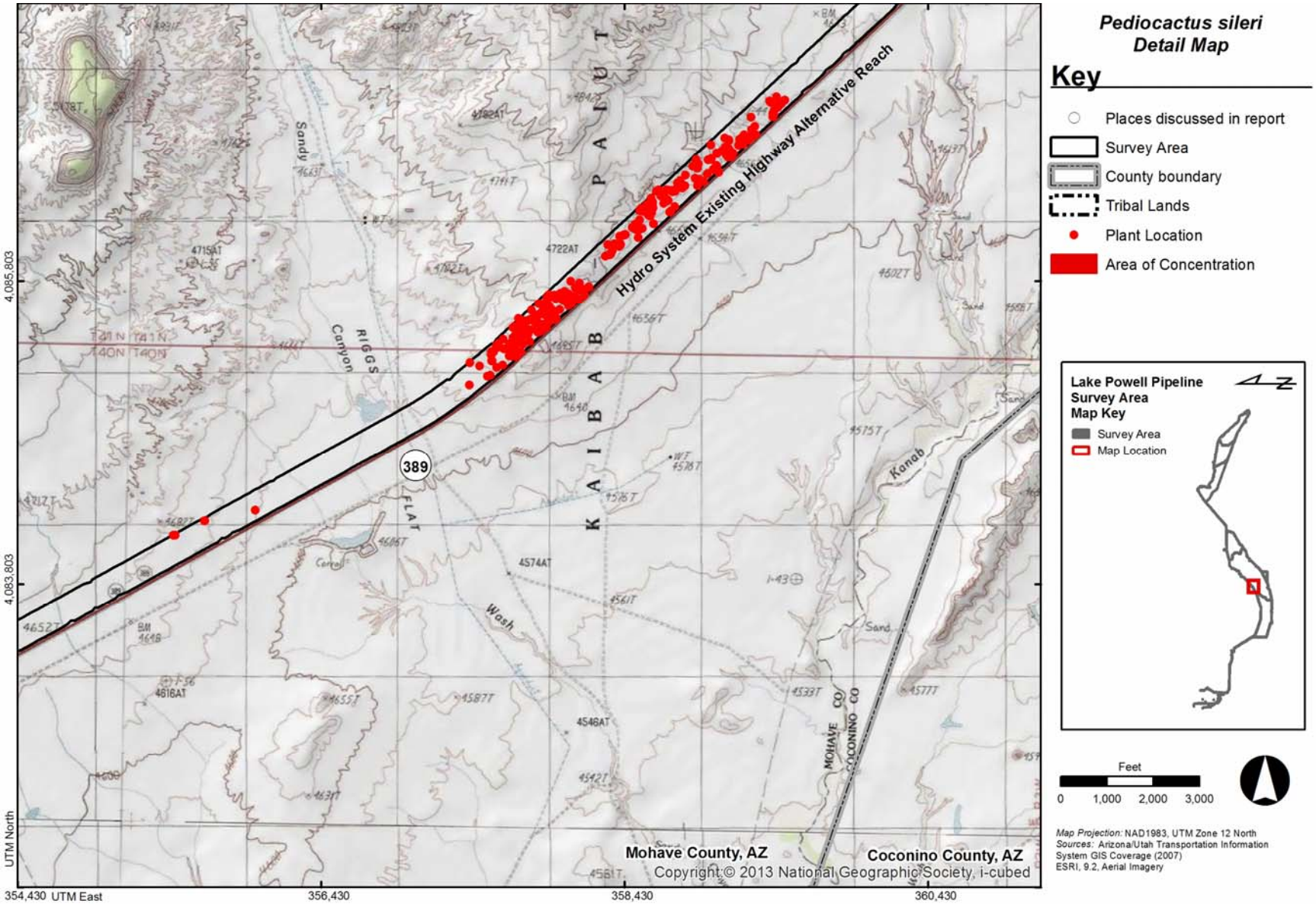

Figure 4-21
***Pediocactus sileri* Detail Map 3**

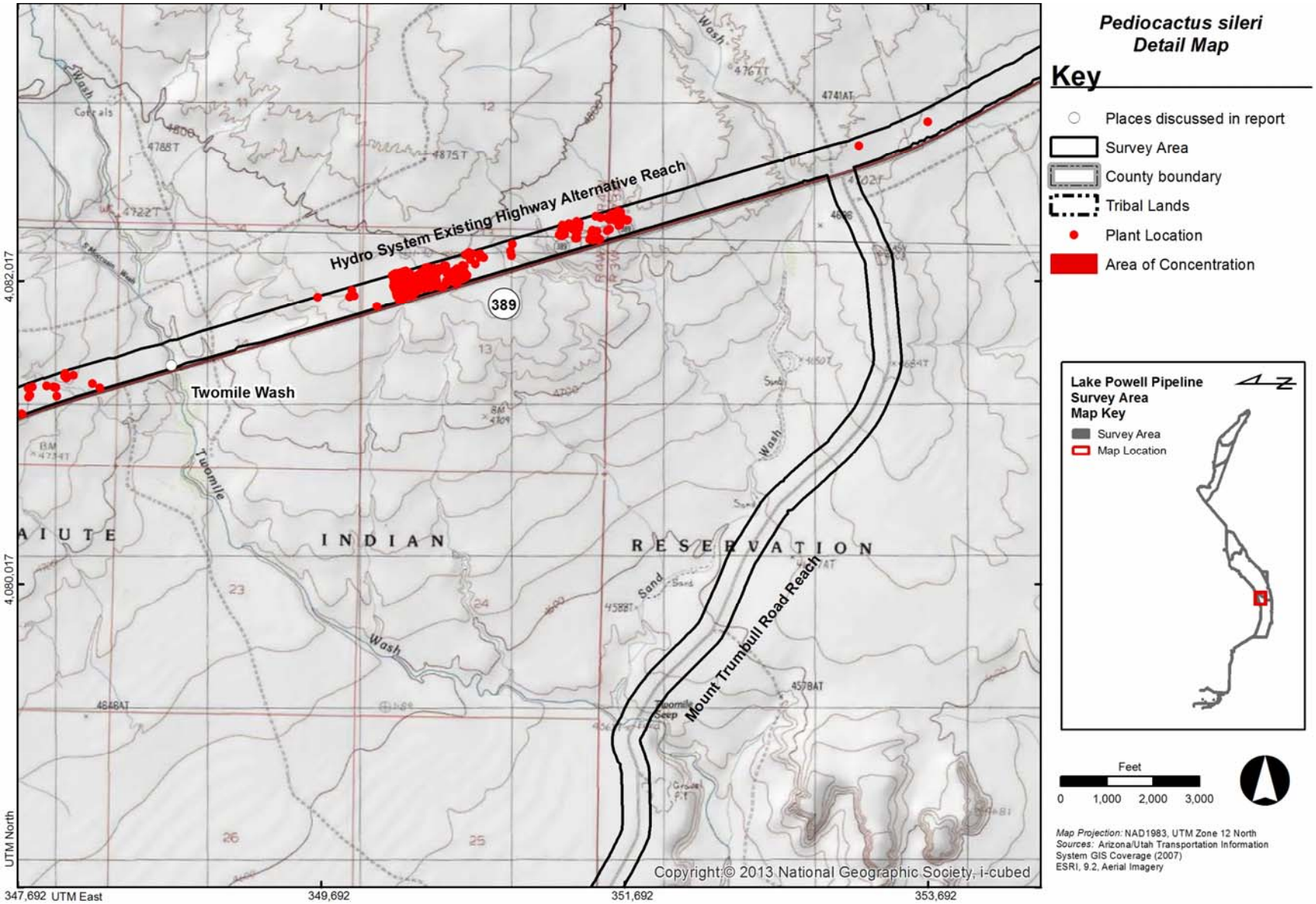

Figure 4-22
***Pediocactus sileri* Detail Map 4**

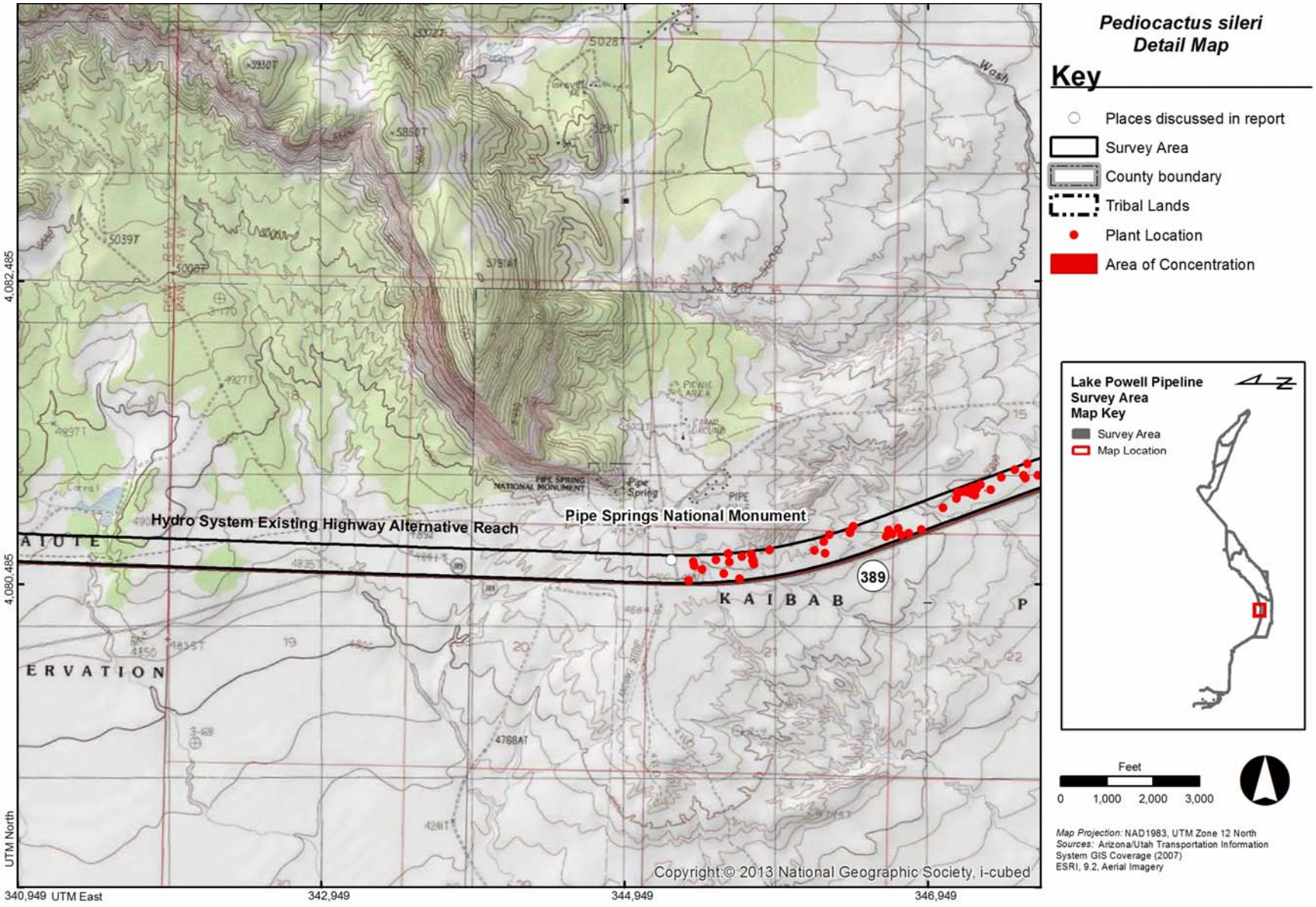

Figure 4-23
***Pediocactus sileri* Detail Map 5**

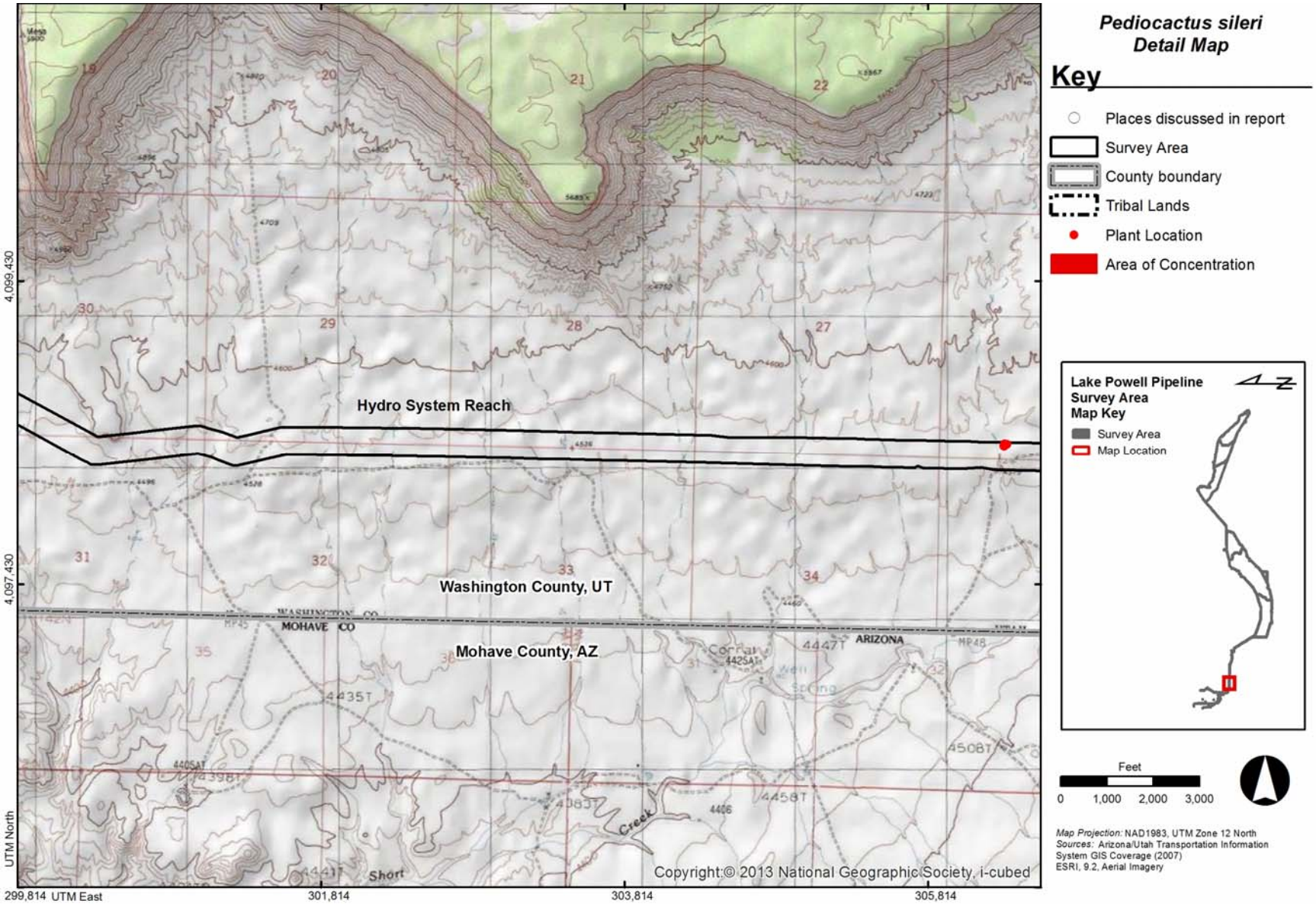

Figure 4-24
***Pediocactus sileri* Detail Map 6**

4.3.33 *Pediomelum aromaticum* var. *barnebyi* (Indian breadroot)

4.3.33.1 Natural History

Pediomelum aromaticum var. *barnebyi* is a perennial herb of the Fabaceae (Pea Family) with a woody base and a definite leafy stem reaching 3 inches (8 centimeters) to 6 inches (15 centimeters) tall. Rhizomes, underground stems, are slender. Gray green leaflets are covered in stiff, sharp hairs below and above, or just along the veins above. The lowermost racemes support 10 to 12 flowers on stalks reaching 0.2 inches (0.5 centimeters) to 0.5 inches (1.3 centimeters) long. Flowers bloom from July to August (Welsh et al. 2008, UNPS 2003-08).

Pediomelum aromaticum var. *barnebyi* is restricted to Kane County and southwestern Washington County, Utah and immediately adjacent Mohave County, Arizona. It is known in Hildale and to 2.3 miles west of Kanab, Utah, north of Colorado City, and Short Creek east to Moccasin, Arizona (Welsh et al. 2008). *P. a.* var. *barnebyi* is found on fine-textured soils derived from the Triassic Chinle Formation in pinyon-juniper and *Shepherdia rotundifolia* communities at 4,430 feet (1,350 meters) in elevation (Welsh et al. 2008).

Three varieties of *Pediomelum aromaticum* exist, all with purple flowers, but *P. a.* var. *barnebyi* can be distinguished from other varieties by the flowers and peduncles of the lowermost flower clusters, or racemes. In *P. a.* var. *barnebyi*, the lowermost racemes support 10 to 12 flowers while the lowermost racemes of *P. aromaticum* var. *tuhyi* and *P. a.* var. *aromaticum* support only three to seven flowers (Welsh et al. 2008).

4.3.33.2 Survey Results

Pediomelum aromaticum var. *barnebyi* was not encountered during project surveys.

4.3.33.3 Discussion

The survey area includes portions of the known range of *Pediomelum aromaticum* var. *barnebyi*. Short Creek at Colorado City is a sandy wash that could support potential habitat; however, the area is heavily impacted by residential and recreational use and not suitable for *P. a.* var. *barnebyi*. Mapped soils of the Chinle Formation were targeted and surveyed except for the private property described in *Astragalus ampullarius*. Potentially suitable habitat on private property at Cedar Ridge does not support the pinyon-juniper communities preferred by *P. a.* var. *barnebyi*. Although *Juniperus osteosperma* woodlands are present at the Kanab site, the site is slightly above the elevation range documented for this species. Thus, there is a low-potential for *P. a.* var. *barnebyi* to occur at the Kanab site if access to private property is granted for future surveys. No further surveys are warranted within the survey area for this plant.

4.3.34 *Pediomelum epipsilum* (Kane breadroot)

4.3.34.1 Natural History

Pediomelum epipsilum is a perennial herb from the Fabaceae (Pea Family) that grows from an underground woody base from deep tuberous roots. This plant grows in clumps reaching 1.4 inches (3.5 centimeters) to 6.1 inches (15.5 centimeters) tall, and produces leaves with five bi-colored leaflets, each yellow green and typically hairless above, and grayish with stiff hairs below. Flower clusters are 0.8 inches (2 centimeters) to 2.4 inches (6 centimeters) long, baring pale violet flowers 0.4 (1.1 centimeters) to 0.6 inches (1.6 centimeters) long (Figure 4-25). The leaf-like structure under the flower is strongly swollen on one side, and the lower tooth extends from 0.3 inches (0.8 centimeters) to 0.4 inches (1.0 centimeters) long (Welsh et al. 1993, UNPS 2003-08).

Figure 4-25
Close-up View of *Pediomelum epipsilum* Observed within the Survey Area

P. epipsilum is endemic to Kane County, Utah, and adjacent Mohave County, Arizona (Welsh et al. 2008). *P. epipsilum* is found in pinyon-juniper woodland on fine-textured soils derived from the Triassic Chinle or Upper Red, Middle Red, and Schnabkaib Members of the Moenkopi Formations (Welsh et al. 2008). At its type locality, it is found on brown, gypsiferous (soils with a high gypsum content) outcrops in a semibarren habitat with few other plants, and can be found growing up through the bed of an old highway (UNPS 2003-2008, Welsh et al. 2008). It is known from 4,000 feet (1,219 meters) to 5,500 feet (1,676 meters) in elevation (UNPS 2003-08).

The bicolored leaflets (yellow green above and grayish below) distinguish this species from all other species of *Pediomelum* (UNPS 2003-08).

4.3.34.2 Survey Results

P. epipsilum was encountered on the Colorado Plateau from Buckskin Gulch west to Johnson's Wash, within the Kaibab Indian Reservation west of Cottonwood Wash, and south of the Kaibab Indian Reservation just west of Mount Trumbull Road. Surveys located a total of 5,369 individual plants. The majority (5,327 of 5,369) of *P. epipsilum* occurrences were scattered between Telegraph Flat and Seaman Wash. These occurrences were all on BLM lands, within the Water Conveyance System, the Hydro System, the Hydro System Existing Highway Alternative, and the Hydro System South Alternative reaches. The remaining 42 *P. epipsilum* were found on BLM lands (12 individuals) and the Kaibab Indian Reservation (30 individuals) within the Hydro System South Alternative and the Hydro System Existing Highway Alternative (Table 4-18). The distribution of *P. epipsilum* across the survey area is shown in Table 4-18 and in Figure 4-27 through Figure 4-34.

P. epipsilum was encountered in seven ecological systems across the Colorado Plateau Ecological Region. Within these seven ecological systems, *P. epipsilum* was documented in 10 alliances and 16 associations. The plant was most abundant in the *Artemisia tridentata ssp. tridentata* Shrubland Alliance of the Colorado Big Sagebrush Shrubland Ecological System (1,300 individuals) and the *Juniperus osteosperma* Woodland of the Colorado Plateau Gypsum Badlands Ecological System (1,210 individuals). Plants were identified from between 4,497 feet (1,371 meters) and 5,680 feet (1,731 meters) in elevation. Table 4-19 includes all *P. epipsilum* documented within the survey area by Ecological System, Alliance, and Association.

P. epipsilum was documented on a number of different geologic formations across the project area (Table 4-20). It was most abundant on the Middle Red Member of the Moenkopi Formation and the alluvial deposits from floods associated with the Middle Red Member of the Moenkopi Formation.

P. epipsilum occurred on 10 different soil types within the survey area; it was most abundant on Kenzo- Retsabal-Progresso, Ruinpoint-Barx, and Lemrac-Simel-Humbug soils. Table 4-21 includes a list of all soil types supporting *P. epipsilum*.

P. epipsilum tended to occur in areas of previous disturbance; individuals were often found along the remnants of old two-track roads, adjacent to old cattle holding areas, and in areas that have been grazed by cattle. During surveys, *P. epipsilum* was frequently encountered in vegetation openings, particularly where breaks in the groundcover (generally *Artemisia* spp.) occurred, and there was a short distance to nearby *Juniperus osteosperma* individuals. The species was often found in the open, growing in localized bare areas, further suggesting an affinity for sparse vegetation cover.

Table 4-18
A Summary of *Pediomelum epipsilum* Survey Results by Location

Reach	Location	Land Ownership	# of Plants
Water Conveyance System	0.5 miles northeast of Telegraph Wash	BLM	1,263
Water Conveyance System, Hydro System	1 mile southwest of Telegraph Wash to 1.2 miles southwest of Petrified Hollow Wash	BLM	2,464
Hydro System Existing Highway Alternative, Hydro System South Alternative	1 mile to 2.7 miles southwest of Petrified Hollow Wash and to Shinarump Cliffs	BLM	1,575
Hydro System South Alternative	2.2 miles southwest of Shinarump Cliffs	BLM	25
Hydro System South Alternative	0.65 miles southwest of White Sage Wash	BLM	1
Hydro System Existing Highway Alternative	2.65 miles southwest of Cottonwood Wash	Kaibab Indian Reservation	30
Hydro System South Alternative	2.8 miles west of Bitter Seep Wash	BLM	11
		Total	**5,369**

Table 4-19
A Summary of *Pediomelum epipsilum* Survey Results by Alliance and Association

Alliance	Association	# of Plants
COLORADO PLATEAU GRASSLAND ECOLOGICAL SYSTEM		
Achnatherum hymenoides Herbaceous	*Achnatherum hymenoides* Herbaceous	11
COLORADO PLATEAU BIG SAGEBRUSH SHRUBLAND ECOLOGICAL SYSTEM		
Artemisia tridentata Shrubland	*Artemisia tridentata – Ericameria nauseosa* Shrubland	3
Artemisia tridentata ssp. *tridentate* Shrubland	*Artemisia tridentata* ssp. *tridentata* Sparse Understory Shrubland	1,300
Artemisia tridentata ssp. *tridentate* Shrubland	*Juniperus osteosperma* / *Artemisia tridentata* ssp. *tridentata* Wooded Shrubland	292
COLORADO PLATEAU GYPSUM BADLANDS ECOLOGICAL SYSTEM		
Artemisia tridentata ssp. *vaseyana* Shrubland	*Juniperus osteosperma* / *Artemisia tridentata* ssp. *vaseyana* Gypsum Badlands Wooded Shrubland	208
Eriogonum corymbosum Shrubland	*Eriogonum corymbosum – Artemisia tridentata* ssp. *vaseyana* Gypsum Badlands Sparse Shrubland	25
Eriogonum thompsoniae var. *atwoodii* Sparsely Vegetated	*Eriogonum thompsoniae* var. *atwoodii* Gypsum Badlands Sparse Vegetation	30
Juniperus osteosperma Woodland	*Juniperus osteosperma* / *Artemisia tridentata* ssp. *vaseyana* Gypsum Badlands Woodland	1,210
COLORADO PLATEAU PINYON-JUNIPER WOODLAND ECOLOGICAL SYSTEM		
Artemisia tridentata ssp. *vaseyana* Shrubland	*Pinus edulis – Juniperus osteosperma* / *Artemisia tridentata* ssp. *vaseyana* Wooded Shrubland	21
Juniperus osteosperma Woodland	*Juniperus osteosperma* / *Artemisia tridentata* Sparse Woodland	598
Juniperus osteosperma Woodland	*Juniperus osteosperma* / *Artemisia tridentata* ssp. *vaseyana* Woodland	1,124
Juniperus osteosperma Woodland	*Juniperus osteosperma* / *Artemisia tridentata* ssp. *vaseyana* Sparse Woodland	25
Pinus edulis – Juniperus osteosperma Woodland	*Pinus edulis – Juniperus osteosperma* / *Artemisia tridentata* ssp. *vaseyana* Sparse Woodland	157
COLORADO PLATEAU WASH ECOLOGICAL SYSTEM		
Artemisia tridentata ssp. vaseyana Shrubland	*Artemisia tridentata ssp. vaseyana Shrubland*	1
INVASIVE UPLAND VEGETATION ECOLOGICAL SYSTEM		
Salsola tragus Semi-natural Herbaceous	*Salsola tragus* Semi-natural Herbaceous Vegetation	363
COLORADO PLATEAU DEVELOPED ROAD		
Developed – Road Graded	Developed – Road Graded	1
	Total	**5,369**

Table 4-20
A Summary of *Pediomelum epipsilum* Survey Results by Geologic Formation

Geologic Formation	# of Plants
COLORADO PLATEAU GRASSLAND ECOLOGICAL SYSTEM	
Lower Red Member of the Moenkopi Formation	11
COLORADO PLATEAU BIG SAGE SHRUBLAND ECOLOGICAL SYSTEM	
Quaternary alluvial deposits	1,269
Middle Red Member of the Moenkopi Formation	292
Lower Red Member of the Moenkopi Formation	2
Shnabkaib Member of the Moenkopi Formation	32
COLORADO PLATEAU GYPSUM BADLANDS ECOLOGICAL SYSTEM	
Quaternary alluvial deposits	900
Undivided Moenkopi Formation	55
Middle Red Member of the Moenkopi Formation	207
Shnabkaib Member of the Moenkopi Formation	311
COLORADO PLATEAU PINYON-JUNIPER WOODLAND ECOLOGICAL SYSTEM	
Quaternary alluvial deposits	21
Middle Red Member of the Moenkopi Formation	1,627
Shnabkaib Member of the Moenkopi Formation	277
COLORADO PLATEAU WASH ECOLOGICAL SYSTEM	
Undivided Moenkopi Formation	1
INVASIVE UPLAND VEGETATION ECOLOGICAL SYSTEM	
Quaternary alluvial deposits	72
Middle Red Member of the Moenkopi Formation	47
Shnabkaib Member of the Moenkopi Formation	244
COLORADO PLATEAU DEVELOPED ROAD	
Middle Red Member of the Moenkopi Formation	1
Total	**5,369**

Table 4-21
A Summary of *Pediomelum epipsilum* Survey Results by Soil Type

Soil Type	# of Plants
Barx fine sandy loam, 2 to 10 percent slopes	455
Clayhole loam, 1 to 3 percent slopes	1
Gypsiorthids-Gypsiorthids, shallow complex, 1 to 50 percent slopes	29
Hillburn, dry-Sazi, moist complex, 2 to 3 percent slopes	2
Kenzo-Retsabal-Progresso, cool complex, 2 to 30 percent slopes	1,861
Klondike sandy clay loam, 2 to 15 percent slopes	1
Lemrac-Simel-Humbug, moist complex, 2 to 20 percent slopes	1,124
Pennell gravelly loam, 1 to 12 percent slopes	11
Ruinpoint-Barx complex, 2 to 8 percent slopes	1,860
Torriorthents, 3 to 50 percent slopes	25
Total	**5,369**

4.3.34.3 Discussion

P. epipsilum was documented within the central portion of the Colorado Plateau Region of the survey area; it was most abundant from Telegraph Wash to Seaman Wash within the Water Conveyance System and the Hydro System Existing Highway Alternative reaches. *P. epipsilum* was most abundant within the Colorado Plateau Big Sagebrush Shrubland Ecological System, and across ecological systems it was often found in close proximity to *Juniperus osteosperma* communities. The species was most frequently observed within the *Artemisia tridentata ssp. tridentata* Shrubland Association, within the *Artemisia tridentata ssp. tridentata* Sparse Understory Shrubland Alliance of the Colorado Plateau Big Sagebrush Shrubland Ecological System; and was most common on the Middle Red Member of the Moenkopi Formation and alluvial deposits from floods associated with the Middle Red Member of the Moenkopi Formation.

P. epipsilum was encountered in habitat consistent with published literature, although some individuals were found to occur at elevations lower than the published range of the species. Also, all of the plants encountered had bi-colored, white and violet, flowers, which contrasts with the description of the species as originally published (Grimes 1986), which states that the flowers are a monochromatic pale violet.

P. epipsilum was often observed in disturbed areas, including old road beds and areas that experience natural flooding (Figure 4-26). Much of the area where *P. epipsilum* was documented has been grazed by cattle; the species is likely able to tolerate grazing because its tuberous root enables it to store carbohydrates. Despite the disturbance commonly found in association with the species, invasive weeds were not abundant in these habitats. Individual *P. epipsilum* were primarily found in the open, surrounded by bare ground. Whether invasive weeds were absent because they are poorly adapted to these habitats, or because these localized areas are too shaded by nearby trees (*Juniperus osteosperma*) and shrubs, invasive weeds do not appear to be a significant threat to *P. epipsilum*. Given the ability of the species to colonize disturbed areas, and the observed lack of invasive weeds in these disturbed habitats, project-related disturbance is not expected to greatly impact the habitats identified as supporting the species. Therefore, project impacts to *P. epipsilum* would mostly likely be manifested in the direct loss of individuals due to project activities.

Figure 4-26
View of *Pediomelum epipsilum* and Habitat within the Survey Area

Since *P. epipsilum* appears to thrive in disturbed areas, this species is an excellent candidate to propagate following construction. Seeds could be harvested prior to construction from existing plants and dispersed on site. Consideration could also be given to growing individuals from collected seed in order to supplement revegetation efforts in affected areas. Topsoil containing potentially viable seed should also be salvaged and re-used on site.

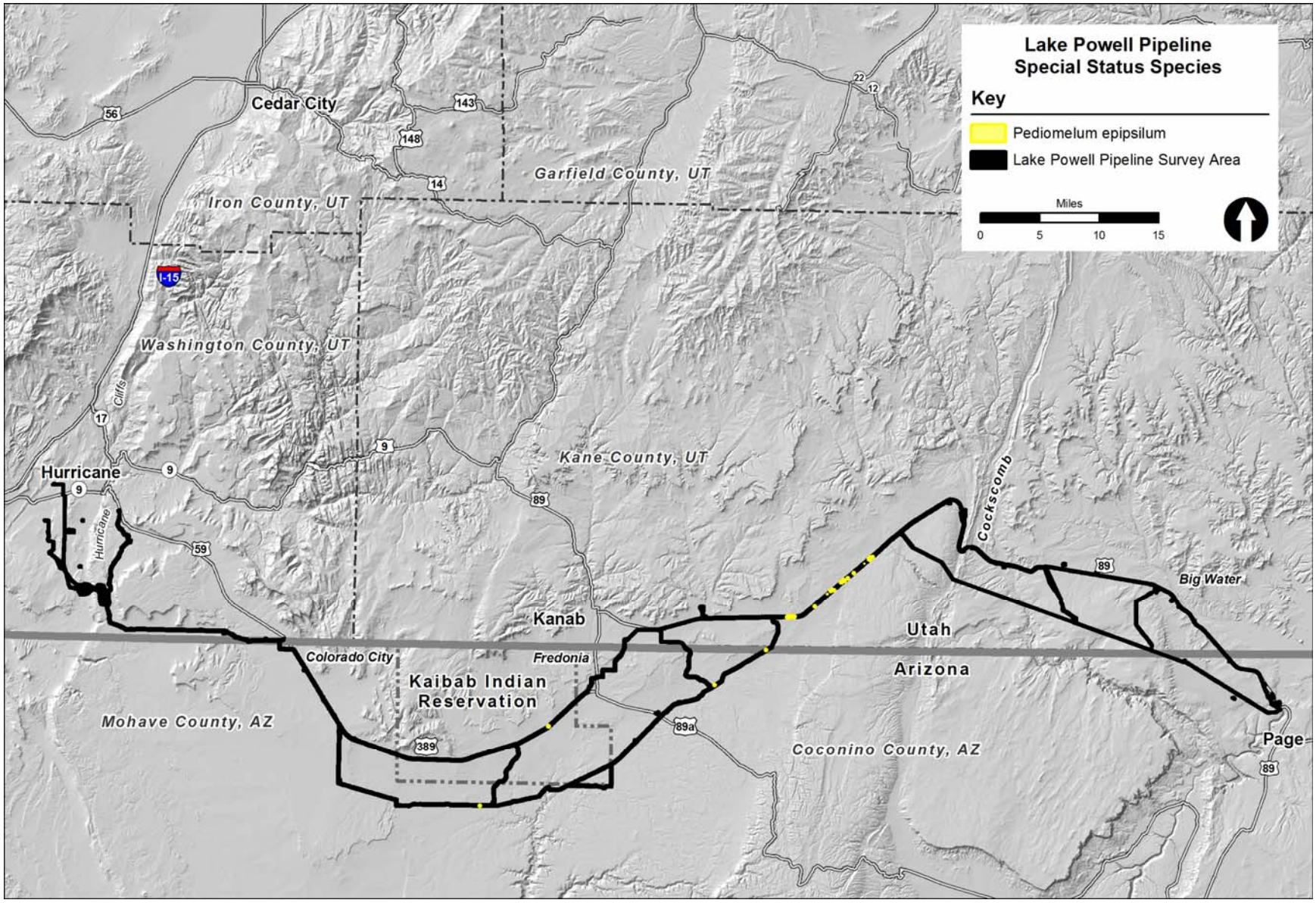

Figure 4-27
***Pediomelum epipsilum* Overview Map**

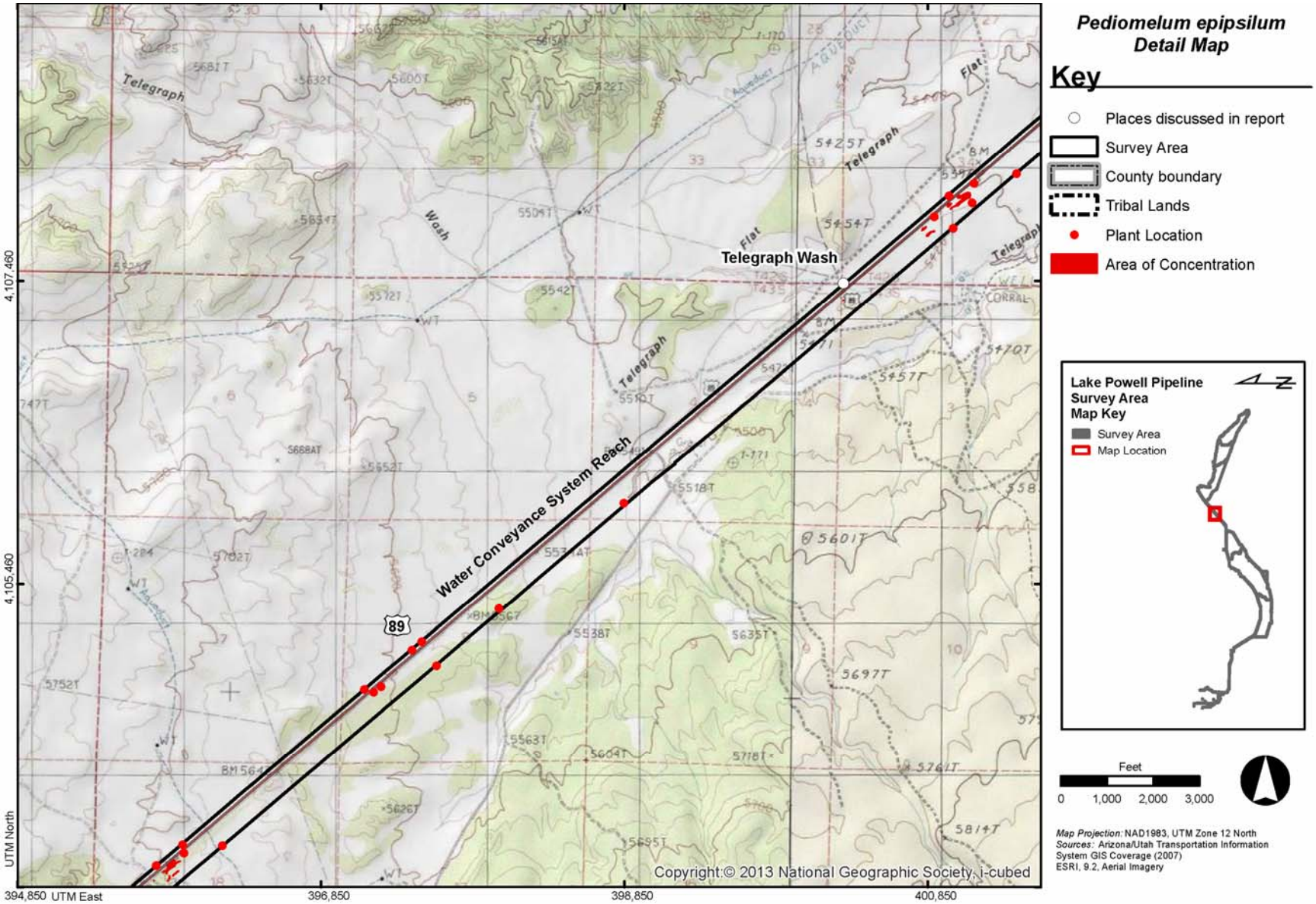

Figure 4-28
***Pediomelum epipsilum* Detail Map 1**

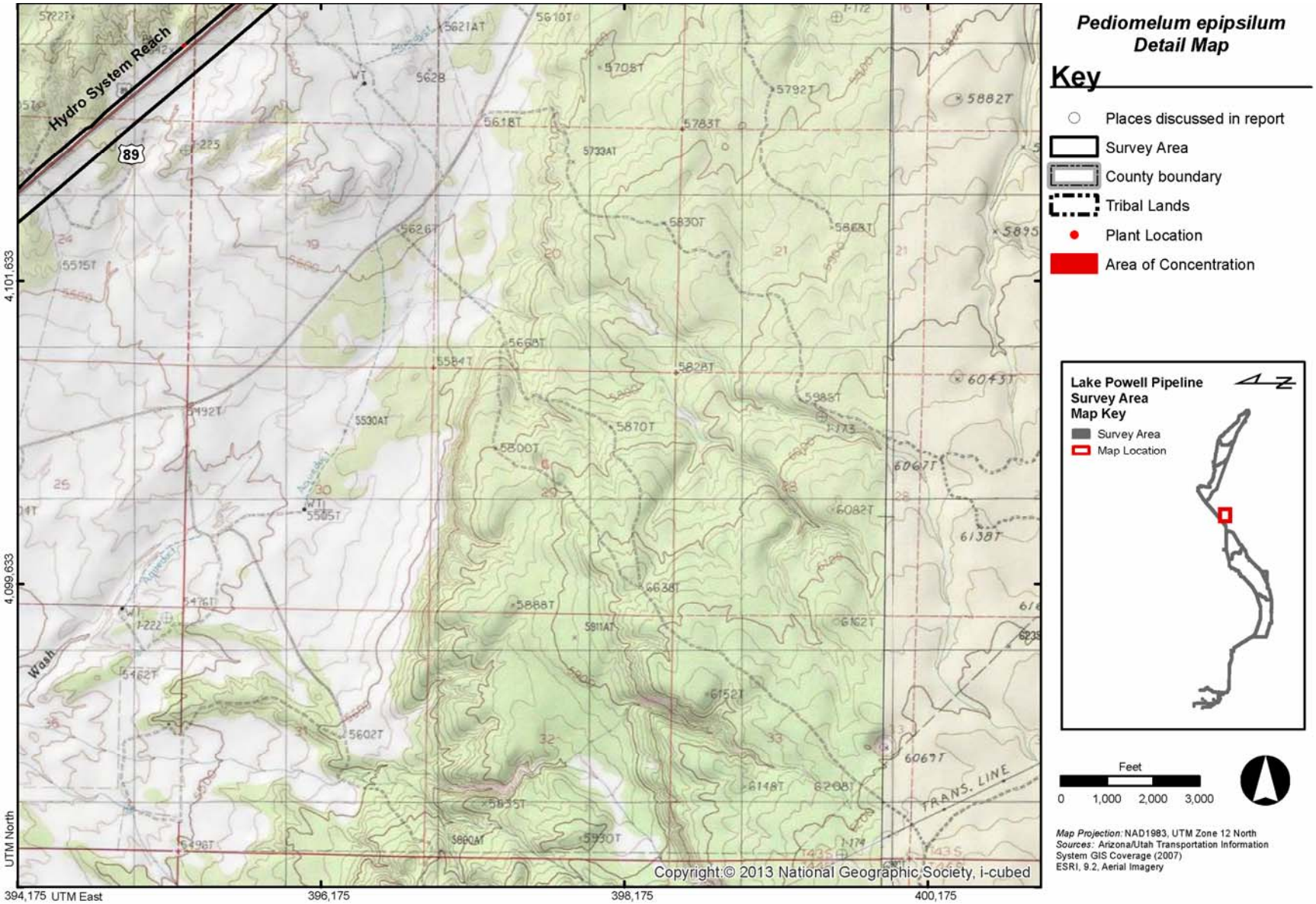

Figure 4-29
***Pediomelum epipsilum* Detail Map 2**

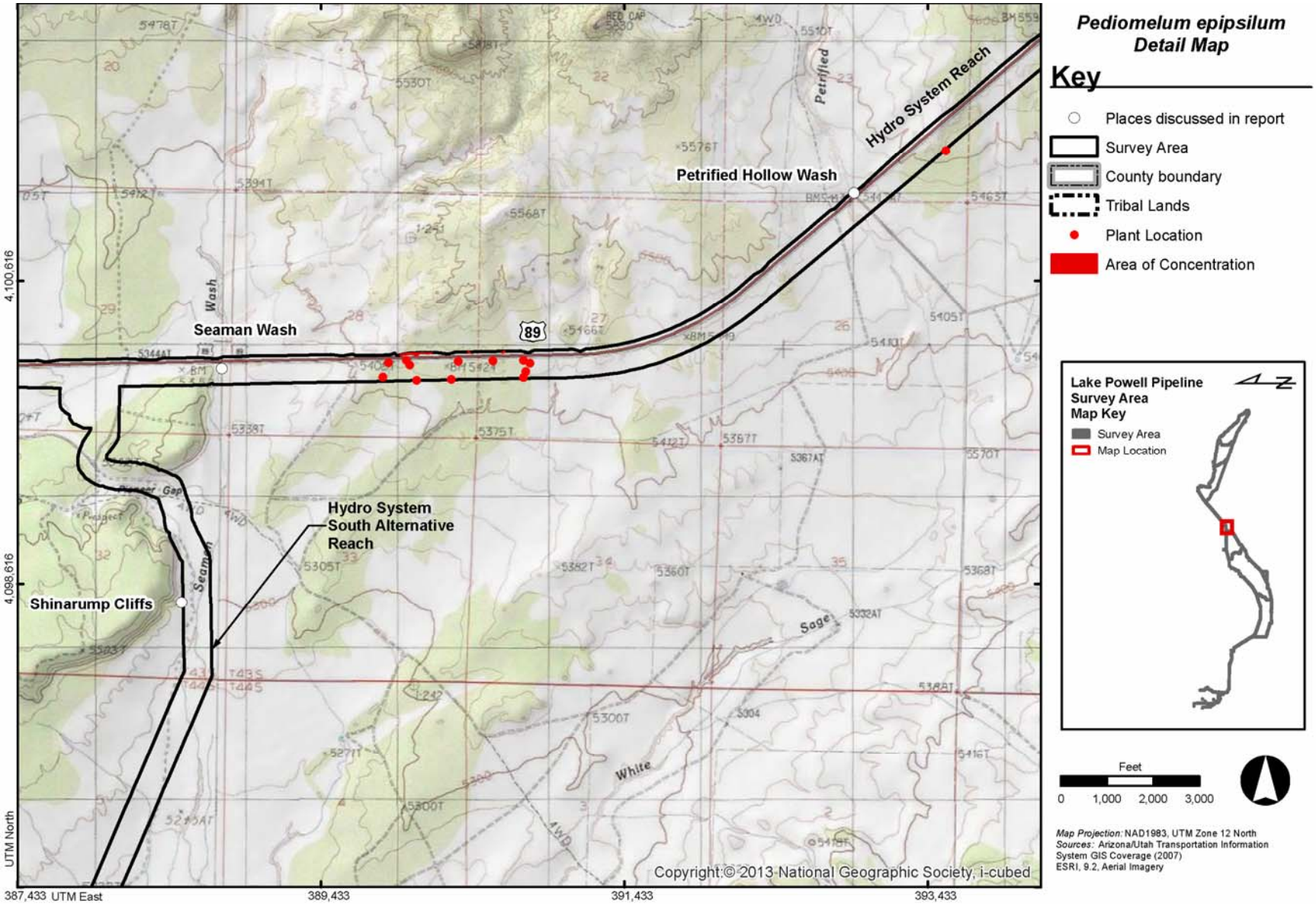

Figure 4-30
***Pediomelum epipsilum* Detail Map 3**

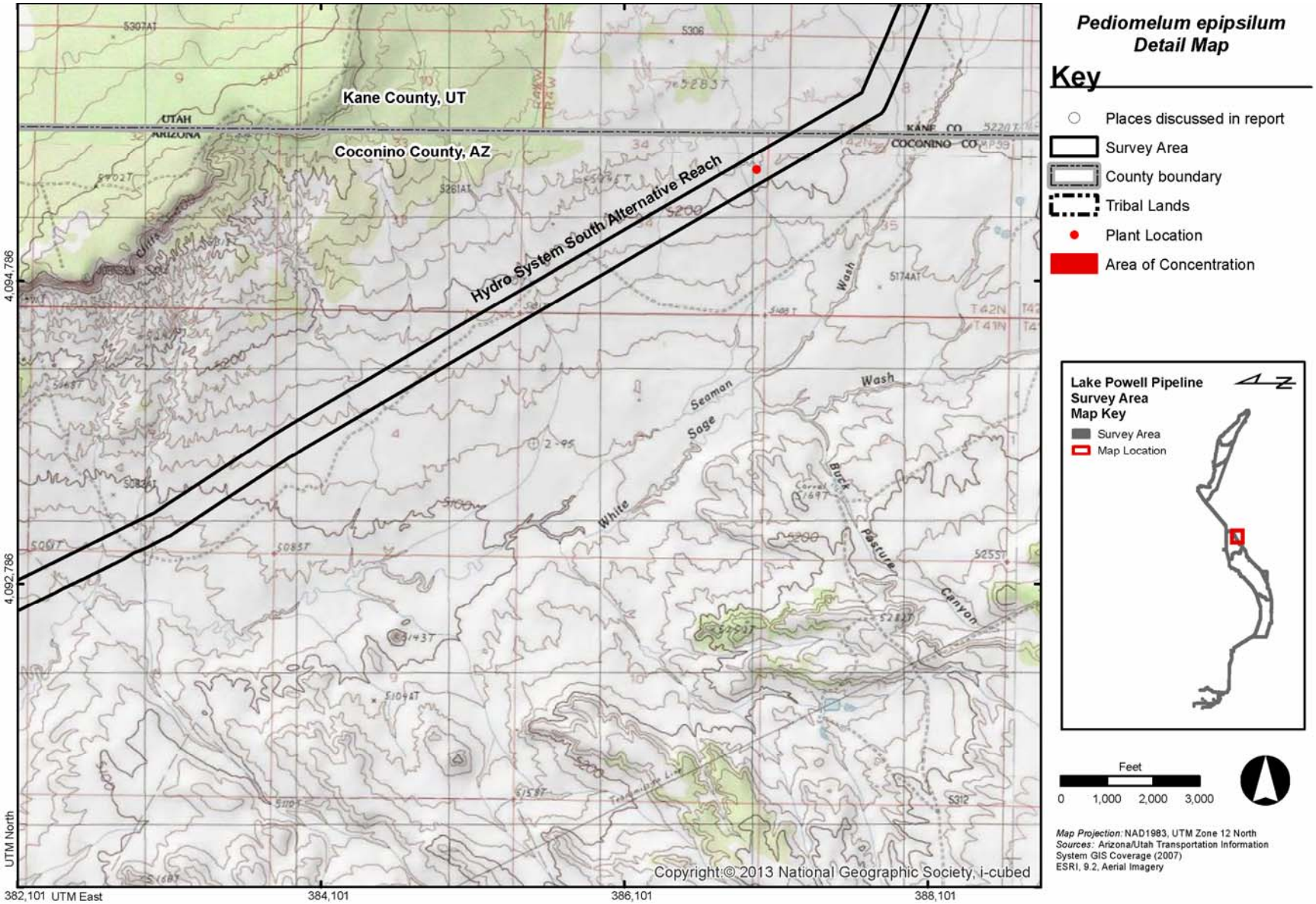

Figure 4-31
***Pediomelum epipsilum* Detail Map 4**

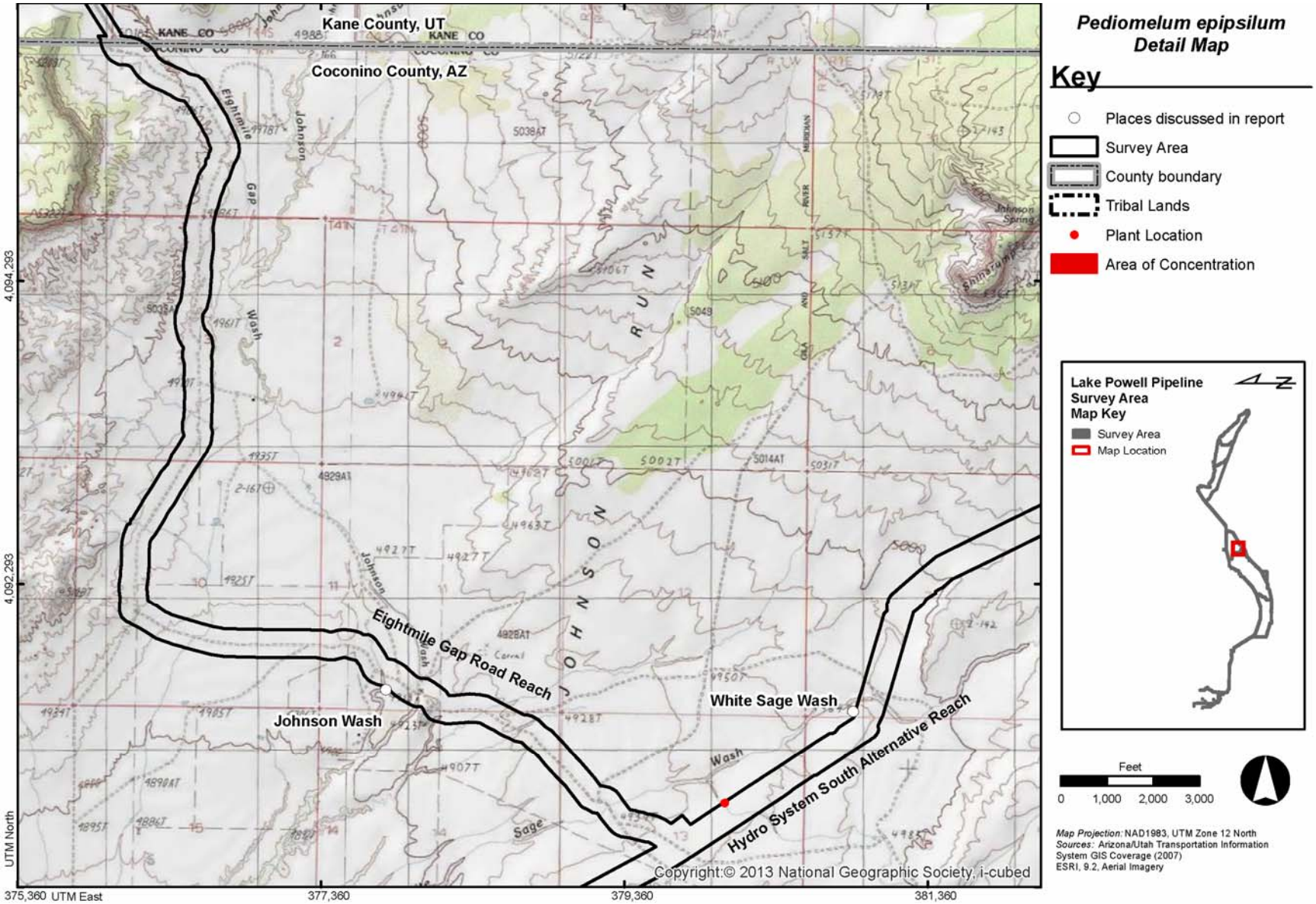

Figure 4-32
***Pediomelum epipsilum* Detail Map 5**

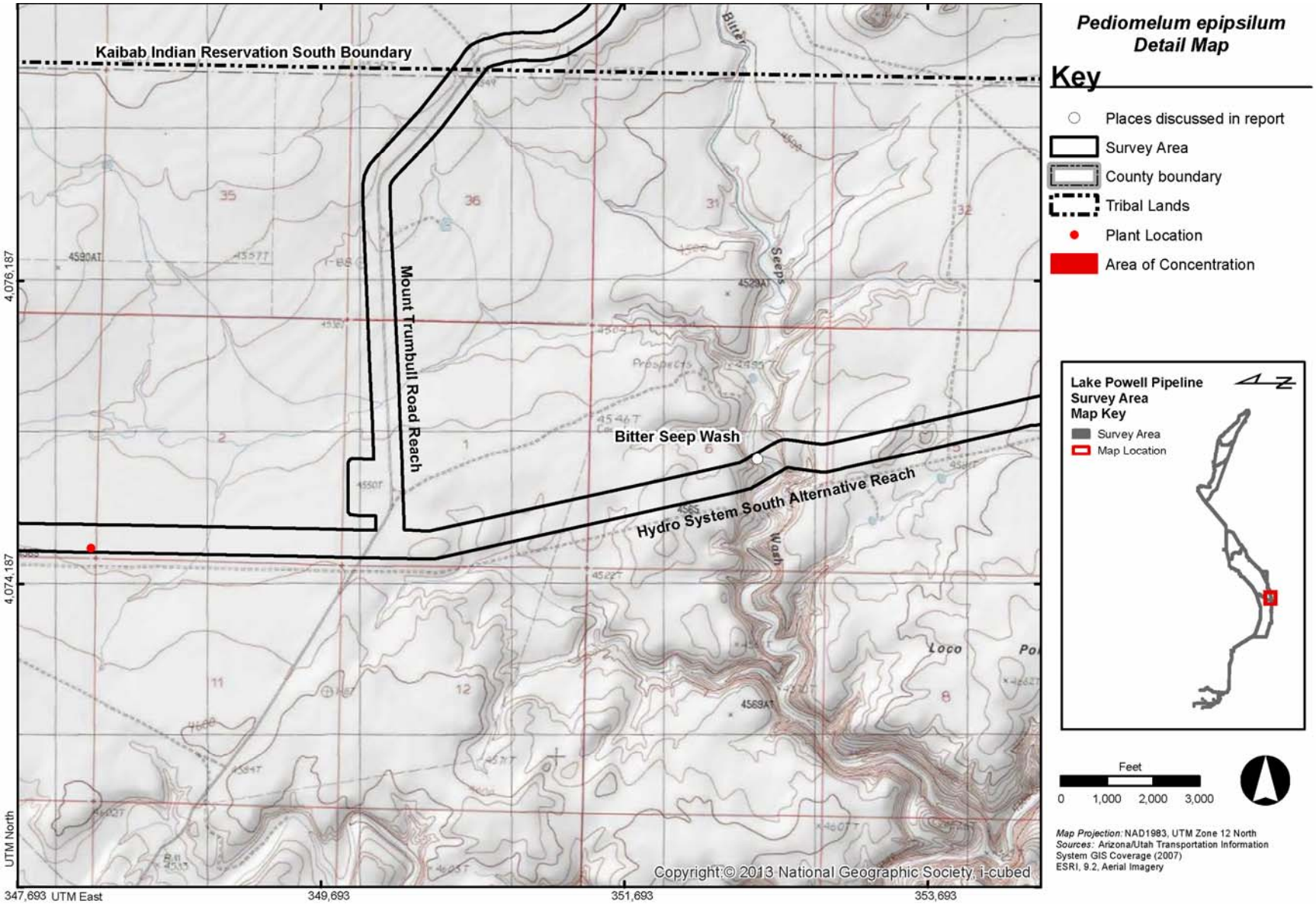

Figure 4-33
***Pediomelum epipsilum* Detail Map 6**

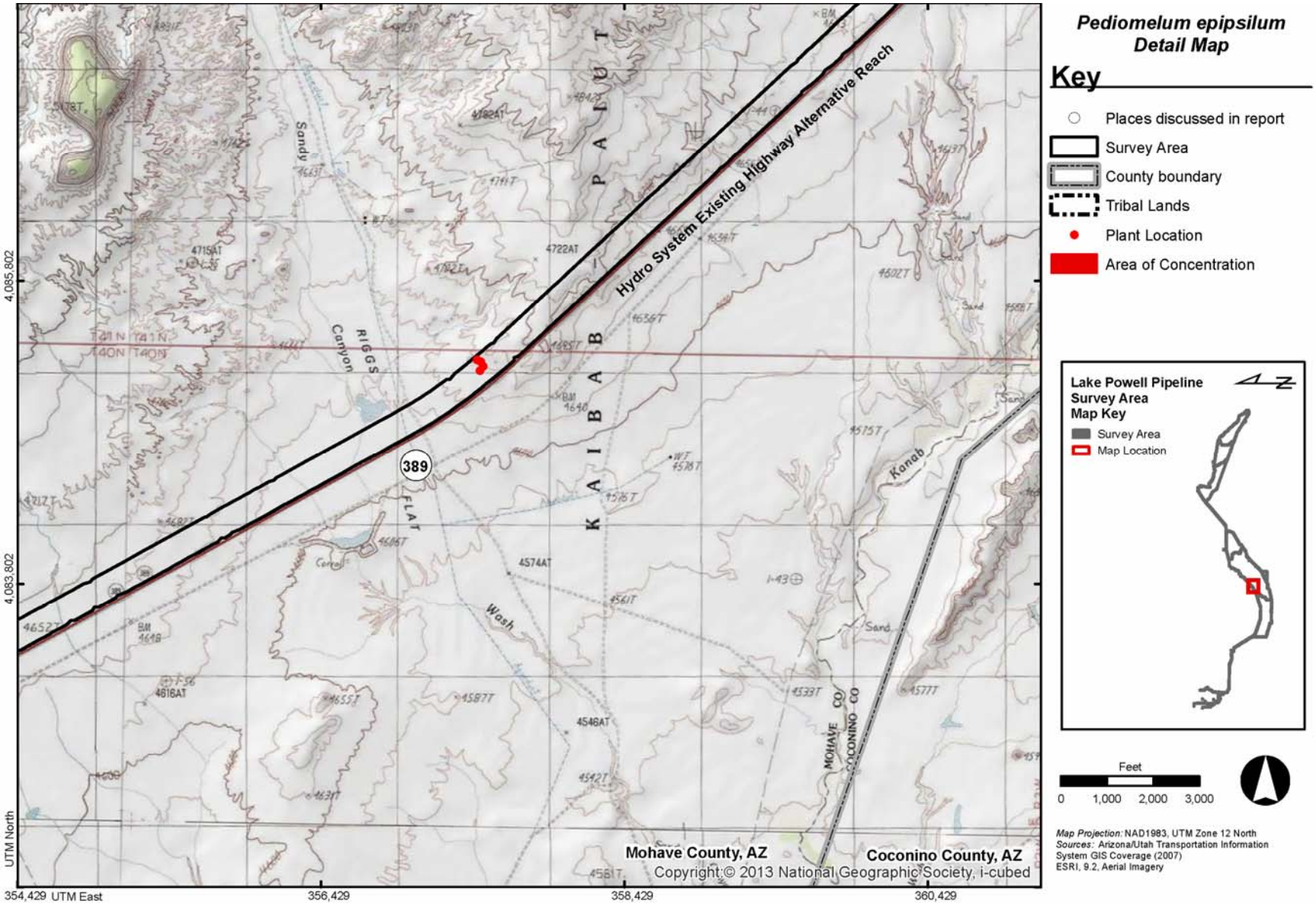

Figure 4-34
***Pediomelum epipsilum* Detail Map 7**

4.3.35 *Penstemon ammophilus* (Sandloving penstemon)

4.3.35.1 Natural History

Penstemon ammophilus is a clumped herbaceous perennial from the Scrophulariaceae (Figwort Family) with hollow, swollen stems from a branched underground woody base. Stems are 2 inches (5 centimeters) to 12.6 inches (32 centimeters) tall, either resting on the ground or growing erect. This plant grows in clumps and develops elongated, fibrous roots. Lower leaves completely surround the stem. Upper leaves are attached directly to the stem, are curled, oblong, and slightly lance-shaped. Flowers are arranged in whorls of two to eight and have lavender blue petals.

P. ammophilus is endemic to Garfield, Kane and Washington counties (Welsh et al. 2008). *P. ammophilus* occurs in blown sand derived from Navajo Sandstone below the White Cliffs, where long lived clumps act as a sand stabilizer. It is also found in ponderosa pine and mixed shrub communities. It tends to grow alone and does not appear to tolerate competition. *P. ammophilus* is found from 5,900 feet (1,800 meters) to 7,220 feet (2,200 meters) elevation (Welsh et al. 2008).

4.3.35.2 Survey Results

P. ammophilus was not encountered during project surveys.

4.3.35.3 Discussion

Welsh et al. (2008) identified "Navajo Sandstone below the White Cliffs" as the preferred geologic substrate for *P. ammophilus*. This description may have originated from *Penstemon* specialist Noel Holmgren's use of the term "White Cliffs" as the location for a *Penstemon* specimen collected 14 miles north of Kanab. Locating "White Cliffs" on geologic maps is problematic as this is not a recognized geologic formation or member. Hayden (2006) considered Navajo Sandstone as "the White Cliffs step of the Grand Staircase." The closest known occurrence of *P. ammophilus* is from the top of Canaan Mountain (Shultz & Anderson #5349), 4.7 miles from the survey area in the vicinity of Colorado City.

Cedar Mountain, Judd Hollow, and the Paria River Canyon are the only portions of the survey area where the Navajo Sandstone Formation is exposed and Navajo-derived eolian sands accumulate. This is far south and east of known populations of *P. ammophilus*. *P. ammophilus* was not observed during surveys of Cedar Mountain, Judd Hollow, and the Paria River Canyon. No further surveys are warranted within survey area for this plant.

4.3.36 *Petalonyx parryi* (Parry's petalonyx)

4.3.36.1 Natural History

Petalonyx parryi is a mostly woody, rounded perennial shrub from the Loasaceae (Stickleaf Family), grow 2.5 (8 centimeters) to 5 feet (15 decimeters) tall, and with oblong-oval to broadly elliptic leaves. Leaf margins are smooth to wavy. The plant has a naked terminal flower cluster with petals reaching more than 0.4 inches (1.1 centimeters) long (Figure 4-18) (Welsh et al. 2008). Flowers are cream colored and bloom in May (UNPS 2003-08).

P. parryi occurs in Utah, Arizona, and Nevada. In Utah, the species is known from between St. George and Hurricane to south of Hurricane in Washington County, and in Arizona, it is found from western Coconino County and northern Mohave County (AGFD 2005). In Utah, the species is common in *Atriplex confertifolia*, *Psorothamnus* sp., *Larrea tridentata*, and *Ambrosia* communities on Chinle and Moenkopi outcrops (Welsh et al. 2008). In Arizona it can be found in dry desert washes and canyons and on gypsum hills. This species is sometimes the principal component of the vegetation, as in Baird Cove at the south end of the Beaver Dam

Mountains (AGFD 2005). *P. parryii* has been recorded from 2,560 feet (780 meters) to 4,000 feet (1,219 meters) in elevation in Utah (Welsh et al. 2008) and below 3,500 feet (1,067 meters) elevation in Arizona (AGFD 2005).

P. parryi appears similar to *P. nitidus*, but can be distinguished in part by its woody appearance. Additionally, the leaf margins of *P. parryi* are entire to rounded-toothed, while those of *P. nitidus* are coarsely and few-toothed. The petals of *P. parryi* are also greater than 0.43 inches (11 millimeters) long, while those of *P. nitidus* are shorter, reaching up to 0.12 inches (1.4 to 3.0 millimeters) in length (Welsh et al. 2008).

4.3.36.2 Survey Results

P. parryi was not encountered during project surveys.

4.3.36.3 Discussion

P. parryi was not encountered during the project surveys. All potentially suitable habitat occurring within the survey area was surveyed during the survey seasons. No further surveys are warranted within the survey area for this plant.

4.3.37 *Phacelia howelliana* (Howell's phacelia)

4.3.37.1 Natural History

Phacelia howelliana is an annual herb of the Hydrophyllaceae (Waterleaf Family) between 3.5 inches (0.9 decimeters) to 9 inches (2.3 decimeters) tall. Stems are branched and leafy at the base. Leaves are bristled and slightly round, oblong to oval, and irregularly rounded to lobed. The flowers are borne on one side of the flowering stalks in curved, caterpillar-shaped clusters. The flower has pale violet to blue lobes with a white tube and protruding stamens and style. Flowering occurs from April to June (UNPS 2003-08; AGFD 2004). The plant has four brown, elliptic seeds with corrugated margins.

Disjunct groups of *P. howelliana* occur in Grand, San Juan, and Wayne counties, Utah (Welsh et al. 2008) and extreme northern Navajo and Apache counties, Arizona (AGFD 2004). *P. howelliana* is reportedly common in salt and warm desert shrub, and sparse pinyon-juniper communities. Individuals have been recorded from 3,700 feet (1,128 meters) to 5,000 feet (1,524 meters) in elevation.

4.3.37.2 Survey Results

P. howelliana was not encountered during project surveys.

4.3.37.3 Discussion

All known locations for *P. howelliana* are from outside the limits of the survey area. Potentially suitable habitat for this species within the survey area was thoroughly surveyed, resulting in no observations of *P. howelliana.* No further surveys are warranted within the survey area for this plant.

4.3.38 *Phacelia mammalariensis* (Nipple phacelia)

4.3.38.1 Natural History

Phacelia mammalariensis is an annual herb in the Hydrophyllaceae (Waterleaf Family), between 3.5 inches (0.9 decimeters) to 19.7 inches (5 decimeters) tall. Stems are simple or branched and erect. Leaves are simple, oblong to lance-shaped and irregularly toothed or rounded. The flower is tubular-funnel form with pale blue to white

lobes and lavender anthers (Figure 4-35). The plant has four brown seeds that are pitted down the back (Welsh et al. 2008).

P. mammalariensis is endemic to eastern Kane and Garfield counties, Utah and occurs in salt and mixed desert shrub communities from 4,000 feet (1,219 meters) to 6,000 feet (1,829 meters) in elevation (Welsh et al. 2008).

Figure 4-35
Close-up View of *Phacelia mammalariensis* Observed within the Survey Area

P. mammalariensis appears very similar to *P. crenulata*, but the taxa can be distinguished by flower color and their seed. In contrast to the blue violet or purple flowers found on *P. crenulata*, the flowers of *P. mammalariensis* are pale blue to white in color with lavender anthers, a distinguishing characteristic for this plant. The seeds of both species are brown with pitted surfaces, but those of *P. mammalariensis* contain a longitudinal groove (Welsh et al. 2008).

4.3.38.2 Survey Results

P. mammalariensis was encountered in the survey area during field surveys. Surveys located a total of 1,688 individual *P. mammalariensis* plants. All but one *P. mammalariensis* was documented on GCNRA lands at the Glen Canyon Substation and along the BPS-2 Transmission Line Alternative Reach. The other lone *P. mammalariensis* was found on BLM lands just west of Calf Springs along the Glen Canyon to Buckskin Transmission Line North Reach. The distribution of *P. mammalariensis* across the survey area is shown in Table 4-22 and Figure 4-36 through Figure 4-38.

Table 4-22 A Summary of *Phacelia mammalariensis* Survey Results by Location			
Reach	**Location**	**Land Ownership**	**# of Plants**
Glen Canyon Substation	2 miles south and 1.5 miles north of Colorado River at Glen Canyon Dam	Glen Canyon National Recreation Area	1,687
Glen Canyon to Buckskin Transmission Line North	1.5 miles west of Calf Springs	BLM	1
		Total	**1,688**

P. mammalariensis was found growing most often within the Colorado Plateau Active and Stabilized Dune Ecological System, but also within sandy pockets in the Colorado Plateau Mixed Bedrock Canyon and Tableland Ecological System, and sandsheets of the Colorado Plateau Blackbrush-Mormon-tea Shrubland Ecological System. The vast majority of plants were found in the *Artemisia filifolia – Ephedra* (*nevadensis, torreyana, and viridis*) Sparse Shrubland Association of the *Artemisia filifolia* Shrubland Alliance within the Colorado Plateau Active and Stabilized Dune Ecological System. In total, *P. mammalariensis* was documented in three ecological systems, four alliances and five associations. The species was encountered at elevations ranging from 3,792 feet (1,156 meters) and 4,810 feet (1,466 meters). A summary of *P. mammalariensis* occurrences is provided in Table 4-23.

P. mammalariensis was found most frequently on stream channel deposits; these deposits are commonly composed of white to light-red silt, sand, gravel, and pebbles. It was also regularly documented on Navajo Sandstone; these soils are white, light-red and yellowish-gray, fine- to course-grained windblown sandstone (Billingsley et al. 2008). All geologic formations supporting *P. mammalariensis* are given in Table 4-24.

Table 4-23 A Summary of *Phacelia mammalariensis* Survey Results by Alliance and Association		
Alliance	**Association**	**# of Plants**
COLORADO PLATEAU ACTIVE AND STABILIZED DUNE ECOLOGICAL SYSTEM		
Artemisia filifolia Shrubland	*Artemisia filifolia – Ephedra* (*nevadensis, torreyana, viridis*) Sparse Shrubland	1,326
Artemisia filifolia Shrubland	*Juniperus osteosperma* / *Artemisia filifolia* Sparse Woodland	1
Coleogyne ramosissima – Ephedra nevadensis Shrubland	*Coleogyne ramosissima – Ephedra nevadensis* Dwarf- Shrubland	46
COLORADO PLATEAU BLACKBRUSH-MORMOM-TEA SHRUBLAND ECOLOGICAL SYSTEM		
Coleogyne ramosissima Shrubland	*Coleogyne ramosissima* Shrubland	75
COLORADO PLATEAU MIXED BEDROCK CANYON AND TABLELAND ECOLOGICAL SYSTEM		
Eriogonum corymbosum Sparsely Vegetated	*Eriogonum corymbosum – Ephedra nevadensis – Coleogyne ramosissima* Sandstone Slickrock Sparse Vegetation	240
	Total	**1,688**

Table 4-24 A Summary of *Phacelia mammalariensis* Survey Results by Geologic Formation	
Geologic Formation	**# of Plants**
COLORADO PLATEAU ACTIVE AND STABILIZED DUNE ECOLOGICAL SYSTEM	
Curtis Formation	1
Navajo Sandstone	15
Intermediate alluvial fan deposits	46
Steam-channel deposits	1,311
COLORADO PLATEAU BLACKBRUSH-MORMOM-TEA SHRUBLAND ECOLOGICAL SYSTEM	
Navajo Sandstone	75
COLORADO PLATEAU MIXED BEDROCK CANYON AND TABLELAND ECOLOGICAL SYSTEM	
Navajo Sandstone	230
Steam-channel deposits	10
Total	**1,688**

P. mammalariensis was found on multiple soils within the survey area. It was most commonly found on Needle-Sheppard complex soils. Table 4-25 provides a complete list of soils where *P. mammalariensis* was observed.

Much of the areas where *P. mammalariensis* was encountered exhibited signs of disturbance, particularly due to grazing. Localized areas that were less conducive to grazing, such as pockets occurring within slick rock, appeared to support higher densities of the species. Individuals were also encountered that displayed morphological characteristics intermediate between *P. mammalariensis* and *P. crenulata*, and thus, were not positively identified as *P. mammalariensis* and are not included in the presented tallies.

Table 4-25 A Summary of *Phacelia mammalariensis* Survey Results by Soil Type	
Soil Type	**# of Plants**
Pagina-Wahweap complex, 3 to 16 percent slopes	46
Needle-Sheppard complex, 2 to 12 percent slopes	1,321
Mido-Kenzo-Rock outcrop, Carmel Formation, complex, 2 to 30 percent slopes	1
Rock-outcrop-Needle complex, 4 to 50 percent slopes	230
Sheppard loamy fine sand, 5 to 15 percent slopes	90
Total	**1,688**

4.3.38.3 Discussion

A total of 1,688 *P. mammalariensis* individuals were encountered within the survey area. The species occurred predominantly at the far eastern end of the survey area at the Glen Canyon Substation, along the BPS-2 Transmission Line Alternative Reach, and within the Glen Canyon to Buckskin Transmission Line North Reach. *P. mammalariensis* was found growing most often within the Colorado Plateau Active and Stabilized Dune Ecological System, but also was encountered in sandy pockets in the Colorado Plateau Mixed Bedrock Canyon and Tableland Ecological System, and in sandsheets of the Colorado Plateau Blackbrush-Mormon-tea Shrubland Ecological System. The vast majority of plants were found in associations dominated by Artemisia filifolia, *Ephedra* spp., and *Eriogonum corymbosum*. The species was encountered most frequently on stream channel deposits and Navajo Sandstone, and commonly on soils of the Needle-Sheppard complex. *P. mammalariensis* is a GCNRA species of concern; however, no plants were located within GCNRA.

P. mammalariensis individuals were encountered at elevations ranging from 3,792 feet (1,156 meters) and 4,810 feet (1,466 meters), the lower range falling slightly below the recorded range. The species was encountered infrequently, and in few habitat types. Positive identification of individuals was challenging, as *P. mammalariensis* and *P. crenulata* are very similar in appearance, and appear to hybridize easily resulting in plants displaying intermediary characteristics. The highest density of individuals occurred in the vicinity of the Colorado River at Glen Canyon Dam, and decreased in abundance moving westward, as did the presence of definitive morphological characteristics. Near Flat Top and Upper Paria River, individuals were encountered with characteristics intermediate between *P. mammalariensis* and *P. crenulata*, and therefore a positive identification was not justified. The one individual found in the vicinity of Calf Springs was the furthest west that the species was confirmed to occur, although suitable habitat exists in much of the eastern survey area.

The survey observed that some of the encountered groups occurred in areas not as susceptible to grazing, particularly in sand pockets amongst slick rock. This suggests that pressures occurring in the area both historically and currently likely have resulted in diminishment of the species. Further disturbance resulting from project activities would be expected to add continued stress to existing groups. Invasive weeds were encountered in abundance in some of the most disturbed portions of this area, and although field observations and collected data do not provide much insight into the ability of the species to compete with invasive weeds, the introduction of invasive weeds resulting from the project would also likely result in additional pressure on the species.

Due to taxonomic confusion of the species and the occurrence of individuals displaying a range of intermediary characteristics, it is possible that the survey did not capture all existing groups of *P. mammalariensis* occurring within the survey area. As *P. mammalariensis* reproduces from seed, the number of individuals identified during the survey may represent relative distribution of the plant at various locations where *P. mammalariensis* is present within the seed bank. Additionally, it is likely that seed is present within adjacent habitats containing soils derived from the stream channel deposits, where localized climactic conditions may not have been conducive to germination prior to, or during the survey periods. Project construction activities could therefore include salvage and replanting of topsoil from habitats with the potential to contain viable *P. mammalariensis* seed. The presence of individuals identified within the Glen Canyon Substation, the BPS-2 Transmission Line Alternative reach, and the Glen Canyon to Buckskin Transmission Line North Reach, however, suggests that *P. mammalariensis* is present within the seed bank in localized areas immediately surrounding documented individuals and across suitable habitat within these reaches. Additionally, it is likely that seed is present within suitable habitats occurring from the areas of Colorado River at Glen Canyon Dam to Calf Springs and Upper Paria River. Within this area, wherever invasive weed invasions are lacking, topsoil containing potentially viable seed could be salvaged and re-used on site. Additionally, seed from at-risk individuals positively identified as *P. mammalariensis* could be collected prior to construction, and re-distributed as part of the re-vegetation efforts.

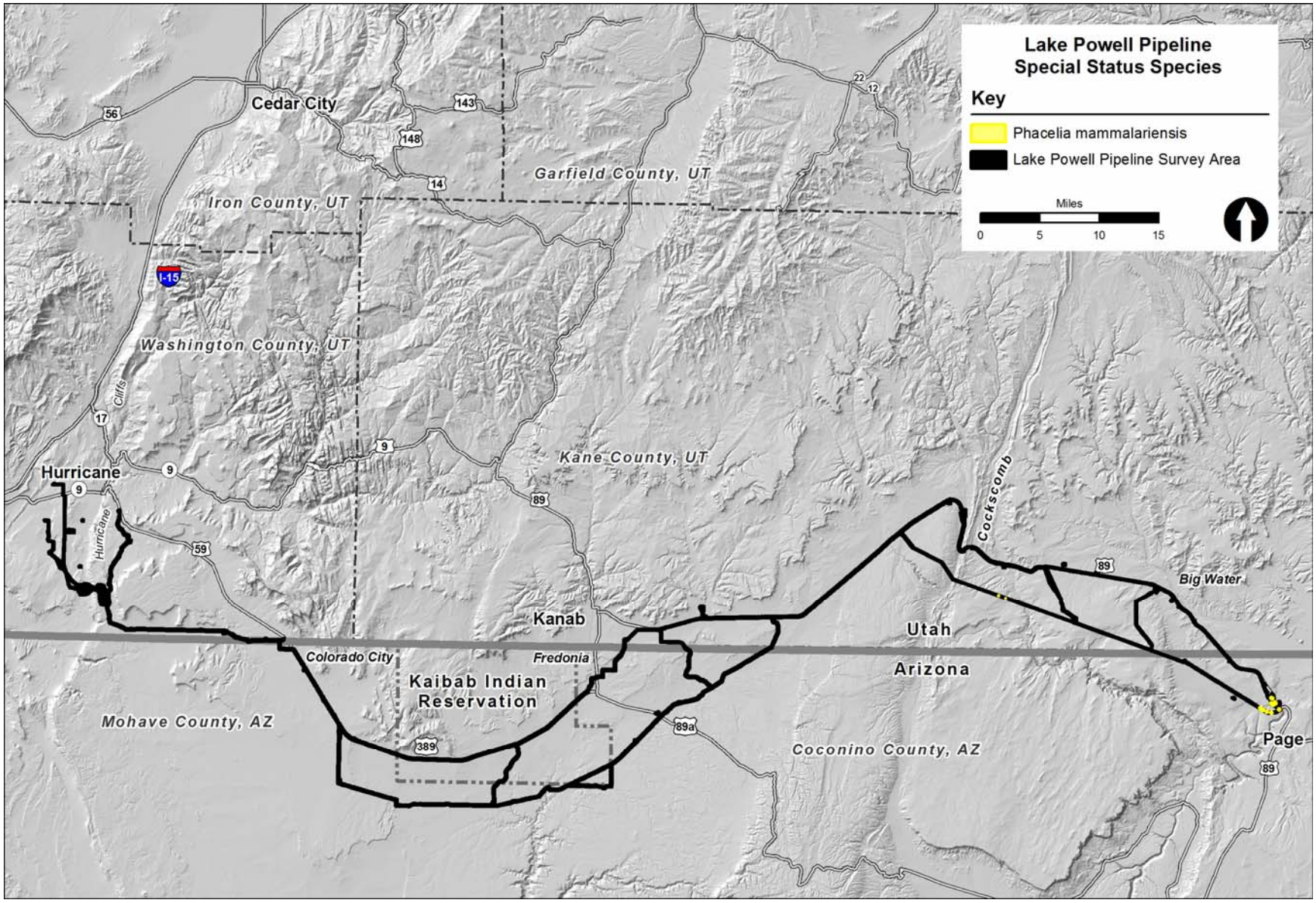

Figure 4-36
***Phacelia mammalariensis* Overview Map**

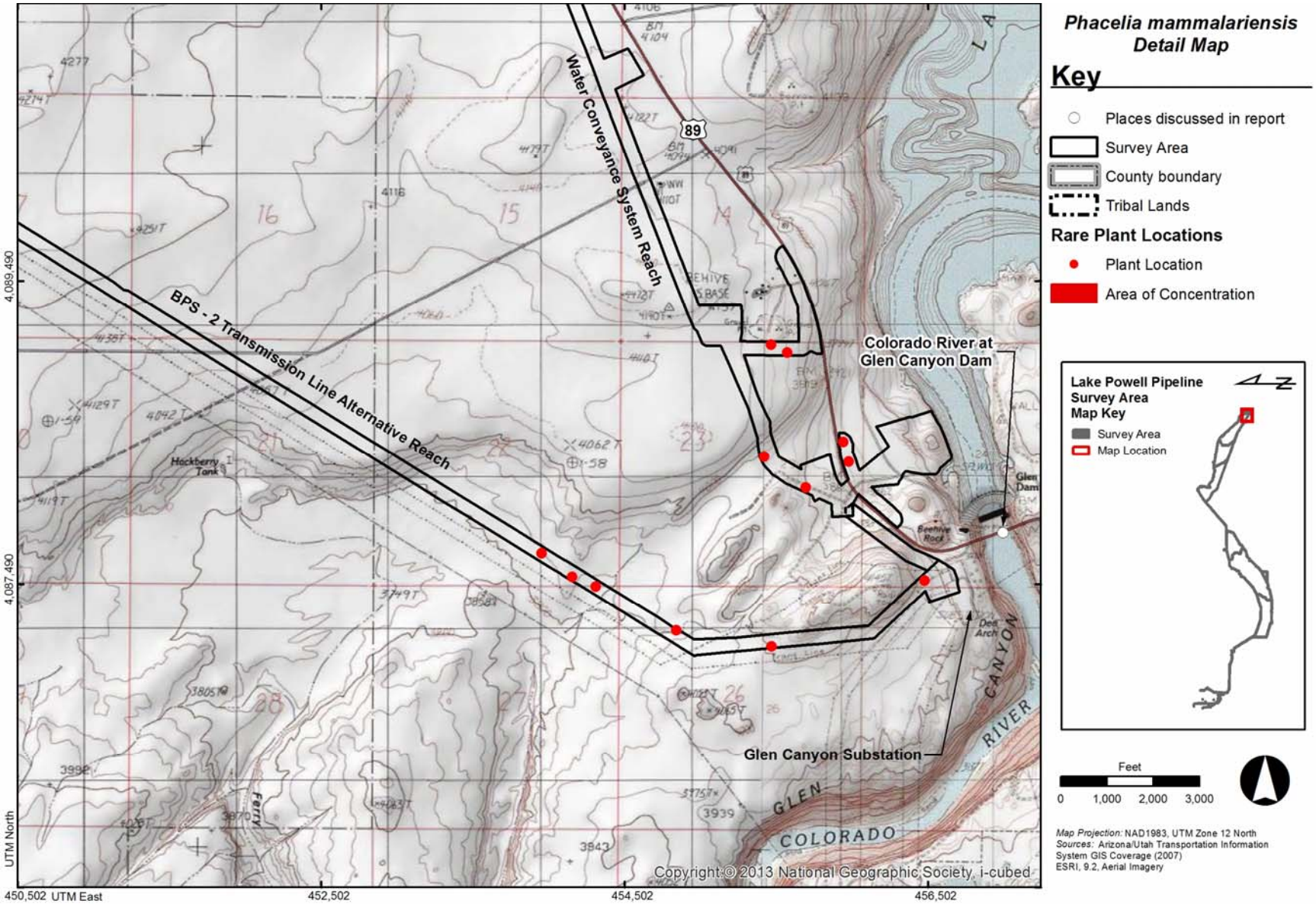

Figure 4-37
***Phacelia mammalariensis* Detail Map 1**

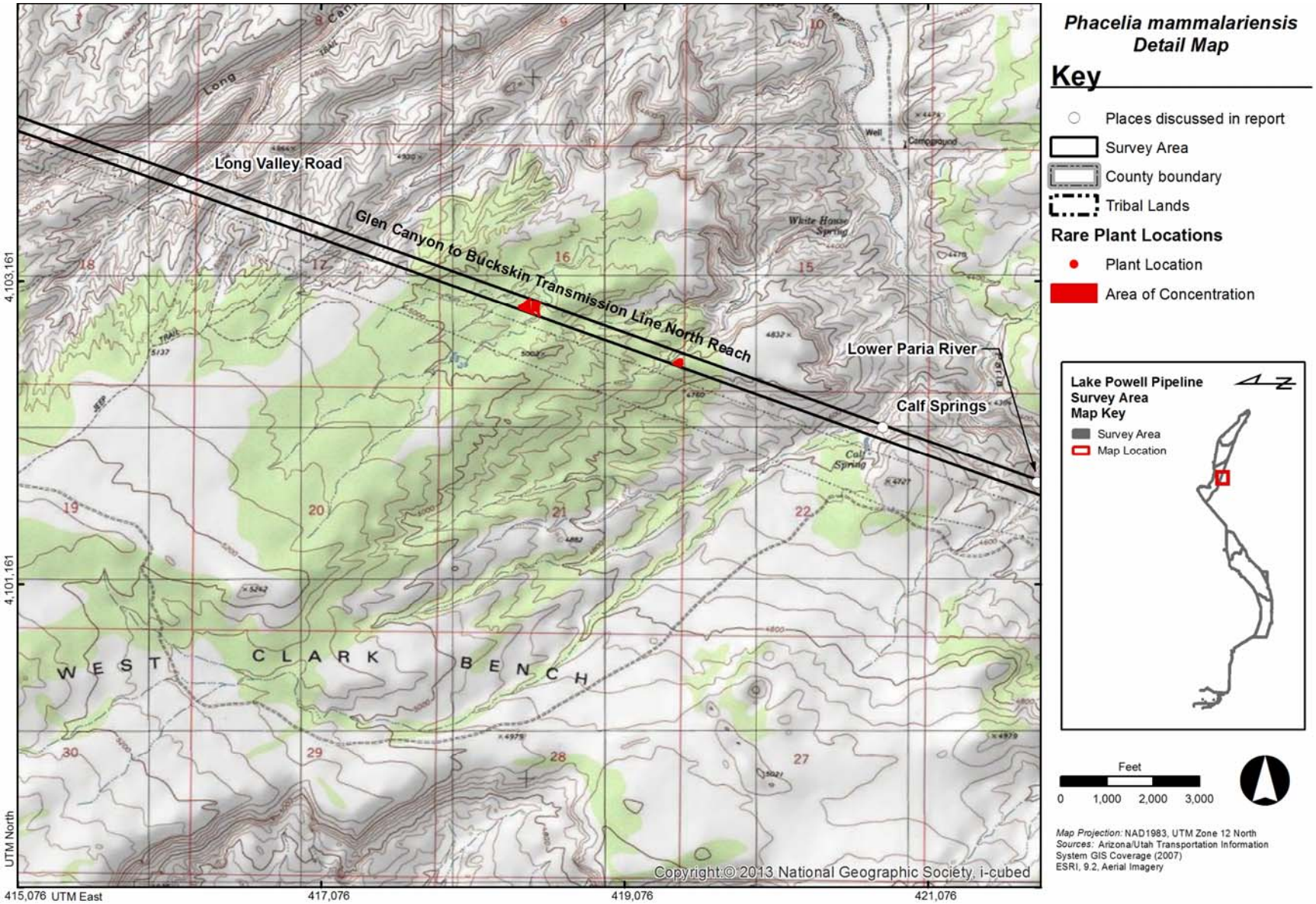

Figure 4-38
***Phacelia mammalariensis* Detail Map 2**

4.3.39 *Phacelia pulchella* var. *atwoodii* (Atwood's pretty phacelia)

4.3.39.1 Natural History

Phacelia pulchella var. *atwoodii* is an annual herb in the Hydrophyllaceae (Waterleaf Family), growing to between 2 inches (0.5 decimeters) and 8 inches (2 decimeters) tall. Succulent, leafy stems branch at the base, and are spreading to erect and finely glandular. Leaves are lobed to rounded, oval to obovate or ovate and simple. Flowers reach up to 0.4 inches (0.7 to 0.9 centimeters) long, bell-shaped, with violet to purple corollas and yellow tubes (Figure 4-39). Flowering occurs from April to May (UNPS 2003-08). Plants produce 28 to 50 oblong to elliptic seeds, each no more than 0.04 inches (0.5 to 1 millimeters) long, brown, and pitted (Welsh et al. 2003).

Figure 4-39
Close-up View of *Phacelia pulchella* var. *atwoodii*
Observed within the Survey Area

P. p. var. *atwoodii* is endemic to Kane County, Utah and is known from west of the Cockscomb to Petrified Hollow (Welsh et al. 2008). *P. p.* var. *atwoodii* occurs on thin gypsum soils within the Moenkopi Formation, or on alluvium contaminated by gypsum (Welsh et al. 2008). It is found in duff under junipers in pinyon-juniper, oak, sagebrush, single-leaf ash, and serviceberry communities from 5,085 feet (1,550 meters) to 5,510 feet (1,679 meters) elevation (UNPS 2008, Welsh et al. 2008).

P. p. var. *atwoodii* appears very similar to other varieties of *P. pulchella*, including var. *pulchella* and var. *gooddingii*. The varieties can be distinguished by leaf characteristics and geographic location. Welsh et al (2008) defines both var. *pulchella* and var. *atwoodii* as taxa with smooth or nearly smooth leaves, while the leaves of var. *gooddingii* are coarsely toothed. Also, while the leaves of var. *pulchella* are mostly less than 0.7 inches (1.8 centimeters) long, those of variety atwoodii are 0.7 (1.8 centimeters) to 1 inch (2.5 centimeters) long, and the leaves of var. *gooddingii* grow to between 1 inches (2.5 centimeters) and 1.4 inches (3.5 centimeters) long. The varieties are also geographically segregated, with only var. *atwoodii* occurring in Kane County, Utah.

4.3.39.2 Survey Results

P. p. var. *atwoodii* was encountered in two reaches, including: the Water Conveyance System, the Hydro System, the Hydro System High Point Alignment Alternative, the Hydro System South Alternative, and Eightmile Gap Road reaches. An estimated total of 1,351 individuals were encountered during the surveys, the majority of which occurred within the Hydro System South Alternative reach. The greatest density of individuals was identified in the area between the Shinarump Cliffs and White Sage Wash. All individuals were encountered on BLM lands, with the exception of a very small group of plants (five individuals) which was identified in both BLM and private lands. The distribution of *P. p.* var. *atwoodii* across the survey area is shown in Table 4-26 and Figure 4-41 through Figure 4-43.

Table 4-26
A Summary of *Phacelia pulchella* var. *atwoodii* Survey Results by Location

Reach	Location	Land Ownership	Estimated # of Plants Based on Density Calculations
Hydro System South Alternative	2.3 miles southwest of Shinarump Cliffs to 2.3 miles northeast of White Sage Wash	BLM	1,346*
Eightmile Gap Road	2.3 miles northwest of Johnson Wash	BLM and Private	5
		Total	1,351*

Note:
*Counts are estimates based on 50-meter transect densities

During 2009, counts of *P. p.* var. *atwoodii* were likely underestimated due to an overlap in morphological variability with other varieties. In some localities, the leaf margins of individuals were found to have a continuum of expressions, ranging from smooth and wavy to lobed or toothed, with the latter stated in UNPS (2003-08) to be characteristic of var. *pulchella*. While those individuals which exhibited toothed margins (approximately one-third of *P. pulchella* individuals encountered in some communities) were identified as var. atwoodii, at least some of the remaining individuals exhibiting intermediary characteristics were likely falsely identified as var. *pulchella*.

P. p. var. *atwoodii* was found within the Colorado Plateau Ecological Region, and occurred in a total of four ecological systems, three alliances, and six associations. *P. p.* var. *atwoodii* was found most often growing within the Colorado Plateau Shrub-Steppe Ecological System. The largest quantity of individuals was found in the *Gutierrezia sarothrae* Shrubland Alliance. The largest group was found in the *Gutierrezia sarothrae – (Opuntia spp.) / Pleuraphis jamesii* Sparse Dwarf-shrubland Association. All encounters were in associations dominated by native species, most often *Artemisia tridentata* ssp. *vaseyana*, *Eriogonum corymbosum*, *Gutierrezia sarothrae*, and/or *Juniperus osteosperma*. Individuals were found at elevations ranging from 4,980 feet (1,518 meters) to 5,620 feet (1,713 meters). All vegetation communities supporting *P. p.* var. *atwoodii* are shown in Table 4-27.

P. p. var. *atwoodii* was found on one geologic formation within the survey area: the Undivided Moenkopi Formation (Table 4-28).

Table 4-27 A Summary of *Phacelia pulchella* var. *atwoodii* Survey Results by Alliance and Association		
Alliance	**Association**	**Estimated # of Plants Based on Density Calculations**
COLORADO PLATEAU BIG SAGEBRUSH SHRUBLAND ECOLOGICAL SYSTEM		
Artemisia tridentata ssp. *vaseyana* Shrubland	*Artemisia tridentata* ssp. *vaseyana* / Sparse Understory Shrubland	1
Artemisia tridentata ssp. *vaseyana* Shrubland	*Artemisia tridentata* ssp. *vaseyana* Shrubland	9
COLORADO PLATEAU GYPSUM BADLANDS ECOLOGICAL SYSTEM		
Artemisia tridentata ssp. *vaseyana* Shrubland	*Artemisia tridentata* ssp. *vaseyana* Gypsum Badlands Sparse Shrubland	4
COLORADO PLATEAU MIXED DESERT SCRUB ECOLOGICAL SYSTEM		
Cylindropuntia echinocarpa Shrubland	*Cylindropuntia echinocarpa* Sparse Shrubland	12
COLORADO PLATEAU SHRUB-STEPPE ECOLOGICAL SYSTEM		
Gutierrezia sarothrae Shrubland	*Gutierrezia sarothrae* – (*Opuntia* spp.) / *Pleuraphis jamesii* Dwarf-shrubland	3
Gutierrezia sarothrae Shrubland	*Gutierrezia sarothrae* – (*Opuntia* spp.) / *Pleuraphis jamesii* Sparse Dwarf-shrubland	1,322*
	Total	**1,351***
Note: *Counts are estimates based on 50-meter transect densities		

Table 4-28 A Summary of *Phacelia pulchella* var. *atwoodii* Survey Results by Geologic Formation	
Geologic Formation	**Estimated # of Plants Based on Density Calculations**
COLORADO PLATEAU BIG SAGEBRUSH SHRUBLAND ECOLOGICAL SYSTEM	
Undivided Moenkopi Formation	10
COLORADO PLATEAU GYPSUM BADLANDS ECOLOGICAL SYSTEM	
Undivided Moenkopi Formation	4
COLORADO PLATEAU MIXED DESERT SCRUB ECOLOGICAL SYSTEM	
Undivided Moenkopi Formation	12*
COLORADO PLATEAU SHRUB-STEPPE ECOLOGICAL SYSTEM	
Undivided Moenkopi Formation	1,325*
Total	**1,351***
Note: *Counts are estimates based on 50-meter transect densities	

P. p. var. *atwoodii* were found on four soil types within the survey area. The majority of individuals occurred on Clayhole silty clay loam soils. The species was often identified in association with well-developed cryptobiotic crusts. *P. p.* var. *atwoodii* often occurred on mounds with cryptobiotic crusts. A summary of *P. p.* var. *atwoodii* occurrences by soil type is provided in Table 4-29.

Table 4-29
A Summary of *Phacelia pulchella* var. *atwoodii* Survey Results by Soil Type

Soil Type	Estimated # of Plants Based on Density Calculations
Barx gravelly loam, 1 to 6 percent slopes	3
Clayhole silty clay loam, 1 to 5 percent slopes	1,256*
Manikan silty clay loam, 1 to 3 percent slopes	90*
Torriorthents, 3 to 50 percent slopes	2
Total	**1,351***

Note:
*Counts are estimates based on 50-meter transect densities

4.3.39.3 Discussion

The survey identified an estimated 1,351 individuals of *P. p.* var. *atwoodii* within the survey area. The species occurred in a total of two reaches: Hydro System South Alternative and Eightmile Gap Road. *P. p.* var. *atwoodii* was documented in four ecological systems, three alliances, and six associations. Most commonly, the species was encountered in Colorado Plateau Shrub-Steppe Ecological System (Figure 4-40) in vegetation communities dominated or co-dominated by *Artemisia tridentata* ssp. *vaseyana*, *Eriogonum corymbosum*, *Gutierrezia sarothrae*, or *Juniperus osteosperma*. All encounters occurred on BLM lands, with the exception of one small group that occurred on a combination of BLM and private lands. The species was primarily found on the Undivided Moenkopi Formation, and in Clayhole silty clay loam soils. *P. p.* var. *atwoodii* was often observed in association with well-developed cryptobiotic crusts, and occasionally underneath shade-providing nurse shrubs. While many of these areas were disturbed, localized disturbance to the preferred microhabitats supporting *P. p.* var. *atwoodii* appeared to be minimal.

P. p. var. *atwoodii* was found in relatively high densities along the Hydro System South Alternative reach in the area between the Shinarump Cliffs and White Sage Wash. When the survey crew encountered high-density localities, rather than counting individuals, the species was noted as present and assigned a relative abundance within each vegetation community. After the initial survey, 50-meter transects were conducted in representative vegetation where *P. p.* var. *atwoodii* was observed. During data analysis, counts for *P. p.* var. *atwoodii* were extrapolated using the 50-meter transect densities and the acreages for each vegetation community where *P. p.* var. *atwoodii* was observed. Field knowledge of the expected densities of the species relative to each vegetation community was utilized to weight the extrapolated quantities across vegetation communities by relative abundance.

This method presents some discrepancies. For instance, *P. p.* var. *atwoodii* was often observed on specific microhabitats of cryptobiotic soils in gypsum badlands. Often these microhabitats existed within a larger vegetation community, and survey crews were unable to capture the boundaries or acreages of the microhabitats within the vegetation community. This could lead to *P. p.* var. *atwoodii* densities being applied to the greater acreages of the vegetation community instead of the more specific acreage of the plant's actual boundary within the microhabitat. Another discrepancy is not all abundances (or densities) and vegetation communities were sampled using 50-meter transects. For example, 50-meter transects were established in *Artemisia tridentata* ssp.

vaseyana Sparse Understory Shrubland where the abundance of *P. p.* var. *atwoodii* was occasional, but a 50-meter transect was not established in the same community where *P. p.* var. *atwoodii* was noted as rare. It should be noted that although the exact number of *P. p.* var. *atwoodii* cannot be determined this way, the counts represented in Table 4-26 through Table 4-29 are still good indicators of the importance of the habitats, geological formations and soil types supporting *P. p.* var. *atwoodii* within the survey area. This method still provides the relative distribution of the plant within the survey area where *P. p.* var. *atwoodii* is present within the seed bank.

Figure 4-40
View of *Phacelia pulchella* var. *atwoodii* Habitat within the Survey Area

P. p. var. *atwoodii* was only encountered in vegetation communities dominated or co-dominated by native species. Although invasive weeds were also found in these communities, field observations suggest that invasive weed species are not well adapted to gypsum badlands, as any invasive weeds encountered in gypsum badland habitat were observed at low densities. However, disturbance to this habitat would be expected to foster the destruction of cryptobiotic soils and the introduction of invasive weeds. Invasive weed species commonly encountered within the survey area, and expected to be further dispersed as a result of project activities, particularly *Bromus Rubens*, *B. tectorum*, and *Erodium cicutarium*, would, once introduced, likely compete with *P. p.* var. *atwoodii* for resources. In addition to its preferred gypsum soils, the species was also encountered on alluvial lands, where clay and silty-clay deposits have occurred through sheet-flow. This process likely distributes its seeds across the landscape, depositing the species into new habitats and extending the boundaries of the group, and suggests that the species is tolerant of disturbance. While this may illustrate the ability of *P. p.* var. *atwoodii* to colonize in disturbed soils, the frequency and density of the resulting groups was observed to be less than those observed in gypsum badland habitat. The species was also found on occasion in association with shade-providing nurse plants; thus, the elimination of nurse-shrubs as a result of project activities should also result in an impact on the species.

As *P. p.* var. *atwoodii* reproduces from seed, the number of individuals identified during the survey may represent relative distribution of the plant at various locations where *P. p.* var. *atwoodii* is present within the seed bank. Additionally, it is likely that seed is present within adjacent habitats containing soils derived from the Middle Red Member of the Moenkopi Formation, where localized climatic conditions may not have been conducive to germination prior to, or during the survey periods. Project construction activities could therefore include salvage and replanting of topsoil from habitats with the potential to contain viable *P. p.* var. *atwoodii* seed. The presence of individuals identified along the Hydro System South Alternative and Eightmile Gap Road reaches, however, suggests that *P. p.* var. *atwoodii* is present within the seed bank in localized areas immediately surrounding documented individuals and across suitable habitat within these reaches. Additionally, it is likely that seed is present within gypsum badlands and in habitats with mineral soils occurring throughout these reaches, where localized climactic conditions may not have been conducive to germination prior to, or during the survey periods. Project construction activities could therefore include salvage and utilization of topsoil from habitats with the potential to contain viable seed. Pipeline and transmission line access road routing through gypsum badlands with known special status plants may be avoided when an adjacent alternative across alluvial soils is available.

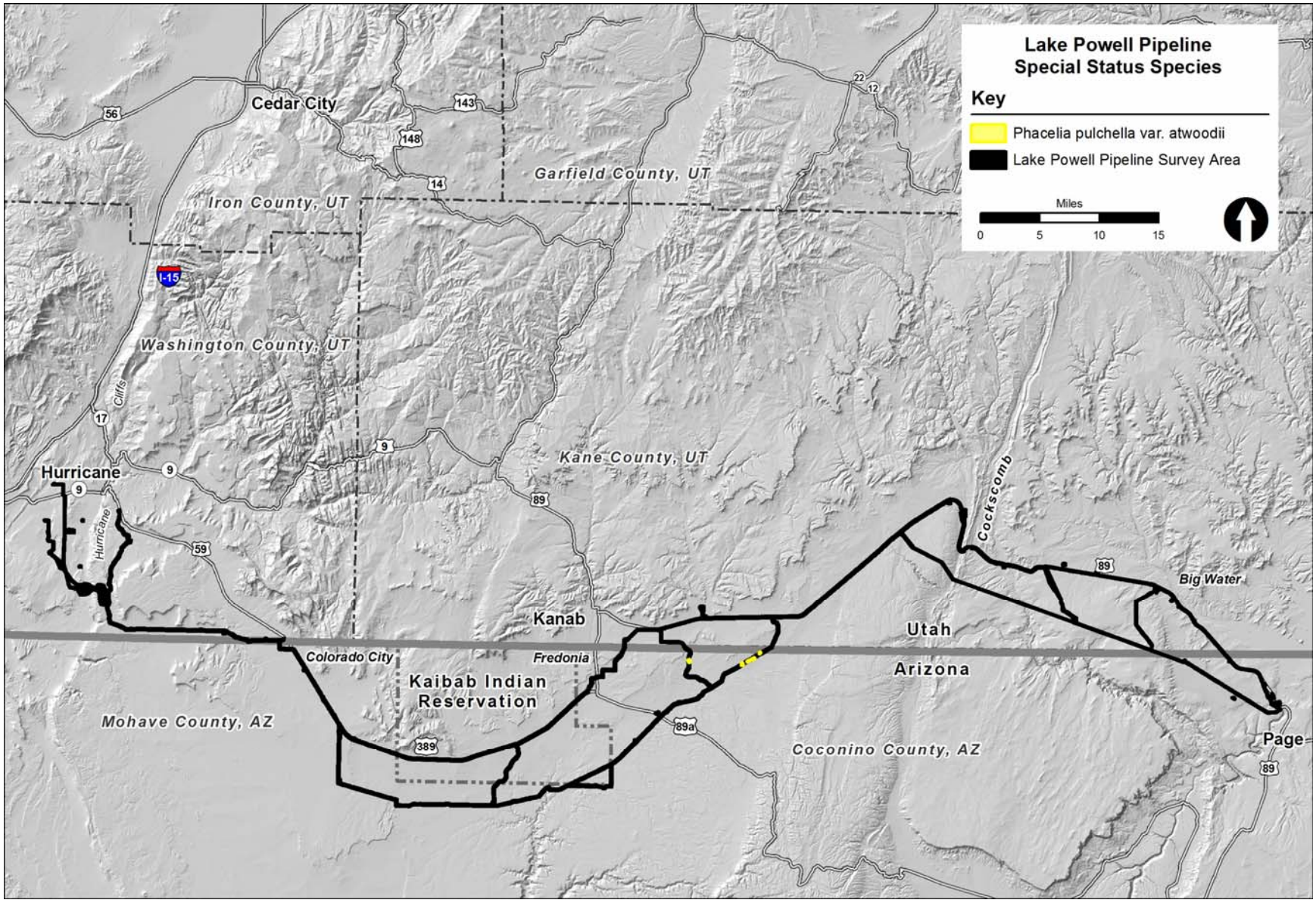

Figure 4-41
***Phacelia pulchella* var. *atwoodii* Overview Map**

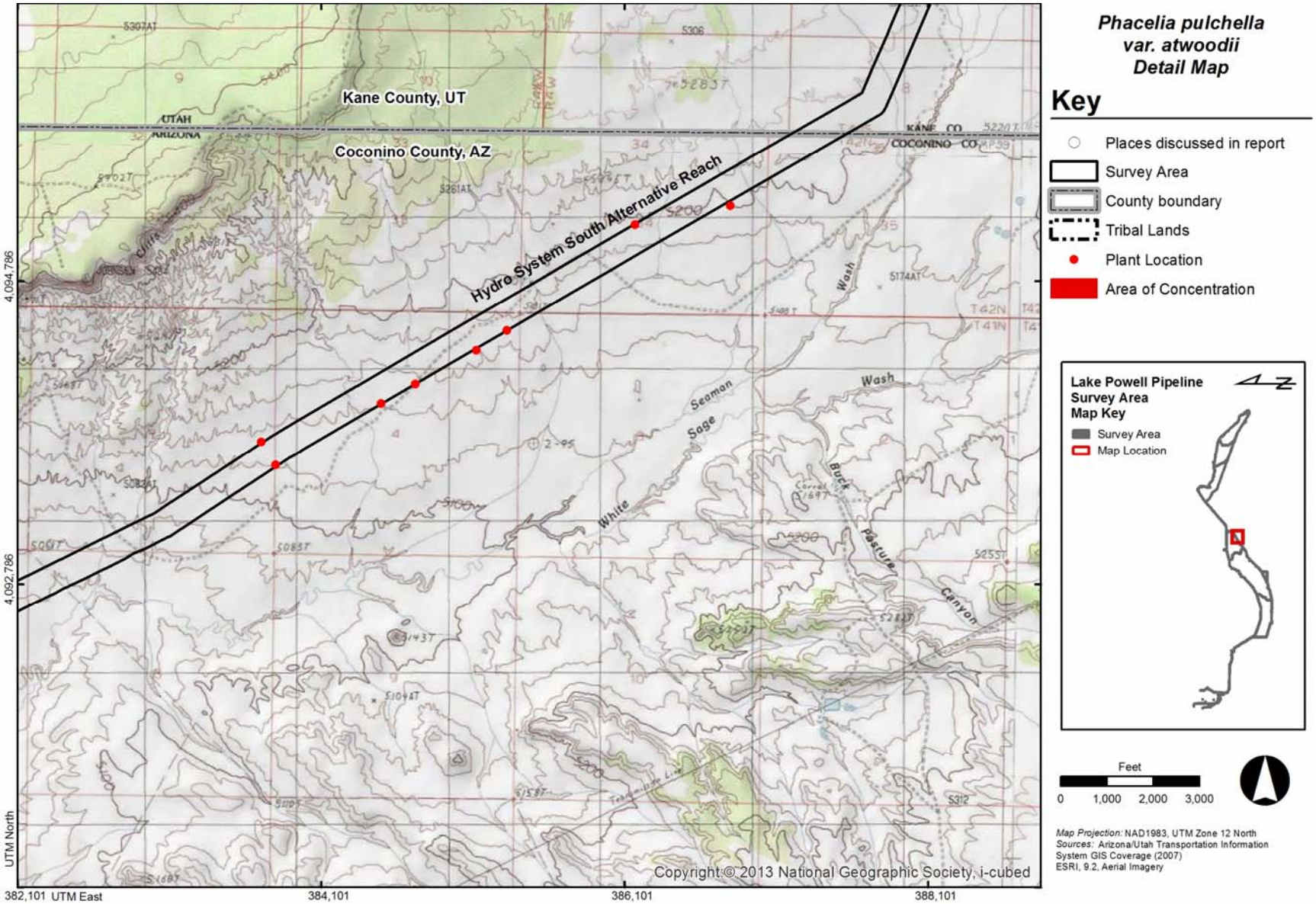

Figure 4-42
***Phacelia pulchella* var. *atwoodii* Detail Map 1**

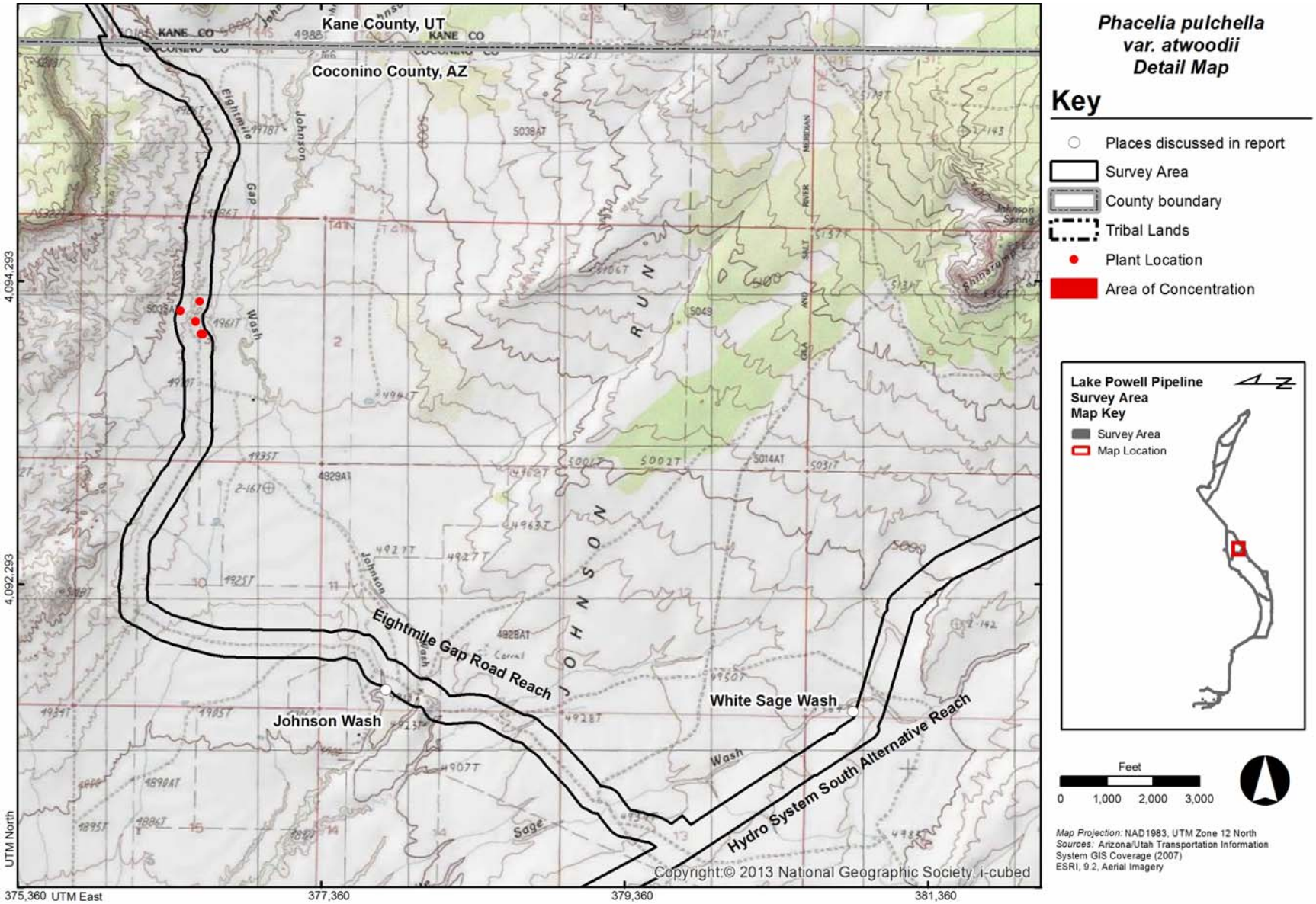

Figure 4-43
***Phacelia pulchella* var. *atwoodii* Detail Map 2**

4.3.40 *Pinus ponderosa* (Ponderosa pine)

4.3.40.1 Natural History

Pinus ponderosa is a large, evergreen tree in the Pinaceae (Pine Family) reaching 60 feet (20 meters) to 130 feet (30 meters) tall. Thick bark covers the tree and is reddish brown with deep grooves. Deep green leaves occur in clusters of three at the end of branches and are 3 inches (8 centimeters) to 4 inches (10 centimeters) long. Two types of cones are found on *P. ponderosa*: the female cone, or seed cone, and the male cone, or pollen cone. Seed cones are reddish brown and grow 2.75 inches (7 centimeters) to 9 inches (15 centimeters) long, with a small prickle at the tip of each scale. Pollen cones appear in small clusters at the ends of branches, are orange or yellow, and only reach 0.6 inches (1.5 centimeters) to 1.4 inches (3.5 centimeters) long. Flowering occurs in the first year between April and June. In the second year, between August and September, cones mature and shed winged seeds.

P. ponderosa is found throughout the western United States from Texas to North Dakota and California to Washington and north through British Columbia. The species occurs in all counties in Utah except Box Elder, Cache, Davis, Morgan, Rich, Salt Lake, and Wasatch (Welsh et al. 2008). In Arizona, *P. ponderosa* is found in all counties except Greenlee, Pinal, Yuma, and La Paz (USDA Plants Database 2010). Trees occur as pure stands or in mixed conifer forests on mountains (Wennerberg 2004). The species occurs in mountain brush, ponderosa pine, aspen, spruce-fir, and lodgepole pine communities in Utah (Welsh et al. 2003). In Arizona, *P. ponderosa* occurs in white fir, Rocky Mountain Douglas-fir, blue spruce, and gamble oak at higher elevations and alligator juniper and Utah juniper at lower elevations. Elevation ranges from 5,200 (1,585 meters) to 8,810 feet (2,685 meters) in Utah and 5,500 (1,680 meters) to 8,000 feet (2,440 meters) in Arizona.

4.3.40.2 Survey Results

P. ponderosa was not encountered during project surveys.

4.3.40.3 Discussion

Based on field surveys, there is no potential of *P. ponderosa* to occur within the survey area. No further surveys are warranted within the survey area for this plant.

4.3.41 *Pseudotsuga menziesii* (Douglas fir)

4.3.41.1 Natural History

Pseudotsuga menziesii is a medium to large, evergreen tree in the Pinaceae (Pine Family) reaching 65 to 100 feet (20 to 30 meters) tall. Bark is smooth on younger trees but becomes deeply furrowed and blackish to dark gray on mature trees (Welsh et al. 1993). Long, flat, needle leaves are 0.6 to 1.4 inches (15 to 35 millimeters) long and vary in color, from dark green, yellow-green, or green-blue (Sibley 2009). Two types of cones are found on *P. menziesii*: the female cone, or seed cone, and the male cone, or pollen cone. Seed cones are brown or reddish brown and grow 1.6 to 2.4 inches (4 to 6 centimeters) long, with roundish scales. Pollen cones are orange red and only reach 0.2 to 0.3 inches (5 to 8 millimeters) long (Welsh et al. 1993). Cones typically open in April with pollination occurring until June. Seeds develop until late August and are shed in September, although timing of phonological events may vary depending on weather, elevation, and latitude (Steinberg 2002).

P. menziesii is common and wide spread from British Columbia south through eastern Washington and eastern Oregon to central Idaho, western Wyoming, and western Montana. It is restricted by mountain topography in Utah, Nevada, Colorado, New Mexico, and in northern and central Mexico (Steinberg 2002). Across its range, *P. menziesii* is found in coniferous or mixed forests from approximately 1,970 to 9,840 feet (600 to 3,000 meters) (eFloras 2010). In Utah, this species is common in many areas of the state, though larger trees are missing in

heavily logged sites (Welsh et al. 1993). In Arizona, stands of *P. menziesii* cover large areas in the Huachuca, Rincon, Santa Rita, Santa Catalina, Chiricauhua, Graham, Santa Teresa, Winchester, and Galiru mountains (Steinberg 2002). In Utah, trees occur in pure, even-aged stands on moist north-facing slopes from 5,000 and recorded up to 10,000 feet (1,525 to 3,050 meters) in elevation in *Abies concolor*, *Populus* spp., and *Picea-Abies* communities (Welsh et al. 1993). In Arizona, *P. menziesii* occurs in large stands with *Pinus ponderosa*, and with *Picea pungens* and *Picea engelmanni* in cool, moist habitats (Steinberg 2002).

4.3.41.2 Survey Results

P. menziesii was not encountered during project surveys.

4.3.41.3 Discussion

P. menziesii was considered as having potential to occur at the Henrieville substation. This area was surveyed in 2010, but no *P. menziesii* were encountered. No further surveys are warranted within the survey area for this plant.

4.3.42 *Psorothamnus thompsoniae* var. *whitingii* (Whiting's dalea)

4.3.42.1 Natural History

Psorothamnus thompsoniae var. *whitingii* is small round shrub in the Fabaceae (Pea Family) reaching 16 to 36 inches (40 to 90 centimeters) tall. The stems and branches are covered with velvety, downward angled hairs and yellow to orange red resinous glands. Short leaf stems bare 7 to 17 pairs of leaflets, each 0.08 to 0.28 inches (2 to 7 millimeters) long (AGFD 1992). Sharp, stiff, straight hairs are found below each leaf. The top of each leaf may or may not be covered with hairs, but is covered in small glands (Welsh et al. 1993). The bright pink or violet-purple flowers are clustered loosely. Petals are 0.24 to 0.34 inches (6 to 8.4 millimeters) long and the calyx bears large red-orange glades and is covered in shaggy hairs. Flowering occurs between May and August (AGFD 1992).

P. t. var. *whitingii* is found only in San Juan County, Utah and Coconino, Apache, and Navajo counties, Arizona from 1,159 to 1,525 meters (3,800 to 5,000 feet) in elevation across its entire range (UNPS 2003-2008, AGFD 1992). In Utah, it occurs in mixed desert shrub communities in sandy soils (UNPS 2003-2008). In Arizona, *P. t.* var. *whitingii* occurs in Great Basin desert scrub communities on sandy- clay banks and talus, gravelly or sandy washes (AGFD 1992).

Psorothamnus thompsoniae var. whitingii is distinguished by its velvety branches covered in yellow to orange resinous glands (AGFD 1992). The leaflets and calyx tubes distinguish *P. t.* var. *whitingii* from *P. t.* var. *thompsoniae*. The leaves of *P. t.* var. *whitingii* are linear while the leaves of *P. t.* var. *thompsoniae* are more oval. The calyx tube of *P. t.* var. *whitingii* is covered in shaggy hairs while the calyx tube of P. t. var. thompsoniae is hairless (Welsh et al. 1993).

4.3.42.2 Survey Results

P. t. var. *whitingii* was not encountered during project surveys.

4.3.42.3 Discussion

Potentially suitable habitat for *P. t.* var. *whitingii* was thoroughly surveyed. However, *P. t.*var. *Whitingii* was not encountered. No further surveys are warranted within the survey area for this plant.

4.3.43 *Ptelea trifoliata* ssp. *pallida* (Hoptree)

4.3.43.1 Natural History

Ptelea trifoliata ssp. *pallida* is a perennial shrub from the Rutaceae (Rue Family) up to 20 feet (6 meters) tall with a broad crown. The twigs of this subspecies are pale and smooth and leaves have 3 linear lance-shaped to oblong-lance-shaped leaflets that are deeply lobed compound. Leaflets are toothed or smooth, shiny dark green above and paler below. Flowers are small and clustered with greenish white petals appearing in April. The fruit is a wafer-like samara with broad wings.

P. trifoliata occurs in Arizona, Utah, Colorado, New Mexico, Oklahoma, and Texas (Natureserve 2010). Two subspecies occur in Utah; *P. t.* ssp. *pallida*, is indigenous and occurs rarely in southern Utah, and *P. t.* ssp. *trifoliata*, is a cultivated ornamental. *P. t.* ssp. *pallida* is found along canyons in Garfield, Kane, and Washington counties, Utah (Welsh et al. 2008). It should be sought near Kanab and possibly persists in Glen Canyon along the shores of Lake Powell. In Arizona, it is known from Mohave County and is plentiful on limestone (Welsh et al. 2008).

4.3.43.2 Survey Results

A suspected *P. t.* ssp. *pallida* was observed in lower Kanab Creek, south of the Kaibab Indian Reservation. This individual was observed 340 feet (104 meters) north of the area, thus outside the survey area. It was growing at the base of the canyon walls, although it could not be determined if it was *P. t.* ssp. *pallida* or *P. t.* ssp. *trifoliata*. This plant was located at UTM Zone 12S 357895mE and 4076768mN, NAD 83.

4.3.43.3 Discussion

Suitable limestone habitat for *P. t.* ssp. *pallida* is very limited within the survey area at the Judd Hollow drainage near Cedar Mountain. These drainages were investigated during the 2010 survey season. No further surveys are warranted within the survey area for this plant.

4.3.44 *Rosa stellata* var. *abyssa* (Grand Canyon rose)

4.3.44.1 Natural History

Rosa stellata var. *abyssa* (Grand Canyon rose) is an armed woody shrub from the Rosacea (Rose Family) with stiff upright stems 0.8 feet (2.5 decimeters) to 4.9 feet (15 decimeters) long. Stems are glandular with tiny, stiff white spines. Leaves have 3 to 5 wedge-shaped leaflets 0.2 inches (0.5 centimeters) to 0.5 inches (1.2 centimeters) long that are rounded at a broad apex, turning red in the fall. Flowers are terminal and solitary with dark pink petals and a densely bristled hypanthium. Fruits are greenish-brown and spiny. Flowering occurs late July to August, with fruiting in August (ARPC 2001).

R. s. var. *abyssa* is currently known from the rims of the Grand Canyon and Kanab Canyon, and at the junction of the Little Colorado River and Big Canyon in northern Arizona (AGFD 2005). *R. s.* var. *abyssa* inhabits gravelly soils derived from Timpoweap Kaibab limestone on or near canyon rims and along edges of mesas or plateaus. The species is found in Great Basin conifer woodland or scrub from 4,500 feet (1,372 meters) to 7,500 feet (2,286 meters) elevation (ARPC 2001).

4.3.44.2 Survey Results

R. s. var. *abyssa* was not encountered during project surveys.

4.3.44.3 Discussion

The only potential location where *R. s.* var. *abyssa* could be found within the survey area is at the Kanab Creek crossing south of the Kaibab Indian Reservation. Intensive survey of the area did not locate this plant. No further surveys are warranted within the survey area for this plant.

4.3.45 *Salvia columbariae* var. *argillacea* (Chinle chia)

4.3.45.1 Natural History

Salvia columbariae var. *argillacea* (Chinle chia) is a branching annual from the Lamiaceae (Mint Family) with stems reaching 3.5 inches (0.9 decimeters) to 14.6 inches (3.7 decimeters) tall. Leaves are oblong-ovate, in toothed or incised divisions. Leaf-like structure below the flower is split into two parts each up to 0.1 inches (1.5 millimeters) in length. Flower structure is green, sometimes blushed with purple. Flowers appear mid-May to mid-June; petals are white.

Endemic to western Kane and eastern Washington counties, Utah (UNPS 2003-08), *S. c.* var. *argillacea* inhabits sparsely vegetated pinyon-juniper woodlands where it is associated with *Oenothera murdockii*, *Phacelia cephalotes*, *Eriogonum subreniform*, *Molucella*, and *Astragalus ampullarius* (NatureServe 2009). The species is restricted to saline-clay silts and gypsum knolls of the Chinle formation at elevations from 4,250 feet (1,295 meters) to 5,600 feet (1,707 meters) (UNPS 2003-08).

4.3.45.2 Survey Results

S. c. var. *argillacea* was not encountered during project surveys.

4.3.45.3 Discussion

All potentially suitable habitat for *S. c.* var. *argillacea* was surveyed during the survey seasons with the exception of private lands discussed with *Astragalus ampullarius*. The Cedar Ridge site does not support the vegetative components preferred by *S. c.* var. *argillacea*. The vegetative and geological components preferred by *S. c.* var. *argillacea* are present at the Kanab site. This site also falls within the elevation range for *S. c.* var. *argillacea*, thus there is a high potential of finding *S. c.*var. *Argillacea* if permission to access the Kanab site is obtained in the future.

4.3.46 *Sclerocactus sileri* (Paria Plateau fishhook cactus)

4.3.46.1 Natural History

Sclerocactus sileri is a perennial succulent from the Cactaceae (Cactus Family) with 1 to 2 green, depressed spherical stems. This cactus has 13 underdeveloped ribs with 0.3 inches (0.7 centimeter) to 0.5 inches (1.2 centimeter) long tubercles, or protrusions. Four central spines, turned or curving downward, are 0.5 inches (1.2 centimeters) to 1.2 inches (3 centimeters) long. The lower central spine is white, gray or tinged purple, angled, and strongly hooked. The upper central spine is white to tan, strongly flattened, conspicuous, and erect. The cactus has six to eight needle-shaped radial spines. Flowers have a hairless exterior floral tube. Outer tepals have brownish/yellowish margins while inner tepals are yellow, suffused with brown. Flowers appear in April and May. Fruits are green, appearing from May to June (ARPC 2001).

S. sileri is known from House Rock Valley and the Paria Plateau in Coconino County, Arizona (AGFD 2003). *S. sileri* inhabits sandstone to sandy soil of the Moenave, Chinle, and Navajo formations along pinyon-juniper mesa tops (ARPC 2001). Plant communities in which this cactus often occurs include *Sporobolus*, *Yucca*,

Echinocereus, *Artemisia*, *Gutierrezia*, *Pinus edulis*, and *Juniperus* (AGFD 2003). Specimens have been recorded from 5,000 feet (1,524 meters) to 6,300 feet (1,920 meters) elevation.

4.3.46.2 Survey Results

S. sileri was misidentified when it was encountered along the Cockscomb and east of Glen Canyon City during the 2009 survey season. None of the *Sclerocactus* observed during surveys were in bloom, a key feature in distinguishing *S. sileri* from similar species, *S. parviflora*. It was correctly identified with help from Dr. Kim Anderson, an ecologist from the Gran Grand Staircase-Escalante National Monument, and the location of a cactus bearing dried flower ruminants during a follow up visit in 2010.

4.3.46.3 Discussion

Tentative identification of *S. sileri* from the Cockscomb in 2009 was found to be incorrect upon reexamination of the site in 2010. Dr. Kim Anderson reported that violet flowers identify the specimen as *S. parviflora* rather than *S. sileri*. One plant relocated in 2010 still had enough of its flower evident to make a positive determination it was violet, rather than the yellow of the local *Pediocactus sileri*.

4.3.47 *Sisyrinchium demissum* (Blue-eyed grass)

4.3.47.1 Natural History

Sisyrinchium demissum is a perennial herb the Iridaceae (Iris Family) growing in tufts and reaching 2.8 inches (0.7 decimeters) to 15.7 inches (4 decimeters) tall (Welsh et al. 1993). Basal leaves turn light green to olive as they dry, are often hairless, and entire or sharply toothed. 1 to 7 flowers are borne on a hairless or glandular with minute, short, downy hairs stalk (eFlora 2010). The calyx and corolla are pale to dark blue, even white, with a yellow center ending in an abrupt slender tip (Welsh et al. 1993). Flowers appear in mid-spring through early fall (eFlora 2010), or June to September in Arizona (Kearney and Peebles 1960).

S. demissum is known from Utah, Nevada, Arizona, New Mexico, Texas, and northern Mexico (eFlora 2010). In Utah, it is found in Beaver, Carbon, Duchesne, Garfield, Iron, Juab, Kane, Millard, Piute, San Juan, Sevier, Tooele, Uintah, Utah, Washington, and Wayne counties (Welsh et al. 1993). In Arizona, *S. demissum* is known from Apache and northern Greenlee counties to Coconino and Yavapai counties (Kearney and Peebles 1960). In Utah, this species is found in seeps, springs, wet meadows, and stream banks, often with a high saline content, at elevations from 2,790 feet (850 meters) to 7,800 feet (2,380 meters) (Welsh et al. 1993), and in Arizona in wet meadows and springs at elevations from 5,000 feet (1,525 meters) to 9,500 feet (2,895 meters) (Kearney and Peebles 1960).

Diagnostic features of *S. demissum* completely overlap with those features of *S. idahoense*. It is not always possible to identify a specimen as either species with complete certainty (Welsh et al. 1993).

4.3.47.2 Survey Results

S. demissum was not encountered during project surveys.

4.3.47.3 Discussion

No seeps or hanging gardens were encountered within the survey area. All potentially suitable springs were investigated during the 2010 survey season. No further surveys are warranted within the survey area for this plant.

4.3.48 *Sphaeralcea gierischii* (Gierisch globemallow)

4.3.48.1 Natural History

Sphaeralcea gierischii is a perennial from the Malvaceae (Mallow Family) that grows from a woody underground base. Stems are dark red-purple, reach 1.4 feet (4.3 decimeters) to 3.4 feet (10.3 decimeters) tall, and are sparingly leafy. Leaves on the lower portion of the stems are large, with an elongated central lobe. Herbage is bright green with sparse stellate pubescence on the margins. Leaf blades are oval-shaped to heart-shaped, 3 to 5-lobed, with the main division being smooth or cleft or parted to irregularly tooth. An open flower structure usually has more than 1 flower per node or is grouped with two to five flowers occurring on axillary stalks. Petals are 0.5 inches (1.5 centimeters) to 1 inches (2.5 centimeters) long and orange.

Seven known groups of *S. gierischii* inhabit an area less than 60 acres in Utah and Arizona, combined (USFWS 2005). The species occurs in Washington County, Utah with the main groups occurring in Arizona south of the Black Knolls, in Black Rock Gulch, and in Pigeon Canyon (AGFD 2003). *S. gierischii* is found in warm desert shrub communities sparsely scattered on gypsiferous outcrops of the Harrisburg Member of the Kaibab Formation. The species is often associated with *Atriplex* sp., *Coleogyne ramosissima*, *Ephedra* sp., *Larrea tridentata*, *Psorothamnus fremontii* and *Purshia mexicana*. (AGFD 2003). Individuals have been recorded from 2,560 feet (780 meters) to 3,580 feet (1,091 meters) in elevation in western Washington County, Utah (UNPS 2003-08, Welsh et al. 2008) and at elevations from 3,000 feet (915 meters) to 4,300 feet (1,310 meters) in Arizona (AGFD 2003).

4.3.48.2 Survey Results

S. gierischii was not encountered during project surveys.

4.3.48.3 Discussion

The elevations within the survey area are higher than the reported range for *S. gierischii* and suitable soils to support *S. gierischii* were not encountered. Habitat for this species does not exist within the survey area. No further surveys are warranted within the survey area for this plant.

4.3.49 *Spiranthes diluvialis* (Ute ladies'-tresses)

4.3.49.1 Natural History

Spiranthes diluvialis is a terrestrial perennial in the Orchidaceae (Orchid Family) with stems 8 inches (20 centimeters) to 20 inches (50 centimeters) tall. Its narrow leaves can reach 11 inches (28 centimeters) long and 0.4 inches (1 centimeter) wide. Basal leaves are the longest and become reduced in size up the stem. The flowering stalk consists of few to many slender, long white or ivory flowers clustered into a spike arrangement at the top of the stem (USFWS 2010a). *S. diluvialis* blooms from late July to September (UNPS 2003-2008).

S. diluvialis is known from Utah, Colorado, Wyoming, Idaho, Nebraska, and possibly Nevada (UNPS 2003-2008). Across its range, *S. diluvialis* occurs in stable wetland and seepy areas associated with old landscape features within historical floodplains of major rivers, as well as in wetlands and seeps near freshwater lakes or springs at elevations from 720 feet (219 meters) to 1,830 feet (558 meters) in Washington to 7,000 feet (2,134 meters) in northern Utah (USFWS 2010a). In Utah it is found in Daggett, Duchesne, Garfield, Salt Lake, Tooele, Uintah, Utah, Wasatch, Wayne, and Weber counties. In Utah, *S. diluvialis* occurs in wet meadows, stream banks, abandoned oxbow meanders, marshes, and raised bogs at elevations from 4,500 feet (1,372 meters) to 6,800 feet (2,073 meters) (UNPS 2003-2008).

S. diluvialis is similar to *S. romanzoffiana*, but *S. diluvialis* can be distinguished by its short flowers that are broad at the base and strongly ascending. The flower petals of *S. diluvialis* are free at the base, exposing the lip petal when examining the plant from a side view (UNPS 2003-2008).

4.3.49.2 Survey Results

S. diluvialis was not encountered during project surveys.

4.3.49.3 Discussion

No seeps or hanging gardens were encountered within the survey area. *S. diluvialis* was not encountered during the survey seasons, and all potentially suitable springs were investigated during the 2010 survey season. No further surveys are warranted within the survey area for this plant.

4.3.50 *Thelypodiopsis ambigua* var. *erecta* (Kanab thelypody)

4.3.50.1 Natural History

Thelypodiopsis ambigua var. *erecta* is a hairless biennial or short-lived perennial from the Brassicaceae (Mustard Family). Stems are 0.7 feet (2 decimeters) to 3.3 feet (10 decimeters) tall and are hairless throughout. Leaves grow low on the stem, 1.2 inches (3 centimeters) to 6 inches (15 centimeters) long, often over 6 times as long as broad. The flower structure is hairless. The petals are pink to lavender or white. Flowers appear between April and May.

T. a. var. *erecta* is found in Kane and possibly Washington counties, Utah and Coconino and Mohave counties, Arizona. It is primarily found in pinyon-juniper woodland and desert shrub communities on clay soils derived from degraded, purple Chinle shales and mudstones (UNPS 2003-08, Welsh et al 2008). Specimens have been recorded from 5,019 (1,530 meters) feet to 5,413 feet (1,950 meters) in elevation in Utah and Arizona.

4.3.50.2 Survey Results

T. a. var. *erecta* was not encountered during project surveys.

4.3.50.3 Discussion

Potential habitat for *T. a.* var. *erecta* in the survey area may be found unsurveyed, private lands discussed under *Astragalus ampullarius*. The vegetative and geological components preferred by *T. a.* var. *erecta* are present at both the Cedar Ridge and Kanab sites. The elevation range documented for this species falls within the range of the Cedar Ridge site and just above the range of the Kanab site. If access to these private lands is granted, there is a high probability of encountering this *T. a.* var. *erecta*, and surveys should be conducted in April or May while flowers are in bloom.

4.3.51 *Viguiera soliceps* (Tropic goldeneye)

4.3.51.1 Natural History

Viguiera soliceps (Tropic goldeneye) is an annual herb from the Asteraceae (Aster Family) reaching 4 to 16.1 inches (10 to 41 centimeters) tall. Leaves are ovate to lance-shaped, opposite, and 0.6 to 1.5 inches (1.5 to 3.8 centimeters) long and 0.2 to 0.8 inches (0.6 to 2.0 centimeters) wide, becoming smaller upwards on the stem. Ten to 12 ray flowers reaching 0.4 to 0.6 inches (1.0 to 1.5 centimeters) are present from April to June. In years of plentiful rainfall, this species forms striking masses of yellow blossoms (Welsh et al. 1993, UNPS 2003-08).

V. soliceps is endemic to Kane County, Utah. It is restricted to clay knolls and bluffs derived from the Tropic Shale Formation. It is found in mat saltbush communities at elevations from 4,600 feet to 4,800 feet (UNPS 2003-08).

4.3.51.2 Survey Results

V. soliceps was not encountered during project surveys.

4.3.51.3 Discussion

Tropic Shale formations with *V. soliceps* are known well north of the survey area in Kane County, Utah. These habitats do not extend into the survey area. No further surveys are warranted within the survey area for this plant.

4.4 Plants of Cultural Concern to the Kaibab Band of Paiute Indians of Northern Arizona

The Kaibab Band of Paiute Indians provided a list of plants of cultural concern that included a total of 72 species. Thirteen species were detected during the special status plant and noxious weed surveys (Table 4-30). These species were noted to be common in their respective habitats within the survey area. Effects are analyzed in Chapter 6 on the same basis as the other described special status plant species in the preceding sections.

Table 4-30
Plants of Cultural Concern Encountered during Surveys

Common Name	Scientific Name
Bigelow sagebrush	*Artemisia bigelovii*
Sand sagebrush	*Artemisia filifolia*
Four-wing saltbush	*Atriplex canescens*
Rubber rabbitbrush	*Chrysothamnus nauseosus*
Torrey Indian tea	*Ephedra torreyana*
Englemann prickly pear	*Opuntia phaecantha*
Indian ricegrass	*Oryzopsis hymenoides*
Squaw bush	*Rhus trilobata*
Russian thistle	*Salsola iberica*
Desert sage	*Salvia dorrii*
Salt cedar	*Tamarix chinensis*
Narrowleaf yucca	*Yucca angustissima*
Banana yucca	*Yucca baccata*