Lake Powell Pipeline

Draft Study Report 12
Special Status Plant Species and Noxious Weeds Assessment

December 2010

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Special Status Plant Species and Noxious Weeds Assessment
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 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 270 miles of proposed and alternative routes for buried water pipelines and approximately 154 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. Three main ecological regions—the Colorado Plateau, Great Basin, and Mohave 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 extending northward to Cedar City. 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 centered on the pipeline and transmission line alignments from April through mid-September 2009 and from mid-April through July 2010. The pedestrian surveys were 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 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 to identify relationships with ecological systems, plant community alliances, and plant community associations.

ES-4 Special Status Plant Species Results

Fifty-eight special status plant species were targeted in the field surveys. Natural history, survey results and discussion is provided for each targeted special status plant species. Of the 58 species for which surveys were performed, 15 species were observed and documented, with detailed information provided including location (maps), land ownership and quantity of plants recorded. The distribution of special status species is analyzed according to the vegetation communities in which they occur.

The three ecological regions represented within the survey area are Colorado Plateau, Great Basin, and Mohave 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 18 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 18 weed species. Two of the 11 Great Basin Region ecological systems contained eight of the 18 weed species. Two of the 12 Mohave Desert Region ecological systems contained seven of the 18 weed species.

Anthropogenic land areas (affected by human activities) contained neither natural or 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 14 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 most species and numbers of special status plants would occur under the Hydro System Existing Highway Alignment Alternative along Arizona State Highway 389. Six species of special status plants would be significantly 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 alternatives studied for the Lake Powell Pipeline (LPP) project, located in north central Arizona and southwest Utah (Figure 1-1) and identifies the issues and impact topics for the Special Status Plant Species and Noxious Weeds Assessment Study Report. The alternatives studied and analyzed include different alignments for pipelines and penstocks and transmission lines, a no Lake Powell water alternative, and the No Action alternative. The pipelines would convey water under pressure and connect to the penstocks, which would convey the water to a series of hydroelectric power generating facilities. The action alternatives would each deliver 86,249 acre-feet of water annually for municipal and industrial (M&I) use in the three southwest Utah water conservancy district service areas. Washington County Water Conservancy District (WCWCD) would receive 69,000 acre-feet, Kane County Water Conservancy District (KCWCD) would receive 4,000 acre-feet and Central Iron County Water Conservancy District (CICWCD) could receive up to 13,000 acre-feet each year.

1.2 Summary Description of Alignment Alternatives

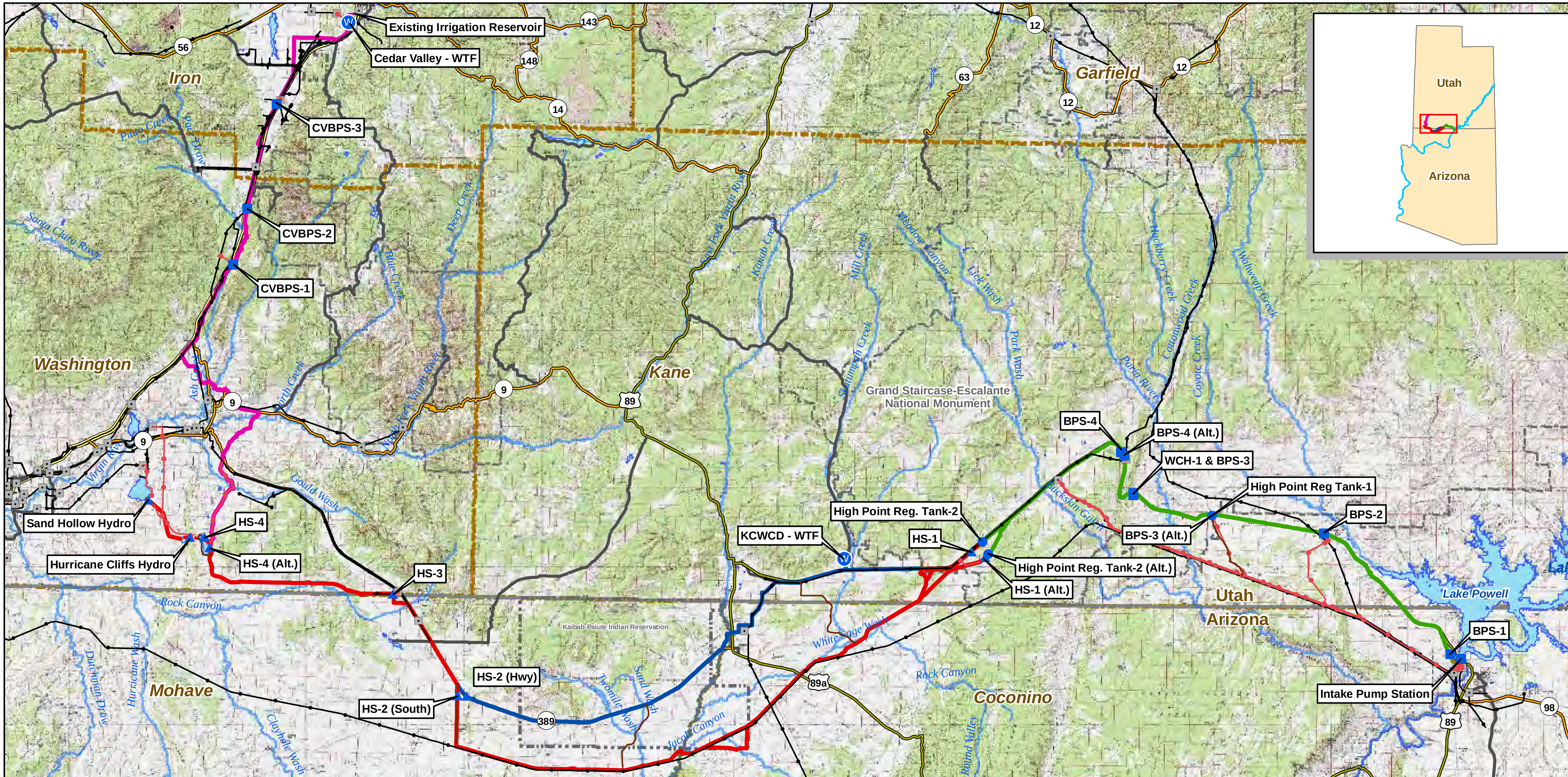
Three primary pipeline and penstock alignment alternatives are described in this section along with the electrical power transmission line alternatives. The pipeline and penstock alignment alternatives share common segments between the intake at Lake Powell and delivery at Sand Hollow Reservoir, and they are spatially different in the area through and around the Kaibab Indian Reservation. The South Alternative extends south around the Kaibab Indian Reservation. The Existing Highway Alternative follows an Arizona state highway through the Kaibab Indian Reservation. The Southeast Corner Alternative follows the Navajo-McCullough Transmission Line corridor through the southeast corner of the Kaibab Indian Reservation. The transmission line alignment alternatives are common to all the pipeline and penstock alignment alternatives. Figure 1-1 shows the overall proposed project features from Lake Powell near Page, Arizona to Sand Hollow and Cedar Valley, Utah.

1.2.1 South Alternative

The South Alternative consists of five systems: Intake, Water Conveyance, Hydro, Kane County Pipeline, and Cedar Valley Pipeline.

The **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 (Figure 1-2). The pump station enclosure would house vertical turbine pumps with electric motors, electrical controls, and other equipment at a ground level elevation of 3,745 feet mean sea level (MSL).

The **Water Conveyance System** would convey the Lake Powell water from the Intake System for about 51 miles through a buried 69-inch diameter pipeline parallel with U.S. 89 in Coconino County, Arizona and Kane County, Utah to a buried regulating tank (High Point Regulating Tank-2) on the south side of U.S. 89 at ground level elevation 5,695 feet MSL, which is the LPP project topographic high point



Water Treatment Facility
Project Pump Station
Project Regulating Tank
Project Hydro Station
Project Transmission Line
Existing Substation
Existing Transmission Line

Water Conveyance
Hydro System - South Alignment Alternative
Hydro System - Highway Alignment Alternative
KCWCD Pipeline System
Cedar Valley Pipeline

Interstate
US Highway
ST Highway
Hwy
Major Road
Access Roads

Hurricane Cliffs Forebay/Afterbay
Lakes & Reservoirs
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

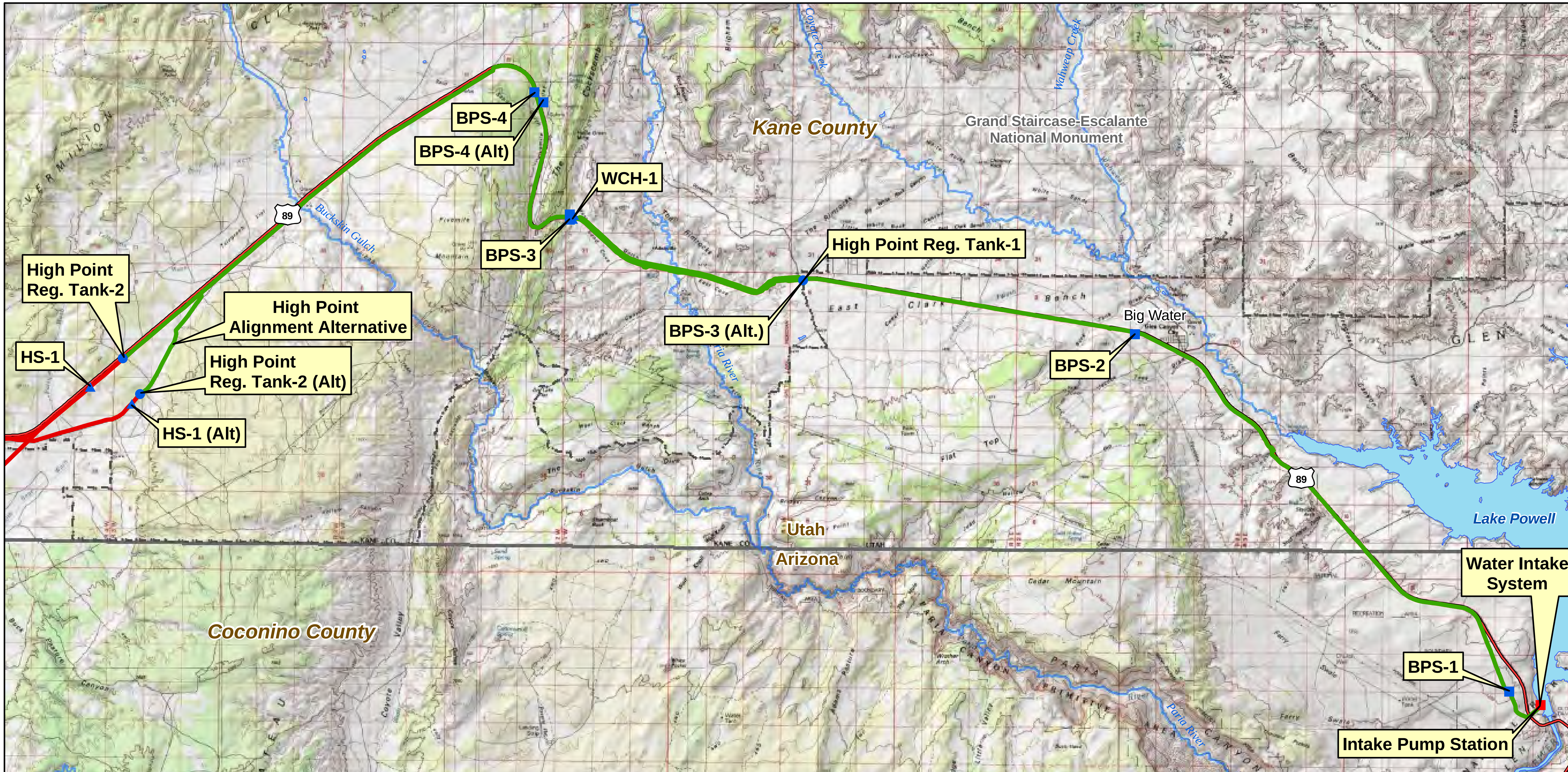
0 2.5 5 10 15 20 Miles

Lake Powell Pipeline Project

Spatial Reference: UTM Zone 12N, NAD-83

UDWR **Figure 1-1** MWH

Lake Powell Pipeline Proposed Project and Alternative Features



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

NGS USA Topographic Maps

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N

0 0.5 1 2 3 4 Miles

Lake Powell Pipeline Project

Spatial Reference: UTM Zone 12N, NAD-83

UDWR **Figure 1-2** MWH

Lake Powell Pipeline Intake and Water Conveyance Systems

(Figure 1-2). The pipeline would be sited within a utility corridor established by Congress in 1998 which extends 500 feet south and 240 feet north of the U.S. 89 centerline on public land administered by the Bureau of Land Management (BLM) (U.S. Congress 1998). Four booster pump stations (BPS) located along the pipeline would pump the water under pressure 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 substation, buried forebay tank and a surface emergency overflow detention basin. BPS-1 would be sited within the Glen Canyon National Recreation Area adjacent to an existing Arizona Department of Transportation maintenance facility located west of U.S. 89. BPS-2 would be sited on land administered by the Utah School and Institutional Trust Lands Administration (SITLA) near the town of Big Water, Utah on the south side of U.S. 89. BPS-3 and an in-line hydro station (WCH-1) would be sited at the east side of the Cockscomb geologic feature in the Grand Staircase-Escalante National Monument (GSENM) within the Congressionally-designated utility corridor. BPS-3 (Alt) is an alternative location for BPS-3 on land administered by the BLM Kanab Field Office near the east boundary of the GSENM on the south side of U.S. 89 within the Congressionally-designated utility corridor. Incorporation of BPS-3 (Alt.) into the LPP project would replace BPS-3 and WCH-1 at the east side of the Cockscomb geologic feature. BPS-4 would be sited on the west side of U.S. 89 and within the Congressionally-designated utility corridor in the GSENM on the west side of the Cockscomb geologic feature.

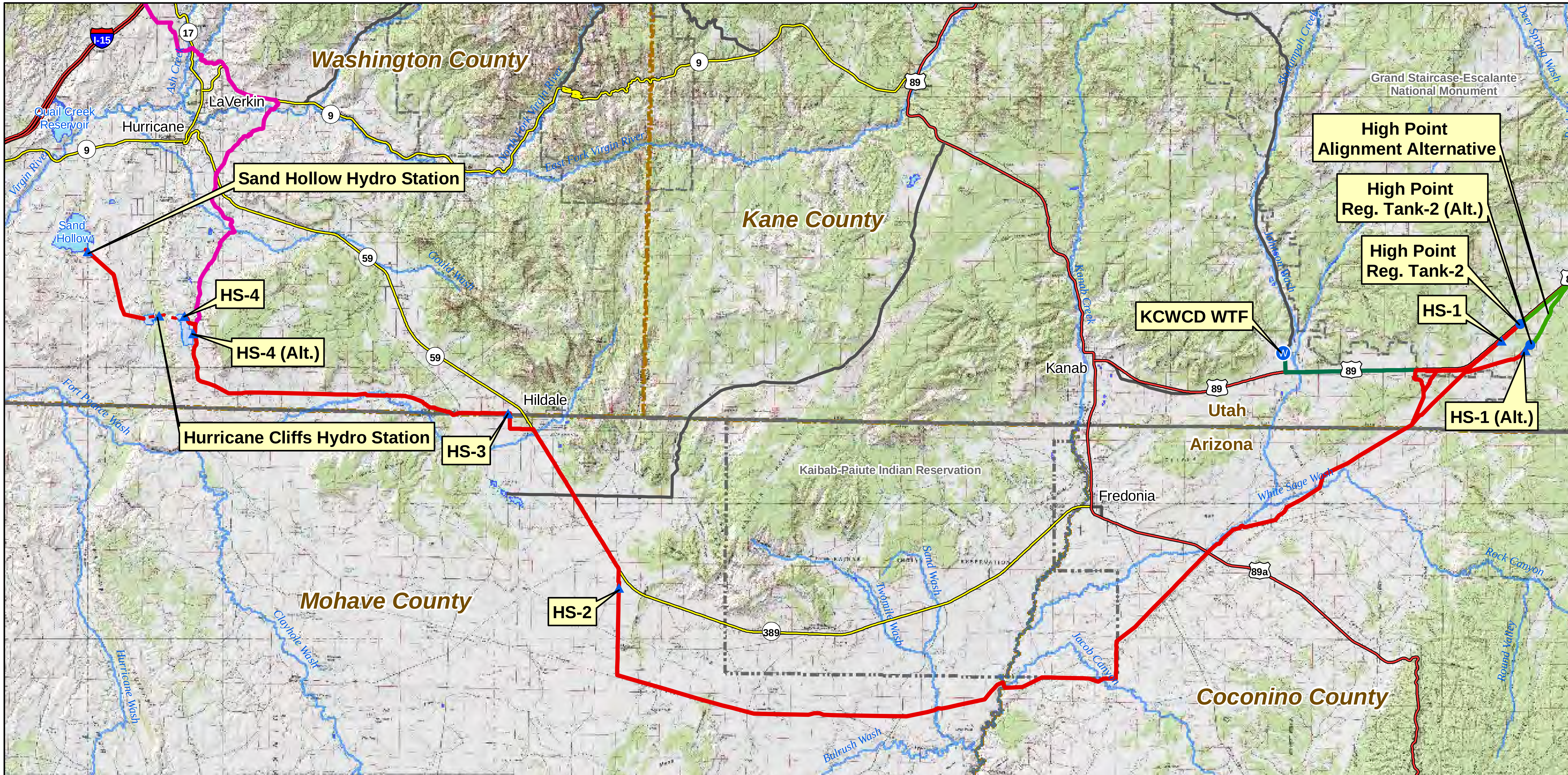
The High Point Alignment Alternative would diverge south from U.S. 89 parallel to the K4020 road and continue outside of the Congressionally-designated utility corridor to a buried regulating tank (High Point Regulating Tank-2 (Alt.) at ground level elevation 5,630 feet MSL, which would be the topographic high point of the LPP project along this alignment alternative (Figure 1-2). The High Point Alignment Alternative would include BPS-4 (Alt.) on private land east of U.S. 89 and west of the Cockscomb geologic feature (Figure 1-2). Incorporation of the High Point Alignment Alternative and BPS-4 (Alt.) into the LPP project would replace the High Point Regulation Tank-2 along U.S. 89, the associated buried pipeline and BPS-4 west of U.S. 89.

A rock formation avoidance alignment option would be included immediately north of Blue Pool Wash along U.S. 89 in Utah. Under this alignment option, the pipeline would cross to the north side of U.S. 89 for about 400 feet and then return to the south side of U.S. 89. This alignment option would avoid tunneling under the rock formation on the south side of U.S. 89 near Blue Pool Wash.

A North Pipeline Alignment option is located parallel to the north side of U.S. 89 for about 6 miles from the east boundary of the GSENM to the east side of the Cockscomb geological feature.

The **Hydro System** would convey the Lake Powell water from High Point Regulating Tank-2 at the high point at ground level elevation 5,695 feet MSL for about 87 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 1-3). The High Point Alignment Alternative would convey the Lake Powell water from High Point Regulating Tank-2 (Alt.) at the high point at ground level elevation 5,641 feet MSL 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 1-3). Four in-line hydro generating stations (HS-1, HS-2 HS-3 and HS-4) with substations located along the penstock would generate electricity and help control water pressure in the penstock. HS-1 would be sited on the south side of U.S. 89 within the Congressionally-designated utility corridor through the GSENM. The High Point Alignment Alternative would include HS-1 (Alt.) along the K4020 road within the GSENM and continue along a portion of the K3290 road.

The proposed penstock alignment and two penstock alignment options are being considered to convey the water from the west GSENM boundary south through White Sage Wash. The proposed penstock



Water Treatment Facility
Project Regulating Tank
Project Hydro Station
Hurricane Cliffs Forebay/Afterbay
Lakes & Reservoirs
Major Rivers & Streams

Hydro System - South Alignment Alternative
Water Conveyance System
Cedar Valley Pipeline
KCWCD Pipeline System

Interstate
US Highway
ST Highway
Hwy
Major Road

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

FERC Project Number:
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BLM Serial Numbers:
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UTU-85472

N

0 1.25 2.5 5 7.5 10 Miles

Lake Powell Pipeline Project

Spatial Reference: UTM Zone 12N, NAD-83

UDWR **Figure 1-3** MWH

Lake Powell Pipeline
Hydro System
South Alternative

alignment would parallel the K3250 road south from U.S. 89 and follow the Pioneer Gap Road alignment around the Shinarump Cliffs. One penstock alignment option would parallel the K3285 road southwest from U.S. 89 and continue to join the Pioneer Gap Road around the Shinarump Cliffs. The other penstock alignment option would extend southwest through currently undeveloped BLM land from the K3290 road into White Sage Wash.

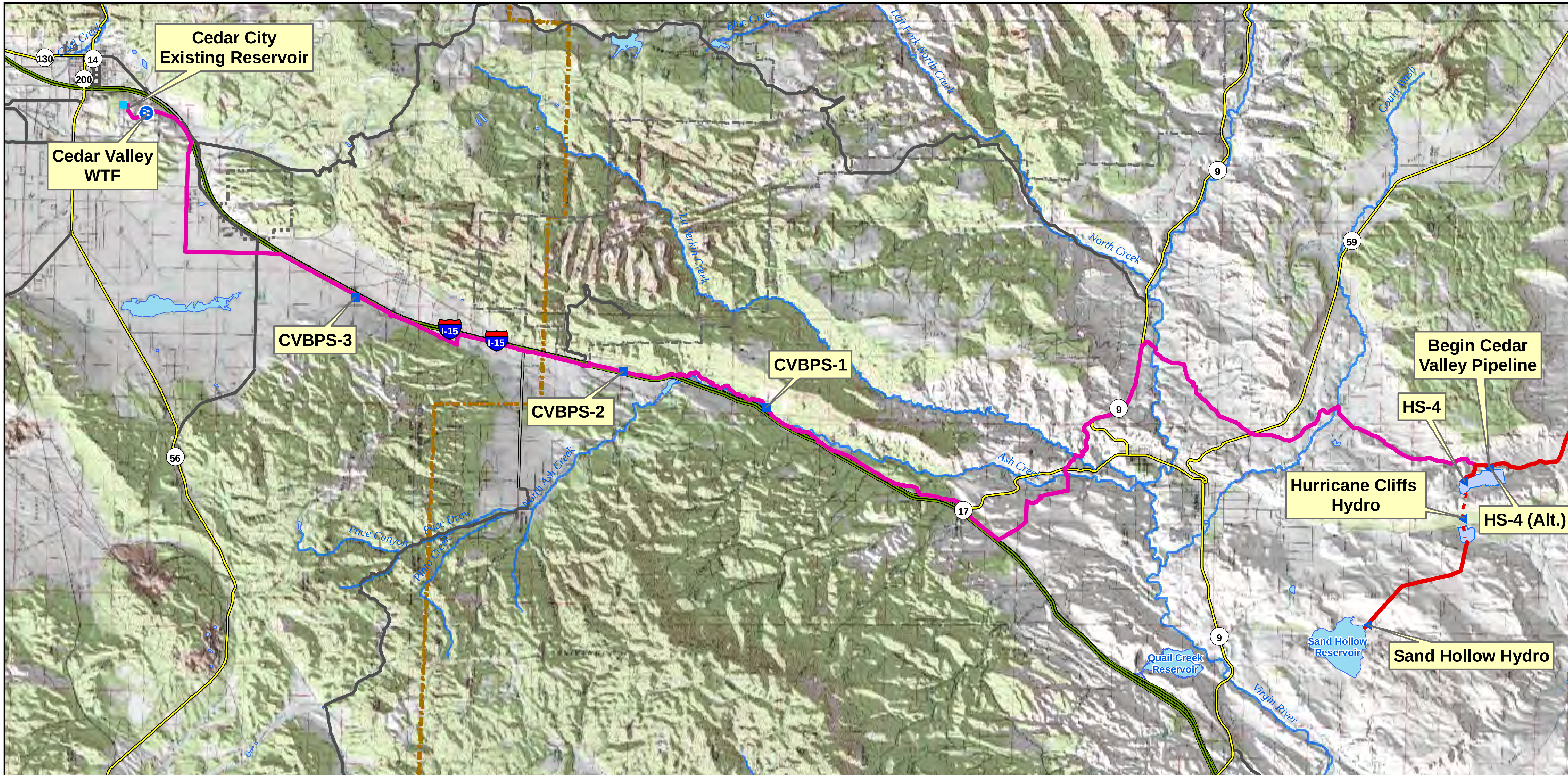
The penstock alignment would continue through White Sage Wash and then parallel to the Navajo-McCullough Transmission Line, crossing U.S. 89 Alt. and Forest Highway 22 toward the southeast corner of the Kaibab Indian Reservation. The penstock alignment would run parallel to and south of the south boundary of the Kaibab Indian Reservation, crossing Kanab Creek and Bitter Seeps Wash, across Moonshine Ridge and Cedar Ridge, and north along Yellowstone Road to Arizona State Route 389 west of the Kaibab Indian Reservation. HS-2 would be sited west of the Kaibab Indian Reservation. 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.

The penstock alignment would follow Uzona Road west through Canaan Gap and south of Little Creek Mountain and turn north to HS-4 above the proposed Hurricane Cliffs forebay reservoir. The forebay reservoir would be contained in a valley between a south dam and a north dam and maintain active storage of 11,255 acre-feet of water. 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 pumped storage hydro generating station. The pumped storage hydro generating station would connect to an afterbay reservoir contained by a single dam in the valley below the Hurricane Cliffs. A low pressure tunnel would convey the water northwest to a penstock continuing on to the Sand Hollow Hydro Station. The water would discharge into the existing Sand Hollow Reservoir.

The peaking hydro generating station option would involve a smaller, 200 acre-foot forebay reservoir with HS-4 (Alt.) discharging into the forebay reservoir, with the peaking hydro generating station discharging to a small afterbay connected to a penstock running north along the existing BLM road and west to the Sand Hollow Hydro Station. 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 peaking hydro generating station, which would discharge into a 200 acre-foot afterbay reservoir. A penstock would extend north from the afterbay reservoir along the existing BLM road and then west to the Sand Hollow Hydro Station. The water would discharge into the existing Sand Hollow Reservoir.

The **Kane County Pipeline System** would convey the Lake Powell water from the Lake Powell Pipeline at the west GSENM boundary for about 8 miles through a buried 24-inch diameter pipe in Kane County, Utah to a conventional water treatment facility located near the mouth of Johnson Canyon. The pipeline would parallel the south side of U.S. 89 across Johnson Wash and then run north to the new water treatment facility site (Figure 1-3).

The **Cedar Valley Pipeline System** would convey the Lake Powell water from the Lake Powell Pipeline just upstream of HS-4 or HS-4 (Alt.) for about 58 miles through a buried 36-inch diameter pipeline in Washington and Iron counties, Utah to a conventional water treatment facility in Cedar City, Utah (Figure 1-4). Three booster pump stations (CBPS) located along the pipeline would pump the water under pressure to the new water treatment facility. The pipeline would follow an existing BLM road north from HS-4, cross Utah State Route 59 and continue north to Utah State Route 9, with an aerial crossing of the Virgin River at the Sheep Bridge. The pipeline would run west along the north side of Utah State Route 9 and parallel an existing pipeline through the Hurricane Cliffs at Nephi's Twist. The pipeline would



Water Treatment Facility
Project Pump Station
Project Hydro Station
Hydro System - South Alignment Alternative
Water Conveyance System
Hurricane Cliffs Pressure Tunnel
Cedar Valley Pipeline
Interstate
US Highway
ST Highway
Hwy
Major Road
Hurricane Cliffs Forebay/Afterbay
Lakes & Reservoirs
Major Rivers & Streams
National Park/Monument
County Boundaries
Tribal Lands

FERC Project Number:
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BLM Serial Numbers:
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UTU-85472

0 1 2 4 6 8
Miles

N

Lake Powell Pipeline Project

Spatial Reference: UTM Zone 12N, NAD-83

UDWR **Figure 1-4** MWH

Cedar Valley Pipeline System

continue across La Verkin Creek, cross Utah State Route 17, and make an aerial crossing of Ash Creek. The pipeline would continue northwest to the Interstate 15 corridor and then northeast parallel to the east side of Interstate 15 highway right-of-way. CBPS-1 would be sited adjacent to an existing gravel pit east of Interstate 15. CBPS-2 would be sited on private property on the east side of Interstate 15 and south of the Kolob entrance to Zion National Park. CBPS-3 would be sited on the west side of Interstate 15 in Iron County. The new water treatment facility would be sited near existing water reservoirs on a hill above Cedar City west of Interstate 15.

1.2.2 Existing Highway Alternative

The Existing Highway Alternative consists of five systems: Intake, Water Conveyance, Hydro, Kane County Pipeline, and Cedar Valley Pipeline. The Intake, Water Conveyance and Cedar Valley Pipeline systems would be the same as described for the South Alternative.

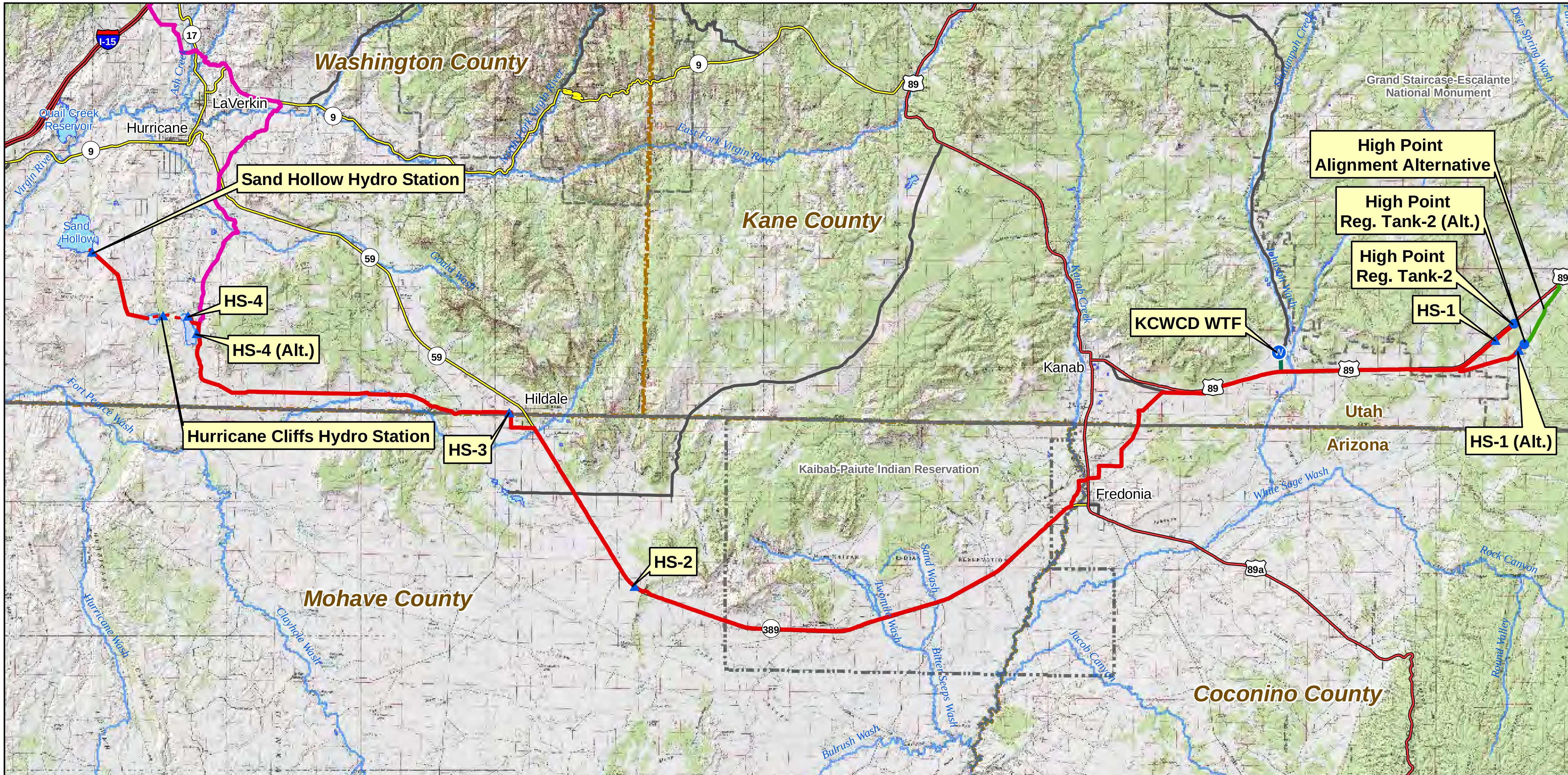
The **Hydro System** would convey the Lake Powell water from the regulating tank at the high point at ground elevation 5,695 feet MSL for about 80 miles through a buried 69-inch diameter penstock in Kane and Washington counties, Utah and Coconino and Mohave counties, Arizona to Sand Hollow Reservoir near St. George, Utah (Figure 1-5). The High Point Alignment Alternative would convey the Lake Powell water from High Point Regulating Tank-2 (Alt.) at the high point at ground level elevation 5,630 feet MSL 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 1-3). The High Point Alignment Alternative would rejoin U.S. 89 about 2.5 miles east of the west boundary of the GSENM. Four in-line hydro generating stations (HS-1, HS-2 HS-3 and HS-4) located along the penstock would generate electricity and help control water pressure in the penstock. HS-1 would be sited on the south side of U.S. 89 within the Congressionally-designated utility corridor through the GSENM. The High Point Alignment Alternative would include HS-1 (Alt.) along the K4020 road within the GSENM and continue along a portion of the K3290 road to its junction with the pipeline alignment along U.S. 89.

The penstock would parallel the south side of U.S. 89 west of the GSENM past Johnson Wash and follow Lost Spring Gap southwest, crossing U.S. 89 Alt. and Kanab Creek in the north end of Fredonia, Arizona. The penstock would run south paralleling Kanab Creek to Arizona State Route 389 and run west adjacent to the north side of this state highway through the 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 the Kaibab-Paiute Indian Reservation to 1.8 miles west of Cedar Ridge (intersection of Yellowstone Road with U.S. 89), from where it would follow the same alignment as the South Alternative to Sand Hollow Reservoir. HS-2 would be sited 0.5 mile west of Cedar Ridge along the north side of Arizona State Route 389.

The **Kane County Pipeline System** would convey the Lake Powell water from the Lake Powell Pipeline crossing Johnson Wash along U.S. 89 for about 1 mile north through a buried 24-inch diameter pipe in Kane County, Utah to a conventional water treatment facility located near the mouth of Johnson Canyon (Figure 1-5).

1.2.3 Southeast Corner Alternative

The Southeast Corner Alternative consists of five systems: Intake, Water Conveyance, Hydro, Kane County Pipeline, and Cedar Valley Pipeline. The Intake, Water Conveyance, Kane County Pipeline and Cedar Valley Pipeline systems would be the same as described for the South Alternative.



- Water Treatment Facility
- Project Regulating Tank
- Project Hydro Station
- Hurricane Cliffs Forebay/Afterbay
- Lakes & Reservoirs
- Major Rivers & Streams
- Water Conveyance
- Hydro System - South Alignment Alternative
- Hurricane Cliffs Pressure Tunnel
- Cedar Valley Pipeline
- KCWCD Pipeline System
- Interstate
- US Highway
- ST Highway
- Hwy
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N

0 1.25 2.5 5 7.5 10 Miles

Lake Powell Pipeline Project

Spatial Reference: UTM Zone 12N, NAD-83

UDWR **Figure 1-5** MWH

Lake Powell Pipeline
Hydro System
Existing Highway Alternative

The **Hydro System** would be the same as described for the South Alternative between High Point Regulating Tank-2 and the east boundary of the 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 Indian Reservation for about 3.8 miles and 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).

1.2.4 Transmission Line Alternatives

Transmission line alternatives include the Intake (3 alignments), BPS-1, Glen Canyon to Buckskin, Buckskin Substation upgrade, Paria Substation upgrade, BPS-2, BPS-2 Alternative, BPS-3 North, BPS-3 South, BPS-3 Underground, BPS-3 Alternative North, BPS-3 Alternative South, BPS-4, BPS-4 Alternative, HS-1 Alternative, HS-2 South, HS-3 Underground, HS-4, HS-4 Alternative, Hurricane Cliffs Afterbay to Sand Hollow, Hurricane Cliffs Afterbay to Hurricane West, Sand Hollow to Dixie Springs, Cedar Valley Pipeline booster pump stations, and Cedar Valley Water Treatment Facility.

The proposed new **Intake Transmission Line** would begin at Glen Canyon Substation and run parallel to U.S. 89 for about 2,500 feet to a new switch station, cross U.S. 89 at the Intake access road intersection and continue northeast to the Intake substation. This 69 kV transmission line would be about 0.9 mile long in Coconino County, Arizona (Figure 1-7). One alternative alignment would run parallel to an existing 138 kV transmission line to the west, turn north to the new switch station, cross U.S. 89 at the Intake access road intersection and continue northeast to the Intake substation. This 69 kV transmission line alternative would be about 1.2 miles long in Coconino County, Arizona (Figure 1-7). Another alternative alignment would bifurcate from an existing transmission line and run west, then northeast to the new switch station, cross U.S. 89 at the Intake access road intersection and continue northeast to the Intake substation. This 69 kV transmission line alternative would be about 1.3 miles long in Coconino County, Arizona (Figure 1-7).

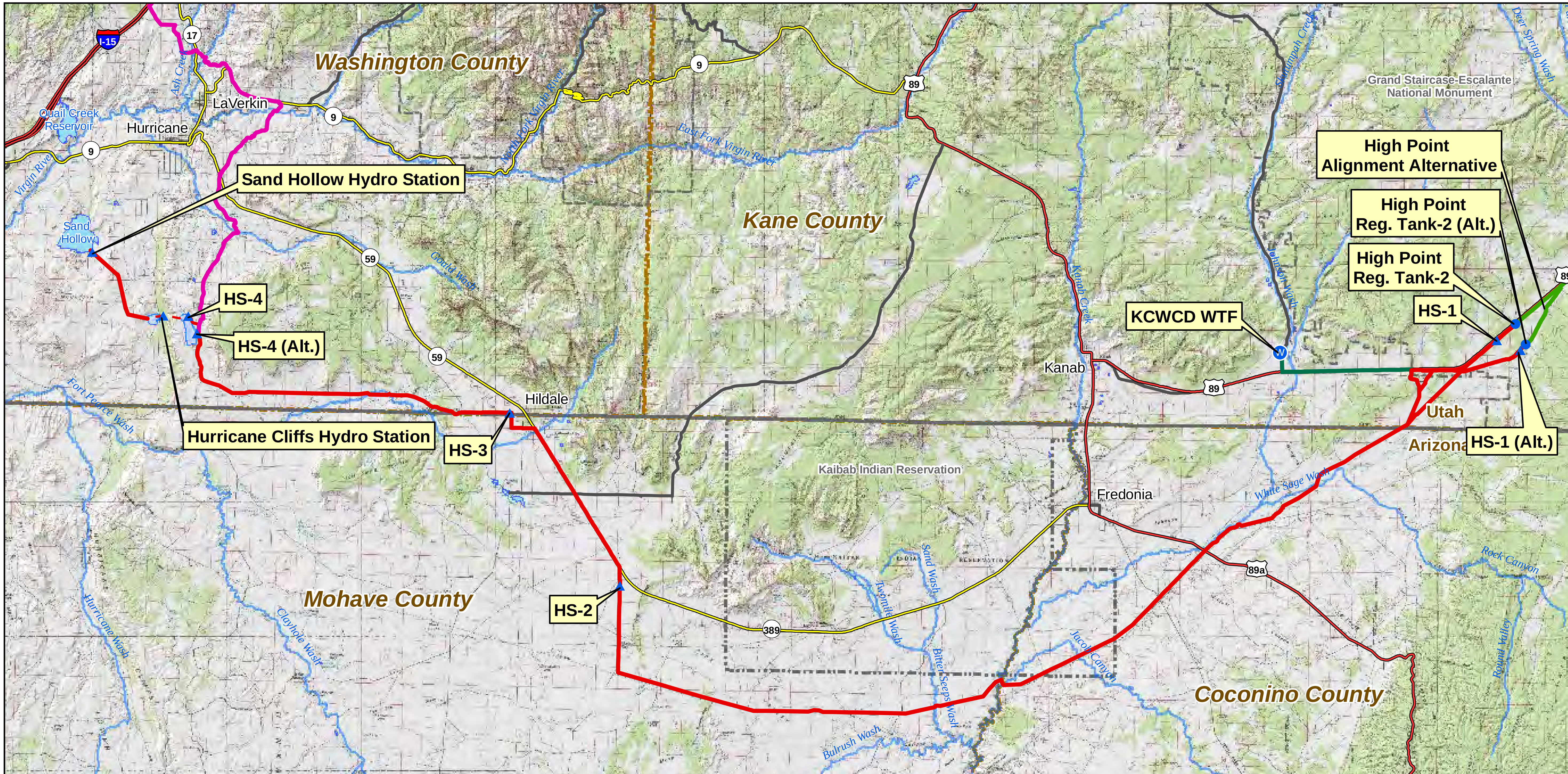
The proposed new **BPS-1 Transmission Line** would begin at the new switch station located on the south side of U.S. 89 and parallel the LPP Water Conveyance System alignment to the BPS-1 substation west of U.S. 89. This 69 kV transmission line would be about 1 mile long in Coconino County, Arizona (Figure 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 5 acres of land within the 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 Alternative. The substation upgrade would require an additional 2 acres of privately-owned land adjacent to the existing substation in Kane County, Utah (Figure 1-7).

The proposed new **BPS-2 Transmission Line** alternative would consist of a new 3-ring switch station along the existing 138 kV Glen Canyon to Buckskin Transmission Line and 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



Water Treatment Facility
Project Regulating Tank
Project Hydro Station
Hurricane Cliffs Forebay/Afterbay
Lakes & Reservoirs
Major Rivers & Streams

Water Conveyance System
Hydro System - Southeast Corner Alternative
Kane County Pipeline System
Cedar Valley Pipeline System

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

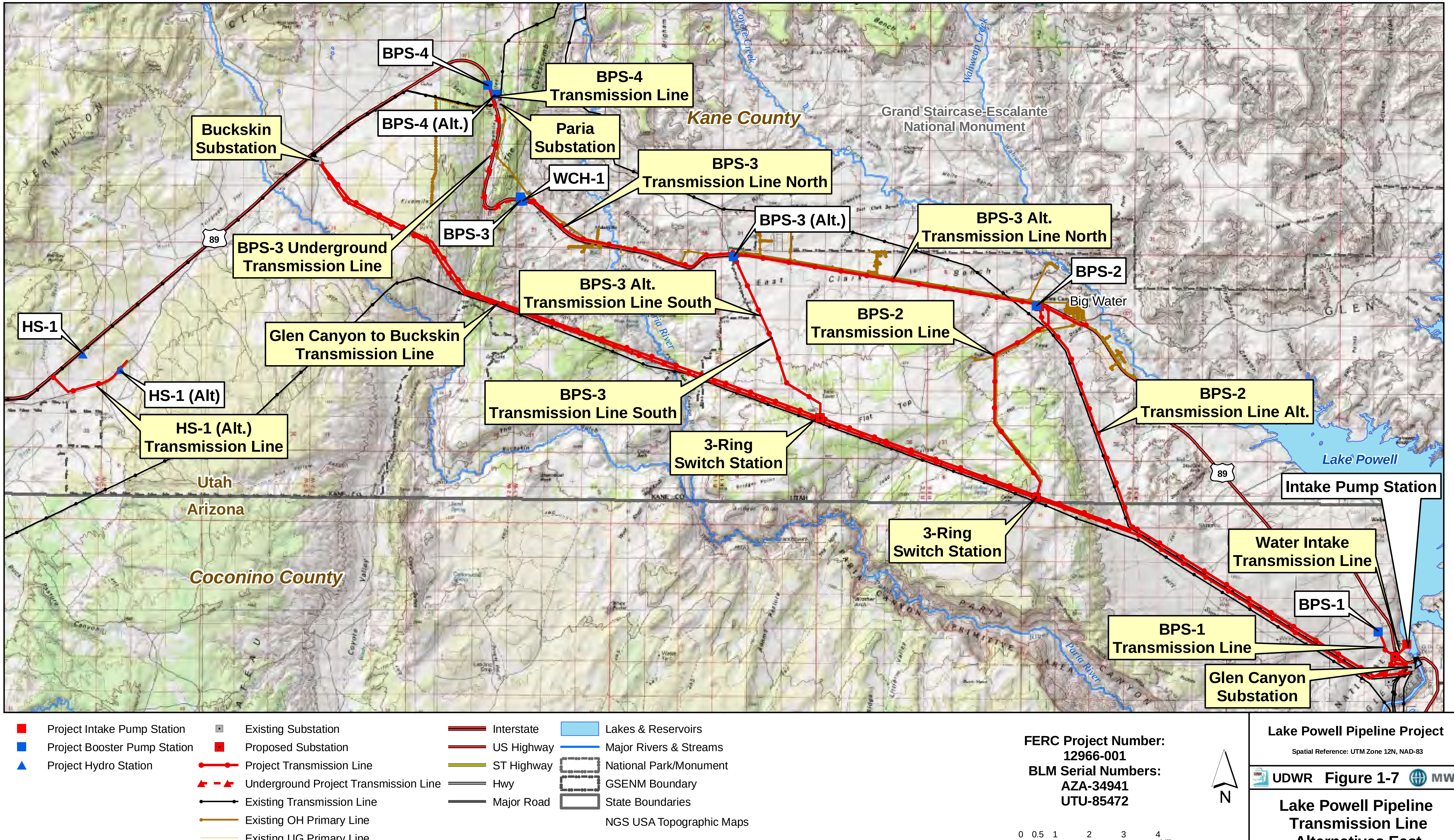
0 1.25 2.5 5 7.5 10 Miles

Lake Powell Pipeline Project

Spatial Reference: UTM Zone 12N, NAD-83

UDWR **Figure 1-6** MWH

Lake Powell Pipeline
Hydro System
Southeast Corner Alternative



Lake Powell Pipeline Project

Spatial Reference: UTM Zone 12N, NAD-83

UDWR Figure 1-7 MWH

Lake Powell Pipeline Transmission Line Alternatives East

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 alternative would be about 7 miles long across Utah SITLA-administered land, with a 138 kV connection to the BPS-2 substation (Figure 1-7).

The new **BPS-2 Alternative Transmission Line** would consist of a new 138 kV transmission line from Glen Canyon Substation parallel to the existing Rocky Mountain Power 230 kV transmission line, connecting to the BPS-2 substation west of Big Water. This new 138 kV transmission line alternative would be about 16.5 miles long in Coconino County, Arizona and Kane County, Utah crossing National Park Service-administered land, BLM-administered land and Utah SITLA-administered land (Figure 1-7).

The new **BPS-3 Transmission Line North** alternative would consist of a new 138 kV transmission line from BPS-2 paralleling the south side of U.S. 89 within the Congressionally designated utility corridor west to BPS-3 at the east side of the Cockscomb geological feature. This new 138 kV transmission line alternative would be about 15.7 miles long in Kane County, Utah (Figure 1-7).

The new **BPS-3 Transmission Line South** alternative would consist of a new 3-ring switch station along the existing 138 kV Glen Canyon to Buckskin Transmission Line and a new transmission line from the switch station north along an existing BLM road to U.S. 89 and then west along the south side of U.S. 89 within the Congressionally designated utility corridor to BPS-3 at the east side of the Cockscomb. This new 138 kV transmission line alternative would be about 12.3 miles long in Kane County, Utah (Figure 1-7).

The new **BPS-3 Underground Transmission Line** alternative would consist of a new buried 24.9 kV transmission line (2 circuits) from the upgraded Paria Substation to BPS-3 on the east side of the Cockscomb geological feature. This new underground transmission line would be parallel to the east and south side of U.S. 89 and would be about 4.1 miles long in Kane County, Utah (Figure 1-7).

The new **BPS-3 Alternative Transmission Line North** alternative would consist of a new 138 kV transmission line from BPS-2 paralleling the south side of U.S. 89 west to BPS-3 Alternative near the GSENM east boundary within the Congressionally-designated utility corridor. This new 138 kV transmission line alternative would be about 9.3 miles long in Kane County, Utah (Figure 1-7).

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

The new **BPS-4 Transmission Line** alternative would begin at the upgraded Paria Substation and run parallel the west side of U.S. 89 north to BPS-4 within the Congressionally designated utility corridor. This new 138 kV transmission line would be about 0.8 mile long in Kane County, Utah (Figure 1-7).

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

The proposed new **HS-1 Alternative Transmission Line** would begin at the new HS-1 Alternative and run southwest parallel to the K4020 road and then northwest parallel to the K4000 road to the U.S. 89 corridor where it would tie into the existing 69 kV transmission line from the Buckskin Substation to the

Johnson Substation. This 69 kV transmission line would be about 3 miles long in Kane County, Utah (Figure 1-7).

The proposed new **HS-2 South Transmission Line** alternative 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 proposed new **HS-3 Underground 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 underground circuit would be about 0.6 mile long in Washington County, Utah (Figure 1-8).

The proposed new **HS-4 Transmission Line** would consist of a new transmission line from the HS-4 hydroelectric station and substation north along an existing BLM road to an existing transmission line parallel to Utah State Route 59. The new 69 kV transmission line would be about 8.2 miles long in Washington County, Utah (Figure 1-8).

The new **HS-4 Alternative Transmission Line** alternative would connect the HS-4 Alternative 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).

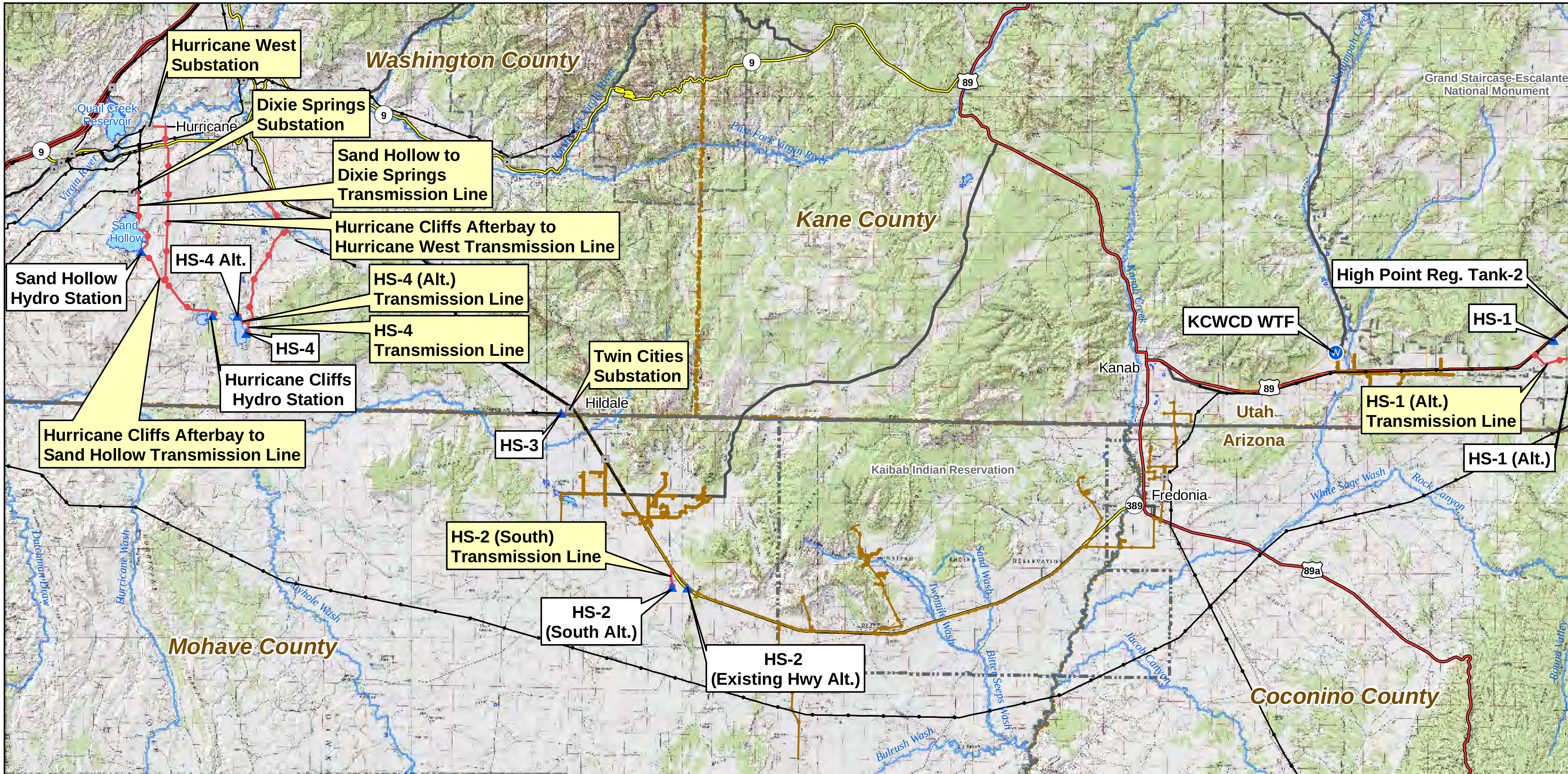
The proposed new **Hurricane Cliffs Afterbay to Sand Hollow Transmission Line** would consist of a new 69 kV transmission line from the Hurricane Cliffs peaking power plant and substation, and run northwest to the Sand Hollow Hydro Station substation. This new 69 kV transmission line would be about 4.9 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 from the Hurricane Cliffs pumped storage power plant and run 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 from the Sand Hollow Hydro Station 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).

The three **Cedar Valley Pipeline** booster pump stations would require new transmission lines from existing transmission lines paralleling the Interstate 15 corridor. The new CBPS-1 transmission line would extend southeast over I-15 from the existing transmission line to the booster pump station substation for about 1.3 miles in Washington County, Utah (Figure 1-9). The new CBPS-2 transmission line would extend east over I-15 from the existing transmission line to the booster pump station substation for about 0.2 mile in Washington County, Utah (Figure 1-9). The new CBPS-3 transmission line would extend west over I-15 from the existing transmission line and southwest along the west side of Interstate 15 to the booster pump station substation for about 0.6 mile in Iron County, Utah (Figure 1-9).

The **Cedar Valley Water Treatment Facility Transmission Line** would begin at an existing substation in Cedar City and run about 1 mile to the water treatment facility site in Iron County, Utah (Figure 1-9).

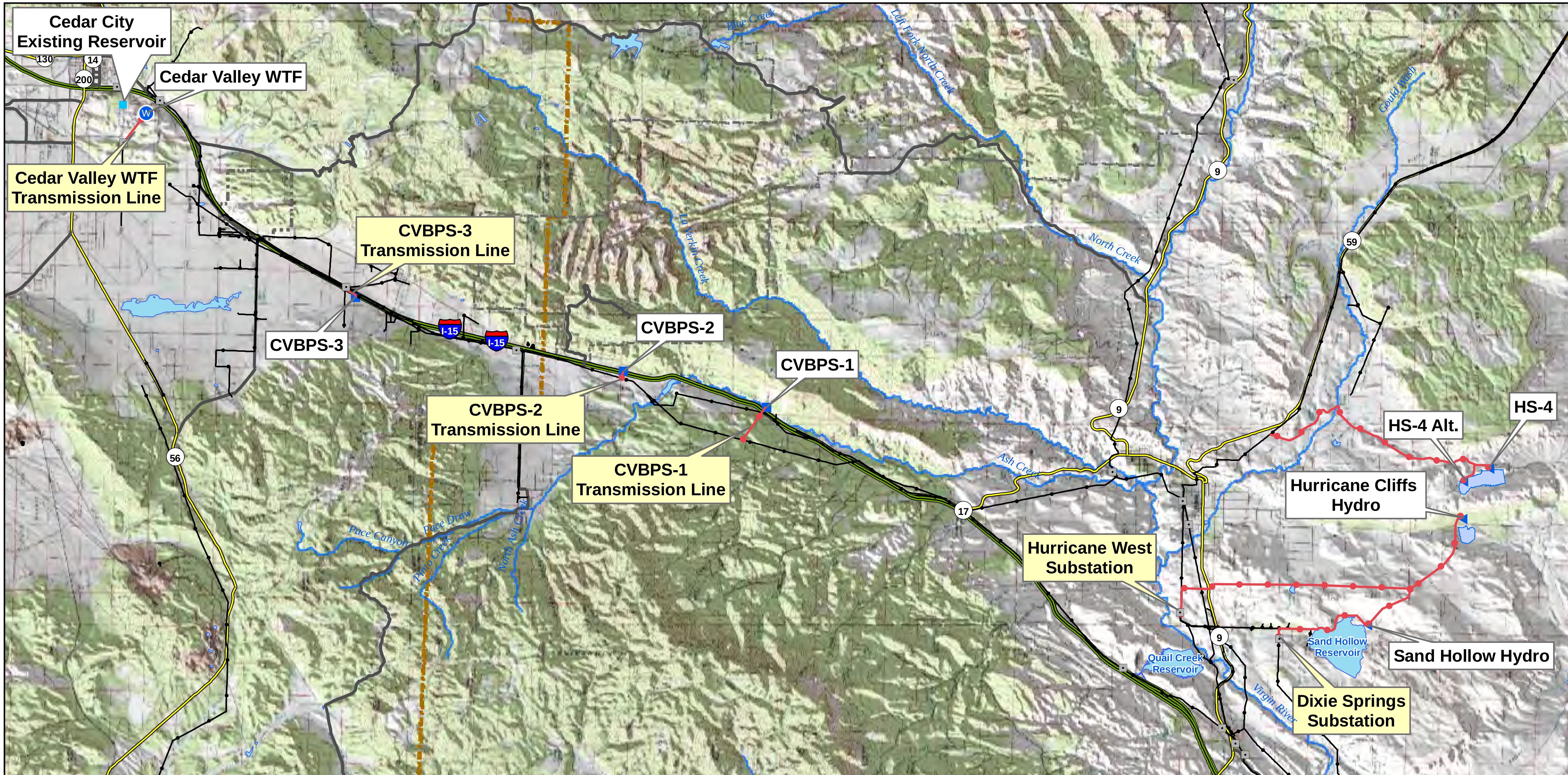


Lake Powell Pipeline Project

Spatial Reference: UTM Zone 12N, NAD-83

UDWR Figure 1-8 MWH

Lake Powell Pipeline Transmission Line Alternatives West



Water Treatment Facility
Project Pump Station
Project Hydro Station
Existing Substation
Project Substation
Project Transmission Line
Existing Transmission Line
Existing OH Primary Line
Existing UG Primary Line
Interstate
US Highway
ST Highway
Hwy
Major Road
Hurricane Cliffs Forebay/Afterbay
Lakes & Reservoirs
Major Rivers & Streams
National Park/Monument
County Boundaries
Tribal Lands

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

0 1 2 4 6 8 Miles

N

Lake Powell Pipeline Project

Spatial Reference: UTM Zone 12N, NAD-83

UDWR **Figure 1-9** MWH

Cedar Valley Transmission Line Alternatives

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 reducing residential outdoor water use in the WCWCD and CICWCD service areas. This alternative could provide a total of 86,249 acre-feet of water annually to WCWCD, CICWCD and KCWCD for M&I use without diverting Utah's water from Lake Powell.

1.3.1 WCWCD No Lake Powell Water Alternative

The WCWCD would implement other future water development projects currently planned by the District, develop additional water reuse/reclamation, and convert additional agricultural water use to M&I use as a result of urban development in agricultural areas through 2020. Remaining planned and future water supply projects through 2020 include the Ash Creek Pipeline (5,000 acre-feet per year), Crystal Creek Pipeline (2,000 acre-feet per year), and Quail Creek Reservoir Agricultural Transfer (4,000 acre-feet per year). Beginning in 2020, WCWCD would convert agricultural water to secondary use and work with St. George City to maximize existing wastewater reuse, bringing the total to 96,258 acre-feet of water supply per year versus demand of 98,427 acre-feet per year, incorporating currently mandated conservation goals. The WCWCD water supply shortage in 2037 would be 70,000 acre-feet per year, 1,000 acre-feet more than the WCWCD maximum share of the LPP water. Therefore, the WCWCD No Lake Powell Water Alternative needs to develop 69,000 acre-feet of water per year to meet comparable supply and demand requirements as the other action alternatives.

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 40,000 acre-feet per year of Virgin River water with high total dissolved solids (TDS) concentration and other contaminants. The RO advanced water treatment facility would produce up to 36,279 acre-feet per year of water suitable for M&I use. The WCWCD would develop the planned Warner Valley Reservoir to store the diverted Virgin River water, which would be delivered to the RO advanced water treatment facility. The remaining 3,721 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 remaining needed water supply of 32,721 acre-feet per year to meet WCWCD 2037 demands would be obtained by reducing and restricting outdoor residential water use in the WCWCD service area. The Utah Division of Water Resources (UDWR) estimated 2005 culinary water use for residential outdoor watering in the communities served by WCWCD was 102 gallons per capita per day (gpcd) (UDWR 2008a). This culinary water use rate is reduced by 30.5 gpcd to account for water conservation attained from 2005 through 2020, yielding 71.5 gpcd residential outdoor water use available for conversion to other M&I uses. The equivalent water use rate reduction to generate 32,721 acre-feet per year of conservation is 56.6 gpcd for the 2037 population within the WCWCD service area. Therefore, beginning in 2020, the existing rate of residential outdoor water use would be gradually reduced and restricted to 14.9 gpcd, or an 85.4 percent reduction in residential outdoor water use.

The combined 36,279 acre-feet per year of RO product water and 32,721 acre-feet per year of reduced residential outdoor water use would equal 69,000 acre-feet per year of M&I water to help meet WCWCD demands through 2037.

1.3.2 CICWCD No Lake Powell Water Alternative

The CICWCD would implement other future groundwater development projects currently planned by the District, purchase agricultural water from willing sellers for conversion to M&I uses, and convert additional agricultural water use to M&I use as a result of urban development in agricultural areas through 2020. Remaining planned and future water supply projects through 2020 include additional groundwater development projects (3,488 acre-feet per year), agricultural conversion resulting from M&I development (3,834 acre-feet per year), and purchase agricultural water from willing sellers (295 acre-feet per year). Beginning in 2020, CICWCD would have a total 19,772 acre-feet of water supply per year versus demand of 19,477 acre-feet per year, incorporating required progressive conservation goals. The CICWCD water supply shortage in 2060 would be 11,470 acre-feet per year. Therefore, the CICWCD No Lake Powell Water Alternative needs to develop 11,470 acre-feet of water per year to meet comparable supply and demand limits as the other action alternatives.

The remaining needed water supply of 11,470 acre-feet per year to meet CICWCD 2060 demands would be obtained by reducing and restricting outdoor residential water use in the CICWCD service area. The UDWR estimated 2005 culinary water use for residential outdoor watering in the communities served by CICWCD was 84.5 gpcd (UDWR 2007). A portion of this residential outdoor water would be converted to other M&I uses. The equivalent water use rate to obtain 11,470 acre-feet per year is 67.8 gpcd for the 2060 population within the CICWCD service area. Therefore, the existing rate of residential outdoor water use would be gradually reduced and restricted to 16.7 gpcd beginning in 2023, an 80 percent reduction in the residential outdoor water use rate between 2023 and 2060. The 11,470 acre-feet per year of reduced residential outdoor water use would be used to help meet the CICWCD demands through 2060.

1.3.3 KCWCD No Lake Powell Water Alternative

The KCWCD would use existing water supplies and implement future water development projects including new groundwater production, converting agricultural water rights to M&I water rights as a result of urban development in agricultural areas, and developing water reuse/reclamation. Existing water supplies (4,039 acre-feet per year) and 1,994 acre-feet per year of new ground water under the No Lake Powell Water Alternative would meet projected M&I water demand of 6,033 acre-feet per year within the KCWCD service area through 2060. The total potential water supply for KCWCD is about 12,140 acre-feet per year (4,039 acre-feet per year existing culinary plus secondary supply, and 8,101 acre-feet per year potential for additional ground water development up to the assumed sustainable ground water yield) without agricultural conversion to M&I supply. Short-term ground water overdrafts and new storage projects (e.g., Jackson Flat Reservoir) would provide reserve water supply to meet demands during drought periods and other water emergencies.

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. 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 or released according to the operating guidelines. Future population growth as projected by the Utah Governor's Office of Planning and Budget (GOPB) would continue to occur in southwest Utah until water and other potential limiting resources such as developable land, electric power, and fuel begin to curtail economic activity and population in-migration.

1.4.1 WCWCD No Action Alternative

The WCWCD would implement other future water development projects currently planned by the District, develop additional water reuse/reclamation, convert additional agricultural water use to M&I use as a result of urban development in agricultural areas, and implement advanced treatment of Virgin River water. The WCWCD could also limit water demand by mandating water conservation measures such as outdoor watering restrictions. Existing and future water supplies under the No Action Alternative would meet projected M&I water demand within the WCWCD service area through approximately 2020. The 2020 total water supply of about 96,528 acre-feet per year would include existing supplies, planned WCWCD water supply projects, wastewater reuse, transfer of Quail Creek Reservoir supplies, and future agricultural water conversion resulting from urban development of currently irrigated lands. Each future supply source would be phased in as needed to meet the M&I 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). Maximum reuse of treated wastewater effluent for secondary supplies would be required to meet the projected M&I water demand starting in 2020. The No Action Alternative would not provide adequate water supply to meet projected water demands from 2020 through 2060. There would be a potential water shortage of approximately 139,875 acre-feet per year in 2060 under the No Action Alternative (UDWR 2008b).

1.4.2 CICWCD No Action Alternative

The CICWCD would implement future water development projects including converting agricultural water rights to M&I water rights as a result of urban development in agricultural areas, purchasing “buy and dry” agricultural water rights to meet M&I demands, and developing water reuse/reclamation. The Utah State Engineer would act to limit existing and future ground water pumping from the Cedar Valley aquifer in an amount not exceeding the assumed sustainable yield of 37,600 ac-ft per year. Existing and future water supplies under the No Action Alternative meet projected M&I water demand within the CICWCD service area during the planning period through agricultural conversion of water rights to M&I use, wastewater reuse, and implementing “buy and dry” practices on irrigated agricultural land. Each future water supply source would be phased in as needed to meet the M&I demand associated with the forecasted population. The CICWCD No Action Alternative includes buying and drying of agricultural water rights covering approximately 8,000 acres between 2005 and 2060 and/or potential future development of West Desert water because no other potential water supplies have been identified to meet unmet demand. The No Action Alternative would not provide CICWCD with any reserve water supply (e.g., water to meet annual shortages because of drought, emergencies, and other losses) after 2010 (i.e., after existing supplies would be maximized).

1.4.3 KCWCD No Action Alternative

The KCWCD would use existing water supplies and implement future water development projects including new ground water production, converting agricultural water rights to M&I water rights as a result of urban development in agricultural areas, and developing water reuse/reclamation. Existing water supplies (4,039 acre-feet per year) and 1,994 acre-feet per year of new ground water under the No Action Alternative would meet projected M&I water demand of 6,033 acre-feet per year within the KCWCD service area through 2060. The total potential water supply for KCWCD is about 12,140 acre-feet per year (4,039 acre-feet per year existing culinary plus secondary supply, and 8,101 acre-feet per year potential for additional ground water development up to the assumed sustainable ground water yield) without agricultural conversion to M&I supply. Short-term ground water overdrafts and new storage projects (e.g., Jackson Flat Reservoir) would provide reserve water supply to meet demands during drought periods and other water emergencies.

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 cycladea, 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

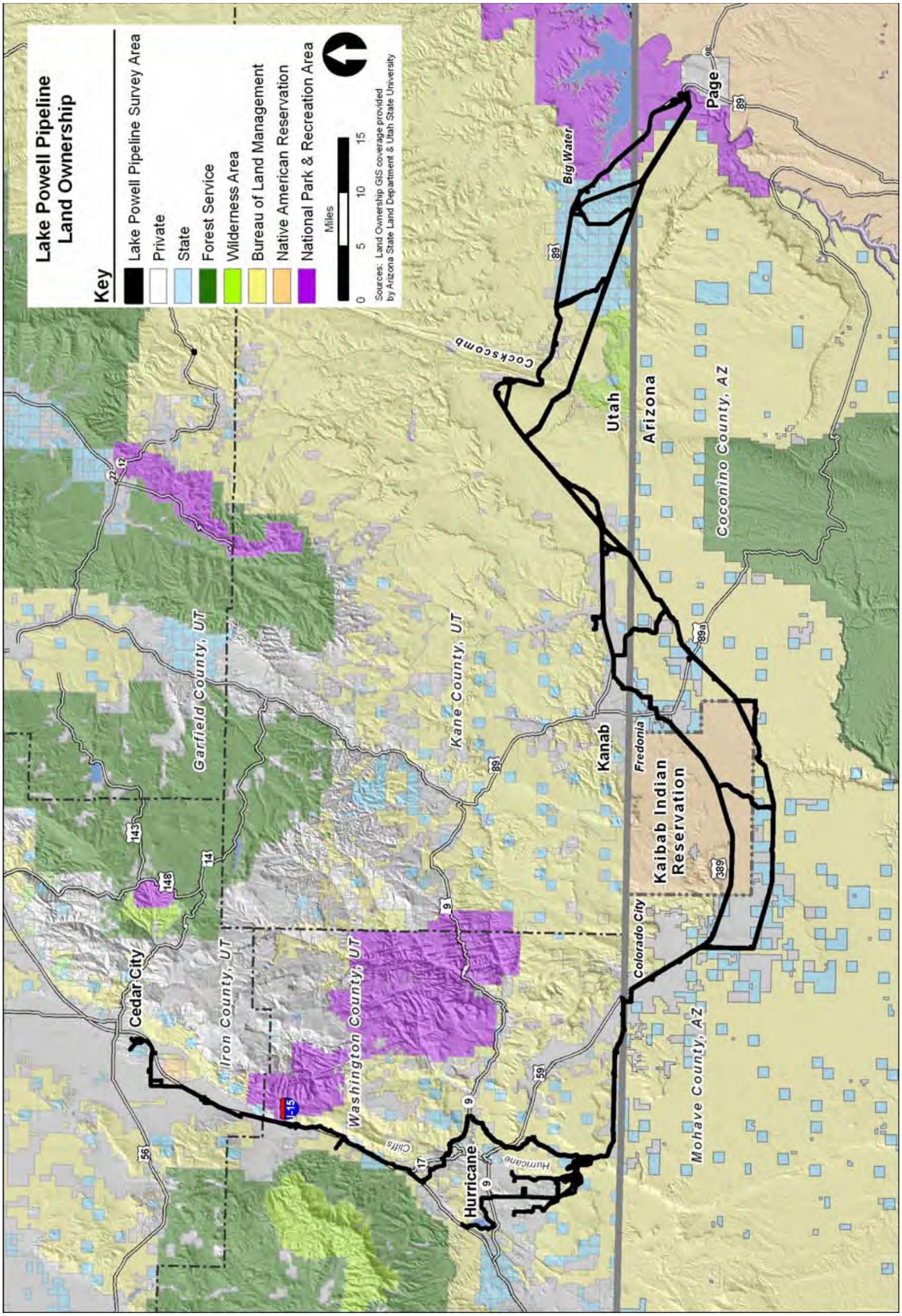
2.1 Project Overview

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 Design Inc. (LSD). 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, Iron, and Kane counties, Utah. The project includes water intake facilities at Lake Powell; approximately 270 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; a water treatment facility west of Cedar City; 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 (Appendix A; 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, Washington, and Iron counties in Utah (Map 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 (US) 89 transportation corridor into Kane County, to an area east of Kanab, where several alternative alignments are being considered. The high point alternative runs south of US 89 on the former roadbed of Utah State Route 136. The existing highway alternative runs southwest of Kanab, then enters Mohave County, passes north of Fredonia, and crosses the Kaibab Indian Reservation within the State Route (SR) 389 transportation corridor. The south alternative crosses US 89a southeast of Fredonia and runs south of the Kaibab 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 Sand Hollow Reservoir. The pipeline alignment also continues north from the Forebay, crosses US 59 and the Virgin River, follows the SR 9 Highway transportation corridor through Toquerville, then turns northward, following the Interstate 15 (I-15) transportation corridor to just southwest of Cedar City, in Iron County, Utah.

The Glen Canyon to Buckskin Transmission line runs from the Glen Canyon Substation west of Page to the Buckskin Substation at the intersection of US89 and 5 Mile Mountain Road. Three shorter transmission line alternatives run from the Glen Canyon to Buckskin Transmission Line to several pump station locations along US89. 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 B. The reach names are derived from the MWH project reach names.



Map 2-1
Proposed Pipeline Alignment Map

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, Hurricane, La Verkin, Toquerville, Kanarraville, and Cedar City 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

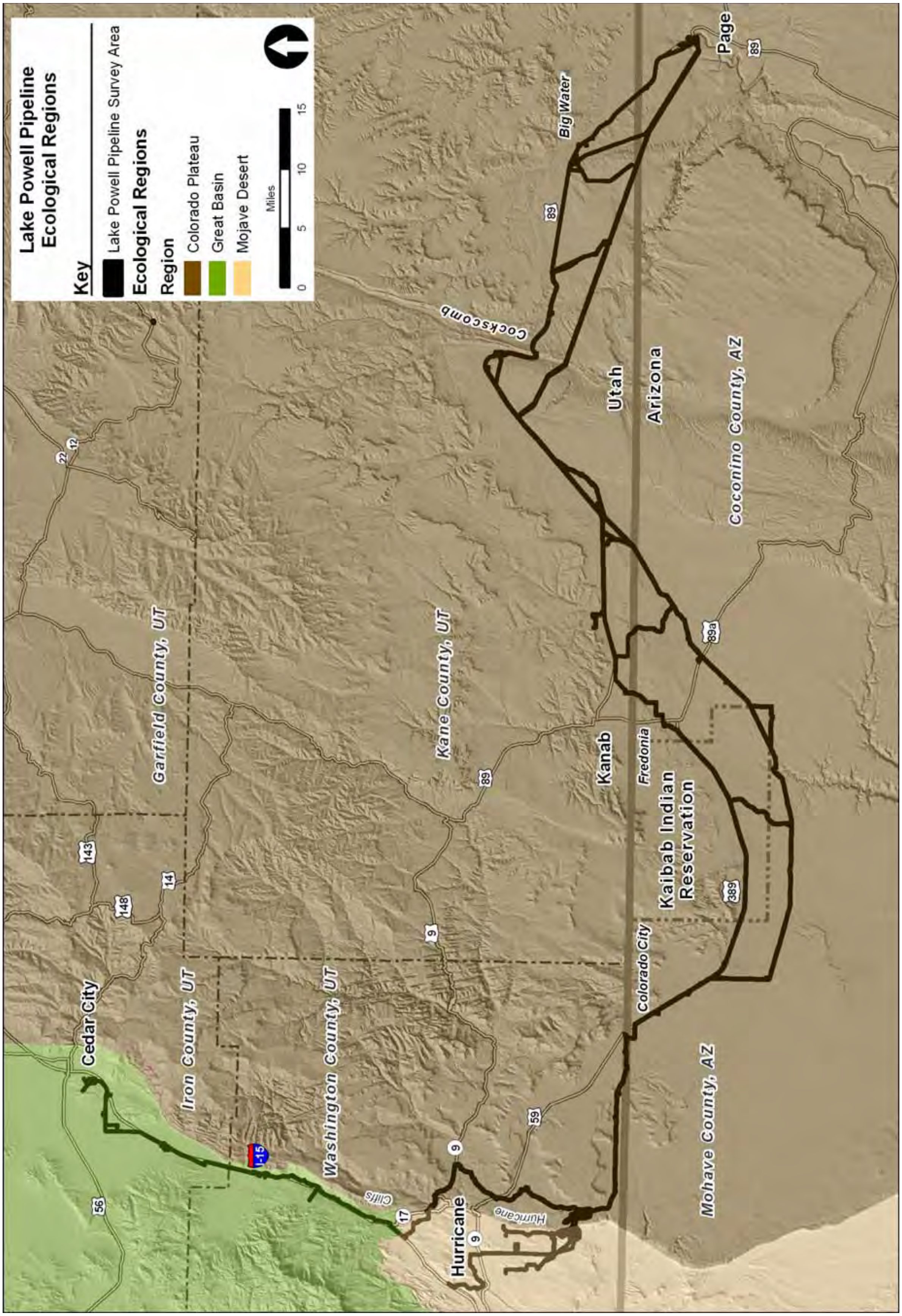
Three main ecological regions, the Colorado Plateau, Great Basin, and Mohave Desert, are represented within the project area (Map 2-2). The vast majority of the project area, from Lake Powell to Hurricane, occurs within the Colorado Plateau Ecological Region. The project area north of Toquerville (northeast of Hurricane) to Cedar City occurs within the Great Basin Ecological Region. The Mohave 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: 2010 Lake Powell Pipeline Project Draft Vegetation Communities Study Report).

2.4.1.1 Colorado Plateau

The Colorado Plateau is a gigantic, uplifted plateau that is generally centered on the "Four Corners" area of the U.S. (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 15,251 acres of study area corridor.

2.4.1.2 Great Basin

The Great Basin is composed of a series of uplifted mountain ranges and their associated intervening valleys. It is the largest arid region in the United States and the largest North American watershed that does not drain to an ocean. Elevations range from 4,000 feet 12,000 feet. Most areas are dominated by saltbush shrublands in the lower elevations and sagebrush shrublands in the higher elevations (WWF 2001). Pinyon-juniper woodland occurs on the slopes of most ranges (Trimble 1999). The Great Basin region is represented within the LPP study area by a total of 634 corridor acres. The region occurs north of Hurricane, to the northern limit of the study area just south of Cedar City.



Map 2-2
Ecological Regions Map

Mohave Desert

The Mohave 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 Ecological Region is dominated by shrublands. The Mohave Desert region within the LPP study area totals 1,216 corridor acres south and west of Hurricane.

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), the City of St. George, Utah (elevation 3,000 feet), and Cedar City, Utah (elevation 5,623 feet). Average monthly maximum temperatures throughout 2008 and 2009, and in 2010 (through the end of the field season), as compared to 30-year averages, are shown in Figure 2-1, Figure 2-2, and Figure 2-3 (USU 2010 and Weather Underground 2010).

Average total precipitation in the communities near the project area ranges from 6.46 inches in Page to 10.60 inches in Cedar City 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 Figure 2-4, Figure 2-5, and Figure 2-6, respectively (USU 2010 and 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, such as *Camissonia exilis*, 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 four 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 and Cedar City continued to see lower-than-average temperatures. By July and August, temperatures in all four 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, St. George, and Cedar City, 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, and in March in the vicinity of Cedar City. At the end of the 2010 survey, lower than average precipitation was experienced in Kanab and Cedar City, while higher than average precipitation occurred in Page and St. George.

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, St. George, and Cedar City, 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, as evidenced by locating flowers of *Camissonia exilis* as late as August 5th. 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 *C. exilis*, and *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.

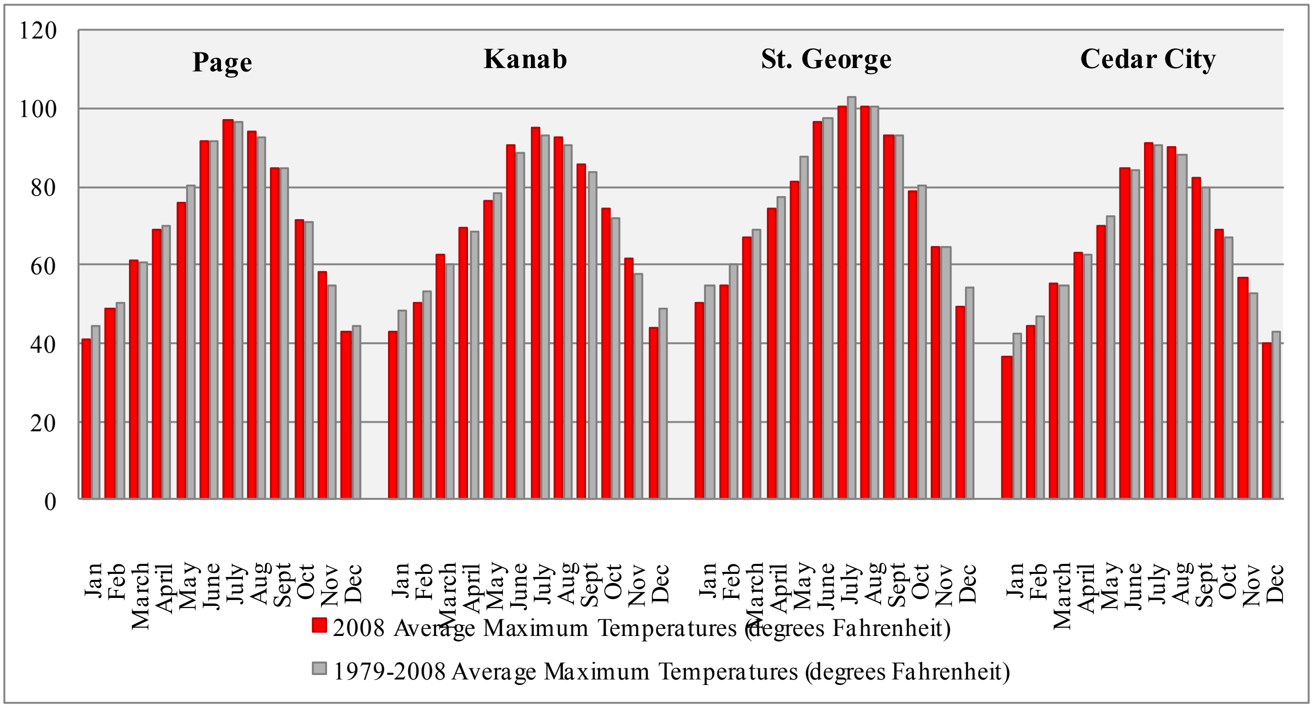


Figure 2-1
2008 Average Monthly Maximum Temperatures, as Compared to 30-year Averages

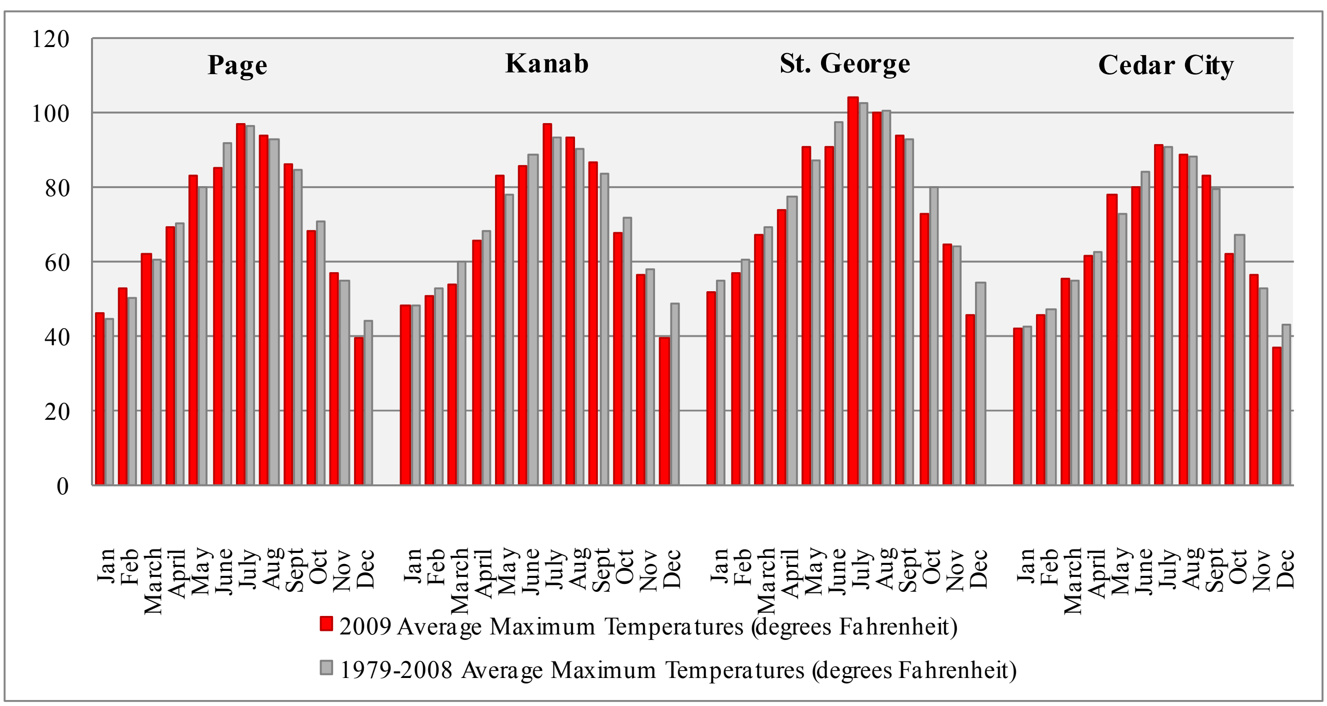


Figure 2-2
2009 Average Monthly Maximum Temperatures, as Compared to 30-year Averages

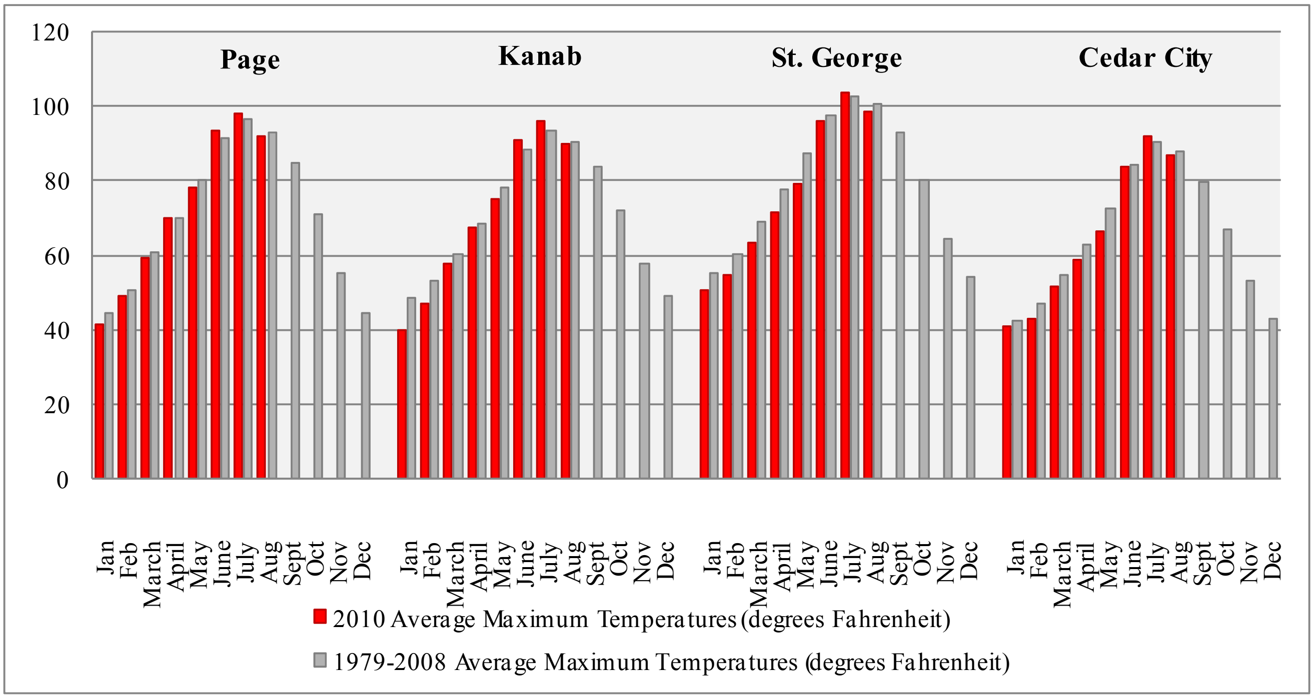


Figure 2-3
2010 Average Monthly Maximum Temperatures, as Compared to 30-year Averages

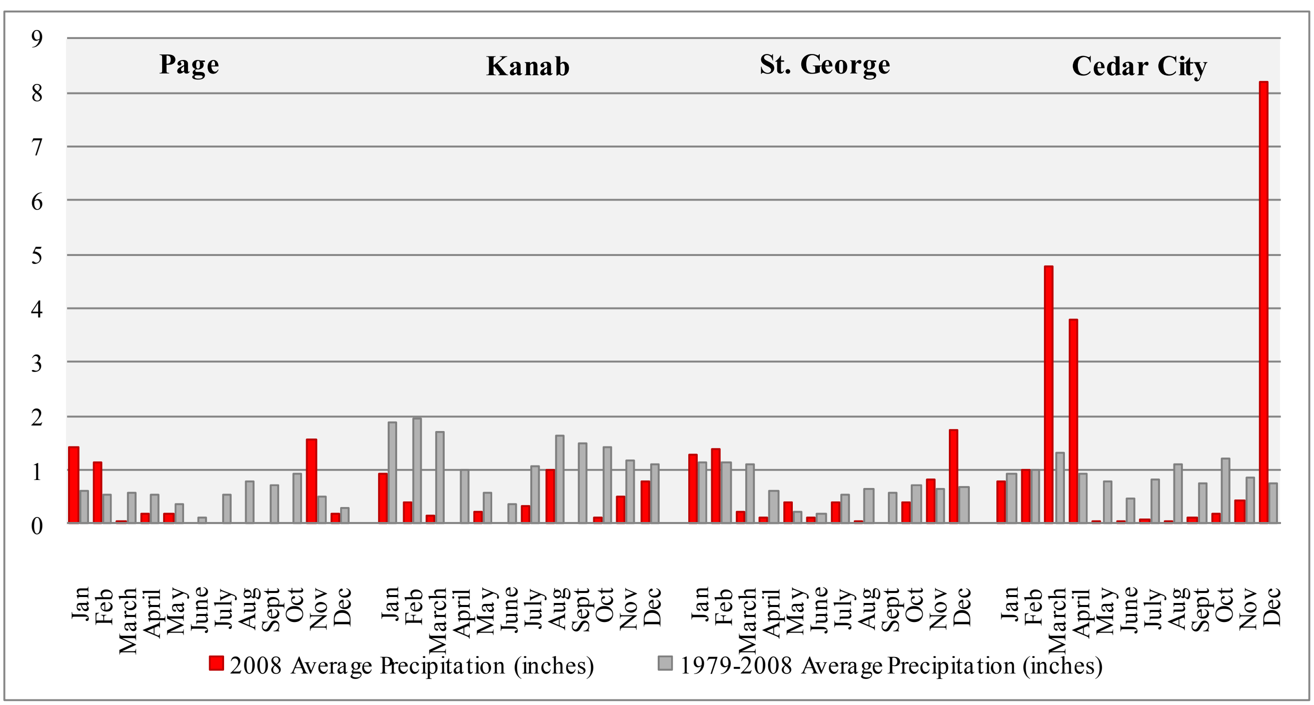


Figure 2-4
2008 Average Monthly Precipitation, as Compared to 30-year Averages

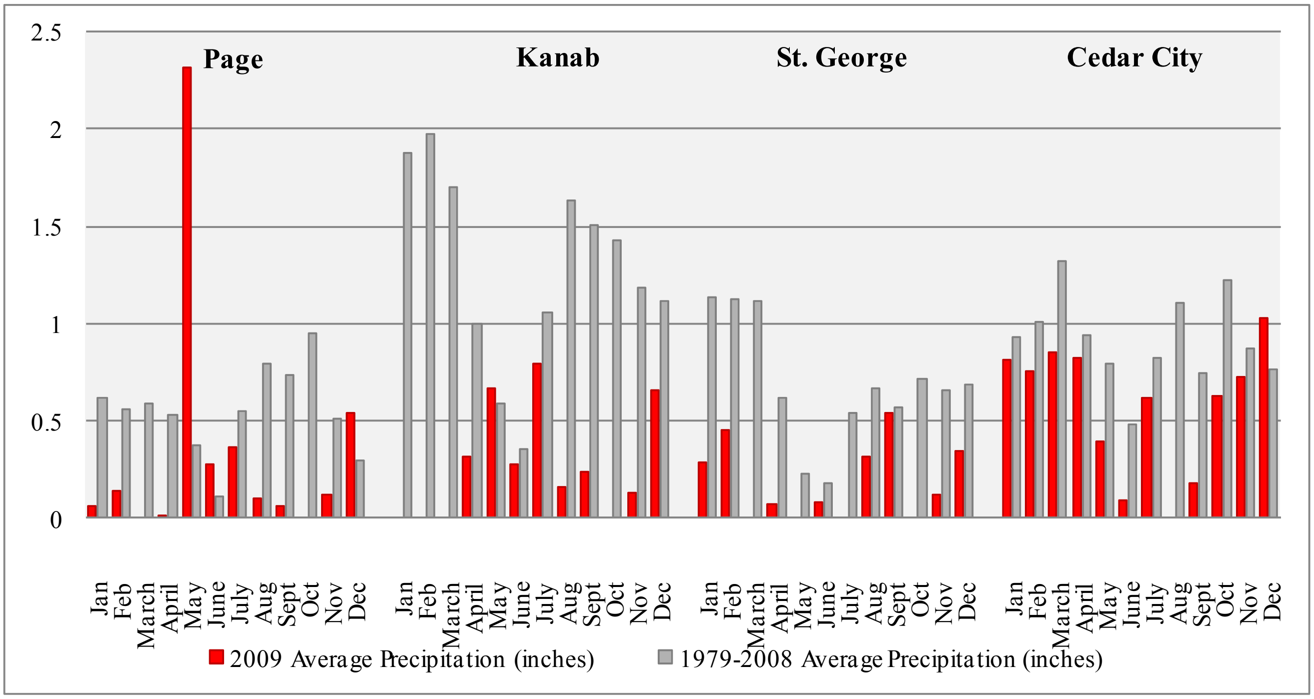


Figure 2-5
2009 Average Monthly Precipitation, as Compared to 30-year Averages

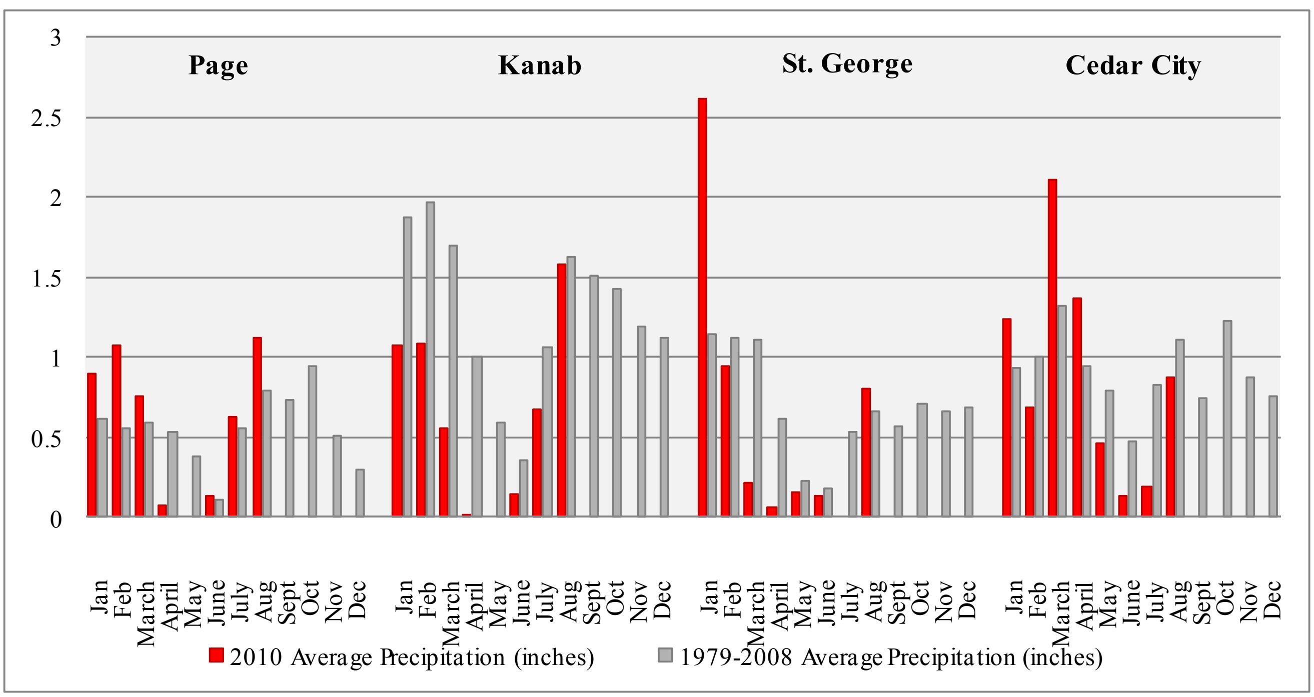
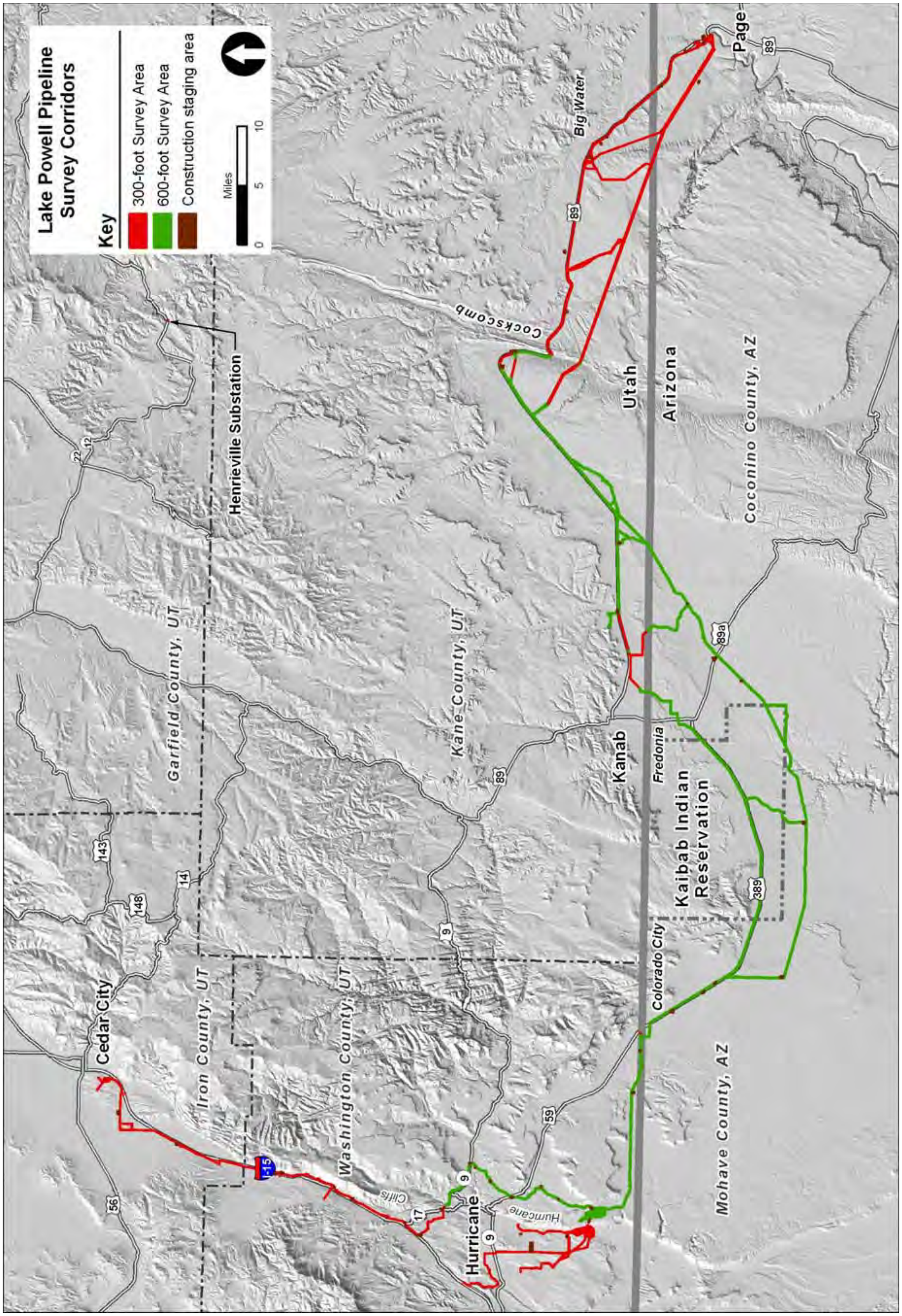


Figure 2-6
2010 Average Monthly Precipitation, as Compared to 30-year Averages

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 (Map 2-3). 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 extending northward to Cedar City. 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.



Map 2-3
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 Design (LSD) 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, Iron, 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 Paiute Tribe provided a list of Plants of Cultural Concern. 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. During the 2009 field season, *Eriogonum corymbosum* var. *nilesii,* listed as a candidate species by USFWS, was also added to the list of target species potentially occurring within the project corridor (this special status species was not previously known to occur within the project area). 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 species for which surveys were conducted during the 2010 survey season.

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

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Species Name	Status[a]	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
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

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

Species Name	Status[a]	Habitat Requirements	Potential for Presence in Project Area
Asclepias welshii (Welsh's milkweed) Asclepidaceae	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 desertscrub 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-junper 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 Nations 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[a]	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 Juanew 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

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

Species Name	Status[a]	Habitat Requirements	Potential for Presence in Project Area
Camissonia exilis (Slender evening primrose) Onagraceae	BLM UT	Slender evening primrose inhabits sagebrush, galleta and pinyon-juniper communities between 3,500 and 5,000 feet in and 5,000 to 6,900 feet in Utah on saline soils of gypsum outcrops of the Triassic Moenkopi and Jurassic Entrada Known populations are found in western Kane County, UT, and Mohave and Coconino counties, AZ.	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
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

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

Species Name	Status[a]	Habitat Requirements	Potential for Presence in Project Area
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)
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 Mohave 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)

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

Species Name	Status[a]	Habitat Requirements	Potential for Presence in Project Area
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 Abejo 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)
Eriogonum corymbosum var. *nilesii* (Las Vegas buckwheat) Polygonaceae	ESA C	On deep, gypsum soil outcrops in sparsely vegetated washes and drainages. Known from Clark and Lincoln counties, Nevada, and potentially along the Paria River in Kane County, UT, in Pierce Wash, Mohave County, AZ and the near Flagstaff in Coconino County, AZ.	Yes
Eriogonum mortonianum (Morton Wild-Buckwheat) Polygonaceae	N/A	Known from Great Basin desert scrub along small drainages and ridges in red gypseous sandy-clay soils derived from the Moenkopi Formation. At 4,650 feet elevation. Known 4 to 6 miles southwest of Fredonia, Mohave County, AZ.	Yes
Eriogonum thompsoniae var. *atwoodii* (Atwood Wild-Buckwheat) Polygonaceae	N/A	Known from Great Basin desert scrub along small drainages and ridges in red gypseous sandy-clay soils derived from the Moenkopi Formation. Between 4,400 to 4,700 feet elevation. Mohave County, AZ (near Fredonia and Lost Spring Mountain).	Yes
Eriogonum viscidulum (Sticky wild buckwheat) Polygonaceae	BLM AZ	Found in low dunes, washes, and areas of loose sandy soils in 3-7pproxi accumulation within Mohave desertscrub. 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

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

Species Name	Status[a]	Habitat Requirements	Potential for Presence in Project Area
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
Iris pariensis (Paria iris) Iridaceae	BLM UT	Springs and stream sides from 4,590 to 5,000 feet. Only known from Paria Canyon drainage, Kane County, UT.	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
Leersia oryzoides (Rice cutgrass) Poaceae	GCNRA G5	Found in wet, heavily vegetated sites along waterways or in marshes. Found in UT below 4,600 feet in Davis, Utah, and Weber counties; and from Canada, throughout the US, 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 Pausaugaunt and Table Cliff Plateaus in Garfield, Kane, and Piute counties, UT.	No (Outside geographic range)

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

Species Name	Status[a]	Habitat Requirements	Potential for Presence in Project Area
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)
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)

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

Species Name	Status[a]	Habitat Requirements	Potential for Presence in Project Area
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, desertscrub, 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 castoreum (Beaver Dam breadroot) Fabaceae	N/A	Found on desert shrub on sand or sandy gravel in open areas and on road cuts from 1,750 to 3,920 feet. Known from Mohave County, AZ, but not confirmed in UT. Range extends in southern Nevada and San Bernardino County, California.	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 Mohave desertscrub. 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)

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

Species Name	Status[a]	Habitat Requirements	Potential for Presence in Project Area
Penstemon laevis (Smooth penstemon) Scrophulariaceae	N/A	Found primarily on deep, sandy soils derived from Navajo Sandstone within pinyon-juniper, ponderosa pine, and mountain brush communities from 4,920 to 6,560 feet in elevation. Known from Kane, Garfield, and Washington counties, UT and Coconino County, AZ.	Yes
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)
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

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

Species Name	Status[a]	Habitat Requirements	Potential for Presence in Project Area
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 US.	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)
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 trifoliate ssp. *pallid* (Hoptree) (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)

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

Species Name	Status[a]	Habitat Requirements	Potential for Presence in Project Area
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 4250 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)
Sphaeralcea 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

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

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Species Name	Status[a]	Habitat Requirements	Potential for Presence in Project Area
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 Wolfhole Mountains, Mohave County, AZ.	No (Outside geographic range)
Tricardia watsonii (Three hearts) Hydrophyllaceae	BLM AZ	Found on dry, rocky, gravelly canyons and slopes, and sandy loam flats in Joshua tree woodland and creosote bush scrub communities. Elevation range between 1,400 and 4,600 feet. Found in Beaver Dam, Grand Gulch Wash, and near Muav Caves in northwestern Mohave County, AZ; and Washington County, UT; into Nevada and California.	Yes
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*:* US Fish and Wildlife Service list of threatened, endangered, proposed, candidate, and conservation agreement species potentially occurring in Mohave County, AZ and Coconino County, AZ , <http://www.fws.gov/southwest/es/arizona>, and Iron, Kane, and Washington counties, UT, <http://www.fws.gov/mountain-prairie/endspp/countylists/utah.pdf> accessed April 1, 2009; the Bureau of Land Management Sensitive Plant Species Lists for Utah dated August 2002; the Bureau of Land Management Sensitive Plant Species Lists for Arizona dated 2005; and Special-Status Terrestrial Species and Communities of Glen Canyon National Recreation Area dated April 2009.

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 Iron 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); those that were located within the project area are highlighted. 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*, *Eriogonum mortonianum*, *Eriogonum thompsoniae* var. *atwoodii*, *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 C). 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 D).

Table 3-2
Noxious and Invasive Weed Species for the Lake Powell Pipeline Project Area
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Species		USDA[1]	USFWS[2]	State of Arizona[3]	State of Utah[4]	Iron Co., UT	Washington Co., UT	BLM (Arizona Strip)	BLM (St. George)	BLM (Kanab)	BLM (Grand Staircase-Escalante)	Glen Canyon N.R.A.
Scientific Name	Common Name											
Acroptilon repens (Syn. Centaurea repens)	Russian knapweed			PNW, RNW				N				
Aegilops cylindrica	Jointed goatgrass			PNW, RNW								

Table 3-2
Noxious and Invasive Weed Species for the Lake Powell Pipeline Project Area
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Species: Scientific Name	Species: Common Name	USDA[1]	USFWS[2]	State of Arizona[3]	State of Utah[4]	Iron Co., UT	Washington Co., UT	BLM (Arizona Strip)	BLM (St. George)	BLM (Kanab)	BLM (Grand Staircase-Escalante)	Glen Canyon N.R.A.
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		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		

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

Species		USDA[1]	USFWS[2]	State of Arizona[3]	State of Utah[4]	Iron Co., UT	Washington Co., UT	BLM (Arizona Strip)	BLM (St. George)	BLM (Kanab)	BLM (Grand Staircase-Escalante)	Glen Canyon N.R.A.
Scientific Name	**Common Name**											
Centaurea melitensis	Malta starthistle							I I				
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 virgata(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			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	Houndstounge				NC							
Drymaria arenarioides	Alfombrilla, lightning weed	N		PNW								

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

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Species												
Scientific Name	**Common Name**	**USDA[1]**	**USFWS[2]**	**State of Arizona[3]**	**State of Utah[4]**	**Iron Co., UT**	**Washington Co., UT**	**BLM (Arizona Strip)**	**BLM (St. George)**	**BLM (Kanab)**	**BLM (Grand Staircase-Escalante)**	**Glen Canyon N.R.A.**
Eichhornia azurea	Anchored water hyacinth	N		PNW								
Eichhornia crassipes	Floating water hyacinth			PNW, RGNW, RNW								
Elaeagnus angustifolia	Russian olive							I				I
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							

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

Species		USDA[1]	USFWS[2]	State of Arizona[3]	State of Utah[4]	Iron Co., UT	Washington Co., UT	BLM (Arizona Strip)	BLM (St. George)	BLM (Kanab)	BLM (Grand Staircase-Escalante)	Glen Canyon N.R.A.
Scientific Name	**Common Name**											
Linaria genistifolia var. dalmatica (Syn. Linaria dalmatica)	Dalmation toadflax			PNW, RNW								
Linaria vulgaris	Yellow toadflax				NA							
Lythrum salicaria	Purple loosestrife			PNW	NA					N		
Medicago polymorpha	Burclover			PNW, RGNW								
Nassella trichotoma	Serrated tussock	N		PNW								
Onopordum acanthium	Scotch thistle			PNW, RNW	NB			N N N	N			
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	Ravennagrass											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			

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

Species		USDA[1]	USFWS[2]	State of Arizona[3]	State of Utah[4]	Iron Co., UT	Washington Co., UT	BLM (Arizona Strip)	BLM (St. George)	BLM (Kanab)	BLM (Grand Staircase-Escalante)	Glen Canyon N.R.A.
Scientific Name	Common Name											
Solanum viarum	Tropical soda apple	N		PNW								
Sonchus arvensis	Perennial sowthistle			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	Johnsongrass				NA	N				N	N	
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		N				
Ulmus pumila	Siberian elm											I

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

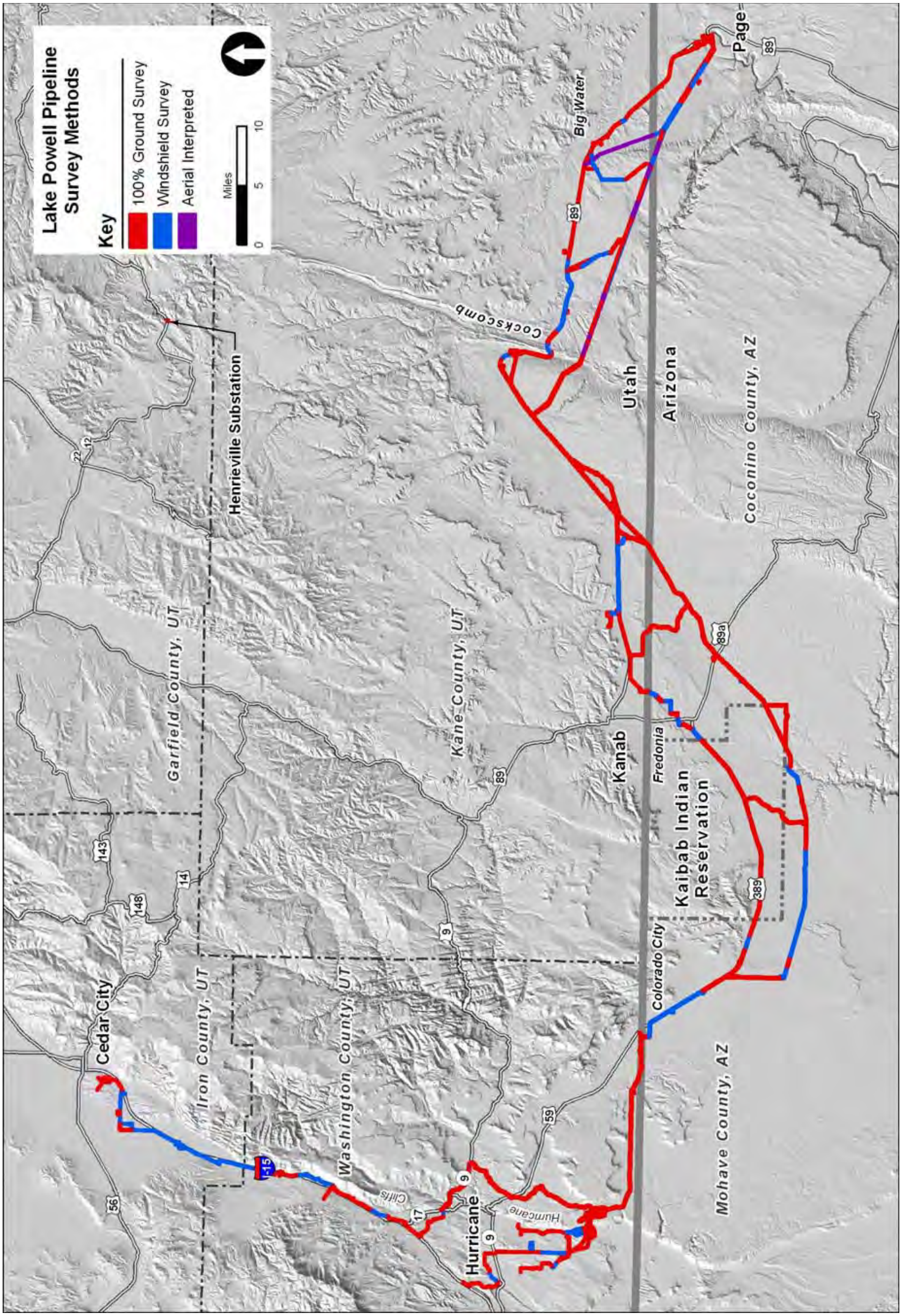
3.2 Survey

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 LSD 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, 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 (191.6 miles) was achieved using a combination of pedestrian surveys (82.4 percent) and windshield/binocular surveys (17.6 percent) (Map 3-1). Approximately 90 percent of the 300-foot-wide corridor (194.8 miles) was surveyed either on foot (60.0 percent) or by windshield/binocular surveys (30.2 percent), with 9.8 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.



Map 3-1
Survey Corridors Map

Figure 3-1
Crew members approximately 20 feet apart, walking parallel transects across the survey area

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 3-1). 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.

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 3-2). In the case of a newly-encountered noxious weed, surveyors observed the plant in order to increase familiarity with the species.

Figure 3-2
Crew members observe *Cryptantha semiglabra* in its natural habitat

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, Eriogonum corymbosum* var. *nilessi, Lupinus caudatus* var. *cutleri, Pediocactus sileri, Penstemon laevis,* 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 3-3). 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: *Camissonia exilis, 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.

Figure 3-3
Collecting and recording Pediocactus sileri data

When a large population of a special status species was encountered, a tally approach was utilized. Species documented using the tally method include: *Camissonia exilis, 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 (*Camissonia exilis, Pediomelum epipsilum, Phacelia mammalariensis*).

Plant counts for the large or dense populations of *Ceanothus greggii* var. *vestitus* and *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.

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 E). 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 D). 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 3-4).

Figure 3-4
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 US 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 US 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 58plant 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 list as threatened, endangered, proposed, candidate, and conservation agreement species potentially occurring in Mohave and Coconino counties, Arizona, and Washington, Kane, and Iron 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 Iron, Kane, and Washington counties Utah (Table 4-1).

Table 4-1
Special Status Plant Species with the Potential to Occur within Lake Powell Pipeline Survey Area
Page 1 of 5

Species Name	Status[a]	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

Table 4-1
Special Status Plant Species with the Potential to Occur within Lake Powell Pipeline Survey Area
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Species Name	Status[a]	Found? (Yes / No)
Camissonia bairdii (Baird camissonia) Onagraceae	BLM UT	No
Camissonia exilis (Slender evening primrose) Onagraceae	BLM UT	Yes
Camissonia gouldii (Diamond Valley suncup) Onagraceae	BLM UT	No
Ceanothus greggii var. *vestitus* (Mohave ceanothus) Rhamnaceae	GCNRA G5	Yes
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
Eriogonum corymbosum var. *nilesii* (Las Vegas buckwheat) Polygonaceae	ESA C	Yes
Eriogonum mortonianum (Morton Wild-Buckwheat) Polygonaceae	N/A Yes	

Table 4-1
Special Status Plant Species with the Potential to Occur within Lake Powell Pipeline Survey Area
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Species Name	Status[a]	Found? (Yes / No)
Eriogonum thompsoniae var. *atwoodii* (Atwood Wild-Buckwheat) Polygonaceae	N/A Yes	
Euphorbia nephradenia (Utah spurge) Euphorbiaceae	BLM UT	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

Table 4-1
Special Status Plant Species with the Potential to Occur within Lake Powell Pipeline Survey Area
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Species Name	Status[a]	Found? (Yes / No)
Pediomelum aromaticum var. *barnebyi* (Indian breadroot) Fabaceae	BLM UT	No
Pediomelum castoreum (Beaver Dam breadroot) Fabaceae	N/A No	
Pediomelum epipsilum (Kane breadroot) Fabaceae	BLM UT	Yes
Penstemon ammophilus (Sandloving penstemon) Scrophulariaceae	BLM UT	No
Penstemon laevis (Smooth penstemon) Scrophulariaceae	N/A Yes	
Petalonyx parryi (Parry petalonyx) Loasaceae	BLM UT	Yes
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

Table 4-1 Special Status Plant Species with the Potential to Occur within Lake Powell Pipeline Survey Area Page 5 of 5		
Species Name	**Status[a]**	**Found? (Yes / 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
Tricardia watsonii (Three hearts) Hydrophyllaceae	BLM AZ	No
Viguiera soliceps Syn. *Heliomeris soliceps* (Tropic goldeneye) Asteraceae	BLM UT, GCNRA G3	No
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 58 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 58 species for which surveys were conducted, fifteen 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 B 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 distribution of special status species is analyzed according to the vegetation communities in whch they occur. The three ecological regions represented within the survey area are Colorado Plateau, Great Basin, and Mohave 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 (LSD 2010).

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 discussions for each taxon summarize 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 occurs 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 *the A. glabrum* are winged and reddish. Flowering occurs from April to May Utah (NPIN 2010).

Acer 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 between 5,500 feet (1,675 meters) and 10,420 feet (3,175 meters) (Weslsh et al. 2008). In Arizona, it is found in white fir, white fir-Douglas fir, and Englemann spruce communities from 5,000 feet (1,524 meters) to 12,000 feet (3,658 meters) (Anderson 2001).

4.3.1.2 Survey Results

Acer glabrum was not encountered during project surveys.

4.3.1.3 Discussion

The survey area does not support potentially suitable habitat for *Acer 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 the *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 milimeters) 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.

Acer 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

Acer gradidentatum was not encountered during project surveys.

4.3.2.3 Discussion

The survey area does not support potentially suitable habitat for *Acer 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 the *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 milimeters) 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).

Aralia 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 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 (1515 meters) to 9,500 feet (2895 meters) (Kearney and Peebles 1951). The species is found in eight Arizona counties, including Coconino (USDA-NRCS 2009).

Aralia 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

Aralia racemosa was not encountered during project surveys.

4.3.3.3 Discussion

The survey area does not support potentially suitable habitat for *Aralia 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.

Arctomecon 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 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 Mohave 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).

Arctomecon 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 US 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

Arctomecon humilis was not encountered during project surveys.

4.3.4.3 Discussion

Arctomecon 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 (1036 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 (1050 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 milimeters) long and cream colored, with a rose-tinged center. *A. welshii* pproduces 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).

Asclepias 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 desertscrub 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 desertscrub 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).

Asclepias welshii was proposed threatened on June 6, 1984 and determined threatened on October 28, 1987 by the US 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 good to excellent viability. In Utah, 1,000's 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

Asclepias welshii was not encountered during project surveys.

4.3.5.3 Discussion

There is a moderate probability of finding *Asclepias 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 (the 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.

Astragalus 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 *Astragalus 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).

The final federal rule listing *A. ampullarioides* as an endangered species also designated critical habitat for the species (66 FR 49560). The survey area occurs within the vicinity of designated critical habitat for *Astragalus ampullarioides*. Four distinct groups occur within the designated critical habitat near Harrisburg Junction at Quail Creek Reservoir in Washington County, Utah. The groups have been separated into two subunits: subunit 4a: Harrisburg Bench and Cottonwood and subunit 4b: Silver Reef (USFWS 2006). Subunit 4a: Harrisburg Bench and Cottonwood includes lands between the northbound and southbound lanes of I-15 and areas east of I-15.

Subunit 4b: Silver Reef occurs immediately north of the project route on outcroppings of the Chinle Formation (71 FR 77986).

4.3.6.2 Survey Results

Astragalus ampullarioides was not encountered during project surveys. Potentially suitable habitat and a portion of critical habitat occurred within the survey area.

4.3.6.3 Discussion

Surveying for *Astragalus ampullarioides* requires precise timing to ensure that both flowers and fruits are present within the same location. For *A. ampullarioides*, the correct timing would be approximately April 1 through April 30 in an average temperature year, given a reported March to April blooming period. Field work in 2009 began April 22 and the potential habitat within the survey area, which included a small portion of the eastern edge of critical habitat subunit 4a, was surveyed on April 29, 2010. Large areas on and adjacent to designated critical habitat were found to be burned by a recent wildfire and subsequently invaded with exotics. No *Astragalus* of any species was observed within this area. Additional surveys of similar plant communities were conducted to the south of critical habitat subunit 4a on May 16th. Again, no *Astragalus* of any species was observed during 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 between 3,200 feet (970 meters) and 5,400 feet (1650 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 Five-Mile Mountain to West Clark Bench on Chinle and Moenave formations.

4.3.7.2 Survey Results

Astragalus ampullarius was not encountered during project surveys.

4.3.7.3 Discussion

Although no *Astragalus 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 area at the Cockscomb and Five-Mile Mountain to West Clark Bench was all suveyed. 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 (the 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).

Astragalus 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

Astragalus 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.

Astragalus 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 collectioned 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 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

Astragalus 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 (the Evening Primrose Family) that growns 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 geopharic 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

Baird’s camissonia 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 exilis* (Slender evening primrose)

4.3.11.1 Natural History

Figure 4-1
Close up view of *Camissonia exilis* in bloom

Camissonia exilis is an annual in the Onagraceae (the Evening Primrose Family). Its single slender, branched leafy stems are purplish-brown in color, contain minute glands, and arise from a tap root (Welsh et al. 1993), growing up to 4 inches in height. The plant is covered with soft, downy hairs that can appear white and shaggy or long. Leaves are 1.4 inches (3.5 centimeters) long, simple, and oval-shaped, with toothed margins and prominent veins below the leaf. Flowers are tiny, less than 0.06 inches (1 to 1.5 millimeters) long (Welsh et al. 1993), with yellow petals fading to purple (Figure 4-1). Flowers are self-pollinating and bloom from May to June in Arizona (ARPC 2001) and from late April to May in Utah (UNPS 2003 – 2008).

Camissonia exilis is distinguished from other *Camissonia* species by having 4 stamens, rather than the 8 that are characteristic of the genus (ARPC 2001). *C. exilis* is also unique in that it lacks the ring of stamens that is attached to the petals of other *Camissonia* species (Welsh et al. 1993).

Camissonia exilis is a Colorado Plateau endemic. The known range of the species is limited to western Kane County, Utah, and Mohave and Coconino counties, Arizona. In Utah, *C. exilis* inhabits sagebrush, galleta, and pinyon-juniper communities between 5,000 feet (1,524 meters) and 6,900 feet (2,103 meters) in elevation (UNPS 2003 – 2008; Welsh et al. 2008). In Coconino County *C. exilis* is known from two sites in the Coyote Valley at the Utah – Arizona state line. In Mohave County, *C. exilis* is known near Fredonia (AGFD 2005). The species is found in warm desert scrub communities from 3,500 feet to 5,000 feet in elevation, on small islands of saline soils (AGFD 2005) derived from clay badlands of the Moenkopi Formation, as well as travertine-sandy gypsum outcrops (ARPC 2001) . *C. exilis* has strict habitat requirements. Germination and plant growth are dependent upon adequate winter rainfall; during dry years, the species is absent from the landscape (ARPC 2001).

4.3.11.2 Survey Results

Camissonia exilis was encountered in six reaches, including: the Water Conveyance System, the Buckskin to Paria Transmission Line, the Hydro System High Point, the Hydro System High Point Alignment Alternative, the Hydro System South Alternative, and 8-Mile Gap Road reaches. Surveys located a total of 6,416 individual plants, most of which (3,890) were encountered in the Hydro System, Hydro System High Point Alignment Alternative, and Hydro System South Alternative reaches on BLM lands southwest of Telegraph Wash extending to Petrified Hollow Wash. A second location of 1,645 individuals, also on BLM lands, was also encountered in the Hydro System and Hydro System High Point Alignment Alternative reaches between Petrified Hollow Wash and Shinarump Cliffs. The smallest numbers were encountered on private land in the vicinity of Kimball Valley (25 individuals), and in an area southwest of White Sage Wash on BLM land where only eight individuals were identified (Table 4-2). From Seaman Wash to White Sage Wash to Eightmile Gap Road, *C. exilis* was found to share a microhabitat with *Phacelia pulchella* var. *atwoodii*. The distribution of *C. exilis* across the survey area is shown in (Table 4-2) and Map 4-1 and Map 4-2.

Table 4-2 A summary of *Camissonia exilis* survey results by location			
Reach	**Location**	**Land Ownership**	**# of Plants**
Water Conveyance System and Buckskin to Paria Transmission Line	Five Mile Valley	Private	25
Water Conveyance System	Kimball Valley to Five Mile Mountain Road at US 89	BLM 174	
Hydro System High Point Alignment Alternative	1.0 mile to 2.5 miles southwest of Telegraph Wash	BLM 370	
Hydro System and Hydro System High Point Alignment Alternative	3.0 miles southwest of Telegraph Wash to Petrified Hollow Wash	BLM 1,645	
Hydro System and Hydro System High Point Alignment Alternative and Hydro System South Alternative	0.62 miles southwest of Petrified Hollow Wash to 0.45 miles northeast of Shinarump Cliffs	BLM 3,890	
Hydro System South Alternative	0.7 miles north and 3.0 miles southwest of th Utah-Arizona state line	BLM 193	
Hydro System South Alternative	0.3 miles to 0.65 miles southwest of White Sage Wash	BLM 8	
8-Mile Gap Road	1.35 to 2.65 north of Johnson Wash	BLM	111
		Total 6,416	

Camissonia exilis was found within the Colorado Plateau Ecological Region, where it occurred in a total of five ecological systems and one area of ruderal vegetation. The species was identified in a total of 10 alliances and 21 associations (see Vegetation Communities Report). *C. exilis* was observed within the Mixed Desert Scrub, Shrub-Steppe, and Pinyon-Juniper ecological systems, and in Ruderal Vegetation (along Highway 89), but was most commonly encountered in the Big Sagebrush Shrubland and Gypsum Badlands ecological systems. The majority of *C. exilis* (2,119 individuals) were found in the Colorado Plateau Gypsum Badlands Ecological System in the *Artemisia tridentata* ssp. *vaseyana* Gypsum Badland Sparse Shrubland Alliance. Another area with large numbers of individuals (1,686 individuals) was located in the Colorado Plateau Big Sagebrush Shrubland Ecoligical System in the *Artemisia tridentata* ssp. *vaseyana* Sparse Understory Shrubland Association. Another large group of plants (764 individuals in total) was also located in an association co-dominated by *Juniperus osteosperma*. Although most *C. exili* were encountered in associations dominated by native species, it was also found in ruderal vegetation. Additionally, three of the areas with the fewest plants documented occurred in associations co-dominated by invasive weeds, including *Bromus rubens*, *B. tectorum*, *Erodium cicutarium*, and *Salsola tragus*. *C. exilis* was frequently located with other special status species, including *Phacelia pulchella* var. *atwoodii* and *Pediomelum epipsulum*. Individuals of *C. exilis* were found at elevations ranging from 1,500 feet (457 meters) to 5,620 feet (1,713 meters). All vegetation communities supporting *C. exilis* are shown in Table 4-3.

Table 4-3 A summary of *Camissonia exilis* survey results by alliance and association		
Alliance	**Association**	**# of Plants**
COLORADO PLATEAU BIG SAGEBRUSH SHRUBLAND ECOLOGICAL SYSTEM		
Artemesia tridentata Shrubland	*Artemesia tridentata* Shrubland 3	
Artemesia tridentata Shrubland	*Artemesia tridentata /* Sparse Understory Shrubland	137
Artemesia tridentata Shrubland	*Artemesia tridentata* / (*Erodium cicutarium, Salsola tragus, Ceratocephala testiculata, Broumus* (*rubens,* tectorum) Semi-natural Sparse Shrubland	10
Artemesia tridentata ssp. *tridentata* Shrubland	*Artemesia tridentata* ssp. *tridentata* / Sparse Understory Shrubland	3
Artemesia tridentata ssp. v*aseyana* Shrubland	*Artemesia tridentata* ssp. v*aseyana* Shrubland	223
Artemesia tridentata ssp. v*aseyana* Shrubland	*Artemesia tridentata* ssp. v*aseyana* / Sparse Understory Shrubland	1,686
Artemesia tridentata ssp. v*aseyana* Shrubland	*Artemesia tridentata* ssp. v*aseyana* / *Chrysothamnus greenei* Shrubland	25
Artemesia tridentata ssp. v*aseyana* Shrubland	*Artemesia tridentata* ssp. v*aseyana* / *Gutierrezia sarothrae* / Sparse Understory Shrubland	85
COLORADO PLATEAU GYPSUM BADLAND ECOLOGICAL SYSTEM		
Artemesia tridentata ssp. *vaseyana* Shrubland	*Artemesia tridentata* ssp. *vaseyana* Gypsum Badlands Shrubland	2
Artemesia tridentata ssp. *vaseyana* Shrubland	*Artemesia tridentata* ssp. *vaseyana* Gypsum Badland Sparse Shrubland	16
Artemesia tridentata ssp. *vaseyana* Shrubland	*Juniperus osteosperma / Artemesia tridentata* ssp. *vaseyana* Gypsum Badlands Wooded Shrubland	2,119
Eriogonum corymbosum Shrubland	*Eriogonum corymbosum - Artemesia tridentata* ssp. *vaseyana* Gypsum Badlands Shrubland	109
Eriogonum corymbosum Shrubland	*Eriogonum corymbosum - Artemesia tridentata* ssp. *vaseyana* Gypsum Badlands Sparse Shrubland	800
Juniperus osteosperma Sparsely Vegetated	*Juniperus osteosperma / Eriogonum corymbosum / Pediomelum epipsilum* Gypsum Badlands Wooded Sparse Vegetation	259
Juniperus osteosperma Woodland	*Juniperus osteosperma* Gypsum Badlands Sparse Woodland	60
COLORADO PLATEAU MIXED DESERT SCRUB ECOLOGICAL SYSTEM		
Salsola tragus Semi-natural Herbaceous	*Gutierrezia sarothrae / Salsola tragus* Semi-natural Shrub Herbaceous Vegetation	1
COLORADO PLATEAU SHRUB-STEPPE SCRUB ECOLOGICAL SYSTEM		
Gutierrezia sarothrae Shrubland	*Gutierrezia sarothrae / Pleuraphis jamesii* – (*Erodium cicutarium, Bromus (tectorum, rubens), Salsola tragus)* Semi-natural Dwarf-shrubland	6
Gutierrezia sarothrae Shrubland	*Gutierrezia sarothrae* - (*Opuntia* spp.) */ Pleuraphis jamesii* Sparse Dwarf-shrubland	29
Gutierrezia sarothrae Shrubland	*Gutierrezia sarothrae* - (*Opuntia* spp.) */ Pleuraphis jamesii* Dwarf-shrubland	38

Gutierrezia sarothrae Shrubland	*Gutierrezia sarothrae /Pleuraphis jamesii, Achnatherum hymenoides)* Dwarf-shrubland	10
COLORADO PLATEAU PINYON-JUNIPER WOODLAND ECOLOGICAL SYSTEM		
Artemesia tridentata ssp. *vaseyana* Shrubland	*Juniperus osteosperma / Artemesia tridentata* ssp. *vaseyana* Wooded Shrubland	764
RUDERAL VEGETATION		
Ruderal Ruderal		31
	Total	6,416

Camissonia exilis was found on six geologic formations within the survey area. It was primarily identified on the Middle Red Member of the Moenkopi Formation and the Shnabkaib Member of the Moenkopi Formation within the Colorado Plateau Gypsum Badlands Ecological System. These are 250-256 million year old formations on which gypsum badlands can typically be found. The Undivided Moenkopi Formation is a light-red and dark-red, slope-forming siltstone and sandstone with minor gray gypsum. This Formation 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. exilis* are given in Table 4-4.

Table 4-4
A summary of *Camissonia exilis* survey results by geologic formation

Geologic Formation	# of Plants
COLORADO PLATEAU BIG SAGEBRUSH SHRUBLAND ECOLOGICAL SYSTEM	
Qah	93
Undivided Moenkopi Formation	87
,Lower Red Member of the Moenkopi Formation	73
Middle Red Member of the Moenkopi Formation	375
Shnabkaib Member of the Moenkopi Formation	416
Alluvium, Middle Red Member of the Moenkopi Formation*	25
Qah, Middle Red Member of the Moenkopi Formation	1,103
COLORADO PLATEAU GYPSUM BADLAND ECOLOGICAL SYSTEM	
Qah	516
Qah, Lower Red Member of the Moenkopi Formation *	34
Qah, Middle Red Member of the Moenkopi Formation*	1,268
Qah, Shnabkaib Member of the Moenkopi Formation*	370
Undivided Moenkopi Formation	20
Lower Red Member of the Moenkopi Formation	36
Middle Red Member of the Moenkopi Formation	283
Shnabkaib Member of the Moenkopi Formation	838

COLORADO PLATEAU MIXED DESERT SCRUB ECOLOGICAL SYSTEM	
Undivided Moenkopi Formation	1
COLORADO PLATEAU SHRUB-STEPPE ECOLOGICAL SYSTEM	
Undivided Moenkopi Formation	83
COLORADO PLATEAU PINYON-JUNIPER WOODLAND ECOLOGICAL SYSTEM	
Qah	80
Qah, Middle Red Member of the Moenkopi Formation	230
Middle Red Member of the Moenkopi Formation	454
RUDERAL VEGETATION	
Middle Red Member of the Moenkopi Formation	26
Shnabkaib Member of the Moenkopi Formation	1
Qah	4
Total 6,416	
*In this case, the resolution of the individual plant location was on a broader scale than the geologic mapping unit. At this occurrence, *Camissonia exilis*may occur on one or both geologic formations.	

Camissonia exilis was found on multiple soil types within the survey area. The majority of plants (2,069 individuals) were found on Kenzo-Retsabal-Progresso, cool complex soils and a combination of Kenzo-Retsabal-Progresso, cool complex and Ruinpoint-Barx complex soils (1,382 individuals). Often, the species was identified in soils with well-established cryptobiotic crusts. Table 4-5 provides a complete list of soils where *C. exilis* was observed.

Table 4-5
A summary of *Camissonia exilis* survey results by soil type

Soil type	# of Plants
Barx fine sandy loam	15
Barx gravelly loam	41
Barx-Radnik, moist-Progresso, dry complex; Simel-Strych, moist-Kenzo complex	25
Clayhole silty clay loam	100
Kenzo-Retsabal-Progresso, cool complex	2,069
Kenzo-Retsabal-Progresso, cool complex; Ruinpoint-Barx complex	1,382
Kenzo-Retsabal-Progresso, cool complex; Ruinpoint-Barx complex; Yarts-Palma-Neville family-Barx-Atchee	666
Kenzo-Retsabal-Progresso, cool complex; Yarts-Palma-Neville family-Barx-Atchee	550
Klondike sandy clay loam	7
Lemrac-Simel-Humbug, moist complex	1
Lemrac-Simel-Humbug, moist complex; Ruinpoint-Barx complex	487
Manikan silty clay loam	99
Mellenthin, moist-Bowdish complex	36

Mellenthin, moist-Bowdish complex; Ruinpoint-Barx complex	34
Ruinpoint-Barx complex	235
Torriorthents	65
Yarts-Palma-Neville family-Barx-Atchee	604
Total	6,416
*In this case, the resolution of the individual plant location was on a broader scale than the soil mapping unit. At this occurrence, *Camissonia exilis* may occur on one or both soil types.	

Most often, *Camissonia exilis* was found in gypsum badlands; however, from Seaman Wash to White Sage Wash to Eight Mile Gap Road, *C. exilis* was encountered on grazed or disturbed lands of red clay soils, growing with *Artemisia tridentata* or *Gutierrezia sarothrae* and *Salsola tragus*. Along SR 389 between Seaman and Kimball Valley, *C. exilis* was primarily found within disturbed right-of-way lands on cracked gray or red clay soils in association with *Phacelia pulchella* var. *atwoodii* and *Artemisia tridentata*.

Camissonia exilis was observed in bloom as late as August 5, 2009, much later than what has been previously reported.

4.3.11.3 Discussion

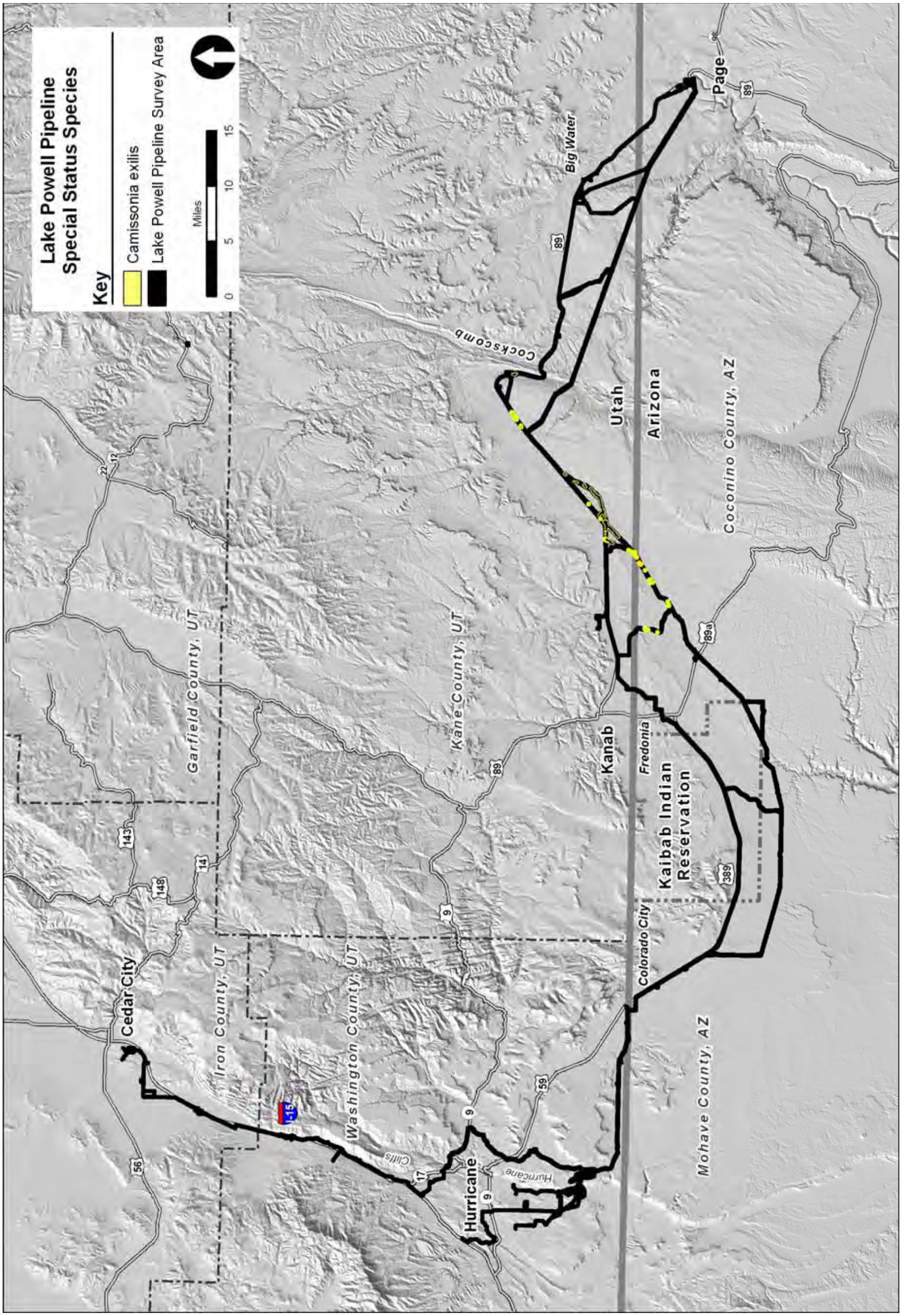
The survey identified a total of 6,416 individuals of *Camissonia exilis* within the survey area, being found within six reaches: the Water Conveyance System, the Buckskin to Paria Transmission Line, the Hydro System High Point, the Hydro System High Point Alignment Alternative, the Hydro System South Alternative, and 8-Mile Gap Road reaches. *C. exilis* was documented entirely on BLM lands, with the exception of a small group of plants found on private land. The majority of individuals were found in Colorado Plateau Big Sagebrush Shrubland and Colorado Plateau Gypsum Badlands Ecological Systems, in associations dominated by *Artemisia tridentata*, *Gutierrezia sarothrae*, or *Juniperus osteosperma. C. exilis* was generally observed on the Middle Red Member and Shnabkaib Member of the Moenkopi Formation. *C. exilis* was mostly encountered in the Kenzo-Retsabal-Progresso soil complex, and in a microhabitat characterized by soils with well-established crytobiotic crusts. While many of these areas were disturbed, localized disturbance to the microhabitats supporting *C. exilis* appeared to be minimal. The species was also found in grazed lands and/or in disturbed rights-of-way.

The affinity of the species for sagebrush and juniper dominated (or co-dominated) vegetation communities is consistent with published data, as were other observations made relative to habitat. Although the species was encountered in 2008, 2009, and in 2010, the same sites were not sampled over multiple years, and therefore, a conclusion regarding variation in densities due to climactic conditions cannot be made. However, the extended blooming period observed in 2009 as a result of mid-summer precipitation is consistent with the known sensitivity of the species relative to climactic conditions.

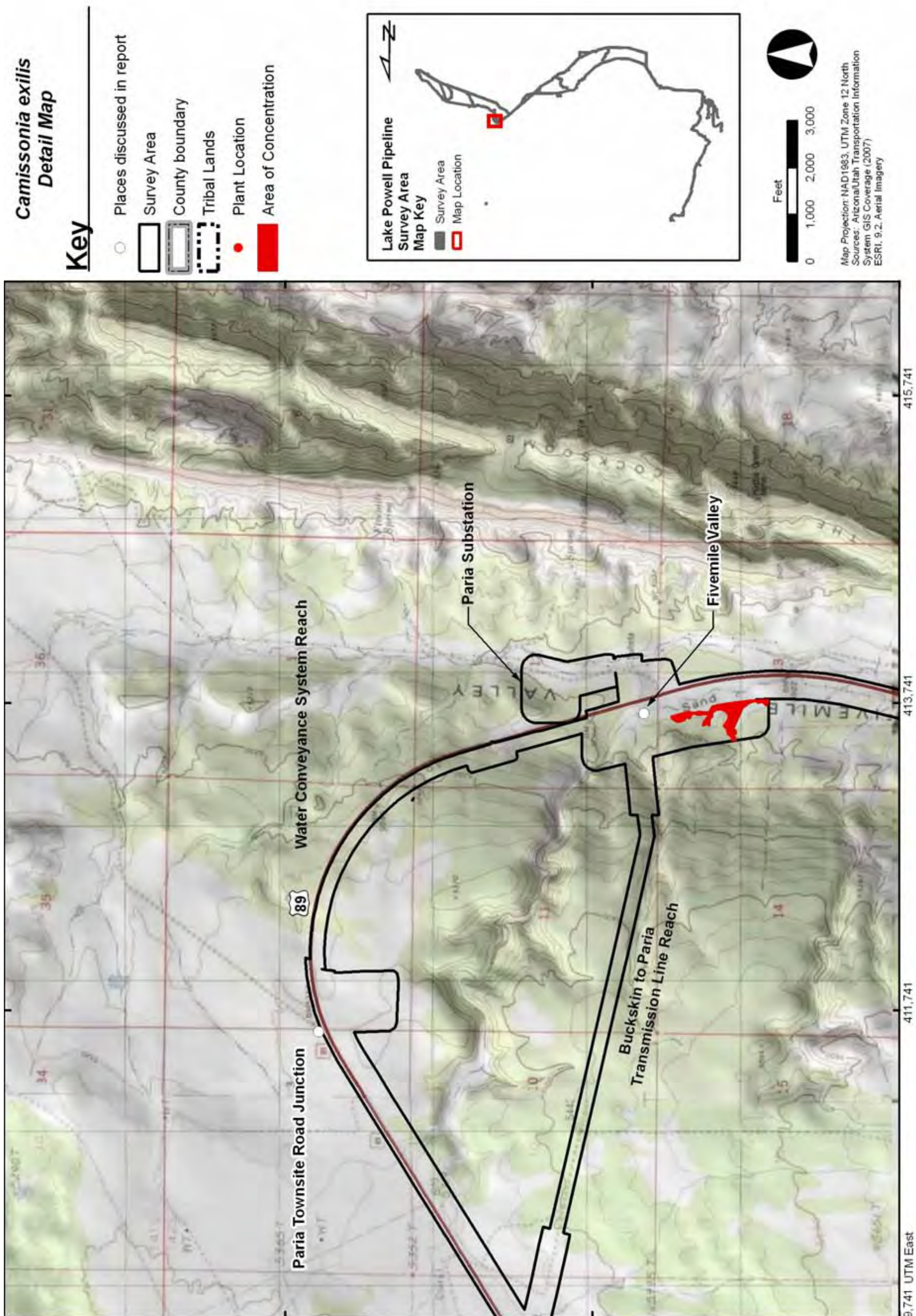
Camissonia exilis was mostly found in vegetation communities dominated or co-dominated by native species; however, it was occasionally encountered in communities co-dominated by invasive weeds. At the same time, these sites had the fewest number of *C. exilis* of those encountered. In microhabitats with well-established cryptobiotic crusts that supported the greatest numbers of *C. exilis*, invasive weeds were noted to be absent or minimally present. Field observation suggests that invasive weeds do not appear to be well-adapted to gypsum badlands. However, disturbances within these microhabitats could result in the introduction of invasive weeds, which may impact the robustness of *C. exilis* within and adjacent to the survey area. Invasive weed species commonly encountered within the survey area, particularly *Bromus rubens*, *B. tectorum*, and *Erodium cicutarium*, would likely compete with *C. exilis* for resources such as moisture and soil nutrients.

The relationship between *Camissonia exilis* and disturbance is not entirely clear. While the species was commonly found in microhabitats that were minimally disturbed, encounters with the species in grazed lands and/or in disturbed rights-of-way indicate that the species is able to colonize disturbed soils. The species also seems to be tolerant of natural disturbance; in addition to the gypsum soils preferred by the species, it was encountered on alluvial lands, where clay and silty-clay deposits have formed through sheet-flow. Likely, this process has carried seeds across the landscape, moving the species into new habitats and extending the boundaries of the location. While the survey illustrates the ability of *C. exilis* to colonize in disturbed soils, the frequency and density of the resulting *C. exilis* was observed to be less than that observed in gypsum badland habitat.

As *Camissonia exilis* reproduces from seed, the number of individuals identified during the survey may represent relative distribution of the plant at various locations where *C. exilis* 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. exilis* seed.



Map 4-1
***Camissonia exilis* Overview Map**



Map 4-2
***Camissonia exilis* Detail Map**

4.3.12 *Camissonia gouldii* (Diamond Valley suncup)

4.3.12.1 Natural History

Camissonia gouldii is an annual in the Onagraceae (the 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).

Camissonia gouldii is allied to *C. 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).

Camissonia 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).

4.3.12.2 Survey Results

Camissonia gouldii was not encountered during project surveys.

4.3.12.3 Discussion

Potential suitable habitat for *Camissonia 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.

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

4.3.13.1 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 (Figure 4-2). Flowering occurs in the spring, with the appearance of white flowers that dry to white.

Figure 4-2
Close up view of *Ceanothus greggii* var. *vestitus*

The range of *Ceanothus greggii* 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).

4.3.13.2 Survey Results

Ceanothus greggii var. *vestitus* was observed during project surveys. A total of 1,520 individuals were found in the the Cedar Valley Pipeline System and the Cedar Valley Transmission Line reaches. The majority of individuals were encountered from between the area of Pintura and Ash Creek Reservoir. Plants were identified on BLM lands and State Trust lands. The distribution of *C. g.* var. *vestitus* across the survey area is shown in Table 4-6 and Map 4-3 to Map 4-5.

Table 4-6
A summary of *Ceanothus gregii* survey results by location

Reach	Location	Land Ownership	# of Plants
Cedar Valley Pipeline System	2.25 miles north of Pintura to Ash Creek Reservoir	BLM and State Trust	1,453
Cedar Valley Transmission Line	3.5 miles southwest of Ash Creek Reservoir	BLM 67	
		Total 1,	520

Ceanothus greggii var. *vestitus* occurred in the Great Basin Ecological Region in Chaparral and Pinyon-Juniper Woodland Ecological Systems, within four alliances and six associations. The majority of *C. greggii* var. *vestitus* occurred within the *Juniperus osteosperma* Woodland Alliance, in the *Juniperus osteosperma / Artemisia tridentata* ssp. *vaseyana* Woodland Association. In the chaparral system, *C. g.* var. *vestitus* was a major component of the vegetation community. Individual *C. g.* var. *vestitus* were found ranging in elevations from 4,180 feet (1,274 meters) and 4,920 feet (1,500 meters). All alliances and associations supporting *C. g.* var. *vestitus* are shown in Table 4-7.

Table 4-7 **A summary of *Ceanothus gregii* survey results by alliance and association**		
Alliance	**Association**	**# of Plants**
GREAT BASIN CHAPARRAL ECOLOGICAL SYSTEM		
Amelanchier utahensis Shrubland	*Amelanchier utahensis – Ceanothus greggii* var. *vestitus* Shrubland	67
Ceanothus greggii Shrubland	*Ceanothus greggii* Shrubland 429	
Ceanothus greggii Shrubland	*Ceanothus greggii* Sparse Shrubland	211
Ceanothus greggii Shrubland	*Juniperus osteosperma / (Ceanothus greggii, Artemisia tridentata)* Wooded Shrubland	201
GREAT BASIN PINYON-JUNIPER WOODLAND ECOLOGICAL SYSTEM		
Bromus (rubens, tectorum) Semi-natural Herbaceous	*Juniperus osteosperma / Gutierrezia sarothrae / Bromus tectorum* Semi-natural Wooded Herbaceous Vegetation	36
Juniperus osteosperma Woodland	*Juniperus osteosperma / Artemisia tridentata* ssp. *vaseyana* Woodland	576
	Total	1,520

Ceanothus greggii var. *vestitus* was documented on a number of different geologic formations across four ecological systems. The species was most abundant on mass-movement deposits, particularly on talus deposits. Talus deposits are recognized by poorly sorted, angular boulders and finer-grained deposits from rock fall at the base of steep slopes. Talus deposits also include alluvial deposits in the bottom of washes (Biek at al. 2007). All geologic formations supporting *C. g.* var. *vestitus* are given in Table 4-8.

Table 4-8 **A summary of *Ceanothus gregii* survey results by geologic formation**	
Geologic Formation	**# of Plants**
GREAT BASIN CHAPARRAL ECOLOGICAL SYSTEM	
Pintura basaltic lava flows	67
Talus deposits	841
GREAT BASIN PINYON-JUNIPER WOODLAND ECOLOGICAL SYSTEM	
Alluvium	168
Alluvial-fan deposits	135
Younger alluvial-fan deposits	78
Talus deposits	231
Total	1,520

Ceanothus greggii var. *vestitus* was found on five soil types within the survey area. The majority of plants were found on Menefee-Rock outcrop complex soils. Table 4-9 provides a complete list of soils supporting *C. g.* var. *vestitus*.

Table 4-9 **A summary of *Ceanothus gregii* survey results by soil type**	
Soil type	**# of Plants**
Chilton gravelly loam, 5 to 30 percent slopes	99
Collbran very cobbly clay loam, 2 to 30 percent slopes	103
Menefee-Rock outcrop complex, 25 to 60 percent slopes	953
Stony colluvial land	365
Total 1,520	

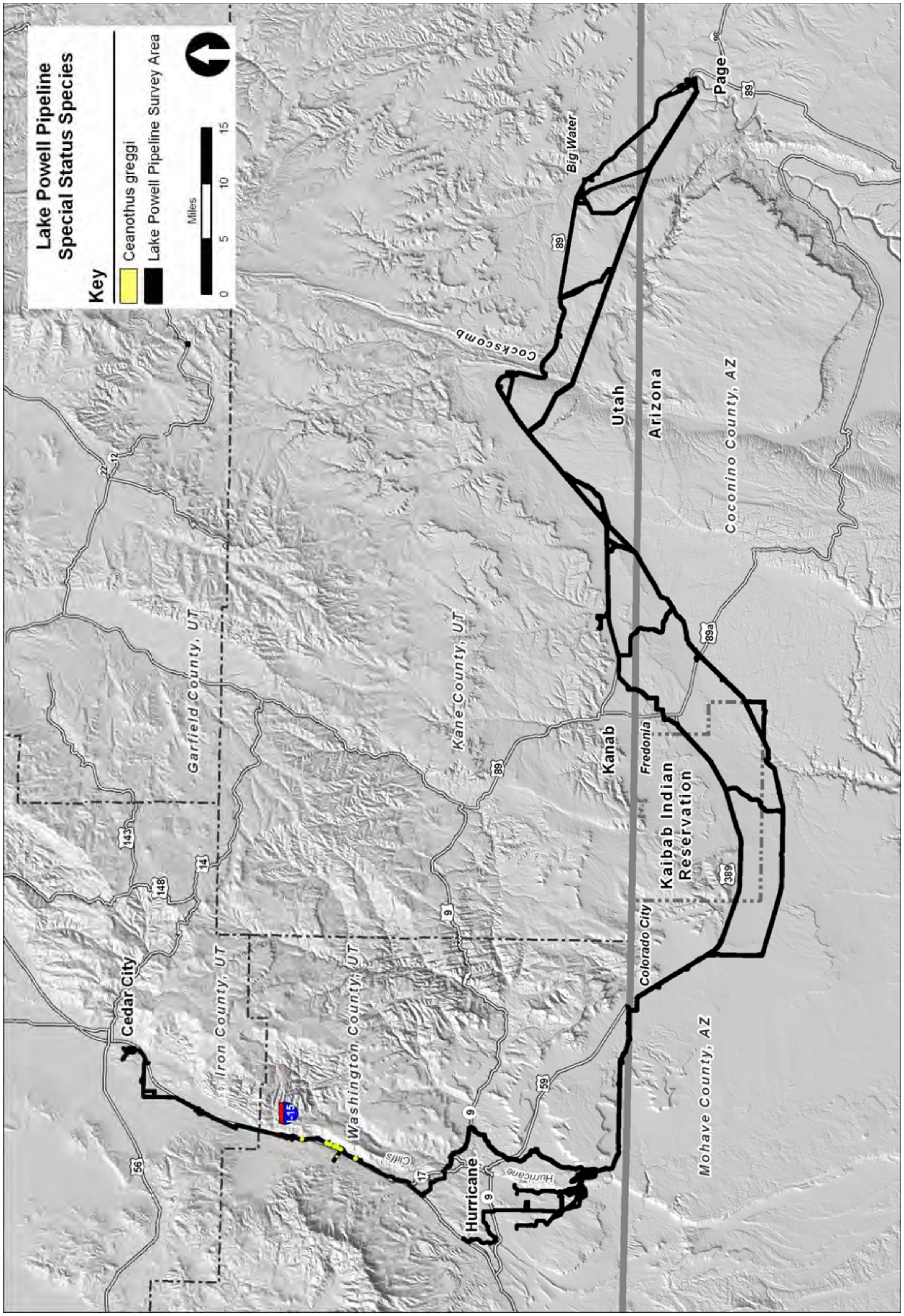
4.3.13.3 Discussion

A total of 1,567 *Ceanothus greggii* var. *vestitus* individuals were noted in the survey area, all of which occurred within the Great Basin Ecological Region. The species was found in the the Cedar Valley Pipeline System and the Cedar Valley Transmission Line reaches. The largest occurence was located on a combination of BLM lands from between the area of Pintura to Ash Creek Reservoir. The majority of individuals were found on volcanic talus deposits, in Menefee-Rock outcrop complex soils. Note, *C. g.* var. *vestitus* is a GCNRA species of concern; however no plants were located within the GCNRA.

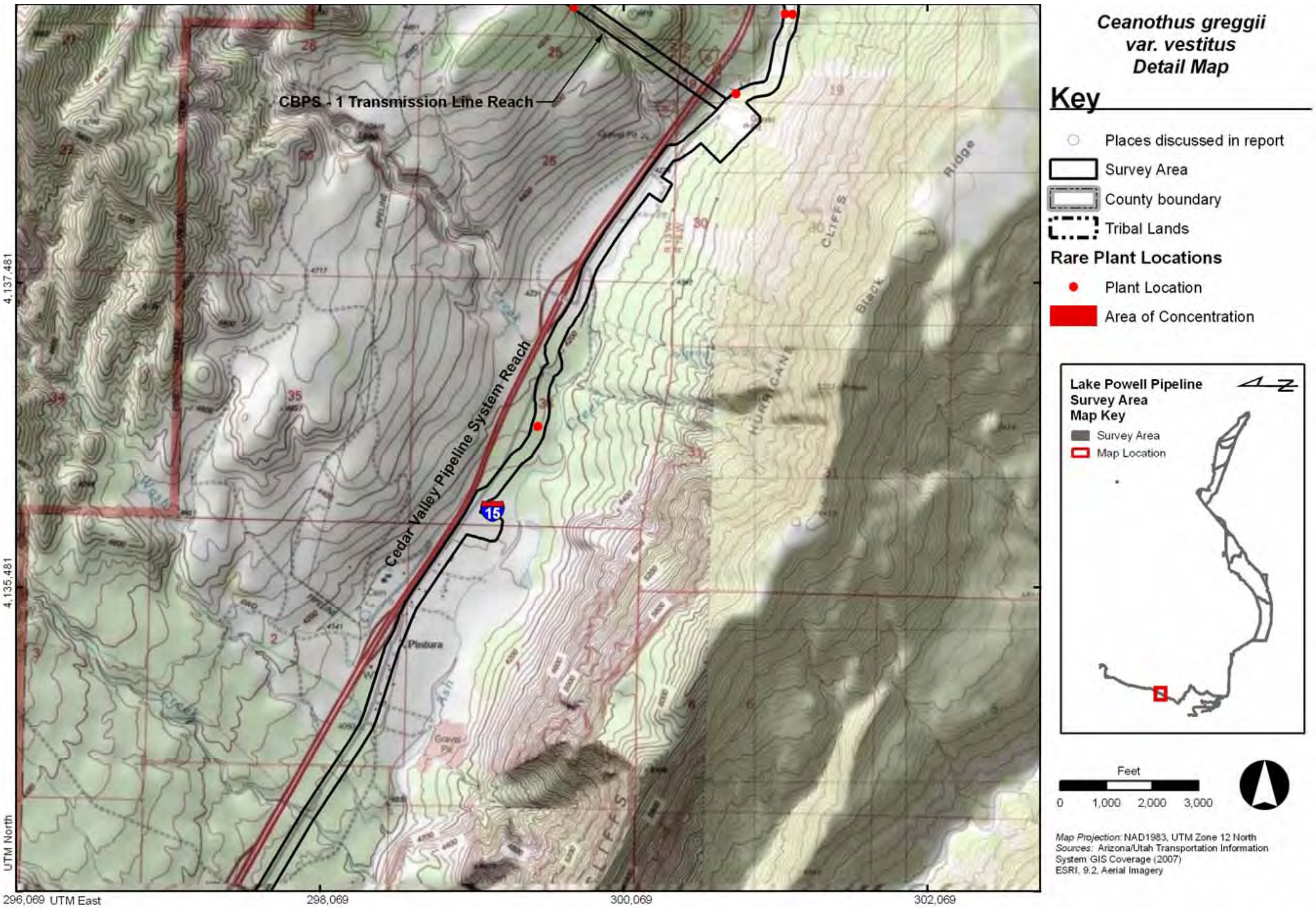
The *Ceanothus greggii* encountered near Pintura were not identified as var. *vestitus* until later in the survey season. Counts of individuals were not taken during the intial surveys, so an extrapolation based on the densities observed at the Ash Creek and the acreage of the Pintura site were used to provide a count. The number of *C. g.* var. *vestitus* reflected for Pintura was also weighted based on the observed abundance.

Ceanothus greggii var. *vestitus* is a characteristic mid-successional species of lava flows, occurring in abundance within suitable habitats adjacent to I-15. The species appears to colonize areas that have experienced small burns, presumably due to lighting strikes. In the last decade, there have been massive man-caused wildfires in the portions of the survey area identified as supporting the species. Because the species seems to be tolerant of disturbance, *C. g.* var. *vestitus* can be expected to persist, so long as seeds remain viable in the soil seed bank, and seed-bearing plants remain in areas adjacent to burns.

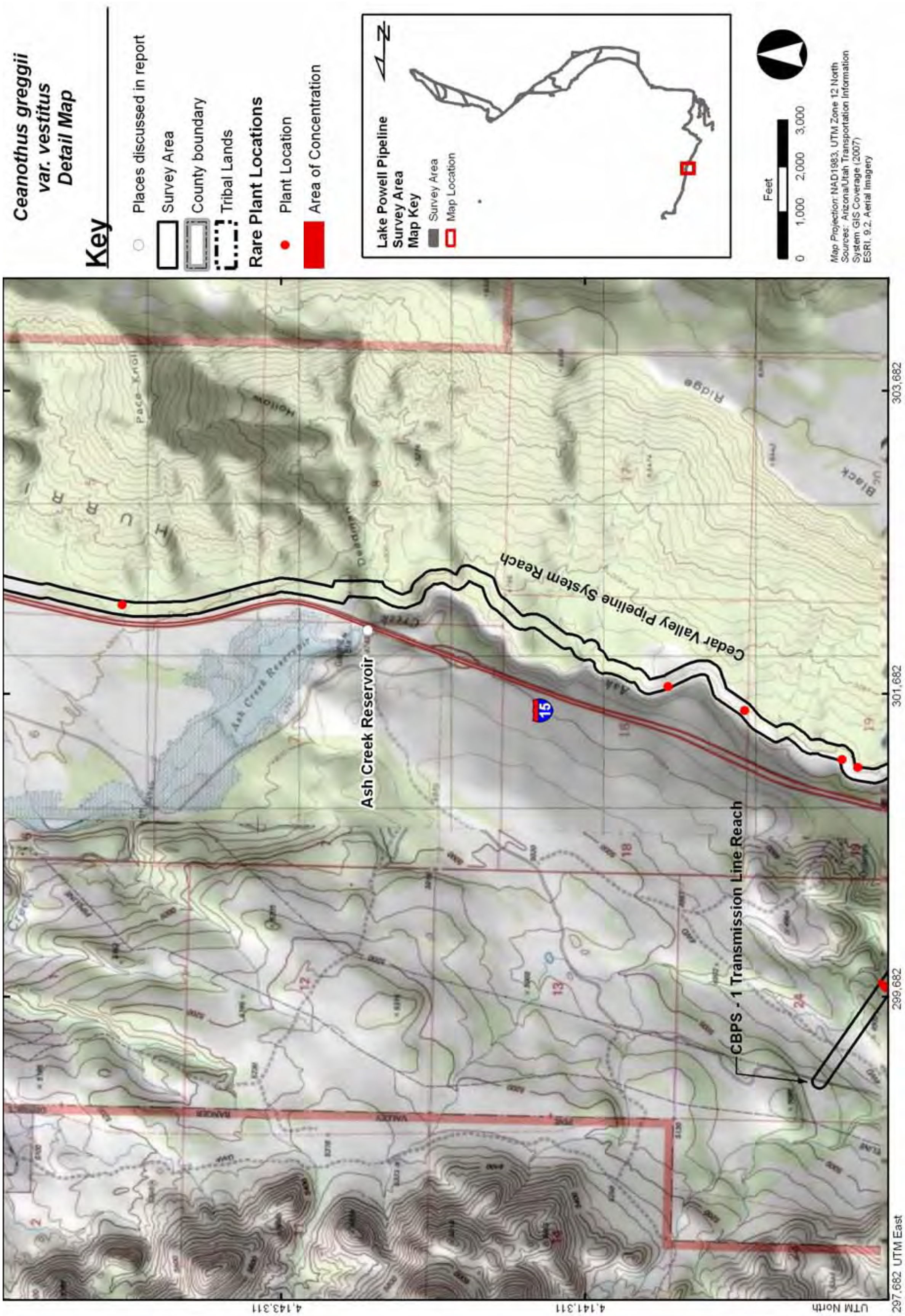
Where project related impacts cannot be avoided individuals could be salvaged and re-located into similar habitats or replaced on site followind disturbance. Additionally, as *C. g.* var. *vestitus* appears to be moderately tolerant of disturbance, this species may be a good candidate for propagation and/or seed collection in order to supplement revegetation efforts of affected areas.



Map 4-3
***Ceanothus greggii* var. *vestitus* Overview Map**



Map 4-4
***Ceanothus greggii* var. *vestitus* Detail Map**



Map 4-5
***Ceanothus greggii* var. *vestitus* Detail Map**

4.3.14 *Cladium californicum* (California sawgrass)

4.3.14.1 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).

Cladium 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).

4.3.14.2 Survey Results

Cladium californicum was not encountered during project surveys.

4.3.14.3 Discussion

No seeps or hanging gardens were encountered in field surveyed survey areas. *Cladium 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.

4.3.15 Cornus sericea (Red-osier dogwood)

4.3.15.1 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).

Cornus 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).

4.3.15.2 Survey Results

Cornus sericea was not encountered during project surveys.

4.3.15.3 Discussion

Cornus 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.

4.3.16 *Cryptantha semiglabra* (Smooth catseye)

4.3.16.1 Natural History

Cryptantha semiglabra is an herbaceous perennial in the *Boraginaceae* (the 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 4-3). The tube of each flower is 0.35 to .50 inches (9 to 12 milimeters) 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 4-3
Close up view of *Cryptantha semiglabra*

Cryptantha 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).

Cryptantha 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 Desertscrub 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 Desertscrub 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).

4.3.16.2 Survey Results

Within the survey area, *Cryptantha 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 SR 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) were 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 SR 389. The fewest number of individuals were encountered adjacent to Twomile Wash, where 103 individuals were identified (Table 4-10). The distribution of *C. semiglabra* across the survey area is shown in Map 4-6 to Map 4-9.

Table 4-10
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 Highway 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 *Cryptantha 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 *Artemesia biglovii – Ephedra torreyana /* Crytobiotic Gypsum Badlands Sparse Shrubland associations. *Cryptantha semiglabra* was mostly found in areas that were sparsely vegetated (**Error! Reference source not found.**); 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 4-11.

The relative abundances of *Cryptantha semiglabra* individuals varied across microhabitats with Gyspum Badlands. Its abundance was documented as locally common on mud washes, as locally abundand at the base of red hills, and on toe slopes below gypsum outcrops. On gypsum outcrops 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.

Table 4-11
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		
Artemesia biglovii Shrubland	*Artemesia biglovii – Ephedra torreyana* / Crytobiotic Gypsum Badlands Sparse Shrubland	830
Atriplex confertifolia Shrubland	*Atriplex cofertifolia* 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 3314	

Cryptantha 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 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 MiddleRred Members. The Shnabkaib Member of the 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 4-12.

Table 4-12
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	
Qa1	100
Undivided Moenkopi Formation	2214
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	3314

Cryptantha 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 4-13

Table 4-13
A summary of *Cryptantha semiglabra* survey results by soil type

Soil type	# of Plants
Clayhole loam	226
Gypsiorthids-Gypsiorthids, shallow complex	3088
Total	3,314
*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.	

4.3.16.3 Discussion

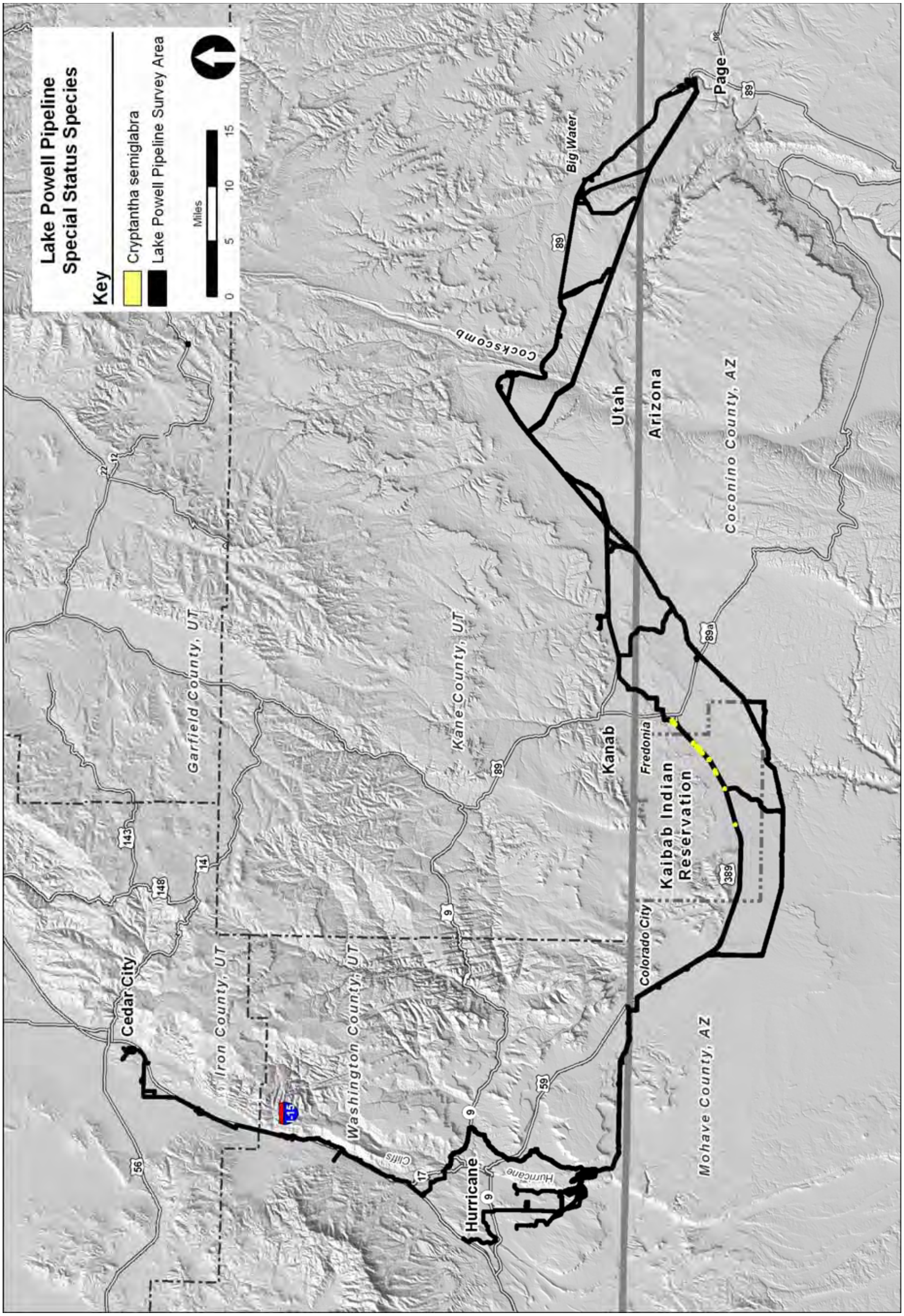
The survey identified a total of 3,314 individuals of *Cryptantha semiglabra* within the survey area, occurring entirely within Mohave County, Arizona; within the Hydro System Existing Highway Alternative Reach. These individuals were documented mostly within the Colorado Plateau Gypsum Badlands Ecological System (Figure 4-4). *C. semiglabra* was observed most often on Gypsiorthids-Gypsiorthids soils of the Undivided Moenkopi Formation. Nearly all individuals were located on the Kaibab Indian Reservation, although some were found on private and State Trust Lands to the east of the Reservation. Note that *C. semiglabra* is a BLM sensitive species found outside BLM jurisdiction.

Cryptantha 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).

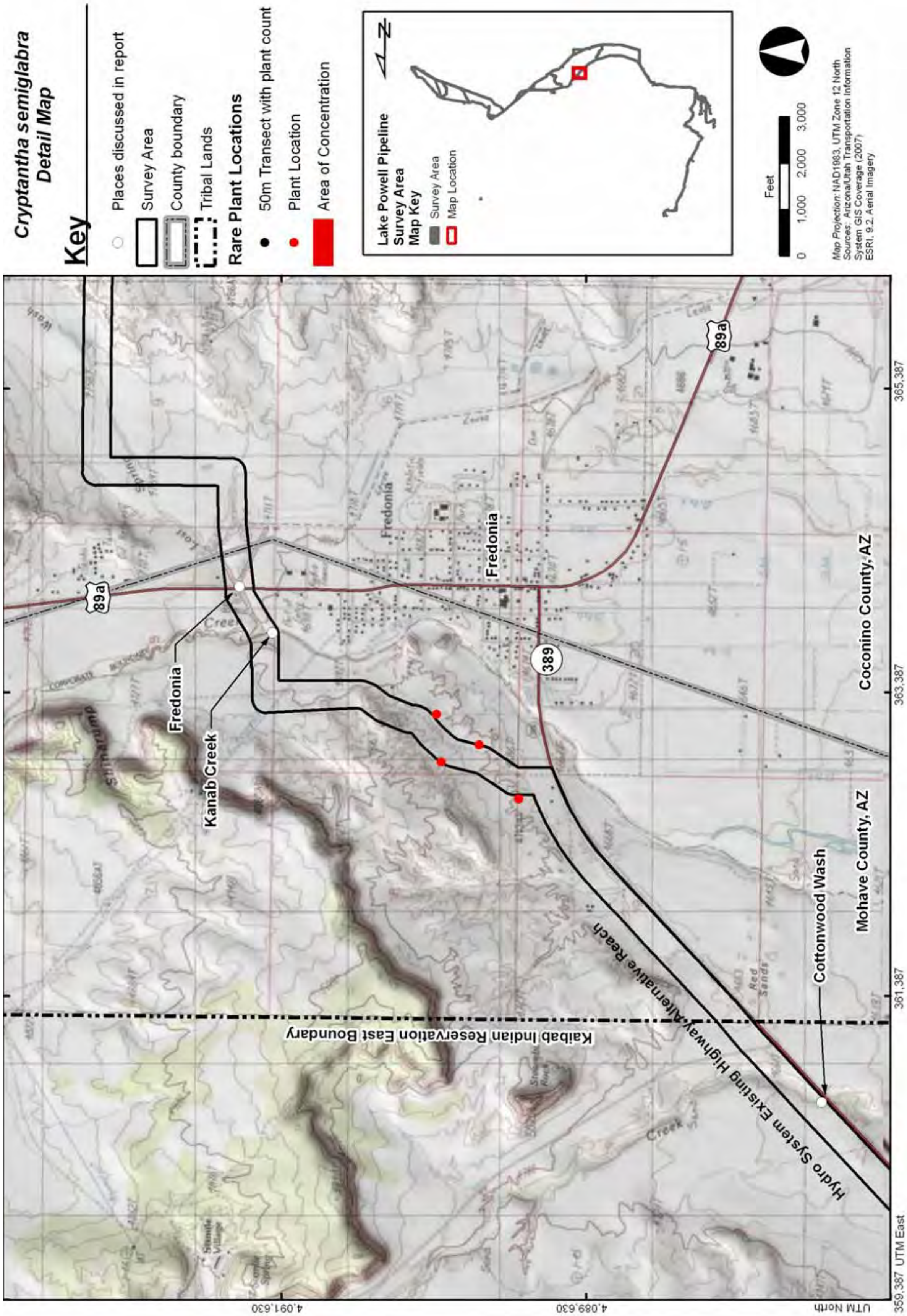
The AGFD reports that *Cryptantha semiglabra* seems to be tolerant of disturbance; however, important management factors include habitat disturbance due to off-road vehicle recreation, trampling, and garbage dumping. Although speculative, survey findings suggest that the presence of *C. semiglabra* is 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.

Figure 4-4
***Cryptantha semiglabra* in habitat within the survey area**

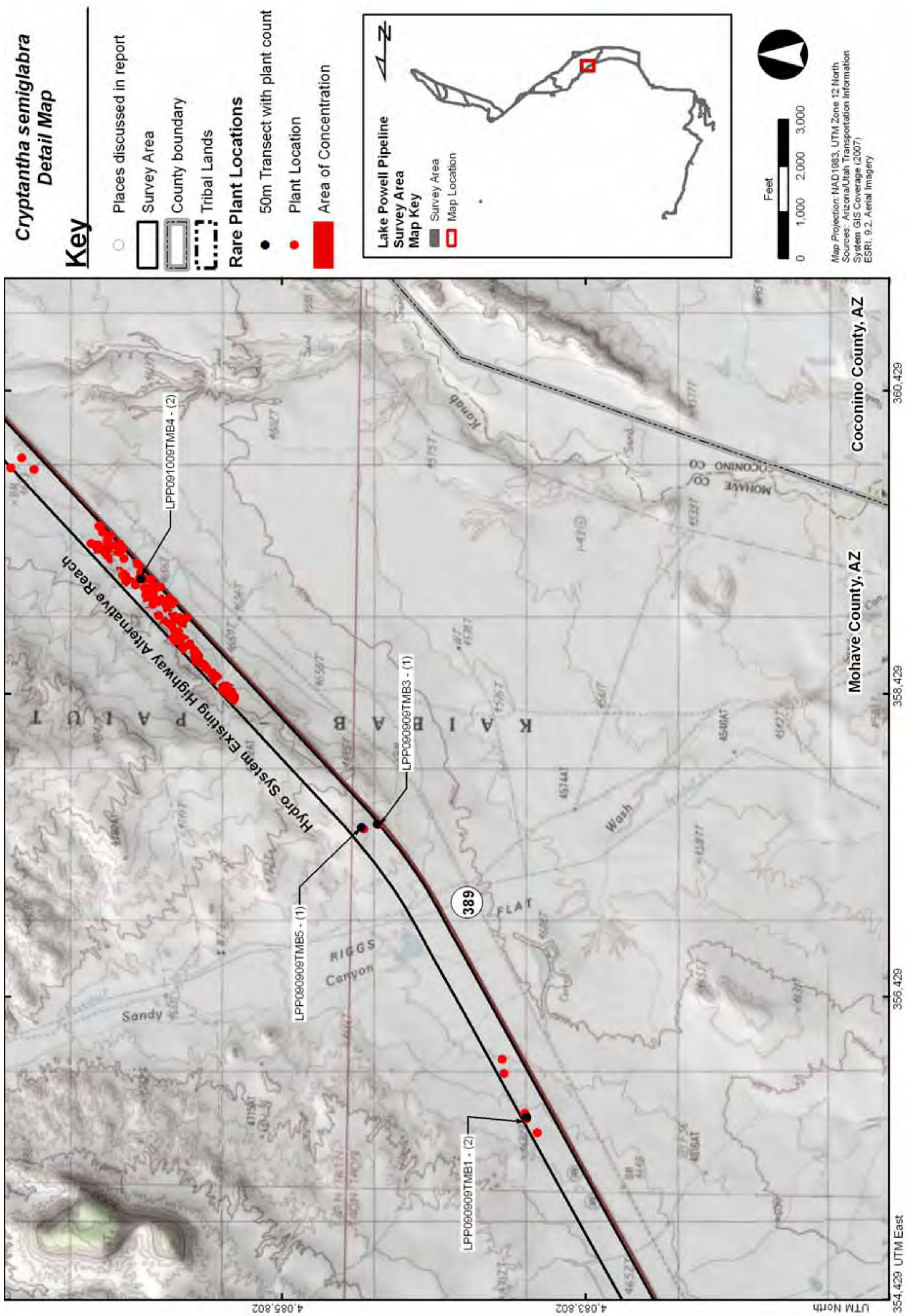
As *Cryptantha semiglabra* reproduces from seed, the number of individuals identified during the survey may represent relative distribution of the plant at various locations where *C. semiglabra* is present within the seed bank. Additionally, it is likely that seed is present within adjacent habitats 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.



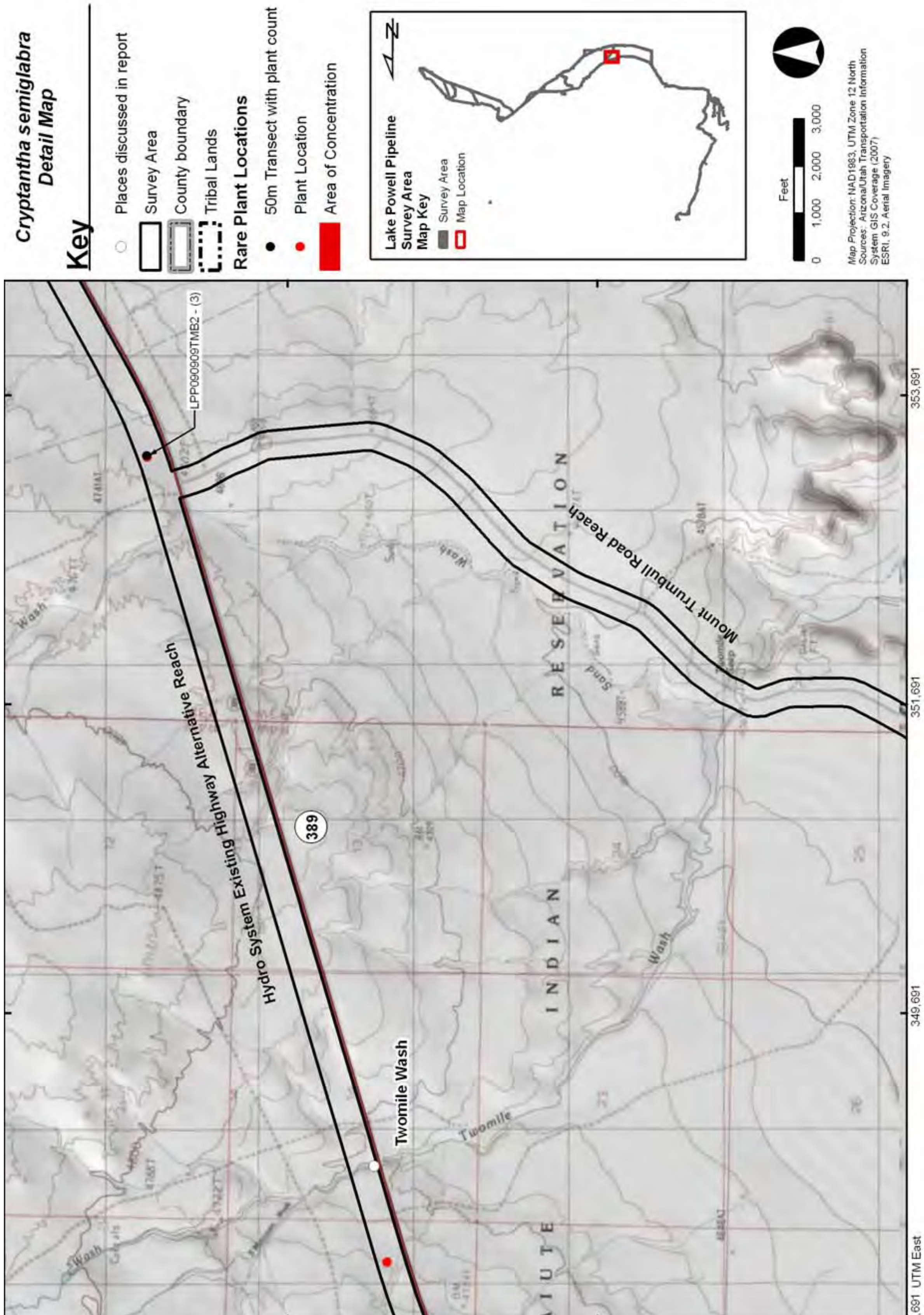
Map 4-6
***Cryptantha semiglabra* Overview Map**



Map 4-7
***Cryptantha semiglabra* Detail Map**



Map 4-8
***Cryptantha semiglabra* Detail Map**



Map 4-9
***Cryptantha semiglabra* Detail Map**

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

4.3.17.1 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 resprout 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. humilis* var. *jonesii* grow in clumps and reproduce by shared rhizomes underground (NatureServe 2009).

Cycladenia humilis 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, Moccassin Mountains, and east of Colorado City in Mohave County (AGFD 2005, Welsh et al. 2008). In Utah, this *C. humilis* 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 desertscrub (AGFD 2005).

4.3.17.2 Survey Results

Cycladenia humilis var. *jonesii* was not encountered during project surveys.

4.3.17.3 Discussion

Although *Cycladenia humilis* 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 highprobability of *C. humilis* 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.

4.3.18 *Cystopteris utahensis* (Utah brittle-fern)

4.3.18.1 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).

Cystopteris 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 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).

4.3.18.2 Survey Results

Cystopteris utahensis was not encountered during project surveys.

4.3.18.3 Discussion

No seeps or hanging gardens were encountered within surveyed areas. *Cystopteris 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.

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

4.3.19.1 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 4-5). 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).

Figure 4-5
Close up view of *Echinocactus polycephalus* var. *xeranthemoides* within the survey area

Echinocactus polycephalus var. *xeranthemoides* isis 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 from 1,803 feet (550 meters) to 6,479 feet (1,975 meters) (AGFD 2006).

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

4.3.19.2 Survey Results

Echinocactus polycephalus var. *xeranthemoides* was encountered only in the Hydro System South Alternative Reach (Table 4-14), 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 Map 4-10 and Map 4-11.

Table 4-14
A summary of *E. p.* 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	

Echinocactus polycephalus 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 4-15.

Table 4-15
A summary of *E. p.* 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		
Artemesia filifolia Shrubland	*Artemesia 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, *Echinocactus polycephalus* 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 4-16.

Table 4-16
A summary of *E. p.* 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	

Echinocactus polycephalus 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 4-17 provides a complete list of soils supporting *E. p.* var. *xeranthemoides*.

Table 4-17
A summary of *E. p.* 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	

Echinocactus polycephalus 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.

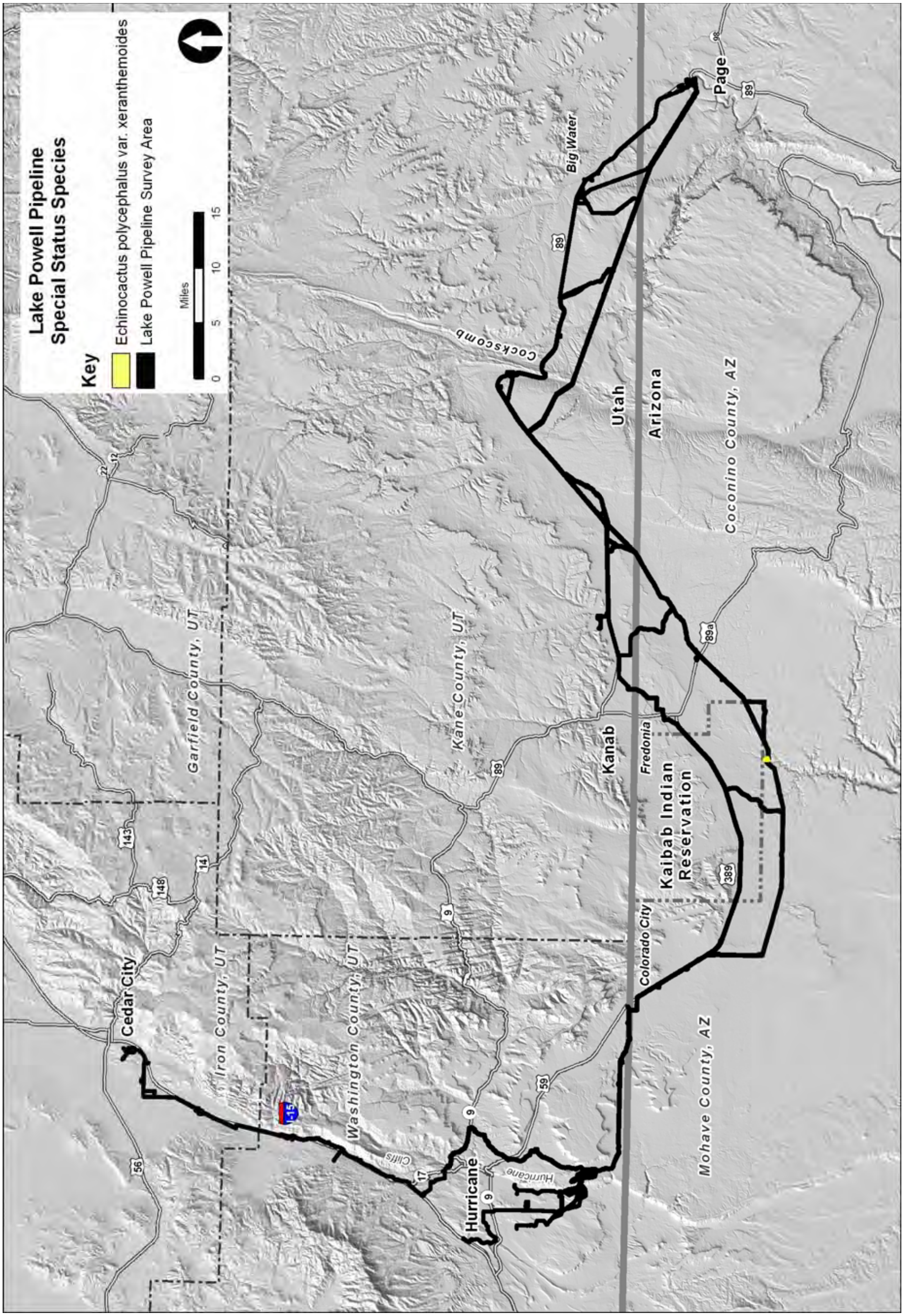
4.3.19.3 Discussion

Figure 4-6
View of *Echinocactus polycephalus* var. *xeranthemoides* cactus within the survey area

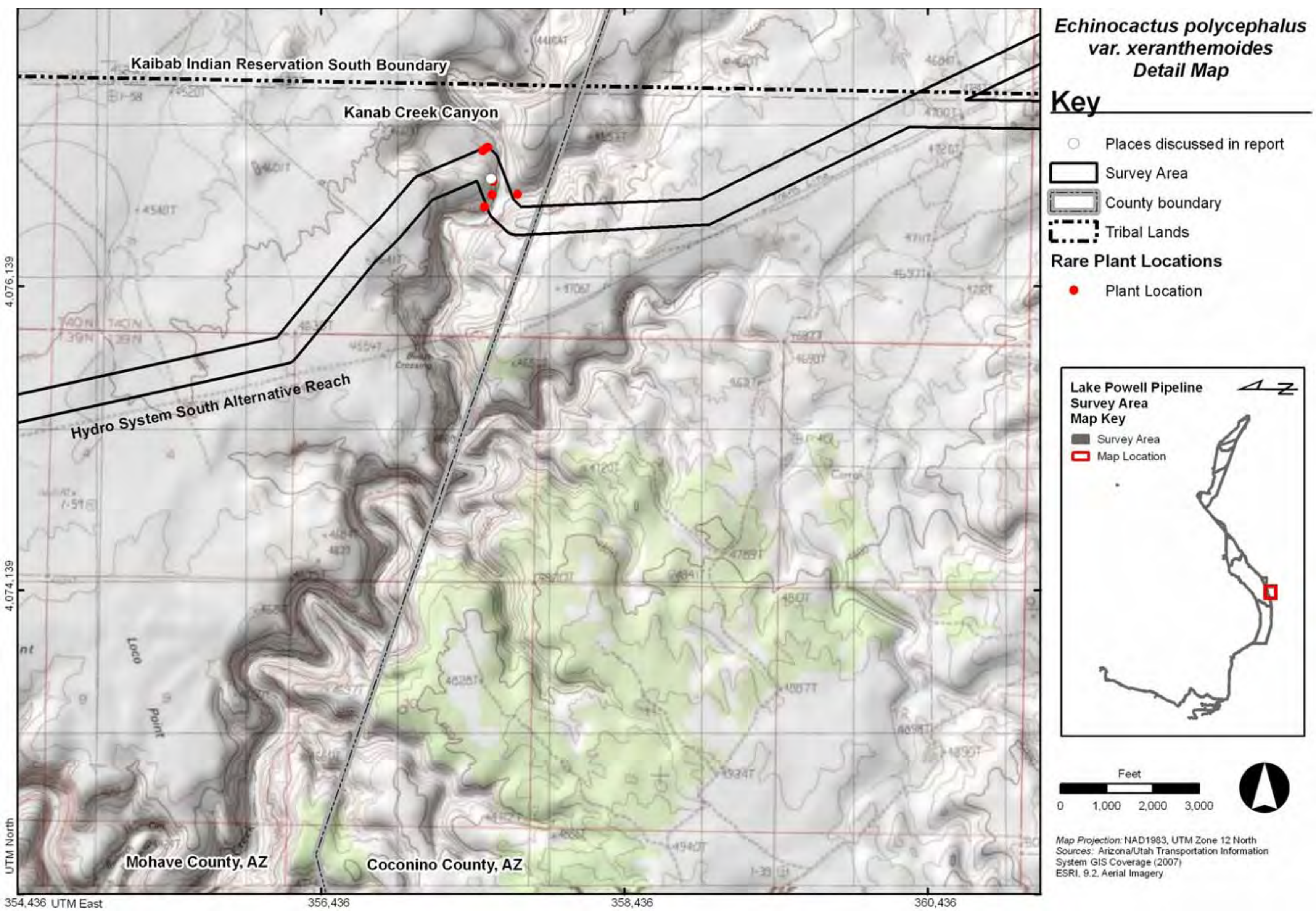
Echinocactus polycephalus var. *xeranthemoides* was only identified in the Hydro System South Alternative Reach, where it was found on the cliffs above Kanab Creek. Each cactus was observed on gravelly, rock outcrops, with southern or western exposures (Figure 4-6). Accompanying vegetation was sparse, but included *Eriogonum corymbosum, Artemisia tridentata, Gutierrezia sarothrae, Pleuraphis jamesii, Ephedra nevadensis*, and *Artemisia filifolia*. Note, *E. p.*var. *xeranthemoides* is a GCNRA species of concern; however no plants were located within the GCNRA.

Echinocactus polycephalus 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.

In order to reduce public accessto the species and avoid illegal collection project related maintenance roads and associated facilities in the vicinity of *E. p.* var. *xeranthemoides* could be minimilized and/ or closed to the public.



Map 4-10
***Echinocactus polycephalus* var. *xeranthemoides* Overview Map**



Map 4-11
***Echinocactus polycephalus* var. *xeranthemoides* Detail Map**

4.3.20 *Enceliopsis argophylla* (Silverleaf sunray)

4.3.20.1 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).

4.3.20.2 Survey Results

Enceliopsis argophylla was not encountered during project surveys.

4.3.20.3 Discussion

Enceliopsis 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.

4.3.21 *Epilobium nevadense* (Nevada willowherb)

4.3.21.1 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 covered 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).

4.3.21.2 *Survey Results*

Epilobium nevadense was not encountered during project surveys.

4.3.21.3 *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 the Zion National Park's Kolob Canyon section. No further surveys are warranted within the survey area for this plant.

4.3.22 *Eriogonum corymbosum* var. *nilesii* (Las Vegas buckwheat)

4.3.22.1 *Natural History*

Eriogonum corymbosum var. *nilesii* is a woody perennial shrub of the Polyonaceae (Buckwheat Family) reaching 4 feet (1.2 meters) tall. Leaves are oval shaped and approximately twice as long as they are wide. Flowering branches and one or both leaf surfaces are densely covered in wooly hairs, a distinguishing characteristic for this variety. The flower clusters reach 4 inches (10.16 centimeters) long, with small, yellow to pale yellow (Figure 4-7), or rarely white flowers, arranged in an umbrella-shape inflorescence (NNHP 2004). *E. corymbosum.* var. *nilesii* begins flowering in late August and blooms through early November (Mrowka 2008, Reveal 2010).

Figure 4-7
View of *Eriogonum corymbosum* var. *nilesii* in bloom within the survey area

E. corymbosum var. *nilesii* is presently known from Clark and Lincoln counties, Nevada, Mohave and Coconino counties, Arizona, and Washington and Kane counties, Utah. Mrowka (2008) lists it near Flagstaff in Coconino County, but no specimen has been confirmed (Reveal 2010). The species was previously considered a gypsophile in Nevada, but Drohan and Merkler (2009) determined that because it occurs on soils with little gypsum and doesn't accumulate sulphur, the species cannot be a gypsophile. Mrowka (2008) reports it growing in gypsum soils with *Arctomecon californica, Petalonyx parryi*, *Phacelia palmeri*, *Mentzelia pterosperma*, and *Camissonia multijuga. E. c.* var. *nilesii* may also be found in habitats dominated by *Ambrosia dumosa, Atriplex canescens, Ephedra torreyana, Larrea tridentata,* and *Psorothamnus fremontii* (NNHP 2004) and is found on exposed, cryptobiotic soils in sparsely vegetated washes and drainages. NNHP (2004) reports the recorded elevation range in Nevada for *E. c.* var. *nilesii*between 1,900 feet (579 meters) and 3,839 feet (1,170 meters). No specific elevation ranges for Utah or Arizona were noted.

Eriogonum corymbosum occurs as multiple varieties which can be difficult to distinguish. Varieties may hybridize, and resulting individuals can display a range of morphological characteristics. Key features used to differentiate them include the new leaves, pubescence, inflorescence, and flower color. *E. c.* var. *nilesii* has a rounded inflorescence, yellow flowers, and hairy leaves.

Eriogonum corymbosum var. *nilesii* is currently a candidate for listing under the ESA (USFWS 2009).

4.3.22.2 Survey Results

Eriogonum corymbosum var. *nilesii* was encountered in four project reaches: the Glen Canyon Substation, the Water Conveyance System, the Hydro System, and the Cedar Valley Pipeline System. A total of 1,815 individuals were documented at the very eastern and western edges of the Colorado Plateau Region within the survey area. The majority of individuals (1,729) occurred in the Glen Canyon Substation Reach, within the GCNRA. One small group of 12 individuals was found in the vicinity of Upper Blue Pool Wash, also within the GCNRA; and eight plants were encountered on private lands near the Honeymoon Trail. In the Cedar Valley Pipeline System Reach the species was found at the Divide and in the vicinity of Sheep Bridge Road, on BLM lands and private lands. In addition to the 1,815 plants identified within the survey area, 174 plants were noted outside of the survey area. *E. c.* var. *nilesii* locations are shown in Table 4-18 and locations are shown in the distribution and detailed maps provided in Map 4-12 to Map 4-21.

Table 4-18
A summary of *Eriogonum corymbosum* var. *nilesii* survey results by location

Reach	Location	Land Ownership	# of Plants
Glen Canyon Substation	Within 1 mile of the Colorado River at Glen Canyon	Glen Canyon National Recreation Area	1,729
Water Conveyance System	0.1 mile north of Upper Blue Pool Wash	Glen Canyon National Recreation Area	12
Hydro System	0.75 miles southeast of the Honeymoon Trail	Private 8	
Cedar Valley Pipeline System	The Divide	BLM	17
Cedar Valley Pipeline System	2.3 miles and 4.8 miles southwest of Sheep Bridge Road	BLM, Private	14
Cedar Valley Pipeline System	1.2 miles and 2.5 miles northwest of Sheep Bridge Road	BLM 35	
		Total	1,815

Eriogonum corymbosum var. *nilesii* was documented in the Colorado Plateau Ecological Region where it occurred in six ecological systems and along a developed road. The species was found in 11 alliances and 14 associations, in two of which *E. c.* var. *nilesii* occurred as a co-dominant member of the vegetation community. *E. c.* var. *nilesii* occurred most often in the Colorado Plateau Mixed Bedrock Canyon and Tableland Ecological System (949 individuals in total), within the majority of those individuals (774) identified in the *Eriogonum corymbosum – Ephedra nevadensis – Coleogyne ramosissima* Sandstone Slickrock Sparse Vegetation Association. Thirty individuals were found growing within the right-of-way of an unnamed developed road on the GCNRA. The species was encountered in elevations ranging from 3,589 feet (1,094 meters) to 4,833 feet (1,473 meters). A summary of *E. corymbosum* var. *nilesii* occurrences by alliance and association is provided in Table 4-19.

Table 4-19
A summary of *Eriogonum corymbosum* var. *nilesii* survey results by alliance and association

Alliance	Association	# of Plants
COLORADO PLATEAU ACTIVE AND STABILIZED DUNE ECOLOGICAL SYSTEM		
Artemesia filifolia Shrubland	*Artemisia filifolia – Ephedra (nevadensis, torreyana, viridis)* Shrubland	200
COLORADO PLATEAU BLACKBRUSH-MORMOM-TEA SHRUBLAND ECOLOGICAL SYSTEM		
Coleogyne ramosissima Shrubland	*Coleogyne ramosissima* Shrubland	179
Ephedra torreyana Shrubland	*Ephedra torreyana – Psorothamnus fremontii* Shrubland	34
Ephedra (*nevadensis, torreyana*) Shrubland	*Ephedra nevadensis - Ephedra torreyana* Shrubland	9
COLORADO PLATEAU GYPSUM BADLANDS ECOLOGICAL SYSTEM		
Pinus monophylla – (Juniperus osteosperma) Woodland	*Pinus monophylla – Juniperus osteosperma / Mahonia fremontii* Gypsum Badlands Sparse Woodland	6
Mahonia fremontii Sparsely Vegetated	*Mahonia fremontii* Gypsum Badlands Sparse Vegetation	11
COLORADO PLATEAU MIXED BEDROCK CANYON AND TABLELAND ECOLOGICAL SYSTEM		
Ephedra nevadensis Sparsely Vegetated	*Ephedra nevadensis* Sandstone Slickrock Sparse Vegetation	125
Ephedra nevadensis Sparsely Vegetated	*Eriogonum corymbosum – Ephedra nevadensis – Coleogyne ramosissima* Sandstone Slickrock Sparse Vegetation	50
Eriogonum corymbosum Sparsely Vegetated	*Eriogonum corymbosum – Ephedra nevadensis – Coleogyne ramosissima* Sandstone Slickrock Sparse Vegetation	774
COLORADO PLATEAU MIXED DESERT SCRUB ECOLOGICAL SYSTEM		
Artemisia filifolia Shrubland	*Artemesia filifolia – Gutierrezia sarothrae* Shrubland 375	
Artemisia filifolia Shrubland	*Artemesia filifolia – Psorothamnus fremontii* Sparse Shrubland	12
Chrysothamnus greeni Shrubland	*Chrysothamnus greeni* Dwarf-Shrubland	7
Mixed Desert Scrub Shrubland	Mixed Desert Scrub Shrubland	1
COLORADO PLATEAU PINYON-JUNIPER WOODLAND ECOLOGICAL SYSTEM		
Ephedra torreyana Shrubland	*Juniperus osteosperma / Ephedra (torreyana, nevadensis) / Pleuraphis jamesii* Wooded Shrubland	1
Coleogyne ramosissima Shrubland	*Pinus monophylla – Juniperus osteosperma / Coleogyne ramosissima* Wooded Shrubland	1
DEVELOPED - ROAD		
Developed – Road	Developed – Road	30
	Total	1,815

Eriogonum corymbosum var. *nilesii* was found on seven different geologic formations, occurring most commonly on Navajo Sandstones which are characterized as white, light-red, and yellowish-gray in color; or on a combination of Navajo Sandstones and stream-channel deposits, gray and tan cliff-forming fresh water limestone. *E. c.* var. *nilesii* occurrences by geologic formation appear inTable 4-20.

Table 4-20 A summary of *Eriogonum corymbosum* var. *nilesii* survey results by geologic formation	
Geologic Formation	**# of Plants**
COLORADO PLATEAU ACTIVE AND STABILIZED DUNE ECOLOGICAL SYSTEM	
Navajo Sandstone, Stream-channel deposits*	200
COLORADO PLATEAU BLACKBRUSH-MORMON-TEA SHRUBLAND ECOLOGICAL SYSTEM	
Navajo Sandstone	177
Lower Red Member Moenkopi Formation	36
Middle Red Member Moenkopi Formation	9
COLORADO PLATEAU GYPSUM BADLANDS ECOLOGICAL SYSTEM	
Middle Red Member Moenkopi Formation	6
Lower Red Member Moenkopi Formation	11
COLORADO PLATEAU MIXED BEDROCK CANYON AND TABLELAND ECOLOGICAL SYSTEM	
Navajo Sandstone	774
Navajo Sandstone, Stream-channel deposits*	175
COLORADO PLATEAU MIXED DESERT SCRUB ECOLOGICAL SYSTEM	
Navajo Sandstone	375
Lower Red Member Moenkopi Formation	6
Timpoweap Member Moenkopi Formation	1
Alluvial and colluvial deposits	1
Eolian and alluvial deposits	12
COLORADO PLATEAU PINYON-JUNIPER WOODLAND ECOLOGICAL SYSTEM	
Lower Red Member Moenkopi Formation	1
Alluvial and colluvial deposits	1
DEVELOPED – ROAD	
Navajo Sandstone	15
Navajo Sandstone, Stream-channel deposits*	15
Total	1,815

Individual *Eriogonum corymbosum* var. *nilesii*were primarily documented on soils classified as Rock outcrop – Needle complex 4 to 50 percent slopes (824 individuals), and the Sheppard loamy fine sand, 5 to 15 percent slopes (905 individuals (Table 4-21).

Table 4-21 A summary of *Eriogonum corymbosum* var. *nilesii* survey results by soil type	
Soil type	**# of Plants**
Rock outcrop – Needle complex, 4 to 50 percent slopes	824
Sheppard loamy fine sand, 5 to 15 percent slopes	905
Eroded land – Shalet complex	70

Yaki-Zukan complex, 1 to 35 percent slopes	4
Rock outcrop – Moenkopi	12
Total	1,815

4.3.22.3 Discussion

A total of 1,815 individuals of *Eriogonum corymbosum* var. *nilesii* were encountered during the survey. Plants were identified in the Glen Canyon Substation, the Water Conveyance System, the Hydro System, and the Cedar Valley Pipeline System reaches, but were predominantly found on the east side of the survey area within the GCNRA, as part of the Glen Canyon Substation for the Water Conveyance System Reach. All other individuals were encountered on BLM or private lands. Most plants were documented within the Colorado Plateau Mixed Bedrock Canyon and Tableland Ecological System, with the majority being found in the *Eriogonum corymbosum* Sparsely Vegetated Alliance and the *Eriogonum corymbosum – Ephedra nevadensis – Coleogyne ramosissima* Sandstone Slickrock Sparse Vegetation Association (Figure 4-8). *E. corymbosum* var. *nilesii* was found in a diverse collection of plant assemblages. The species was commonly documented on Navajo Sandstone, and in stream channel deposits that include Navajo Sandstone.

Much of what is known about the range and habitat preferences of *Eriogonum corymbosum* var. *nilesii* outside of Nevada has been determined from surveys done on the LPP project. Surveys located individual plants between 3,589 feet (1,094 meters) and 4,833 feet (1,473 meters) in elevation, a range extending above the previously recorded elevation range of 1,900 feet (579 meters) to 3,839 feet (1,170 meters). *E. corymbosum* var. *nilesii* was found growing in a wide variety of habitats, including gypsum badlands, sand, slickrock sandstone, roadsides, cinder talus, and in limestone outcrops. The late season phenology of this shrub precluded it from being surveyed at the same time as other special status plants. When encountered during the survey, individuals displaying appropriate vegetative characteristics (specifically, inflorescence branches that were wooly-hairy, and upper leaves with silvery hair) were noted, a voucher specimen was collected, and the site was later revisited (in September 2009 and in September and October 2010) while plants were in bloom. However, few of the re-visited locations displayed the necessary combination of a rounded inflorescence, yellow flower color, and hairy leaves needed to confirm the variety as *nilesii*. Two locations were encountered with intermediate characteristics, displaying mixed white (or pale yellow) and yellow flowers, both of which were positively identified as *E. corymbosum* var. *nilesii*. One location (in Long Canyon, outside the survey area) displayed a continuum of flower colors, occurring as white at lower elevations, yellow at higher elevations, and in a mixture of the two in between. The other location was a group of 3 individuals south of the Divide, and consisted of a single individual with pale yellow flowers and two individuals with yellow flowers. Voucher specimens representing the range of potential *E. c.* var. *nilesii* were presented to Dr. James Reveal in 2009. Dr. Reveal's examination of voucher specimens collected during the transect sampling

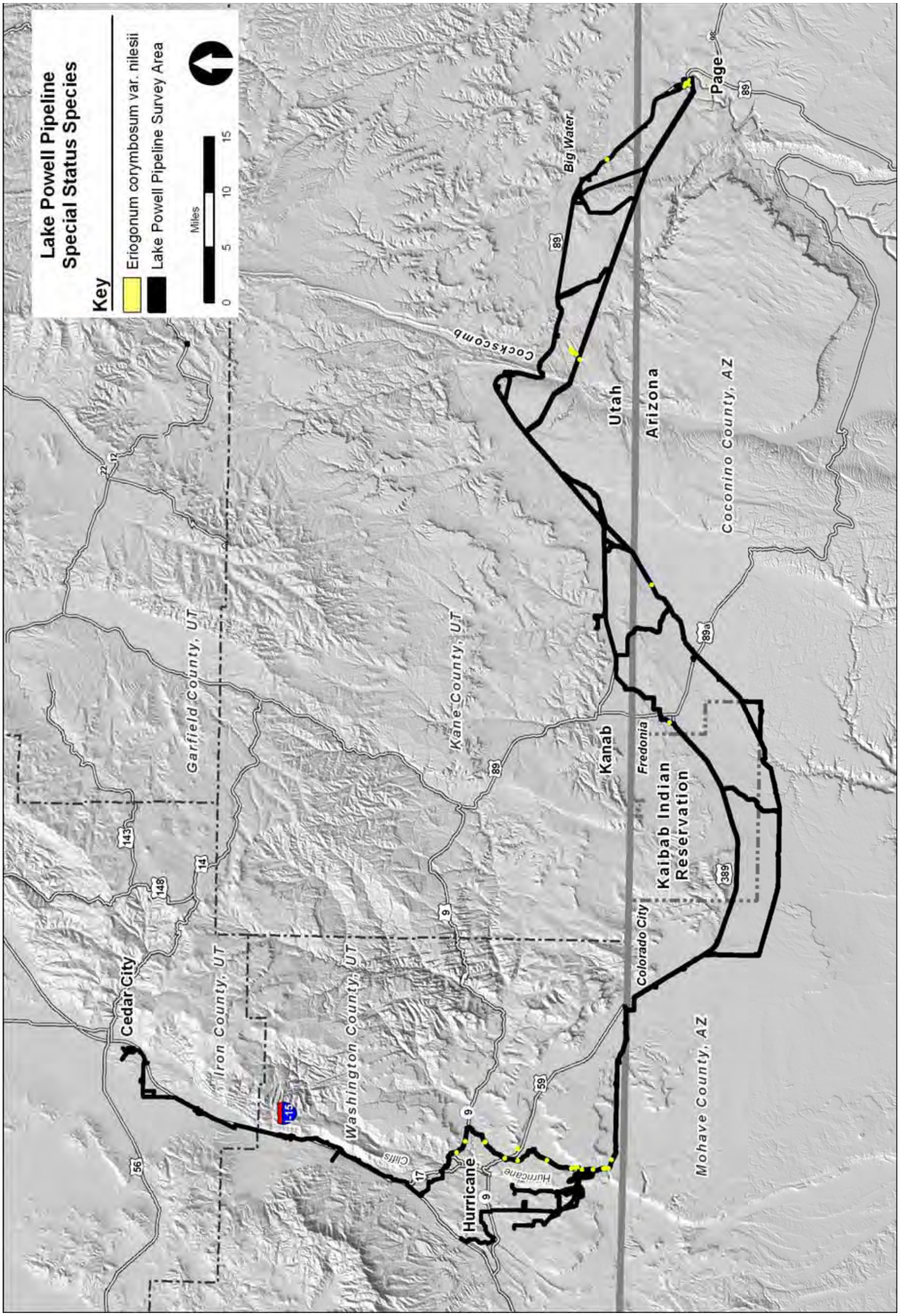
Figure 4-8
View of *Eriogonum corymbosum* var. *nilesii* habitat within the survey area

verified *E. c.* var. *nilesii* presence within the study area.

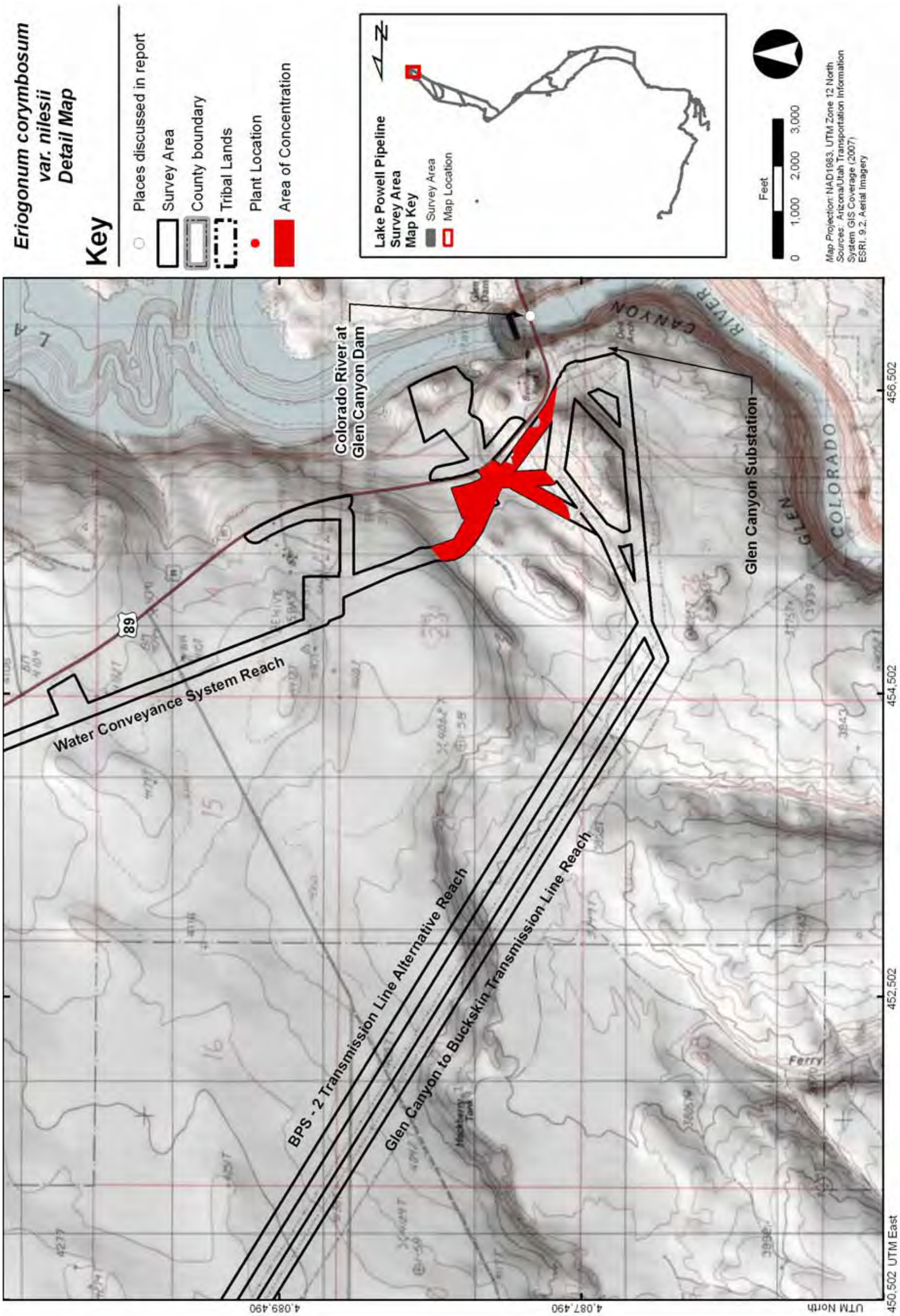
There is a potential that the survey did not capture all existing individuals of *Eriogonum corymbosum* var. *nilesii* within the survey area because of challenges in identification (late blooming period), and the hybridization of the species . Based on field observations and analysis of collected data, the species could occur in washes anywhere south of the Hurricane Cliffs (near Little Creek Mountain), where the Middle Red Member of the Moenkopi Formation is exposed, on the east side of Cedar Mountain where sand dunes meet the bedrock exposures of the mountain, or on gypsum soils between LaVerkin Creek and Sheep Bridge Road.

Few noxious weeds were observed in association with *Eriogonum corymbosum* var. **nilesii**. In one occurrence, on non-gypsum badland, on an overgrazed range *E. c.* var. **nilesii** grew with **Salsola tragus** as the dominant herbaceous plant**.** Lower available moisture from **S. tragus** competition is perhaps less important than having only one seed producing shrubs to colonize or recolonized the site. This is especially true when the herbaceous inflorescence on seed bearing shrubs is removed by grazing animals. Where **E. c.** var. **nilesii** occurs on roadsides in Washington County, the habitat is actively bladed to maintain drainage and the stunted shrubs appear to have resprouted from blading. Weeds are absent from these areas. In Coconino County, the shrubs grew along long abandoned roadbeds where native plants have out competed weeds which might have been present when the highway was active.

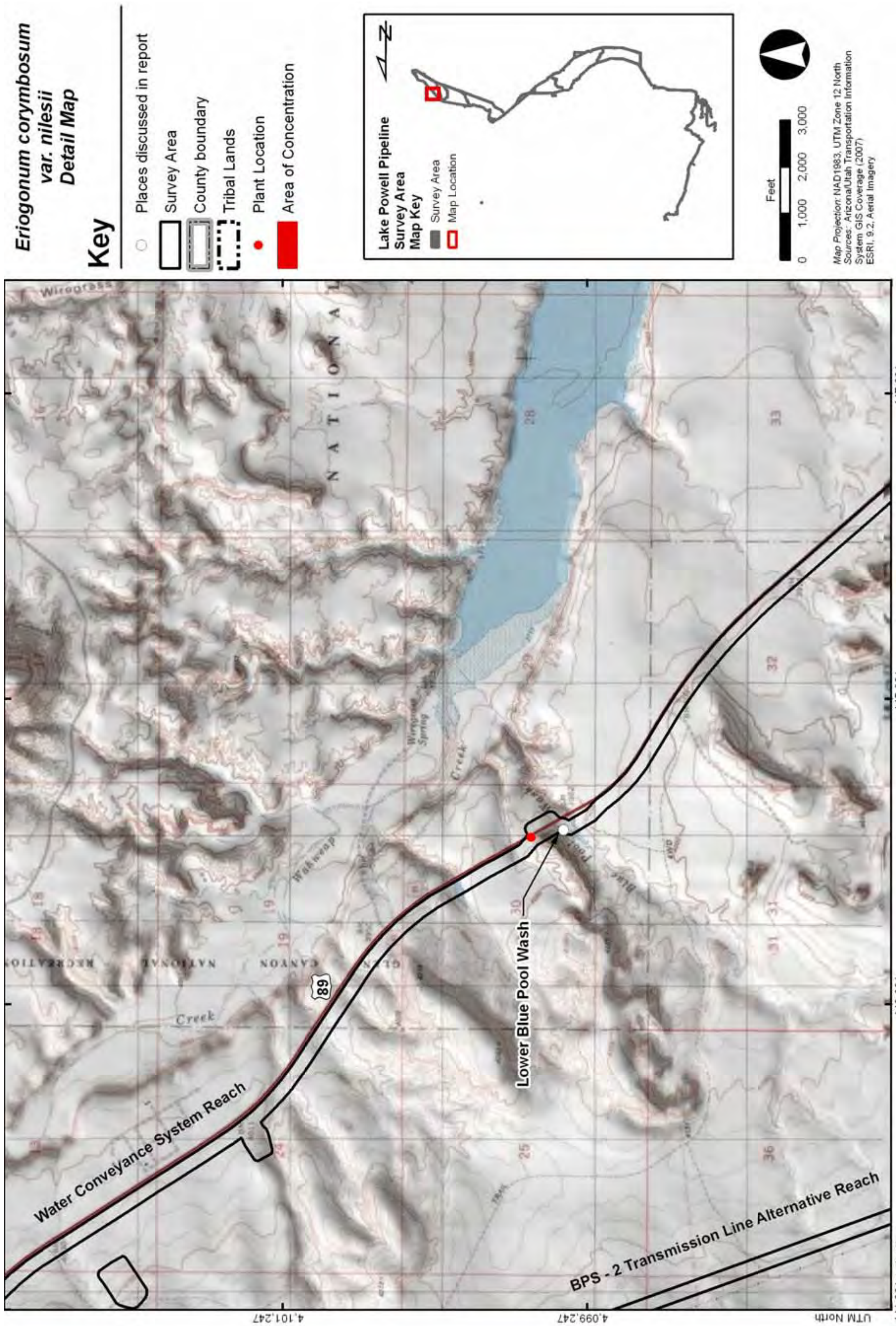
Eriogonum corymbosum var. *nilesii* has been successfully transplanted and propagated from seed, as evidenced by the successes of the Desert Demonstration Gardens at the Springs Preserve in Las Vegas. Any individuals which may not be avoided by project construction could be salvaged and transplanted into similar habitat as that in which it was found. Seed could also be collected from at-risk individuals and re-distributed following completion of construction. Consideration could also be given to growing individuals from collected seed, in order to supplement revegetation efforts of affected areas.



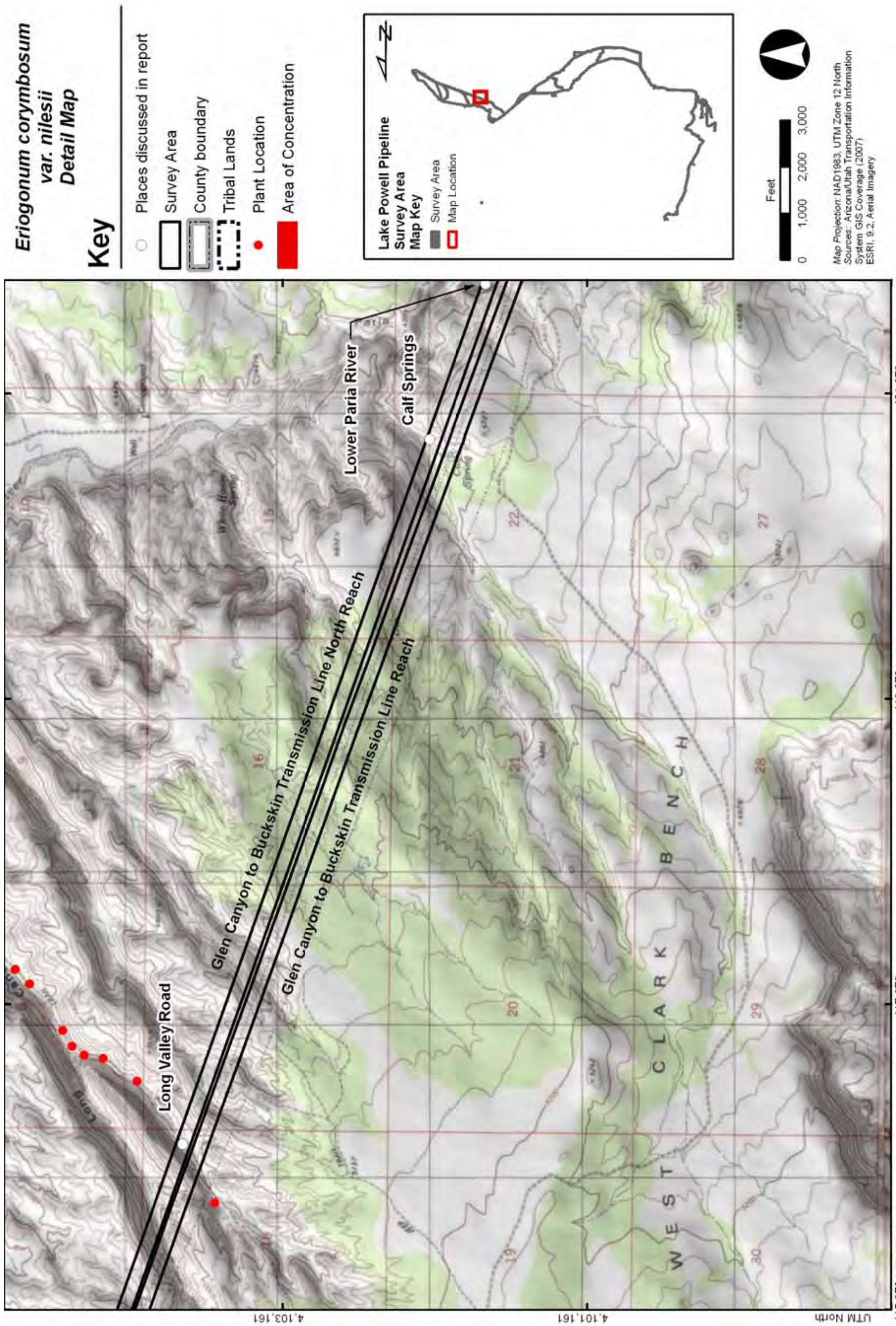
Map 4-12
***Eriogonum corymbosum* var. *nilesii* Overview Map**



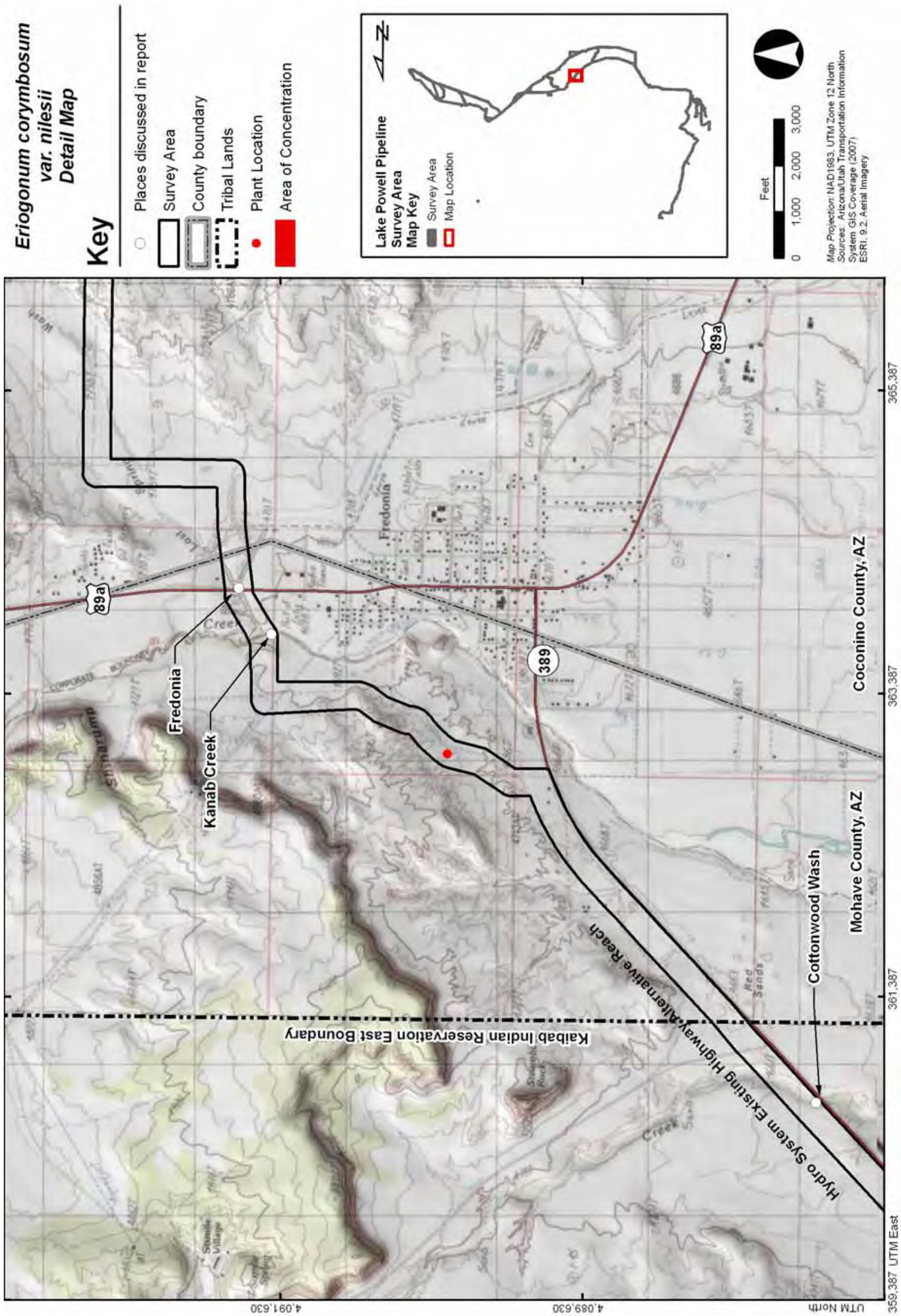
Map 4-13
***Eriogonum corymbosum* var. *nilesii* Detail Map**



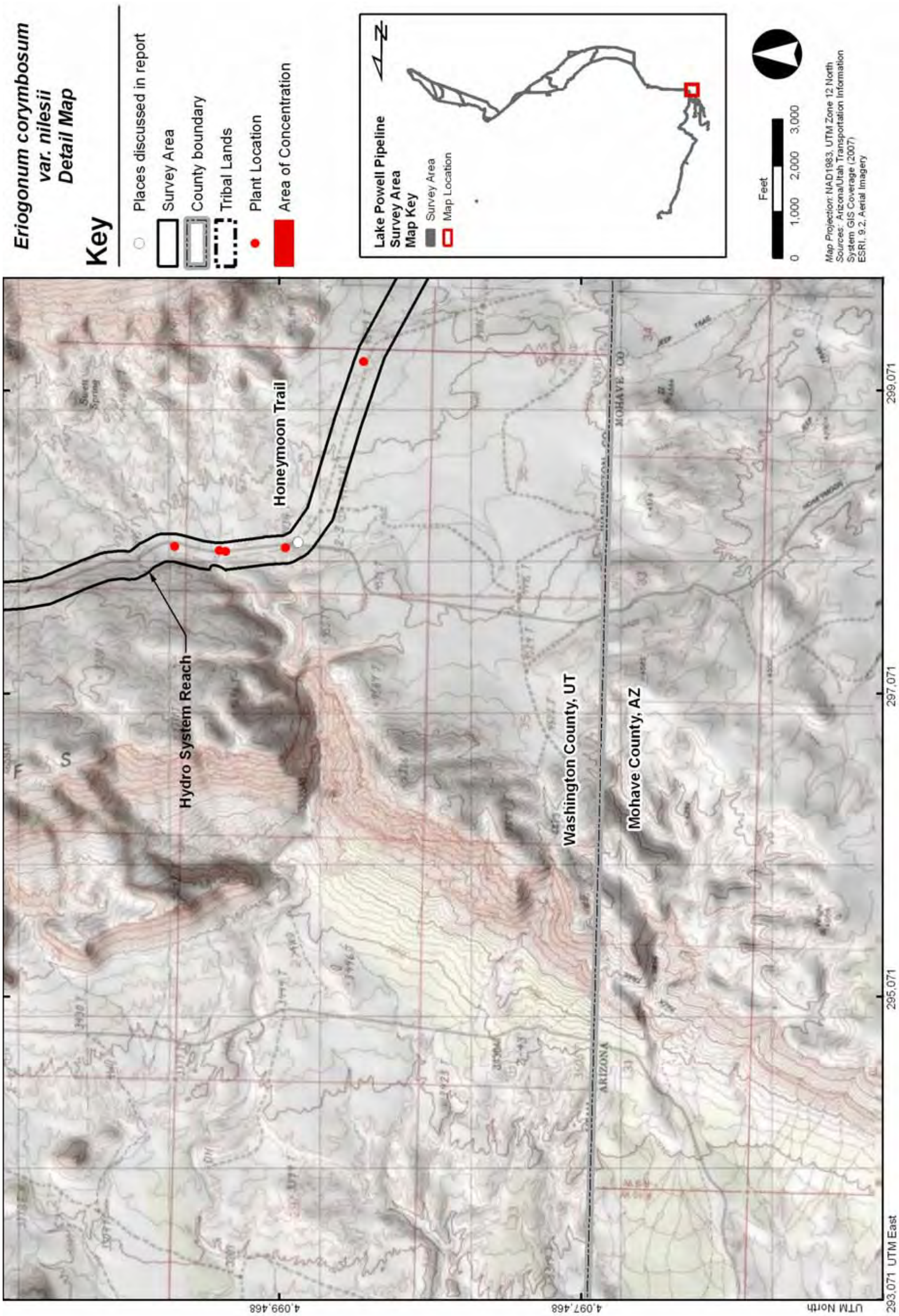
Map 4-14
Eriogonum corymbosum **var.** ***nilesii*** **Detail Map**



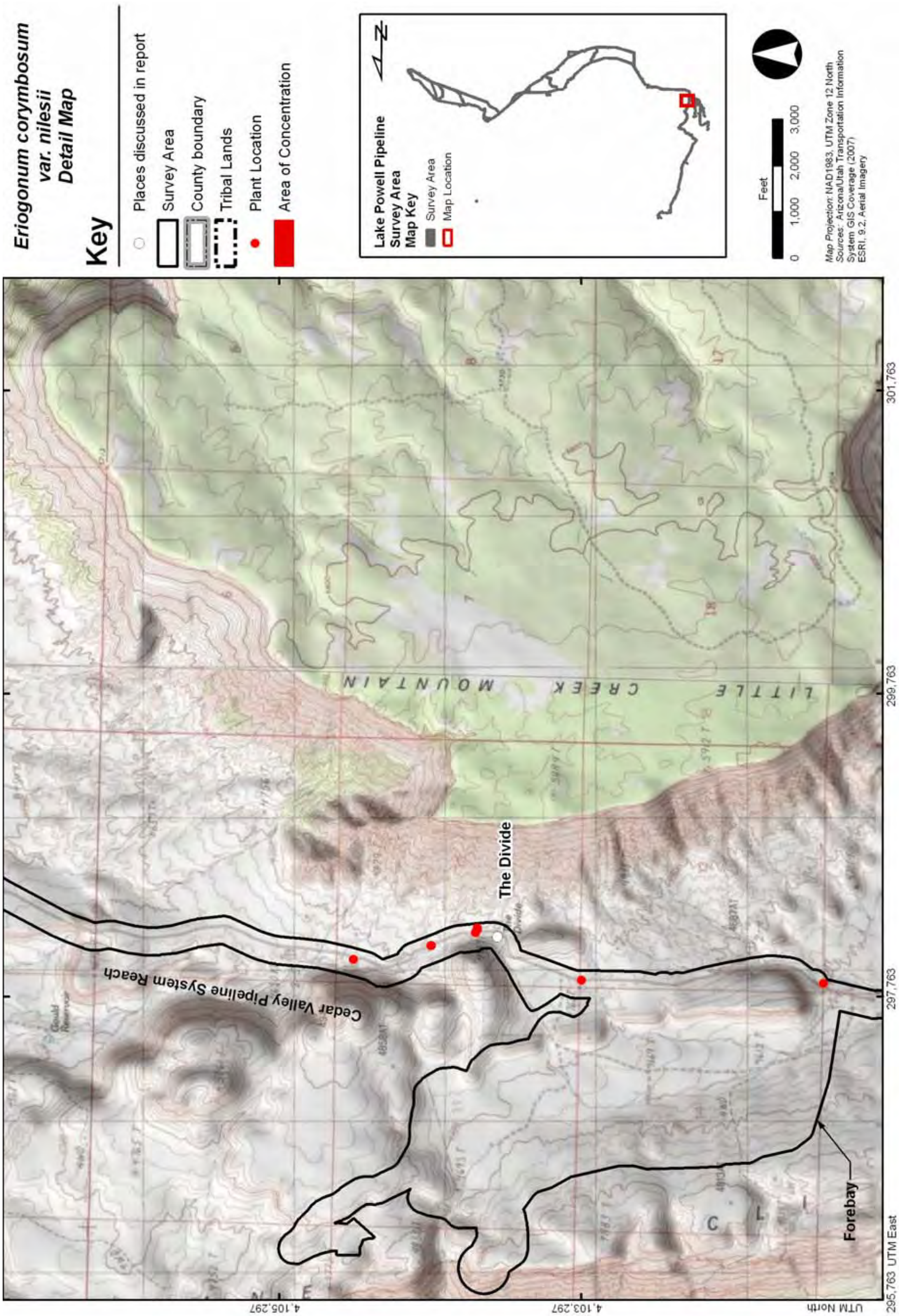
Map 4-15
***Eriogonum corymbosum* var. *nilesii* Detail Map**



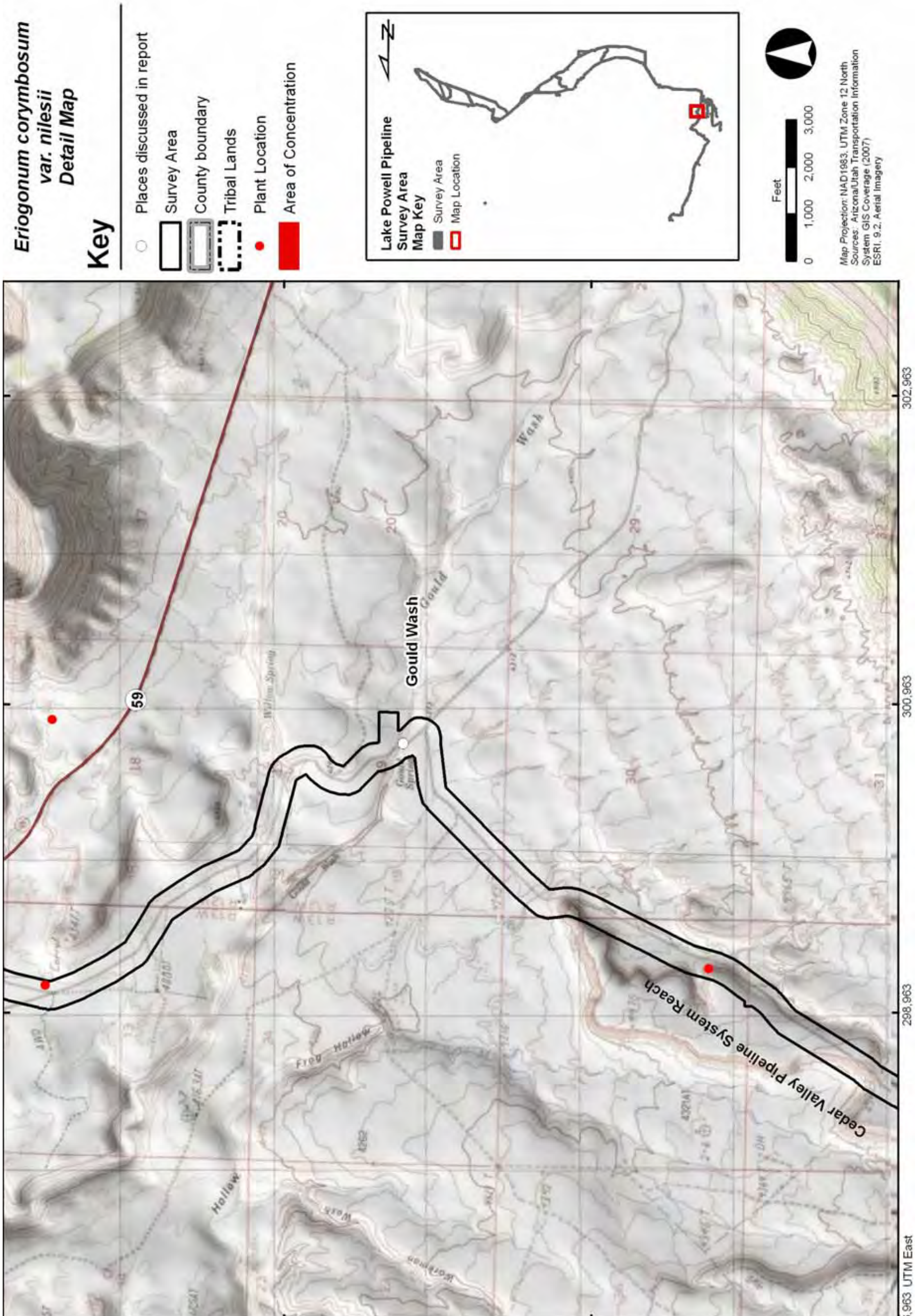
Map 4-16
***Eriogonum corymbosum* var. *nilesii* Detail Map**



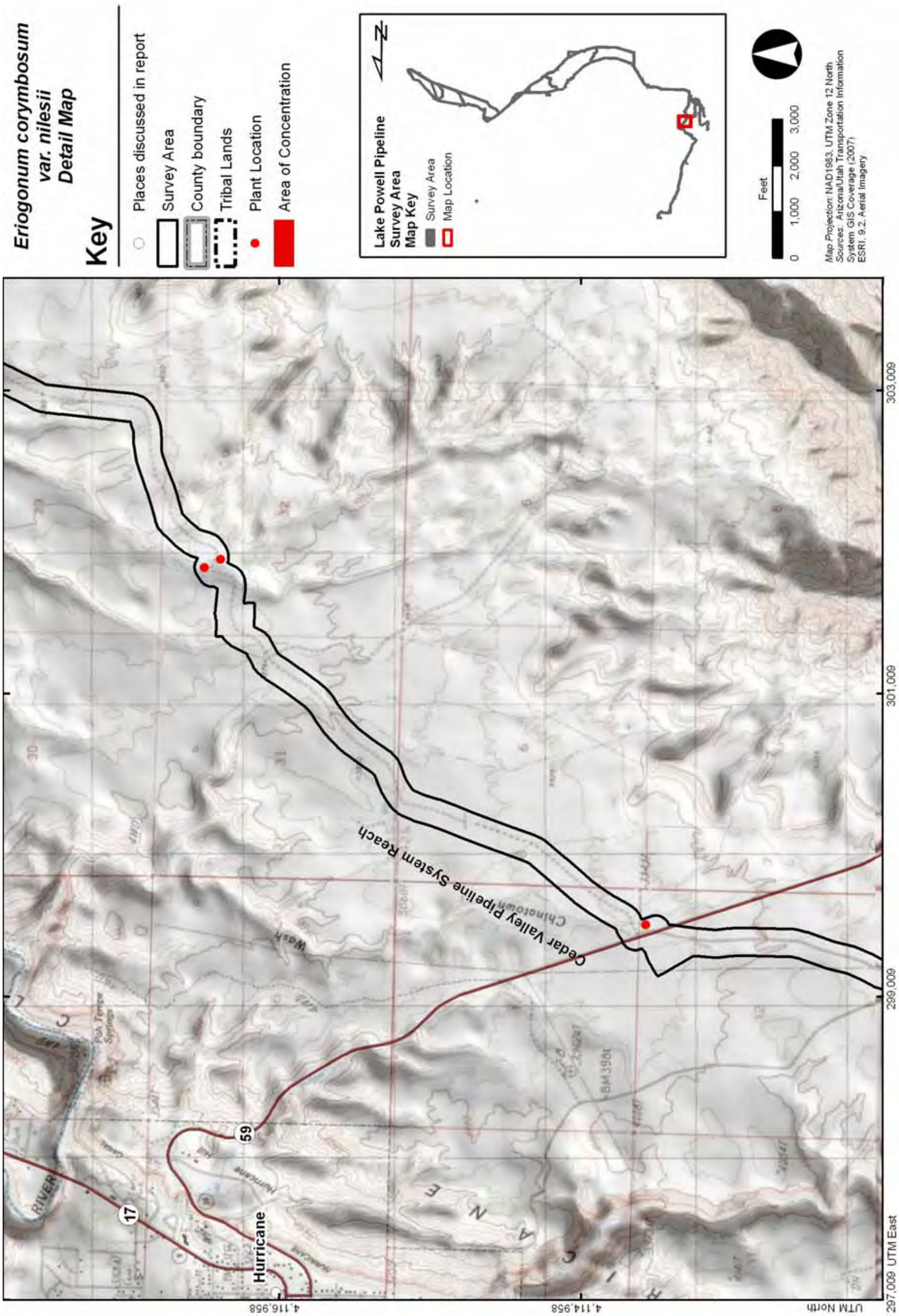
Map 4-17
***Eriogonum corymbosum* var. *nilesii* Detail Map**



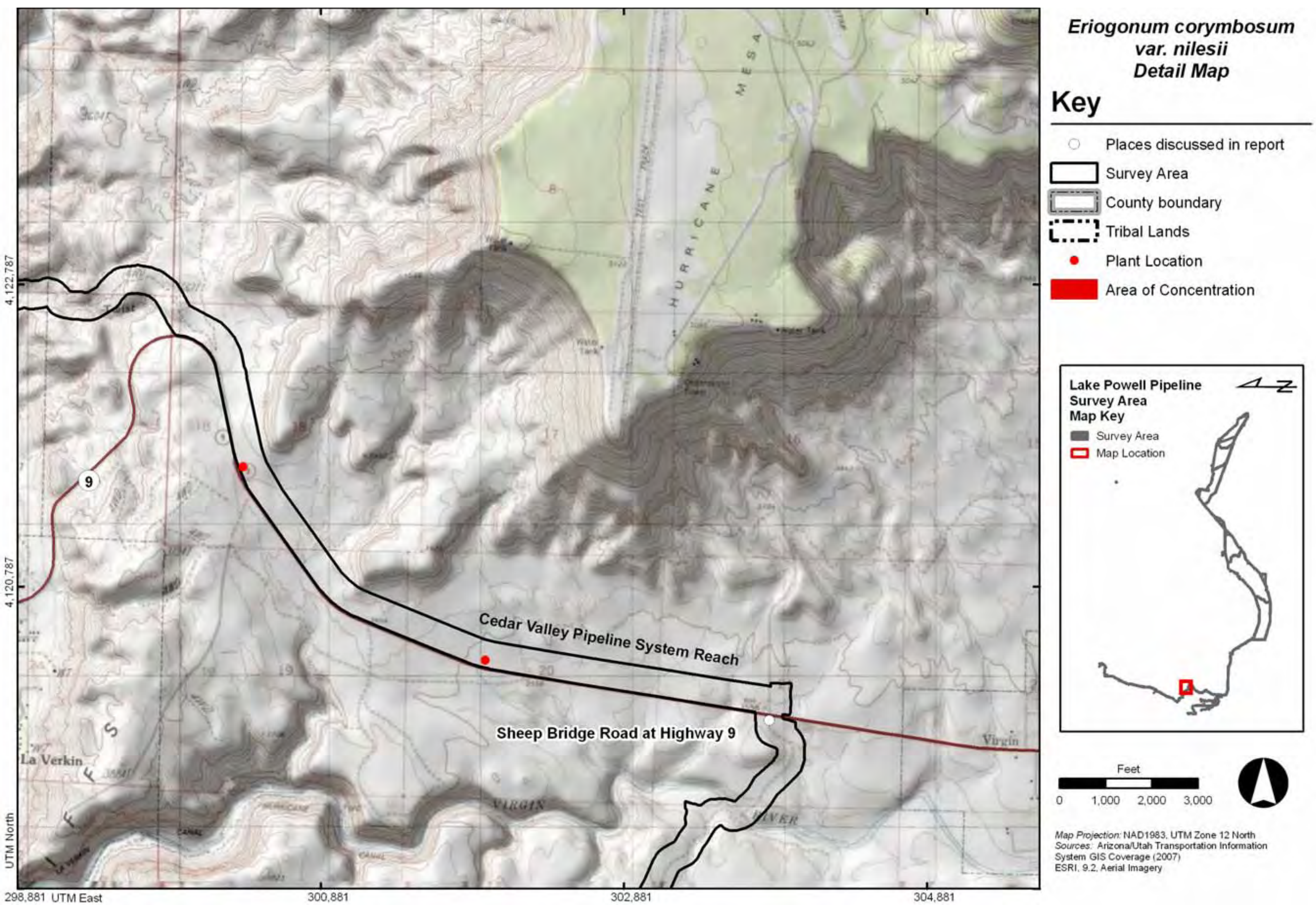
Map 4-18
***Eriogonum corymbosum* var. *nilesii* Detail Map**



Map 4-19
***Eriogonum corymbosum* var. *nilesii* Detail Map**



Map 4-20
***Eriogonum corymbosum* var. *nilesii* Detail Map**



Map 4-21
***Eriogonum corymbosum* var. *nilesii* Detail Map**

4.3.23 *Eriogonum mortonianum* (Morton wild buckwheat)

4.3.23.1 Natural History

Eriogonum mortonianum is a perennial in the Polyonaceae (Buckwheat Family). This woody shrub reaches 2.6 feet (80 centimeters) tall, and has yellowish-green stems and branches. The stems and underside of the leaves are hairless, a characteristic that sets it apart from similar *Eriogonum* species. The leaves are elliptic, 0.6 to 1.6 inches (1.5 to 4 centimeters) long and 0.2 to 0.4 inches (0.6 to 1 centimeter) wide. The flower stalk is highly branched and 5.6 to 10 inches (15 to 25 centimeters) long. The pale yellow to white, minute flowers are reported to bloom and fruit from July to September (ANPS 2001, AGFD 2001).

Eriogonum mortonianum is known only from west of Fredonia along Highway 389 in northwest Arizona. It is found on red gypseous sandy-clay soils derived from Moenkopi Formation outcrops in Great Basin Desertscrub habitats at 4,650 feet (1,400 meters). *E. mortonianum* is reported as occurring "along small drainages on sandstone and shale uplands with *Atriplex* spp., *Artemisia* spp., *Ephedra* spp." (ANPS 2001, AGFD 2001).

Eriogonum mortonianum is known to occur and hybridize with *E. thomsoniae* var. *atwoodii* (AGFD 2001), making identification difficult. Hybrid specimens can be woody like *E. mortonianum* but with long, linear leaves with hair on the bottom like *E. t.* var. *atwoodii*, as observed by Dr. James Reveal (2009). Hybridized intermediates from these species are as common as the parent species (ARPC 2001).

4.3.23.2 Survey Results

A total of 85 individuals of *Eriogonum mortonianum* were found in the Hydro System Existing Highway Alternative Reach, in the vicinity of Cottonwood Wash on the Kaibab Indian Reservation. *E. mortonianum* locations are shown in Table 4-22 and in the distribution and detailed maps provided in Map 4-22 and Map 4-23.

Table 4-22
A summary of *Eriogonum mortonianum* survey results by location

Reach Location		Land Ownership	# of Plants
Hydro System Existing Highway Alternative	1.5 miles southeast of Cottonwood Wash along Highway 389	Kaibab Indian Reservation	85
Hydro System Existing Highway Alternative	East of Riggs Flat	Kaibab Indian Reservation	58,000*
		Total	58,085*

*Extrapolated count based 50-meter transect densities and acreages

Eriogonum mortonianum was only encountered in the Colorado Plateau Ecological Region, and all individuals were found growing within the Gypsum Badland Ecological System where they occurred in two alliances and two associations. The majority of plants were found within the *Eriogonum (corymbosum, mortonianum, thompsoniae)* Shrubland Alliance, in the *Eriogonum (corymbosum, mortonianum, thompsoniae)* Gypsum Badlands Sparse Shrubland Association. A small group was also encountered in shrubland dominated by *Artemisia bigelovii* and *Ephedra torreyana*, in habitat with cryptobiotic crusts as a dominant feature in the landscape. The species was located from between 4,680 feet (1,426 meters) and 4,720 feet (1,438 meters) in elevation. A summary of *Eriogonum mortonianum* occurrences is provided inTable 4-23.

Table 4-23
A summary of *Eriogonum mortonianum* survey results by alliance and association

Alliance	Association	# of Plants
COLORADO PLATEAU GYPSUM BADLANDS ECOLOGICAL SYSTEM		
Artemesia biglovii Shrubland	*Artemesia biglovii – Ephedra torreyana* / Crytobiotic Gypsum Badlands Sparse Shrubland	7
Eriogonum (corymbosum, mortonianum, thompsoniae) Shrubland	*Eriogonum (corymbosum, mortonianum, thompsoniae)* Gypsum Badlands Sparse Shrubland	78
Eriogonum mortonianum dominant or co-dominant communities		58,000*
	Total	58,085*

*Extrapolated count based 50-meter transect densities and acreages

Eriogonum mortonianum was found exclusively on the Undivided Moenkopi Formation within the survey area Table 4-24Table 4-24. This formation produces light-red and dark-red slope-forming siltstone and sandstone and minor gray gypsum (Billingsley 2008). The geologic formations for the extrapolated plants were not documented and do not appear in Table 4-24.

Table 4-24
A summary of *Eriogonum mortonianum* survey results by geologic formation

Geologic Formation	# of Plants
COLORADO PLATEAU GYPSUM BADLANDS ECOLOGICAL SYSTEM	
Undivided Moenkopi Formation	85
Total	85

Eriogonum mortonianum was primarily found on Gypsiorthids-Gypsiorthids, shallow complex soils within the survey area. All soils supporting. *E. mortonianum* are shown in Table 4-25. The soil types for the extrapolated plants were not documented and do not appear in Table 4-25.

Table 4-25
A summary of *Eriogonum mortonianum* survey results by soil type

Soil type	# of Plants
Clayhole loam	2
Gypsiorthids-Gypsiorthids, shallow complex	83
Total	85

Eriogonum mortonianum was observed in a variety of microhabitats within the badlands landscape complex, and its relative abundance varied within this complex. On wash outflows from badland formations, the species was rare to locally occasional, in arroyos it was locally occasional, and on gypsum outcrops, it was a common feature in the landscape. The highest densities of the species occurred on mud flows downslope from ridges with exposed bedrock. *E. mortonianum* was encountered occasionally at the base of these ridges. The species was noted to be absent from knolls with cryptobiotic crusts, and from benches without cryptobiotic crusts.

4.3.23.3 Discussion

The survey identified a total of 85 individuals of *Eriogonum mortonianum* within the survey area, all of which occurred in the Hydro System Existing Highway Alternative Reach, and entirely within the Kaibab Indian Reservation. All individuals were found in the Colorado Plateau Gypsum Badlands Ecological System. The species was often a predominant member of the vegetation community, occurring as a co-dominant along with other species of *Eriogonum*, including *E. mortonianum* and *E. thompsonii. E. mortonianum* was generally observed on the Undivided Moenkopi Formation, in Gypsiorthids-Gypsiorthids soils. Voucher specimens collected across *E. mortonianum's* range within the survey area were presented to Dr. James Reveal in 2009. Dr. Reveal's examination of voucher specimens collected during the 50-meter transect sampling verified *E. mortonianum's* presence within the study area.

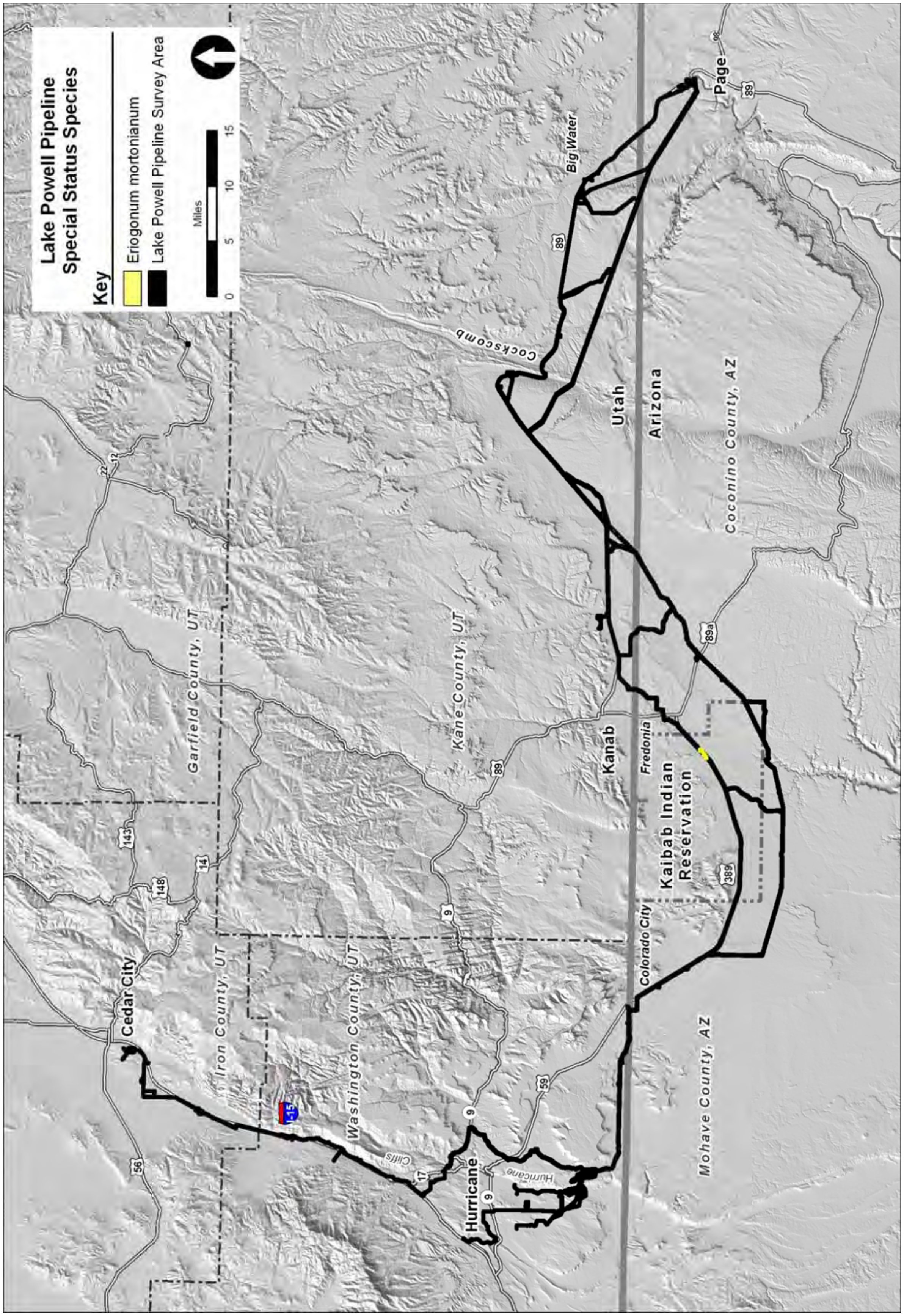
Research on *Eriogonum mortonianum* appears to be limited, and it is not likely to have been collected outside of the narrow highway right-of-way along the south side of the survey area. The survey located the species from 44,680 feet (1,426 meters) to 4,720 feet (1,438 meters) in elevation, which is slightly higher than elevations previously recorded for the species. Additionally, although the species is reported to bloom and fruit from July to September (ANPS 2001, AGFD 2001), plants were not found in bloom (Figure 4-9) until September. *E. mortonianum* was encountered in a variety of microhabitats, including arroyos, on gypsum outcrops, mud flows downslope from ridges with exposed bedrock, and on wash outflows from badland formations. This supplements published data reporting that the species is found on sandstone and shale uplands, and along small drainages (ANPS 2001, AGFD 2001).

Figure 4-9
View of *Eriogonum mortonianum* within the survey area

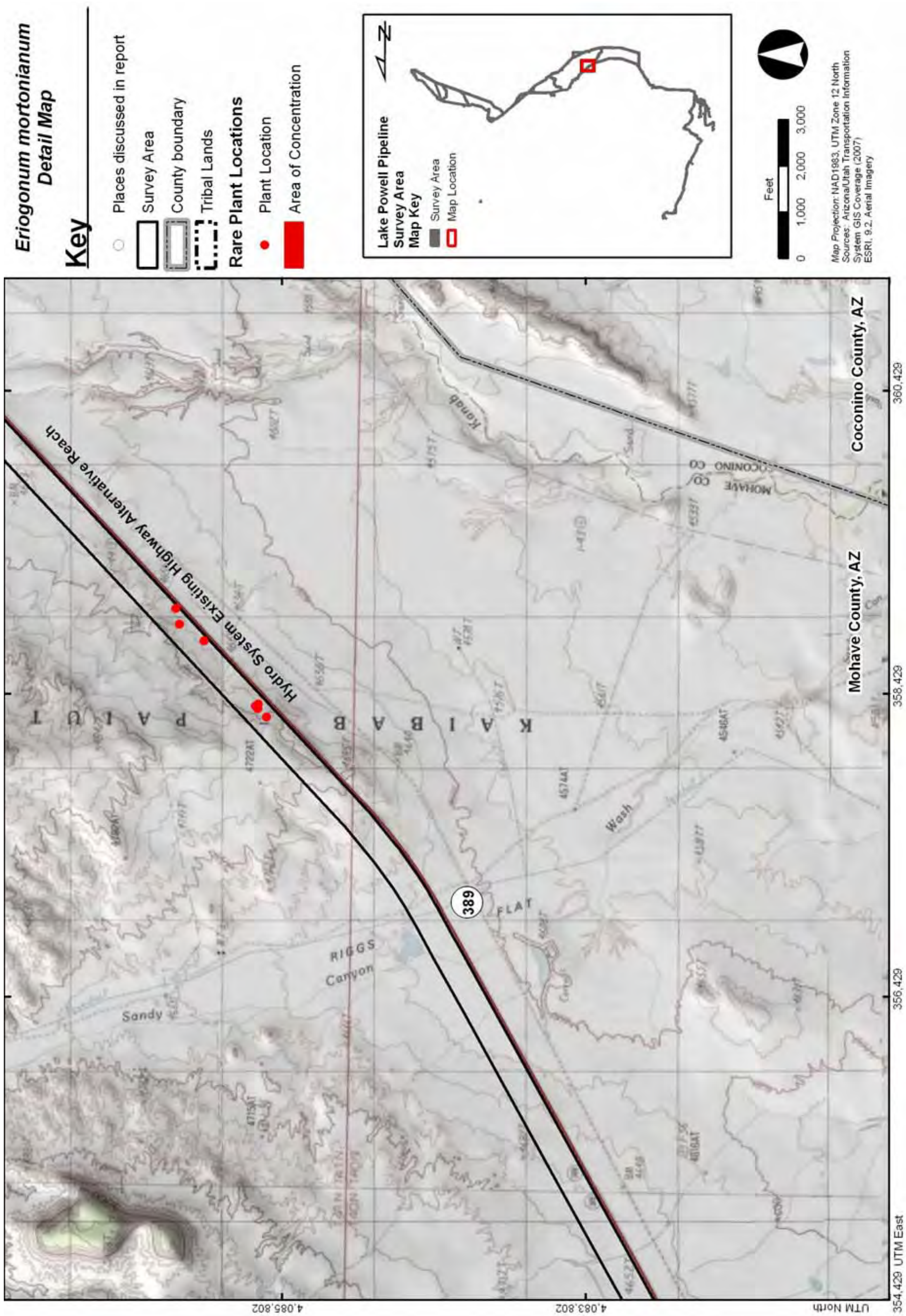
The area east of Riggs Flat is presently the only known location for this plant. However, because contiguous habitat extends northwest from the survey area, it is highly likely that the range of *E. mortonianum* extends beyond that which is known. The species appears to be an important feature in the landscape, often occurring as a dominant or co-dominant species (along with other shrubby species of *Eriogonum*). Fifty-meter belt transects placed in these high-density areas resulted in an average of 0.3 individuals per square meter. Extrapolations of this quantity over the same vegetation community within the survey area yield an estimated 58,000 individuals within the survey area. However, given the presence of likely *E. mortonianum* and *E. thompsonae* var. *atwoodii* hybrids (as determined by Dr. James Reveal's examination of voucher specimens collected during the transect sampling) within this area, at least some proportion of these individuals are expected to be hybrids.

Eriogonum mortonianum was exclusively found on rangelands subjected to cattle grazing. The area was historically used for cattle and sheep range, and for a time feral horses. *E. mortonianum* has evolved in, and is narrowly endemic to, a habitat characterized by sheet erosion and silt deposition within the gypsum badlands. Thus, it appears to be dependent upon natural disturbance regimes. Invasive weeds were minimally observed in association with *E. mortonianum*, and are believed to be poorly adapted to the gypsum habitat which supports *E. mortonianum*.

Eriogonum mortonianum habitat coincided with other rare plant habitats, including *Cryptantha semiglabra, Pediocactus sileri,* and *E. thompsoniae* var. *atwoodii*, as these species share an affinity for red, gypsum soils. While there are no known data regarding the successful transplant of *E. mortonianum*, the identified group is a component of the only known occurrence of the species, and therefore, any individuals at risk due to project construction may be salvaged. It is also recommended that seed be collected from at-risk individuals and re-distributed following completion of construction. Consideration could also be given to growing individuals from collected seed, in order to supplement revegetation efforts of affected areas. Therefore, expected impacts to the species resulting from the project would be a potential loss of habitat, and the direct loss of individuals due to project construction.



Map 4-22
Eriogonum mortonianum **Overview Map**



Map 4-23
***Eriogonum mortonianum* Detail Map**

4.3.24 Eriogonum thompsoniae var. atwoodii (Atwood wild buckwheat)

4.3.24.1 Natural History

Eriogonum thompsoniae var. *atwoodii* is an herbaceous perennial of the Polyonaceae (Buckwheat Family) that grows up to 2 feet (60 centimeters) wide and tall. The presence of a woody underground base gives it the appearance of a sub-shrub. The leaves are narrowly linear and 1.2 to 3.2 inches (3 to 8 centimeters) long with thickened or in-rolled margins. The flower cluster is open and branched in an umbrella shape. White, minute flowers are reported to bloom and set seed from July to October (AGFD 2001) (Figure 4-10).

Figure 4-10
Close up of *Eriogonum thompsoniae* var. *atwoodii* within the survey area

Eriogonum thompsoniae var. *atwoodii* is a narrow endemic known only from near Fredonia and Lost Spring Mountain in Mohave County, Arizona (AGFD reported *E. t.* var. *atwoodii* from Utah in2001, but this specimen was later identified as *E. thompsoniae* var. *albiflorum* by James Reveal). *E. t.* var. *atwoodii* is restricted to small drainages of red clay or red gypsum soils from Moenkopi Formation sandstone and shale outcrops. It is found in Great Basin Desertscrub habitats from 4,400 feet (1,341 meters) to 4,700 feet (1,433 meters) elevation. In Fredonia, it is found with *Artemisia bigelovii*, *Atriplex confertifolia*, and *Hilaria jamesii*. Near Antelope Springs (south of the Divide) in Mohave County, Arizona, it is found with *Atriplex*, *Salvia*, *Ephedra*, *Hilaria*, and *Chrysothamnus* (ARPC 2001, AGFD 2001).

Eriogonum thomsoniae var. *atwoodii* is distinguished from similar species and varities by having leaves that are hairy underneath. It is also known to occur and hybridize with *E. mortonianum* (AGFD 2001), producing woody plants with long, linear leaves with hairs underneath (Reveal 2009). Hybridized intermediates from these species are as common as the parent species (ARPC 2001).

4.3.24.2 Survey Results

Eriogonum thompsoniae var. *atwoodii* were located within the Hydro System Existing Highway Alternative and the Cedar Valley Pipeline Sytem reaches during the survey season. *E. t.* var. *atwoodii* was encountered mostly within the Kaibab Indian Reservation in the vicinity of Cottonwood Wash. Two individuals were also found near the Divide, on BLM lands. *E. t.* var. *atwoodii* locations are shown in Table 4-26, and on the distribution and detailed maps provided in Map 4-24 to Map 4-27.

Table 4-26
A summary of *Eriogonum thompsoniae* var. *atwoodii* survey results by location

Reach	Location	Land Ownership	# of Plants
Hydro System Existing Highway Alternative	1.4 miles southwest of Cottonwood Wash to 5.7 miles southwest of Cottonwood Wash	Kaibab Indian Reservation	694
Hydro System Existing Highway Alternative	3 miles northeast of Twomile Wash	Kaibab Indian Reservation	38
Cedar Valley Pipeline System	0.25 miles north of The Divide	BLM	2
Hydro System Existing Highway Alternative	1.4 miles southwest of Cottonwood Wash to 3 miles northeast of Twomile Wash	Kaibab Indian Reservation	85,000*
		Total	85,734*

*Extrapolated count based 50-meter transect densities and acreages

Eriogonum thomsoniae var. *atwoodii* was found exclusively in the Colorado Plateau Ecological Region and the Colorado Plateau Gypsum Badland Ecological System. It was found within four Alliances and six Associations. The majority of *E. t.* var. *atwoodii* occurred in the *Artemisia bigelovii* Shrubland Alliance, in the *Artemesia bigelovii – Ephedra torreyana /* Crytobiotic Gypsum Badlands Sparse Shrubland Association. *Eriogonum t.* var. *atwoodii* was also encountered as a co-dominant vegetation member in some vegetation communities, along with other shrubby species of *Eriogonum* (*corymbosum, mortonianum*). Surveys identified the species from between 4,640 feet (1,414 meters) and 4,760 feet (1,451 meters) elevation. All occurrences are provided in Table 4-27.

Table 4-27
A summary of *Eriogonum thompsoniae* var. *atwoodii* survey results by alliance and association

Alliance	Association	# of Plants
COLORADO PLATEAU GYPSUM BADLANDS ECOLOGICAL SYSTEM		
Artemesia biglovii Shrubland	*Artemesia biglovii – Ephedra torreyana /* Crytobiotic Gypsum Badlands Sparse Shrubland	520
Eriogonum (corymbosum, mortonianum, thompsoniae) Shrubland	*Eriogonum (corymbosum, mortonianum, thompsoniae)* Gypsum Badlands Shrubland	38
Eriogonum (corymbosum, mortonianum, thompsoniae) Shrubland	*Eriogonum (corymbosum, mortonianum, thompsoniae)* Gypsum Badlands Sparse Shrubland	2
Eriogonum (corymbosum, mortonianum, thompsoniae) Shrubland	*Eriogonum (corymbosum, mortonianum, thompsoniae)* Gypsum Badlands Sparse Dwarf-shrubland	29
Eriogonum thompsoniae var. *atwoodii* Sparsely Vegetated	*Eriogonum thompsoniae* var. *atwoodii* Gypsum Badlands Sparse Vegetation	143
Pinus monophylla – (Juniperus osteosperma) Woodland	*Pinus monophylla – Juniperus osteosperma / Mahonia fremontii* Gypsum Badlands Sparse Woodland	2
Eriogonum thomsponiae var. *atwoodii* dominated or co-dominated		85,000*
	Total	85,734*

*Extrapolated count based 50-meter transect densities and acreages

Eriogonum t. var. *atwoodii* was found on two geologic formations within the survey area. It was primarily found on Undivided Moenkopi Formation and the Middle Red Member of the Moenkopi Formation. 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. Often the Middle Red Member exhibits mud cracks and ripple marks (Billingsley et al. 2008). All geologic formations supporting *E. t.* var. *atwoodii* are given in Table 4-28. The geologic formations for the extrapolated plants were not documented and do not appear in Table 4-28.

Table 4-28
A summary of *Eriogonum thompsoniae* var. *atwoodii* survey results by geologic formation

Geologic Formation	# of Plants
COLORADO PLATEAU GYPSUM BADLANDS ECOLOGICAL SYSTEM	
Undivided Moenkopi Formation	694
Middle Red Member Moenkopi Formation	40
Total	734

Eriogonum thompsoniae var. *atwoodii* were found on three soil types within the survey area. The majority of plants were found on Gypsiorthids-Gypsiorthids, shallow complex soils. Table 4-29 provides a complete list of soils where *E. t.* var. *atwoodii* was observed. The soil types for the extrapolated plants were not documented and do not appear in Table 4-29.

Table 4-29
A summary of *Eriogonum thompsoniae* var. *atwoodii* survey results by soil type

Soil type	# of Plants
Clayhole loam	73
Eroded land – Shalet complex	2
Gypsiorthids-Gypsiorthids, shallow complex	659
Total	734

Eriogonum t. var. *atwoodii* was found on red, clay soils and red mud flats derived from diverse badlands topography, ranging from gypsum outcrops to thin soils with microbiotic crusts. This species was found growing on mud flats and also on red, sheet eroded hillsides. Its habitat coincided with other special status species, including *Cryptantha semiglabra, Pediocactus sileri,* and *E. mortonianum*, all of which share an affinity for red, gypsum soils. *E. t.* var. *atwoodii* was observed in sparse shrubland and sparsely vegetated habitats. The associated species which were most often present included *Artemisia bigelovii*, *Ephedra torreyana*, *E. corymbosum*, and *Pleuraphis jamesii.* Individuals were found on rangelands subjected to cattle grazing and to natural disturbances, particularly sheet erosion.

4.3.24.3 Discussion

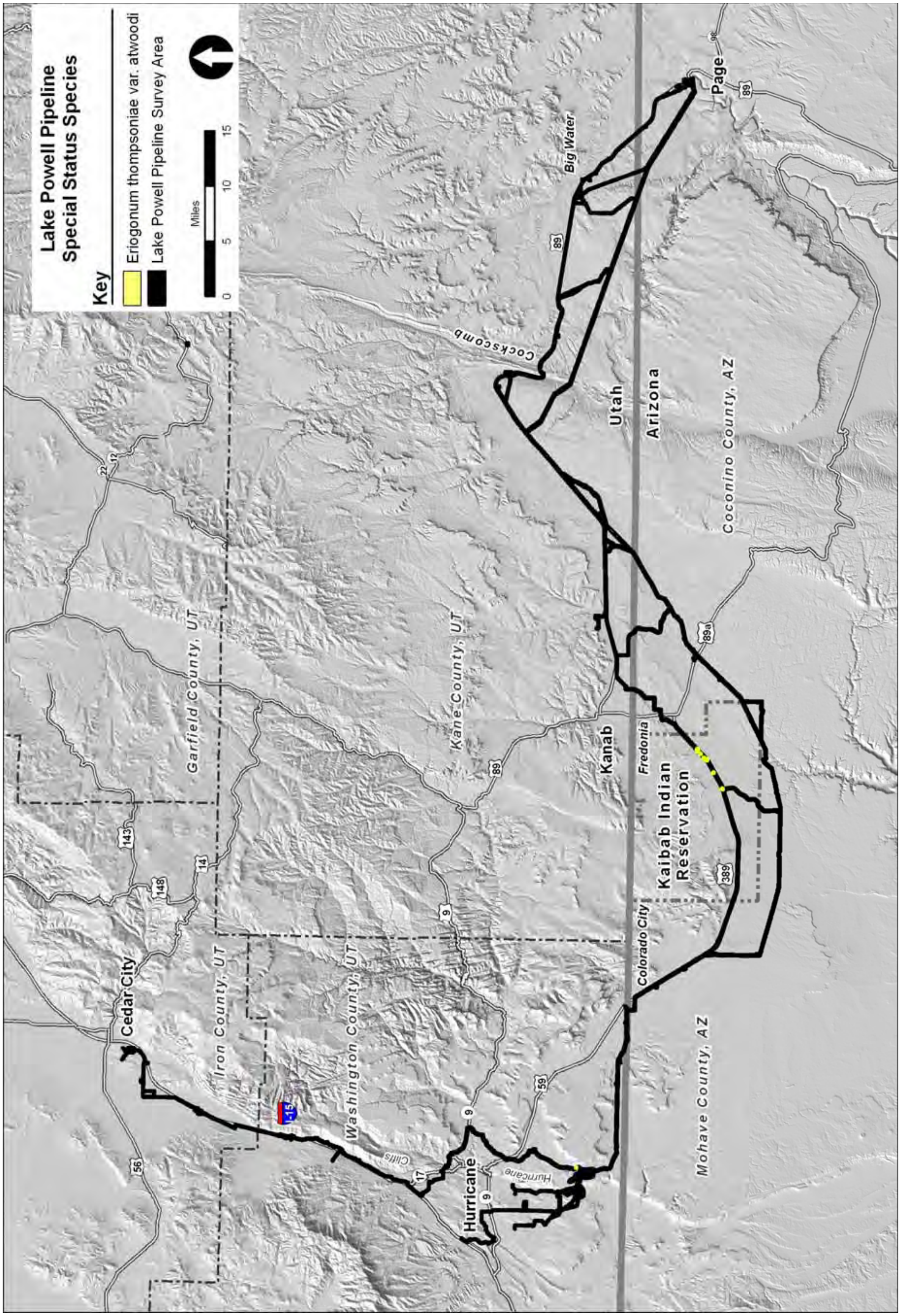
The survey identified a total of 85,734 individuals of *Eriogonum thompsoniae* var. *atwoodii* within the survey area, mostly within the Kaibab Indian Reservation and entirely within the Colorado Plateau Gypsum Badlands Ecological System. *E. t.* var. *atwoodii* were located within the Hydro System Existing Highway Alternative and the Cedar Valley Pipeline Sytem reaches. *E. t.*var. *atwoodii* was generally observed on Undivided Moenkopi Formation and in Gypsiorthids-Gypsiorthids soils. Voucher specimens collected across *E. t.*var. *atwoodii's* range within the survey area were presented to Dr. James Reveal in 2009. Dr. Reveal's examination of voucher specimens collected during the 50-meter transect sampling verified *E. t.*var. *atwoodii's* presence within the study area.

Surveys identified *Eriogonum thompsoniae* var. *atwoodii* from between 4,640 feet (1,414 meters) and 4,760 feet (1,451 meters) elevation, which is slightly higher than the documented elevation range of the species. While the species is reported to bloom and set seed from July to October, individuals were observed to bloom until September within the survey area. *E. t.* var. *atwoodii* was often observed to be a co-dominant member of the vegetation community, and in some areas high densities inhibited the ability of the survey crew to count individuals. The 50-meter belt transect technique was applied in these areas, and resulted in an average of one plant per square meter. Extrapolations of this quantity over the vegetation community yield an estimated 84,000 live plants within the survey area. However, due to the likely presence of hybrids, at least some proportion of these individuals cannot be confirmed as *E. t.*var. *atwoodii*. Nevertheless, this extrapolated quantity provides insight into the importance of the identified habitats to the species. Surveys for *E. t.* var. *atwoodii* were adequate to identify all potential habitats within the survey area. However, the known extent of *E. t.* var. *atwoodii* on the Kaibab Indian Reservation is limited by the survey area artificially; thus, while the survey has counted or estimated special status plant occurrences on the Reservation, they do not include the entire contiguous locations, as those groups extended outside the survey area. Suitable habitat extends further north of the survey area for *E. t.* var. *atwoodii*.

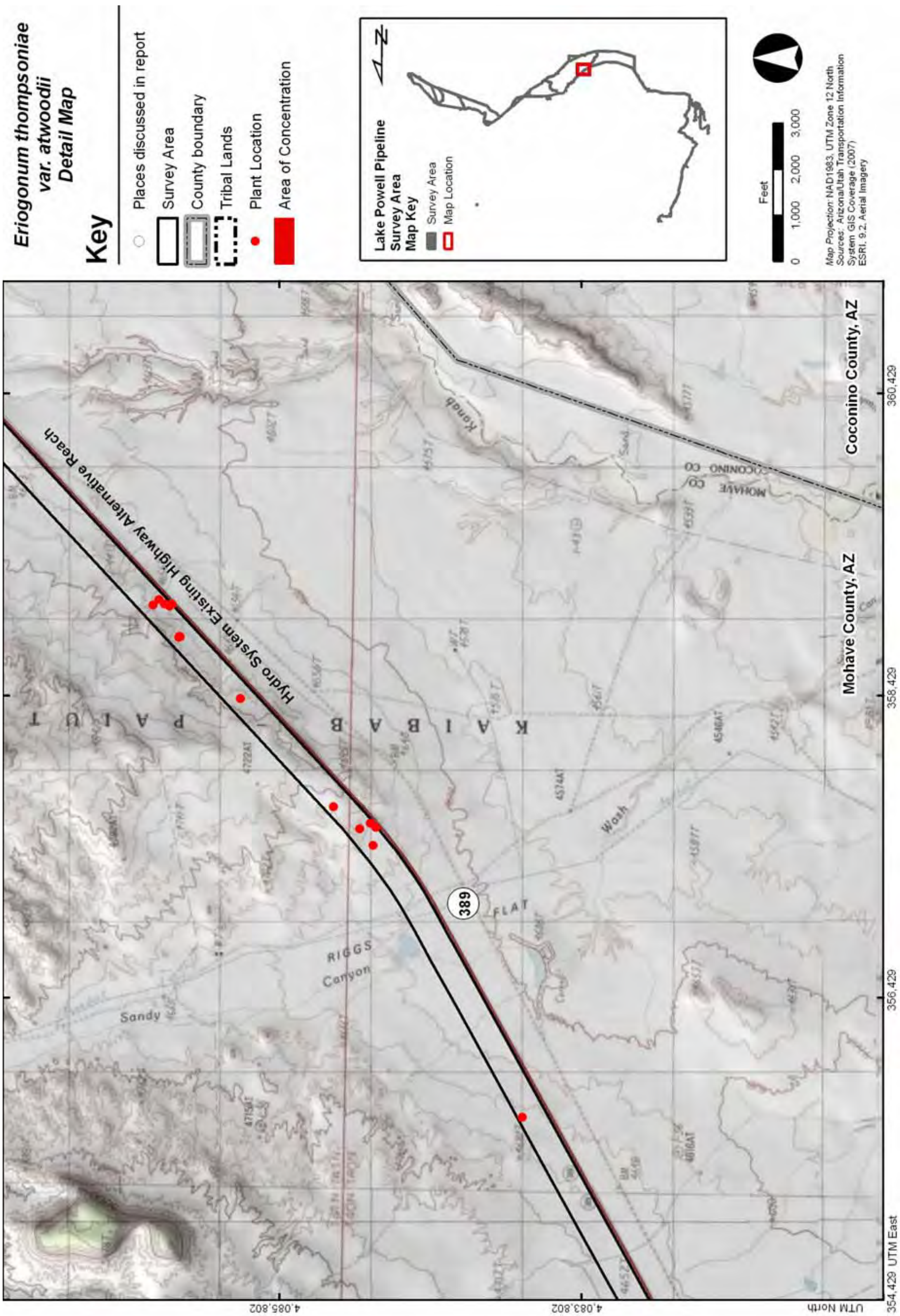
The known range of *Eriogonum thompsoniae* var. *atwoodii* is believed to due in part to human activity within the area in the 1800s. Its range extends east to west along and in proximity to Indian routes used by Spaniards for livestock drives on the Old Spanish Trail, much of which became the Honeymoon Trail. By 1870, livestock driven along the route numbered over 10,000 head per drive. These levels of activity could have contributed to the dispersal of *E. t.* var. *atwoodii* to either its Antelope Spring (south of the Divide) habitat near Hurricane Cliffs, or the Shinarump Cliffs habitat on the Kaibab Indian Reservation.

Eriogonum thompsoniae var. *atwoodii* was exclusively found on rangelands subjected to cattle grazing. Historically these areas were used as cattle and sheep range. It also had grazing pressure from a portion of a reported 5,000 feral horses which roamed the range between Kanab and the Hurricane Cliffs in 1902 (Mead and Teal 1903). However, present stocking rates are much lower than those reported in the period 1870 to 1913, before the establishment of the Kaibab Indian Reservation and when the land was ranched under LDS church and corporate ownerships (Austin et al. 2005). Plants which are within the right-of-way of Highway 389 are scarce and subjected to disturbance by graders. However, plants are growing in graded roadsides at the south of the Divide, and therefore the plant seems to be adapted to either colonizing bare ground, or recovering from top removal. There are no data or observations to determine if *E. t.* var. *atwoodii* is an increaser herb under cattle or sheep grazing, although other varieties of this species do appear to increase under grazing. *E. t.* var. *atwoodii* has evolved in and is narrowly endemic to a habitat characterized by sheet erosion and silt deposition. Thus, it appears to be dependant on the natural disturbance regime of gypsum badlands where they exist on the Kaibab Indian Reservation and south of the Divide. Invasive weeds were not commonly observed in association with *E. thompsoniae* var. *atwoodii*, and are believed to be poorly adapted to the gypsum habitat which supports the species. Therefore, expected impacts to the species resulting from the project would be a potential loss of habitat, and the direct loss of individuals due to project construction.

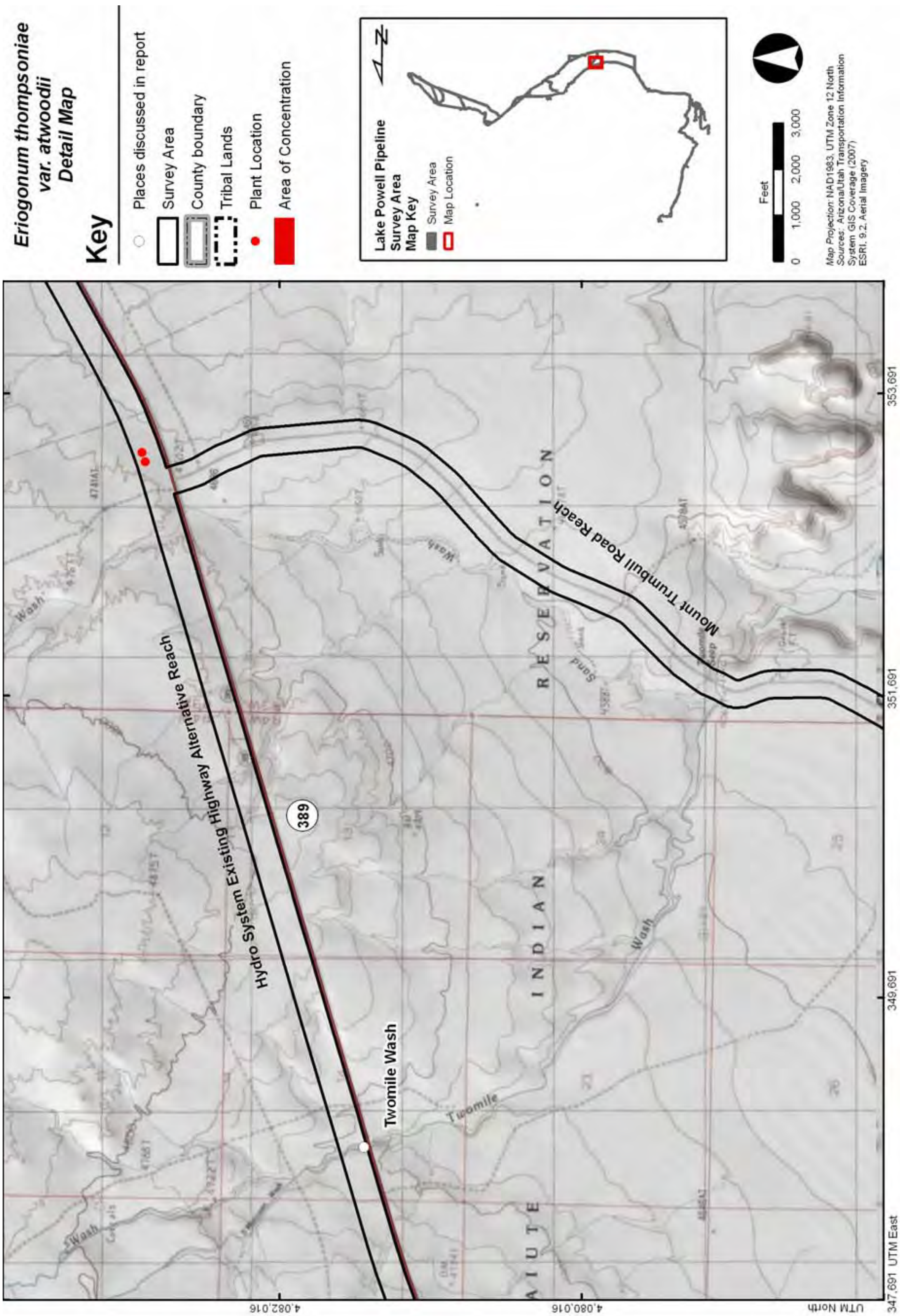
While there are no known data regarding the successful transplant of *Eriogonum thompsoniae* var. *atwoodii*, the identified location is a component of the only known group of the species, and therefore, any individuals at risk due to project construction should be salvaged wherever possible. Additionally, it is recommended that seed be collected from at-risk individuals and re-distributed following completion of construction. Consideration could also be given to growing individuals from collected seed, in order to supplement revegetation efforts of affected areas.



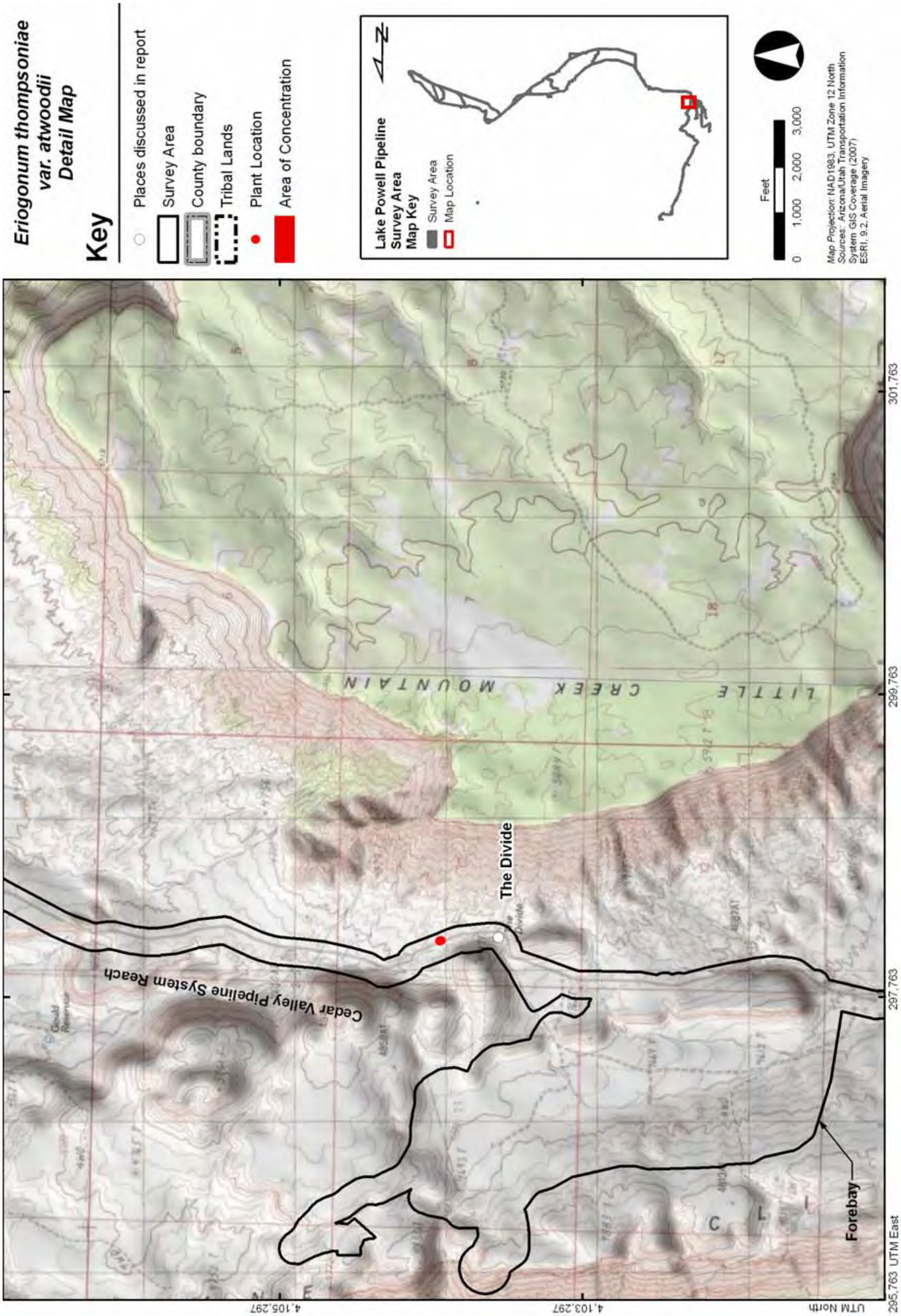
Map 4-24
***Eriogonum thompsoniae* var. *atwoodii* Overview Map**



Map 4-25
***Eriogonum thompsoniae* var. *atwoodii* Detail Map**



Map 4-26
***Eriogonum thompsoniae* var. *atwoodii* Detail Map**



Map 4-27
Eriogonum thompsoniae **var.** ***atwoodii*** **Detail Map**

4.3.25 *Euphorbia nephradenia* (Utah spurge)

4.3.25.1 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).

Euphorbia nephradenia is found in mixed, sandy desertshrub 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).

4.3.25.2 Survey Results

Euphorbia nephradenia was not found during the survey season.

4.3.25.3 Discussion

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

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

4.3.26.1 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).

Gilia latifolia var. *imperialis* is found on shadscale and other mixed desert shrub communities 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).

4.3.26.2 Survey Results

Gilia latifolia var. *imperialis* was not found during the survey season.

4.3.26.3 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.

4.3.27 Habenaria zothecina (Alcove bog orchid)

4.3.27.1 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).

Habenaria 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 3,950 feet (1,204 meters) to 6,400 feet (1,951 meters) (AGFD 2004).

Habenaria zothecina is widely scattered and nowhere in great numbers, though groups appear stable (ARPC 200). The range includes the Colorado and Green rivers and their tributaries in Utah, adjacent northwest Colorado, and northern Arizona (AGFD 2004).

4.3.27.2 Survey Results

Habenaria zothecina was not encountered during project surveys.

4.3.27.3 Discussion

Habenaria 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.

4.3.28 *Imperata brevifolia* (Satintail grass)

4.3.28.1 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).

Imperata brevifolia is found growing along streamsides and other moist areas in sandstone canyons 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 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, 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).

4.3.28.2 Survey Results

Imperata brevifolia was not encountered during project surveys.

4.3.28.3 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 *Imperata 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.

4.3.29 *Iris pariensis* (Paria iris)

4.3.29.1 Natural History

Iris pariensis is a perennial herb from rhizomes 0.2 inches (5 millimeters) to 0.4 inches (10 millimeters) thick. Rhizomes are clothed with shredded fibrous leaf bases. Brownish or purplish leaves are up to 0.2 inches (2 to 5 millimeters) wide and form a sheath around the stem. Linear shaped bracts 2 to 5 millimeters wide enclose the single, white flower that blooms in May (Welsh et al. 1993, UNPS 2003-08).

Iris pariensis is known only from Kane County, Utah. It was collected once in a grass-shrub community at 4,600 feet (181 meters). Intensive searches of the East and West Clark Benches in 1991 and 1993 failed to relocate the Paria iris (Welsh et al. 1993).

4.3.29.2 Survey Results

Iris pariensis was not encountered during project surveys.

4.3.29.3 Discussion

This taxon is not recognized in the Flora of North America. (eFlora 2009): A single plant found on the Paria Plateau [actually East Clark Bench, as per type specimen cited by Welsh et al. 2008] in Kane County, Utah, with leaves only 0.1 inches (3 to 4 millimeters) wide and a single flower stem only 1.6 inches (4 centimeters) long, which meant that the flower was at almost ground level, was named *Iris pariensis*. No other such specimen has been located, and this entity is considered an aberrant form that due to the desert-like conditions in which it was growing. No further surveys are warranted within the survey area for this plant.

4.3.30 *Jamesia americana* var. *zionis* (Zion jamesia)

4.3.30.1 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, *Jamesia americana* 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 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).

4.3.30.2 Survey Results

Jamesia americana var. *zionis* was not encountered during project surveys.

4.3.30.3 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.

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

4.3.31.1 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).

Lepidium montanum var. *claronense* is endemic to the Pausaugunt 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).

Lepidium montanum var. *claronense* is one of 12 accepted varieties in *Lepidium montanum* (eFlora 2010). In *L. montanum* 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).

4.3.31.2 Survey Results

Lepidium montanum was not encountered during project surveys.

4.3.31.3 Discussion

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

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

4.3.32.1 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.caudatus* 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).

Lupinus caudatus 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. Cutler lupine 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 of *Lupinus caudatus* var. *cutleri* within the survey area

4.3.32.2 Survey Results

A total of 54 *Lupinus caudatus* var. *cutleri* plants were found, one of which was encountered near Fivemile Valley in the Buckskin to Paria Transmission Line 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 4-30 and shown in the distribution and detailed maps included in Map 4-28 to Map 4-30.

Table 4-30
A summary of *Lupinus caudatus* var. *cutleri* survey results by location

Reach	Location	Land Ownership	# of Plants
Buckskin to Paria Transmission Line	0.15 miles north of Fivemile Valley	Private	1
Water Conveyance System	1 miles 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 *Lupinus caudatus* 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 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 4-31). Plants were encountered between 4,760 feet (1,451 meters) and 5,000 feet (1,524 meters) in elevation.

Table 4-31
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

Lupinus caudatus var. *cutleri* was encountered on four geologic formations (Table 4-32). 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 siltsone 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 4-32
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 4-33).

Table 4-33
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	

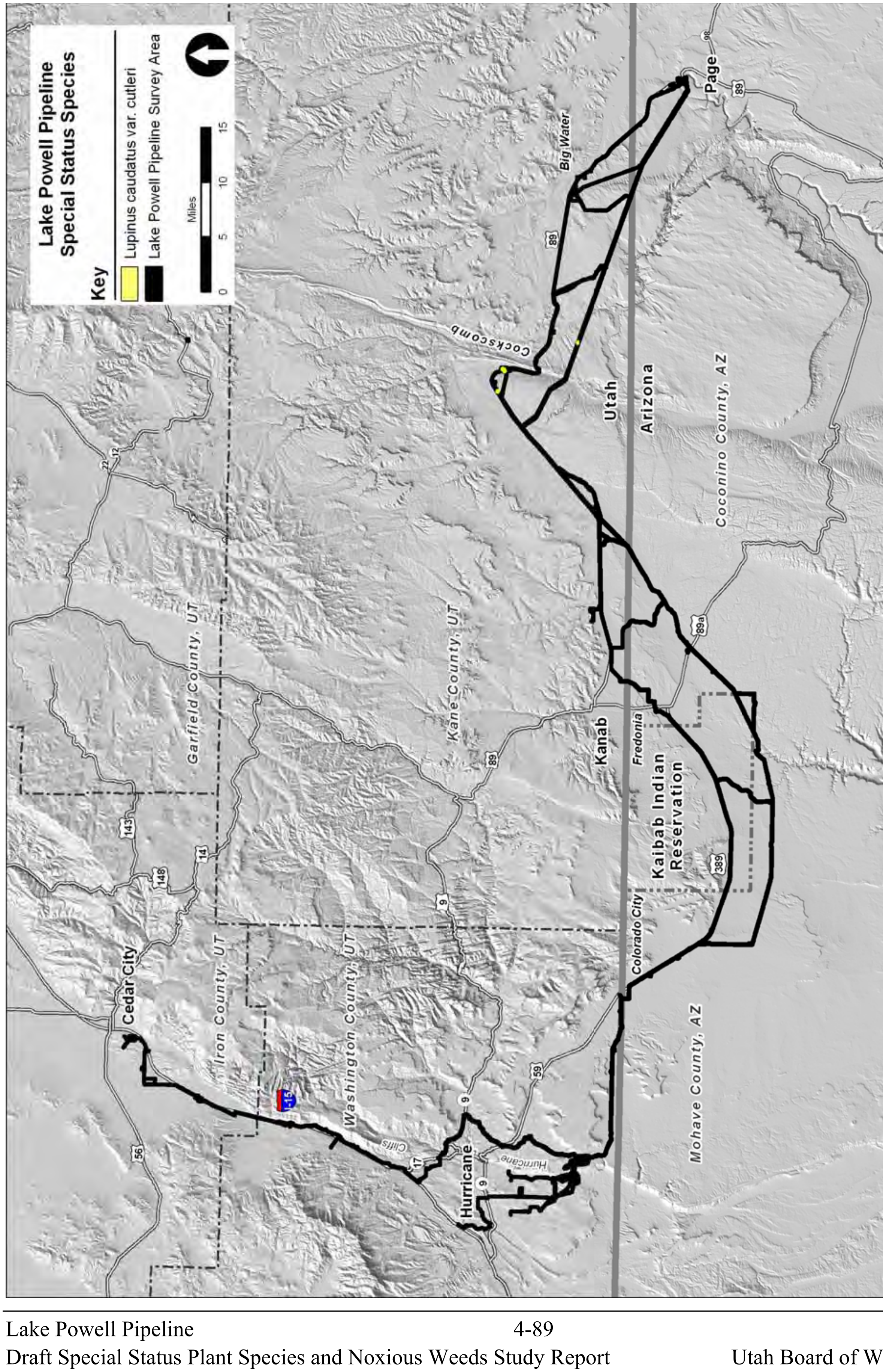
4.3.32.3 Discussion

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 *Lupinus caudatus* 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.

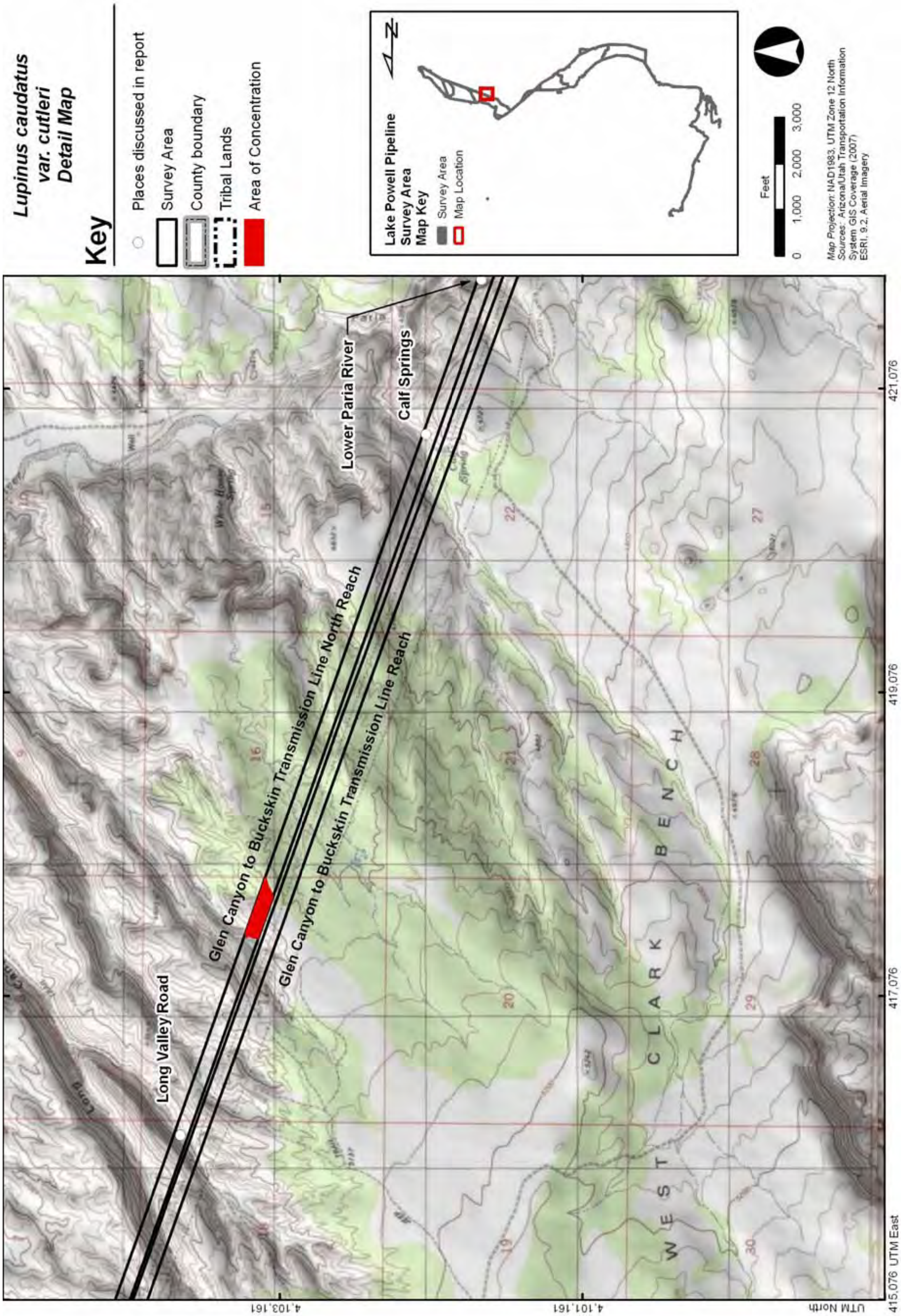
Because positive confirmation of the variety is dependent upon key floral features, and none of the individuals encountered during the survey were in flower or fruit, a positive identification was not possible. However, the individuals identified by the survey as *Lupinus caudatus* var. *cutleri* displayed vegetative morphological characterics 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 *Lupinus caudatus* 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*.

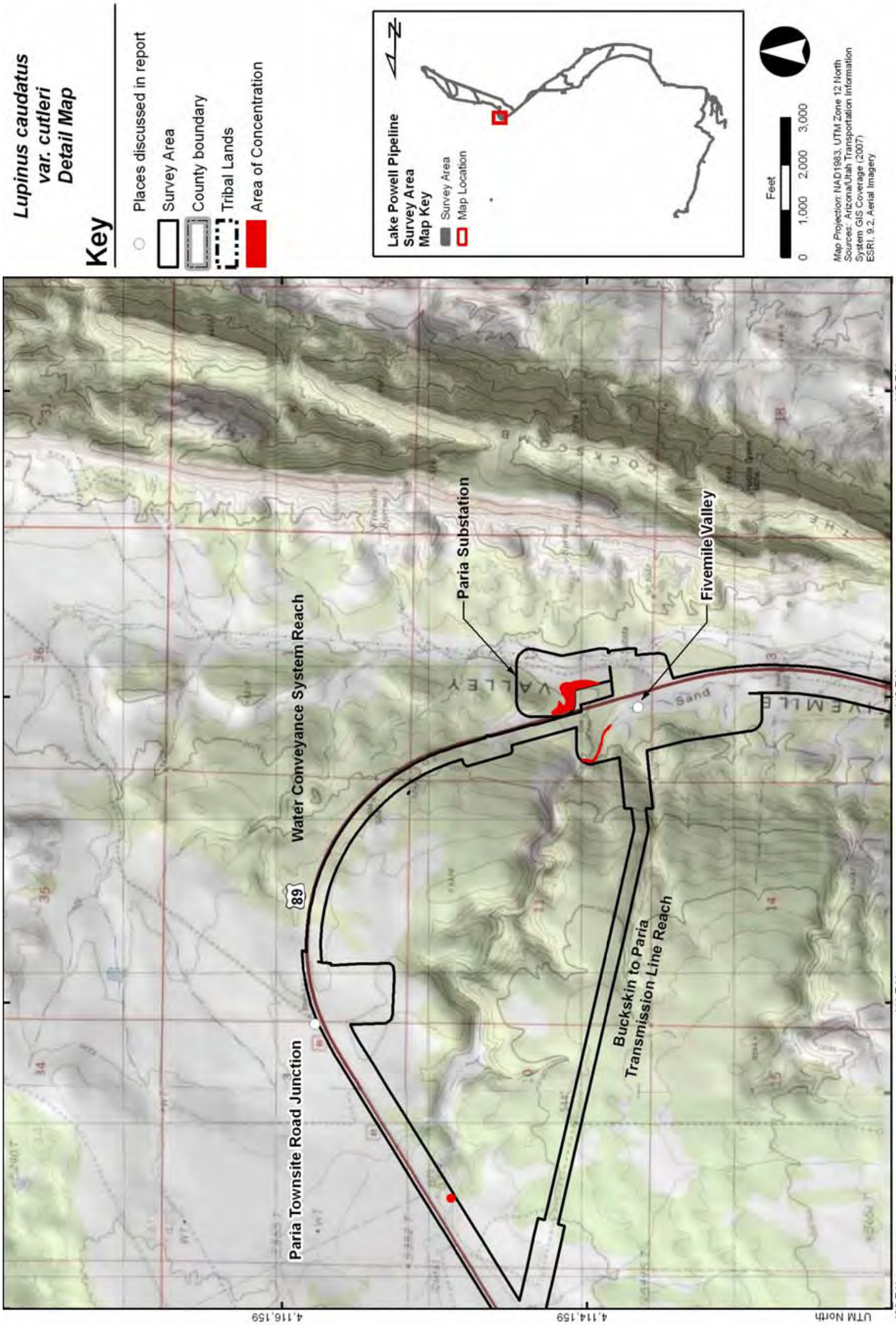
If avoidance of *Lupinus caudatus* var. *cutleri* is not possible, it is recommended that the identified locations be re-visited prior to project construction. These visits should begin in April in order to observe individuals in flower, and positively identify the species. If the identified groups are 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.



Map 4-28
***Lupinus caudatus* var. *cutleri* Overview Map**



Map 4-29
***Lupinus caudatus* var. *cutleri* Detail Map**



Map 4-30
***Lupinus caudatus* var. *cutleri* Detail Map**

4.3.33 *Mentzelia memorabalis* (September 11 stickleaf)

4.3.33.1 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).

Mentzelia memorabalis is endemic to northern Mohave County, Arizona from Clayhole Wash between Colorado City and Mount Trumbell. This species is found only on gypsum-clay outcrops 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).

4.3.33.2 Survey Results

Mentzelia memorabalis was not encountered during project surveys.

4.3.33.3 Discussion

Mentzelia memorabalis is known only from Claypole Wash, which occurs outside of the survey area. All collections of perennial *Mentzelia*'s 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.

4.3.34 *Oenothera murdockii* (Chinle evening primrose)

4.3.34.1 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 only0.4 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).

Oenothera 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 from 4,400 feet (173 meters) to 5,600 feet (220 meters) (UNPS 2003-08).

4.3.34.2 Survey Results

Oenothera murdockii was not encountered during project surveys.

4.3.34.3 Discussion

Oenothera 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.

4.3.35 *Ostrya knowltonii* (Western hophornbeam)

4.3.35.1 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).

Ostrya 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 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).

4.3.35.2 Survey Results

Ostrya knowltonii was not encountered during the survey seasons.

4.3.35.3 Discussion

Ostrya 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.

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

4.3.36.1 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).

Pediocactus peeblesianus 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).

Pediocactus peeblesianus var. *fickeiseniae* occurs 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 Desertscrub, 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*.

4.3.36.2 Survey Results

Pediocactus peeblesianus var. *fickeiseniae* was not encountered during project surveys.

4.3.36.3 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 *Pediocactus peeblesianus* var. *fickeiseniae* were found during surveys. No further surveys are warranted within the survey area for this plant.

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

4.3.37.1 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 4-12). 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 4-12
Close up of *Pediocactus sileri* observed within the survey area

Pediocactus 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 Desertshrub biotic community, but also from the Great Basin Conifer Woodland and Plains, Great Basin Grassland, and Mohave Desertscrub 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 canenses*, *Artemisia tridentata, Artemisia bigelovii*, *Chrysothamnus* spp., *Salvia dorrii*, *Eriogonum corymbosum, Eriogonum mortonianum, Eriogonum thompsoniae* var. *atwoodii*, and *Gutierrezia sarothrae* (USFWS 1986).

Pediocactus 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 (eFlora 2010).

Pediocactus sileri was listed as endangered under the ESA in 1979 and delisted to threatened in 1993 (USFWS 1993).

4.3.37.2 Survey Results

Pediocactus 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 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 Indian Reservation, scattered along Highway 389 from west of Fredonia to the intersection of Highway 389 and the road to Pipe Springs National Monument. *P. sileri* locations are shown in Table 4-34 and in the distribution and detailed maps provided inMap 4-31 to Map 4-37.

Table 4-34
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	

Pediocactus 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 Bandlands 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 4-35). All plants were found from between 4,462 feet (1,360 meters) and 5,020 feet (1,530 meters) in elevation.

Table 4-35
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		

Artemesia biglovii Shrubland	*Artemesia biglovii – Ephedra torreyana /* Crytobiotic Gypsum Badlands Sparse Shrubland	367
Artemesia biglovii 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

Pediocactus 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 4-36 and Table 4-37.

Table 4-36
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
Shnbkaib 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

The vast majority of *Pediocactus 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.

Table 4-37
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

The abundance of *Pediocactus sileri* varied notably across the variety of microhabitats within the gypsum badlands landsape. 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, including: *Cryptantha semiglabra, Eriogonum mortonianum,* and *Eriogonum thompsoniae* var *atwoodii* all of which share an affinity for soils with alternating layers of red mudstone and gypsum.

Much of the area occupied by *Pediocactus sileri* has been used for cattle grazing; however, on the Reservation, minimal grazing was observed in the localized areas around encountered individuals. Areas occupied by *P. sileri* outside the Reservation had greater impacts due to grazing, as evidenced by a lesser quantity of cryptobiotic soils and the observation of more trampled and disturbed lands. 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.

4.3.37.3 Discussion

The survey identified an estimated 2,946 individuals of *Pediocactus 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, *Artemesia biglovii* 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 4-13), 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.

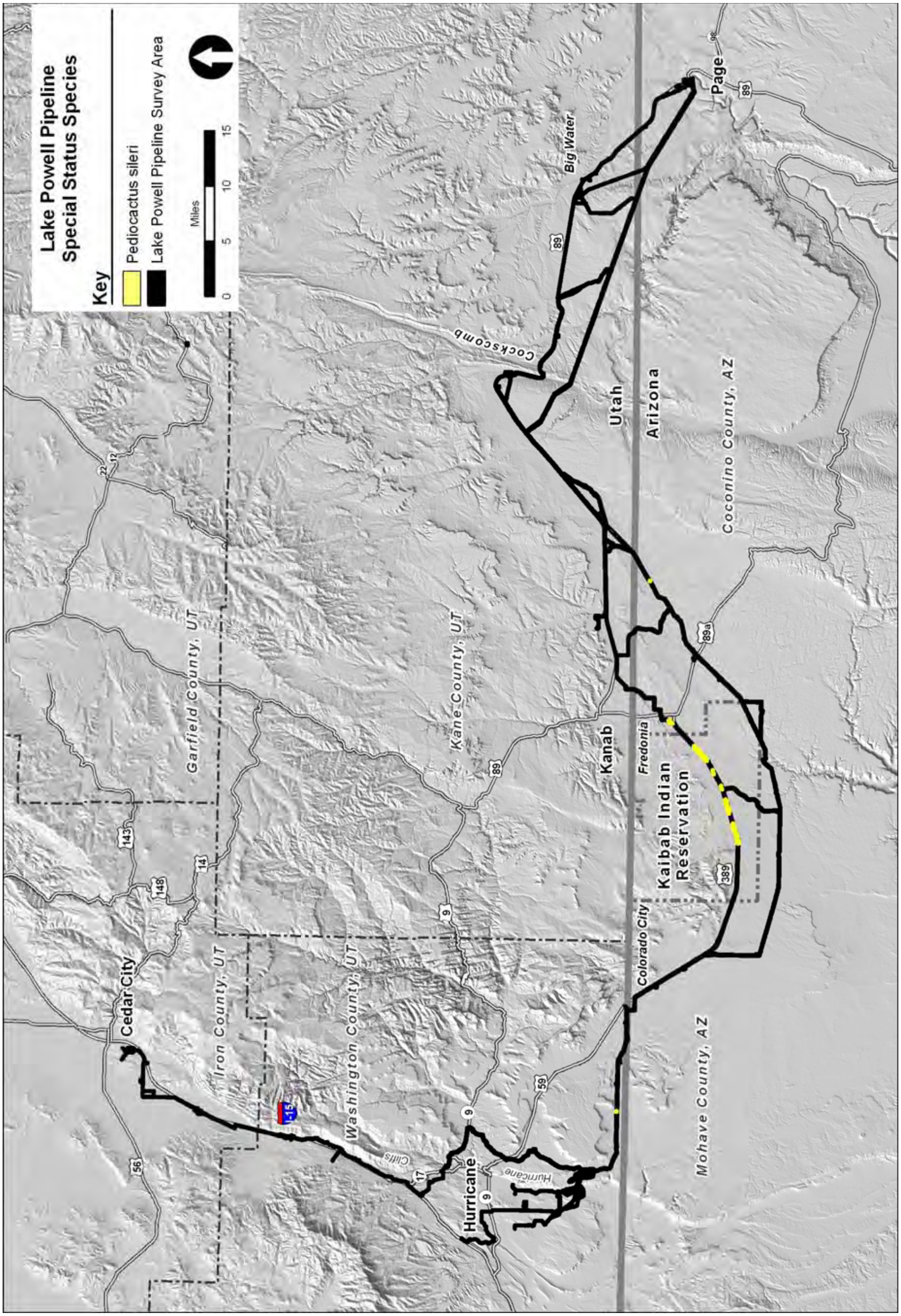
Figure 4-13
Red clay and gypsum soils representing *Pediocactus sileri* habitat within the survey area

Pediocactus 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 cyptobiotic 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. Extended periods of time without subsequent precipitation to wash off this sediment could result in retardation of photosynthesis, and ultimately mortality (Figure 4-14).

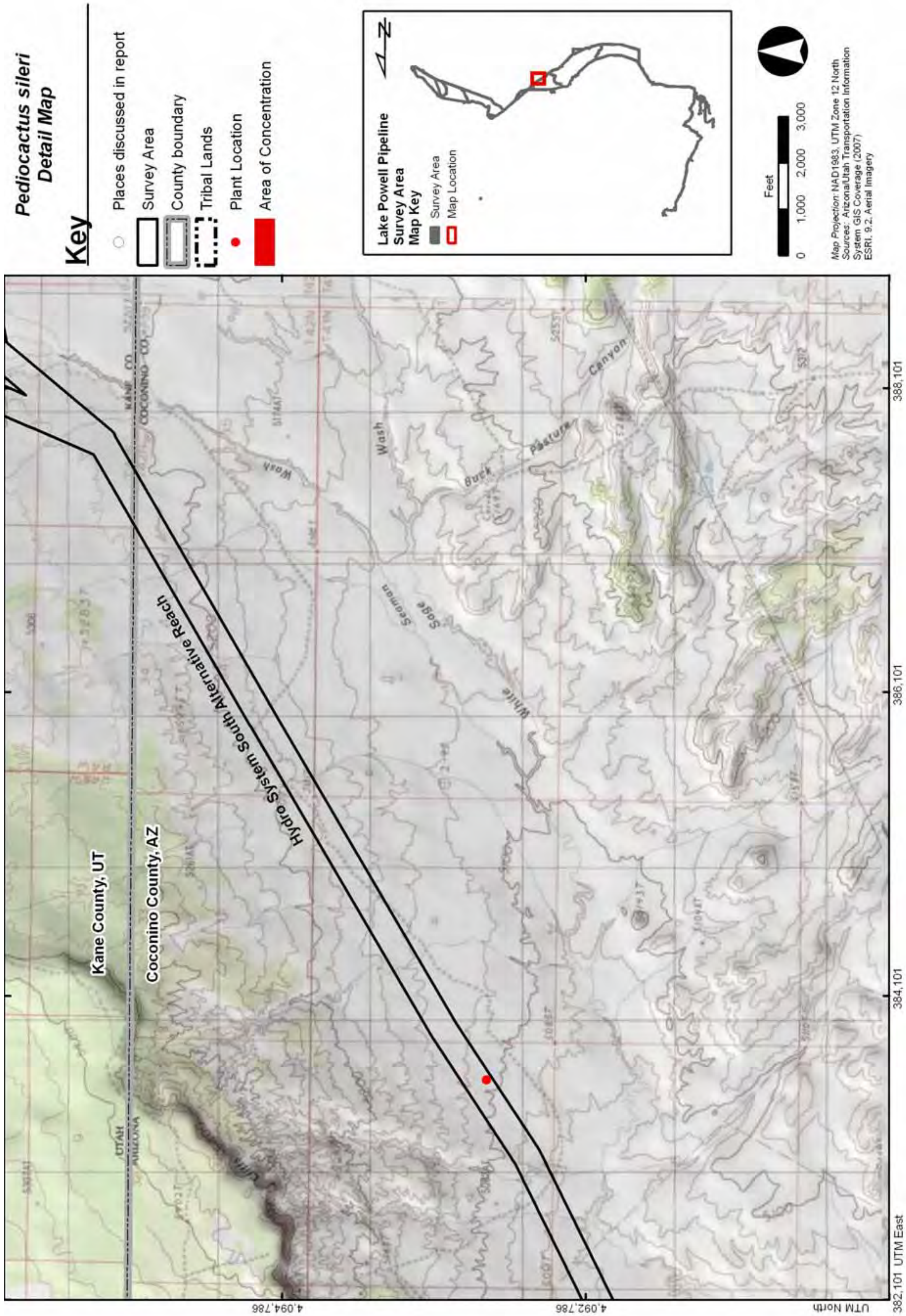
Figure 4-14
***Pediocactus sileri* caked in mud**

Pediocactus sileri was only encountered in vegetation communities dominated by native species. Invasive weeds do not appear to be a current threat to the species, as many non-native plants encountered in *P. sileri* habitat were observed at low densities (field observations suggest that invasive weeds are not well adapted to the preferred gypsum badland habitat of the species). Potential existing threats to the species appear to be sediment deposition resulting from intense rainfall events, and anthropogenic disturbance, primarily grazing. This type of disturbance directly impacts the species by trampling the cryptobiotic microhabitat on which the species is dependent, and indirectly by increasing erosion and causing the mudflows that may be responsible for sediment deposition over the plants. Project related disturbance may be expected to create a loss of habitat for *P. sileri*, and also may foster the spread of non-native plants into the landscape. Once introduced, the dense monotypical growth of many of these non-native species may result in shading of individuals, and otherwise compete for resources with *P. sileri*.

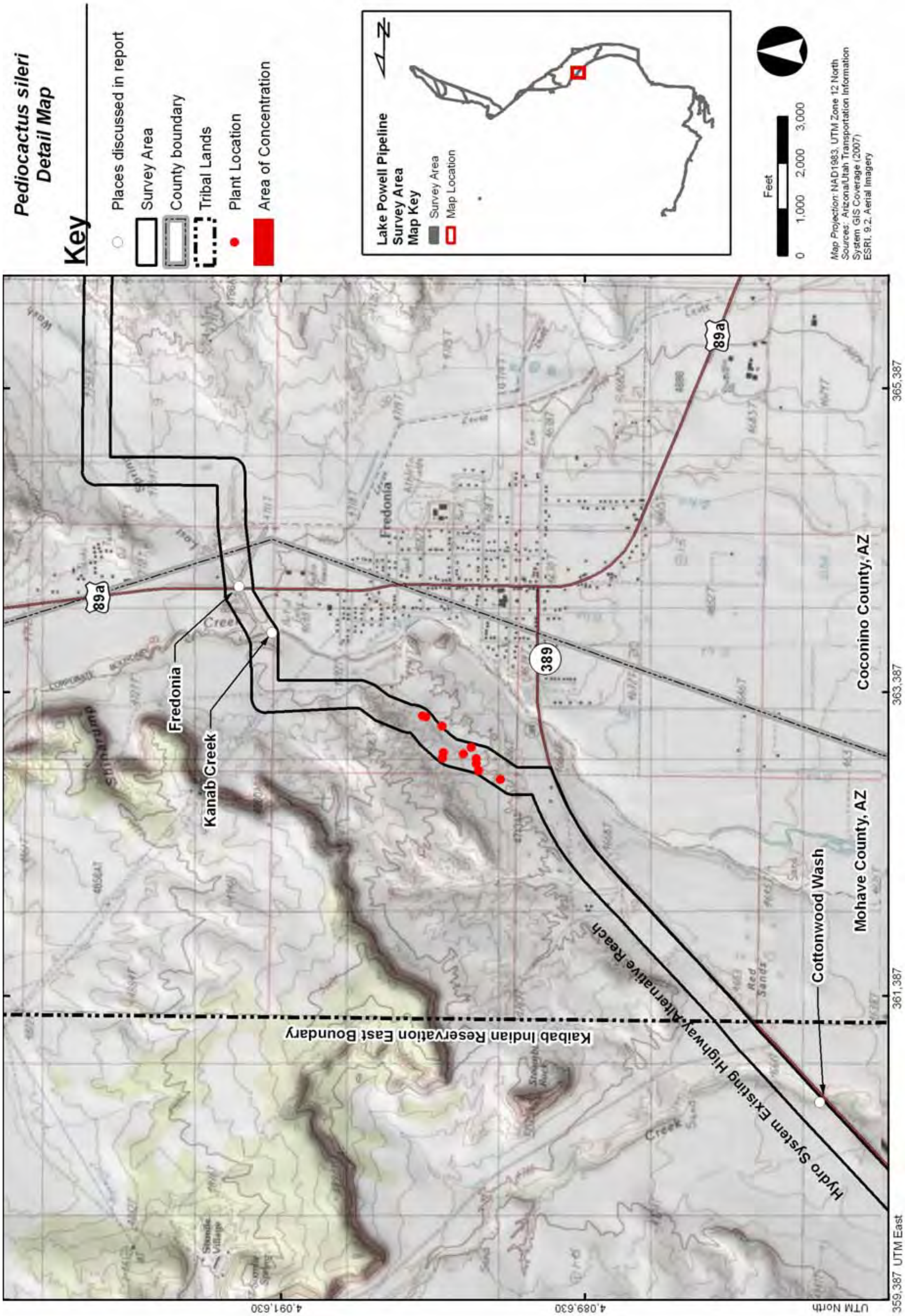
Pediocactus sileri was predominantly found within gypsum badlands of the Colorado Plateau supporting diverse plant communities that included other rare, endemic plants, including *Cryptantha semiglabra, Eriogonum mortonianum,* and *Eriogonum thompsoniae* var *atwoodii.* The cryptobiotic soils that provide 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 could be avoided when an alternative is available. Where avoidance is not possible, living *P. sileri* could be salvaged and re-located into similar habitats outside of the area of disturbance. Any salvaged individuals could be re-planted with the same aspect and at the same depth as which they were found. Additionally, topsoil containing viable seed could be salvaged from these areas and re-used on-site.



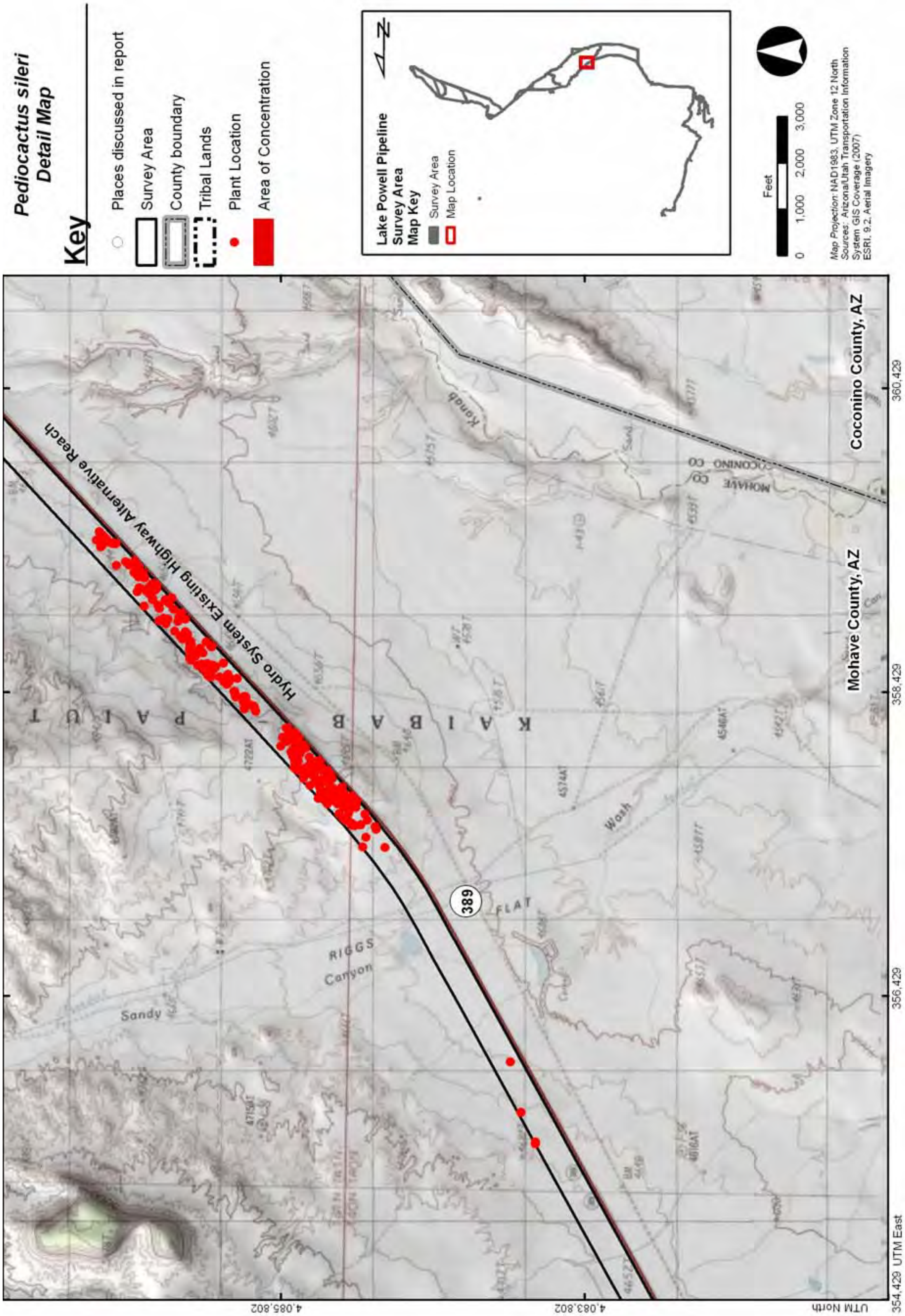
Map 4-31
***Pediocactus sileri* Overview Map**



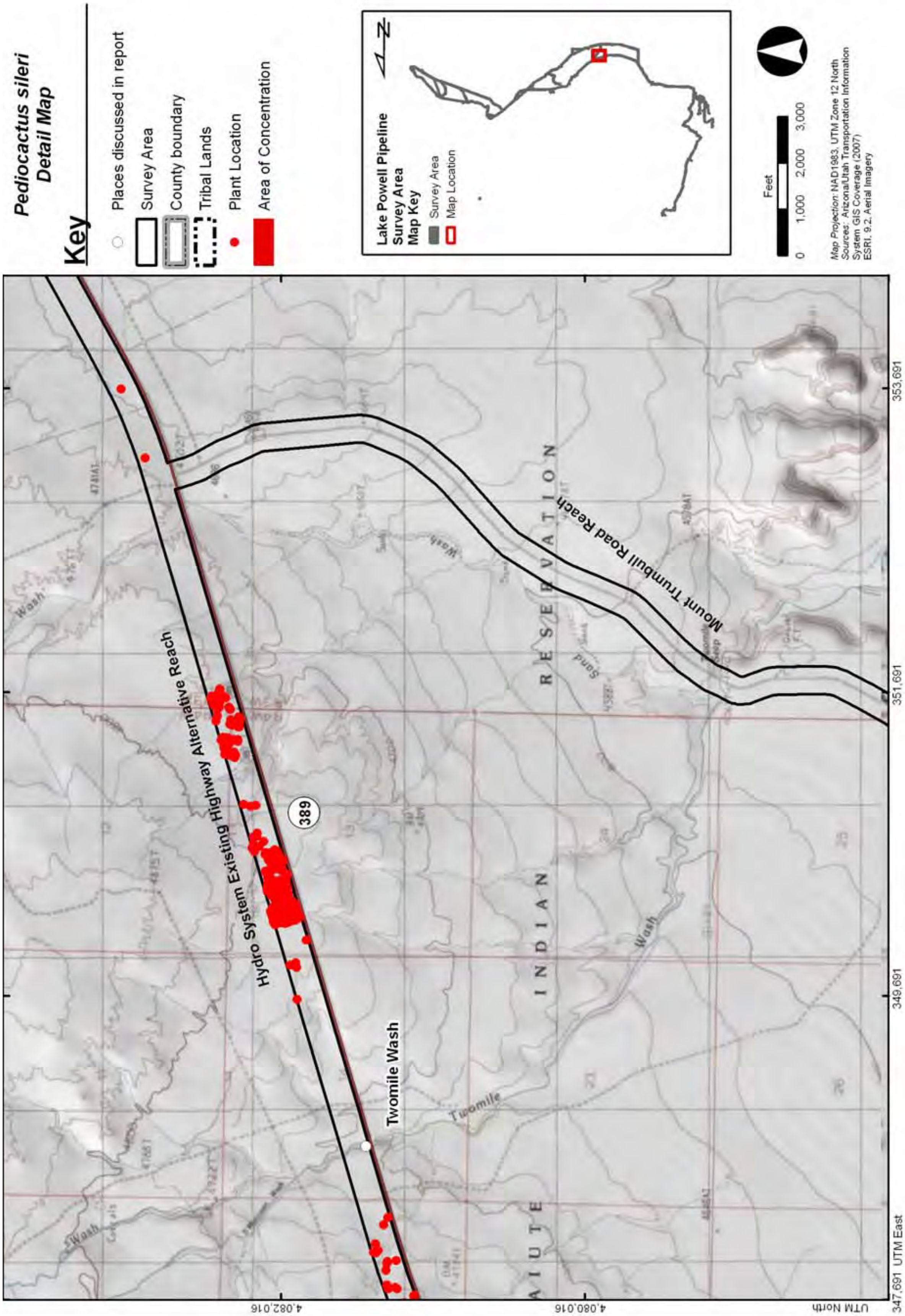
Map 4-32
***Pediocactus sileri* Detail Map**



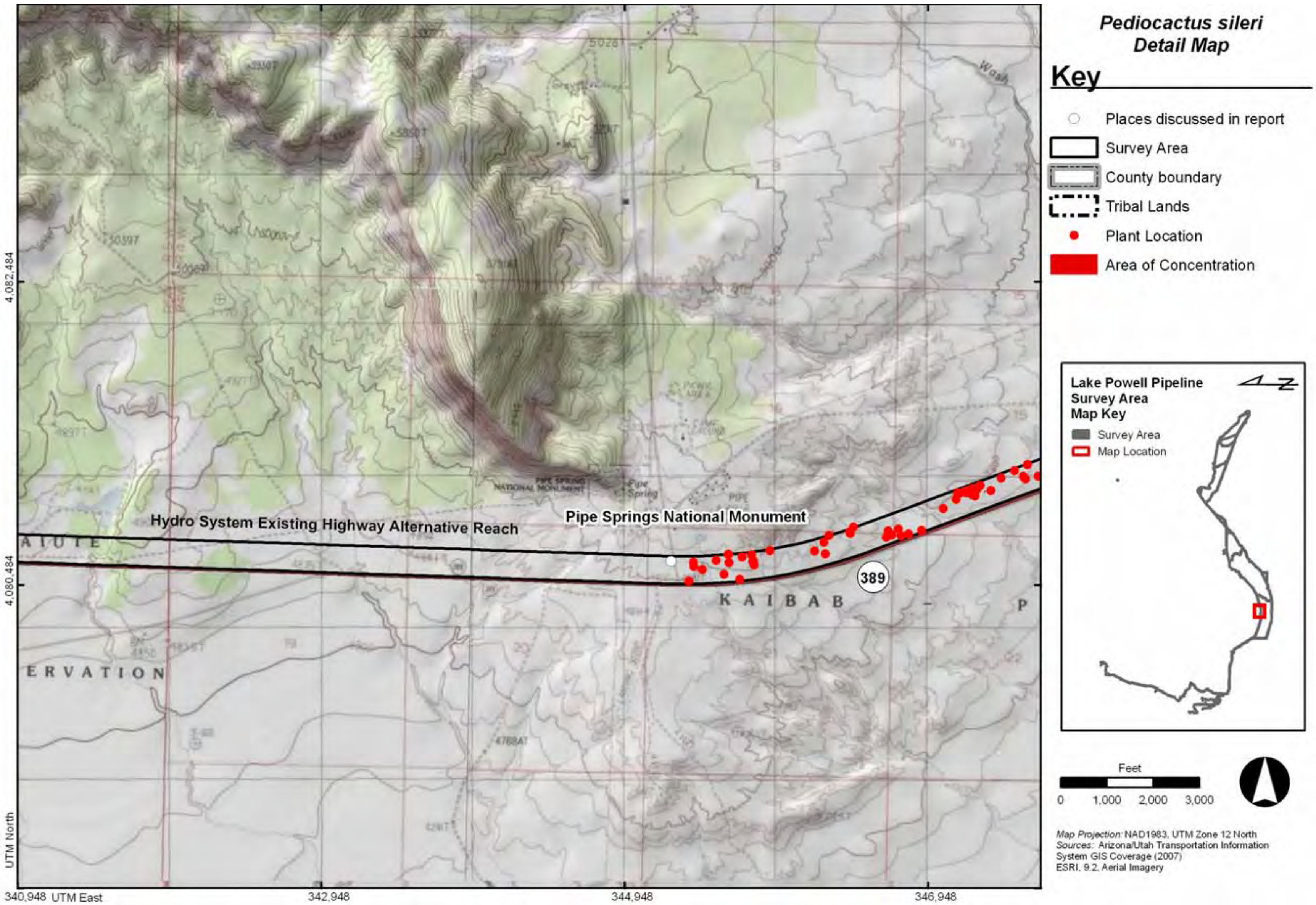
Map 4-33
***Pediocactus sileri* Detail Map**



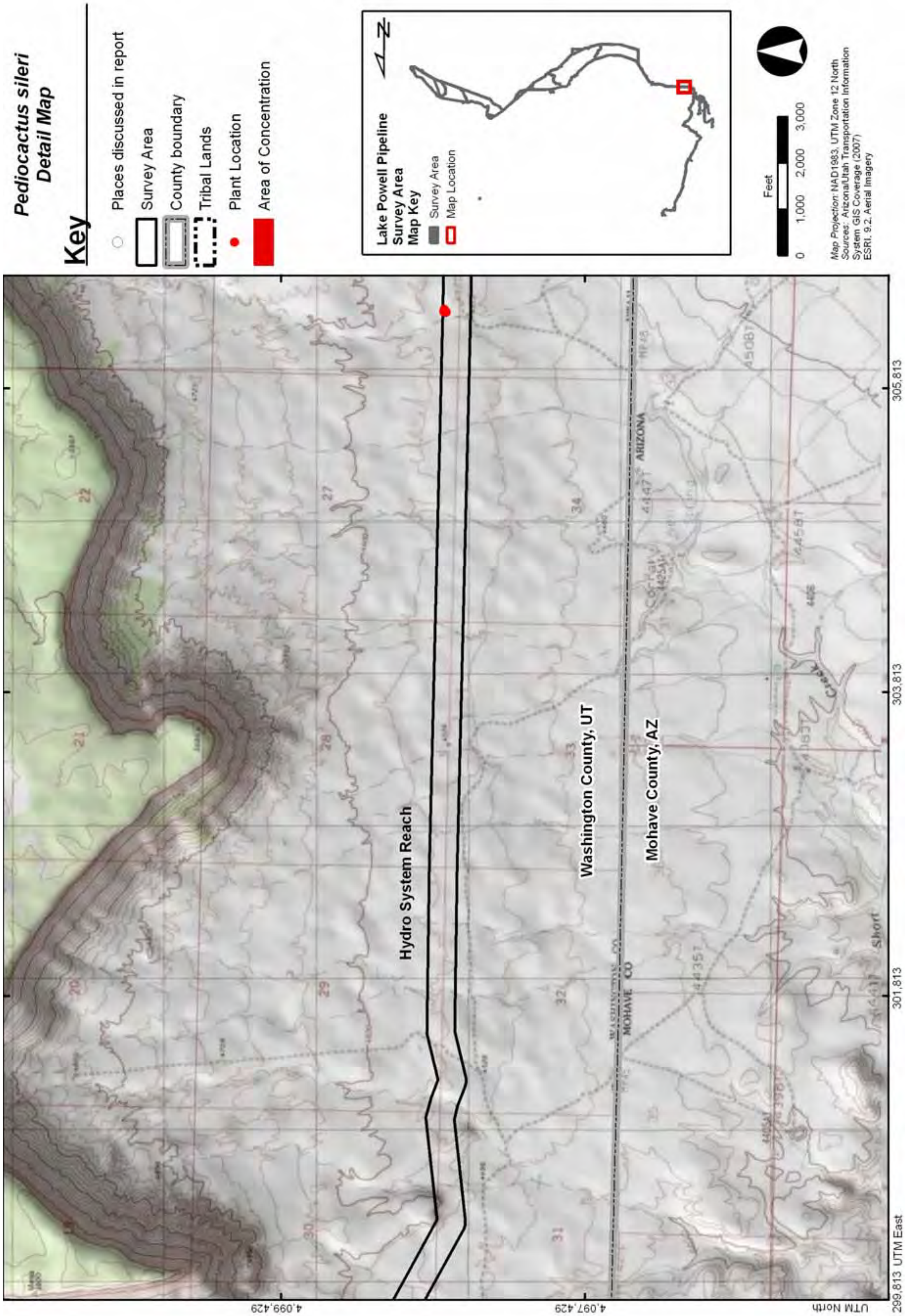
Map 4-34
***Pediocactus sileri* Detail Map**



Map 4-35
***Pediocactus sileri* Detail Map**



Map 4-36
***Pediocactus sileri* Detail Map**



Map 4-37
***Pediocactus sileri* Detail Map**

4.3.38 Pediomelum aromaticum var. barnebyi (Indian breadroot)

4.3.38.1 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) (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).

4.3.38.2 Survey Results

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

4.3.38.3 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 proprety is granted for future surveys.. No further surveys are warranted within the survey area for this plant.

4.3.39 *Pediomelum castoreum* (Beaver Dam breadroot)

4.3.39.1 Natural History

Pediomelum castoreum is a low growing, single-stemmed, deep-rooted perennial herb from the Fabaceae (Pea Family). *P. castoreum* has four to five oval, lobe-shaped leaves. The flowers clusters are showy, with 0.5 inch (1.5 centimeter) long, bluish flowers and a single, very broadly oblong sepal (the leaf-like structure under the flower) that is lobe-shaped (AGFD 2005).

Pediomelum castoreum is found in southern Nevada; San Bernardino Co, California; and Arizona (Barneby 1989). *P. castoreum* has not been confirmed from Utah. It is known from the northwest corner of Mohave County, Arizona in Beaver Dam Wash, above Mormon Well, north of Peach Springs, southwest of Littlefield, and Black Rock Gulch. In Arizona, it is found from 1,750 feet (533 meters) to 3,920 feet (1,195 meters) elevation in desert shrub on sand or sandy gravel in open areas and on road cuts (AGFD 2005).

4.3.39.2 Survey Results

Pediomelum castoreum was incorrectly reported from the Colorado Plateau south of Fredonia on both sides of Forest Service Road 22 between Wildcat Canyon and White Sage Wash at 4,400 feet (1340 meters) during the 2009 survey season. These plants were misidentified.

4.3.39.3 Discussion

Further inspection and consideration of the *Pediomelum* species found on both sides of Forest Service Road 22 led to the discovery that these plants were actually *P. retrorsum.* The direction of the hairs on the pedicel, the elevation of the group, and the occurrence in Coconino County, Arizona led to the proper identified the plant as *P. retrorsum.* The known elevation range for *P. castoreaum* is below the elevation range within the survey area. No further surveys are warranted within the survey area for *P. castoreum*.

4.3.40 *Pediomelum epipsilum* (Kane breadroot)

4.3.40.1 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 4-15). 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 4-15
Close up of *Pediomelum epipsilum* observed within the survey area

Pediomelum 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, gypsious (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).

4.3.40.2 Survey Results

Pediomelum 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 23,041 individual plants. The majority (22,999 of 23,041) 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 High Point Alternative, the Hydro System Existing Highway Alternative, and the Hydro System South Alternative reaches. The remaining 42 *P. epipsilum* were found on BLM lands (one individual), the Kaibab Indian Reservation (30 individuals), and Arizona State Trust lands (11 individuals) within the Hydro System South Alternative and the Hydro System Existing Highway Alternative (Table 4-38). The distribution of *P. epipsilum* across the survey area is shown in Table 4-38and Map 4-10 through Map 4-45.

Table 4-38
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	876
Water Conveyance System, Hydro System, Hydro System High Point Alternative	1 mile southwest of Telegraph Wash to 1.2 miles southwest of Petrified Hollow Wash	BLM 13,609	
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 8,489	
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	Arizona State Trust	11
		Total	23,041

Pediomelum epipsilum was encountered in seven ecological systems across the Colorado Plateau Region, with over half (14,181 individuals) occurring within the Colorado Plateau Gypsum Badlands Ecological System. Within these seven ecological systems, *P. epipsilum* was doumented in 16 alliances and 20 associations. The plant was most abundant in the *Juniperus osteosperma* Woodland Alliance of the Colorado Plateau Gypsum Badlands Ecological System (6,434 individuals) and the *Juniperus osteosperma* Woodland of the Colorado Plateau Pinyon-Juniper Woodland Ecological System (5,706 individuals). Plants were identified from between 4,497 feet (1,371 meters) and 5,680 feet (1,731 meters) in elevation. Table 4-39 includes all *P. epipsilum* documented within the survey area by Ecoligcal System, Allaniance, and Association.

Table 4-39
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. *tridentata* Shrubland	*Artemisia tridentata* ssp. *tridentata* Sparse Understory Shrubland	1,300
Artemisia tridentata ssp. *tridentata* Shrubland	*Juniperus osteosperma / Artemisia tridentata* ssp. *tridentata* Wooded Shrubland	292
Artemisia tridentata ssp. *vaseyana* Shrubland	*Artemisia tridentata* ssp. *vaseyana* Shrubland	56
Artemisia tridentata ssp. *vaseyana* Shrubland	*Artemisia tridentata* ssp. *vaseyana* / Sparse Understory Shrubland	828
COLORADO PLATEAU GYPSUM BADLANDS ECOLOGICAL SYSTEM		
Artemisia tridentata ssp. *vaseyana* Shrubland	*Juniperus osteosperma / Artemisia tridentata* ssp. *vaseyana* Gypsum Badlands Wooded Shrubland	4,376
Eriogonum corymbosum Shrubland	*Eriogonum corymbosum – Artemisia tridentata* ssp. *vaseyana* Gypsum Badlands Sarase Shrubland	25
Eriogonum thompsoniae var. *atwoodii* Sparsely Vegetated	*Eriogonum thompsoniae* var. *atwoodii* Gypsum Badlands Sparse Vegetation	30
Juniperus osteosperma Sparsely Vegetated	*Juniperus osteosperma / Eriogonum corymbosum / Pediomelum epipsilum* Gypsum Badlands Wooded Sparse Vegetation	6,434
Juniperus osteosperma Woodland	*Juniperus osteosperma / Artemisia tridentata* ssp. *vaseyana* Gypsum Badlands Woodland	1,098
Pinus edulis – Juniperus osteosperma Woodland	*Pinus edulis – Juniperus osteosperma / Chrysothamnus greenei / (Pediomelum epipsilum)* Gypsum Badland Woodland	2,218
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 nova* Woodland 680	
Juniperus osteosperma Woodland	*Juniperus osteosperma / Artemisia tridentata* Sparse Woodland	623
Juniperus osteosperma Woodland	*Juniperus osteosperma / Artmisia tridentata* ssp. *vaseyana* Woodland	4,403
Pinus edulis – Juniperus osteosperma Woodland	*Pinus edulis – Juniperus osteosperma / Artemisia tridentata* ssp. *vaseyana* Sparse Woodland	269

COLORADO PLATEAU WASH ECOLOGICAL SYSTEM		
Artmisia tridentata ssp. *vaseyana* Shrubland	*Artemisia tridentata* ssp. *vaseyana* Shrubland	10
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	23,041

Pediomelum epipsilum was documented on a number of different geologic formations across the seven ecological systems (Table 4-40). It was most abundant on the Shnabkaib Member of the Moenkopi Formation and the alluvial deposits from floods associated with the Middle Red Member of the Moenkopi Formation. The Shnabkaib Member is recognized by its white to light gray siltstone and silty gypsum and includes some light-red mudstone, siltstone and sandstone (Billingsley et al. 2008).

Table 4-40
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	
Quarternary alluvial deposits	1,310
Quarternary alluvial deposits, Lower Red Member of the Moenkopi Formation	13
Quarternary alluvial deposits, Lower Red Member of the Moenkopi Formation, Middle Red Member of the Moenkopi Formation	3
Quarternary alluvial deposits, Lower Red Member of the Moenkopi Formation, Timpoweap Member of the Moenkopi Formation	10
Quarternary alluvial deposits, Middle Red Member of the Moenkopi Formation	210
Quarternary alluvial deposits, Middle Red Member of the Moenkopi Formation, Timpoweap Member of the Moenkopi Formation	10
Middle Red Member of the Moenkopi Formation	898
Lower Red Member of the Moenkopi Formation	2
Shnabkaib Member of the Moenkopi Formation	32
Timpoweap Member of the Moenkopi Formation	1
COLORADO PLATEAU GYPSUM BADLANDS ECOLOGICAL SYSTEM	
Quarternary alluvial deposits	917
Quarternary alluvial deposits, Lower Red Member of the Moenkopi Formation	4
Quarternary alluvial deposits, Middle Red Member of the Moenkopi Formation	4,115
Quarternary alluvial deposits, Shnabkaib Member of the Moenkopi Formation	11

Undivided Moenkopi Formation	55
Middle Red Member of the Moenkopi Formation	2,313
Shnabkaib Member of the Moenkopi Formation	6,756
COLORADO PLATEAU PINYON-JUNIPER WOODLAND ECOLOGICAL SYSTEM	
Quarternary alluvial deposits	33
Quarternary alluvial deposits, Lower Red Member of the Moenkopi Formation, Middle Red Member of the Moenkopi Formation, Timpoweap Member of the Moenkopi Formation	680
Quarternary alluvial deposits, Middle Red Member of the Moenkopi Formation	24
Quarternary alluvial deposits, Middle Red Member of the Moenkopi Formation, Timpoweap Member of the Moenkopi Formation	3,200
Middle Red Member of the Moenkopi Formation	1,670
Shnabkaib Member of the Moenkopi Formation	389
COLORADO PLATEAU WASH ECOLOGICAL SYSTEM	
Quarternary alluvial deposits	3
Quarternary alluvial deposits, Lower Red Member of the Moenkopi Formation	6
Undivided Moenkopi Formation	1
INVASIVE UPLAND VEGETATION ECOLOGICAL SYSTEM	
Quarternary 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	23,041

Pediomelum epipsilum occurred on 21 different soil types within the survey area; it was most abundant on Kenzo-Retsabal-Progresso, Ruinpoint-Barx, and Yarts-Palma-Neville family-Barx-Atchee soils. Table 4-41 includes a list of all soil types supporting *P. epipsilum*.

Table 4-41
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
Hillburn, dry-Sazi, moist complex, 2 to 3 percent slopes; Lemrac-Simel-Humbug, moist complex, 2 to 20 percent slopes; Ruinpoint-Barx complex, 2 to 8 percent slopes*	3
Hillburn, dry-Sazi, moist complex, 2 to 3 percent slopes; Ruinpoint-Barx complex, 2 to 8 percent slopes*	2

Hillburn, dry-Sazi, moist complex, 2 to 3 percent slopes; Mellenthin, moist-Bowdish complex, 2 to 3 percent slopes; Ruinpoint-Barx complex, 2 to 8 percent slopes*	10
Kenzo-Retsabal-Progresso, cool complex, 2 to 30 percent slopes	4,850
Kenzo-Retsabal-Progresso, cool complex, 2 to 30 percent slopes; Ruinpoint-Barx complex, 2 to 8 percent slopes*	4,224
Kenzo-Retsabal-Pregresso, cool complex, 2 to 30 percent slopes; Yarts-Palma-Neville family-Barx-Atchee*	2,443
Kenzo-Retsabal-Progresso, cool complex, 2 to 30 percent slopes; Mellenthin, moist-Bowdish complex, 2 to 3 percent slopes; Mellenthin, moist-Rock outcrop, Moenkopi Formation, complex, 25 to 60 percent slopes; Ruinpoint-Barx complex, 2 to 8 percent slopes*	3,210
Klondike sandy clay loam, 2 to 15 percent slopes	1
Lemrac-Simel-Humbug, moist complex, 2 to 20 percent slopes	1,124
Lemrac-Simel-Humbug, moist complex, 2 to 20 percent slopes; Ruinpoint-Barx complex, 2 to 8 percent slopes*	102
Mellenthin, moist-Bowdish complex, 2 to 3 percent slopes	11
Mellenthin, moist-Bowdish complex, 2 to 3 percent slopes; Mellenthin, moist-Rock outcrop, Moenkopi Formation, complex, 25 to 60 percent slopes; Ruinpoint-Barx complex, 2 to 8 percent slopes*	680
Mellenthin, moist-Bowdish complex, 2 to 3 percent slopes; Ruinpoint-Barx complex, 2 to 8 percent slopes*	11
Pennell gravelly loam, 1 to 12 percent slopes	11
Ruinpoint-Barx complex, 2 to 8 percent slopes	1,747
Torriorthents, 3 to 50 percent slopes	25
Yarts-Palma-Neville family-Barx-Atchee	4,100
Total	23,041

Pediomelum 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, *Pediomelum 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.

4.3.40.3 Discussion

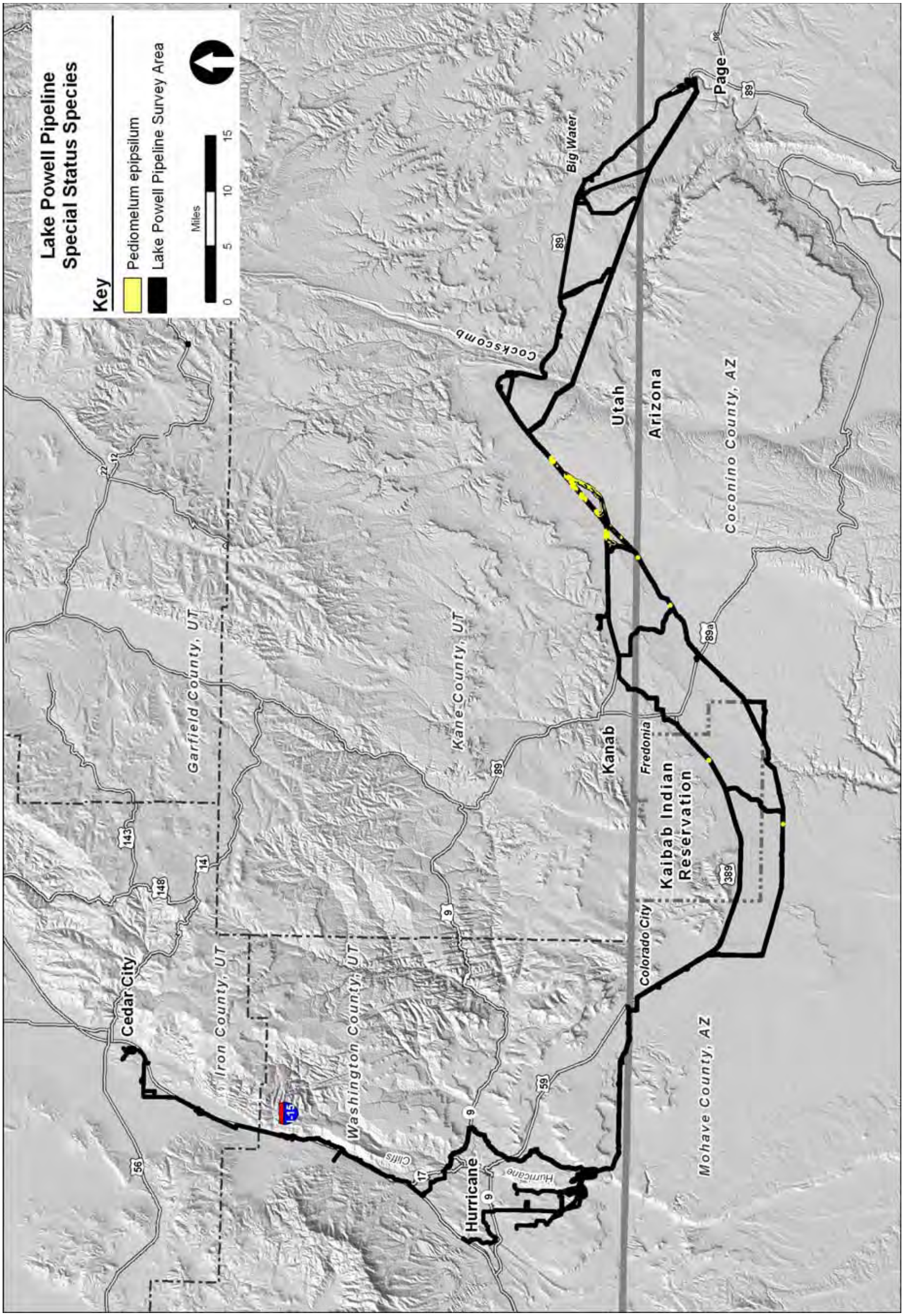
Pediomelum epipsilum was documented within the central portion of the Colorado Plateau Region of the survey area; it was most abundant from Telegraph Wash to Seaman Wash within the Water Conveyance System and the Hydro System Existing Highway Alternative reaches. *P. epipsilum* was most abundant within the Colorado Plateau Gypsum Badlands 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 *Juniperus osteosperma / Eriogonum corymbosum / Pediomelum epipsilum* Gypsum Badlands Wooded Sparse Vegetation Association, within the *Juniperus osteosperma* Sparsely Vegetated Alliance of the Colorado Plateau Gypsum Badlands Ecological System; and was most common on the Shnabkaib Member of the Moenkopi Formation and alluvial deposits from floods associated with the Middle Red Member of the Moenkopi Formation.

Pediomelum 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.

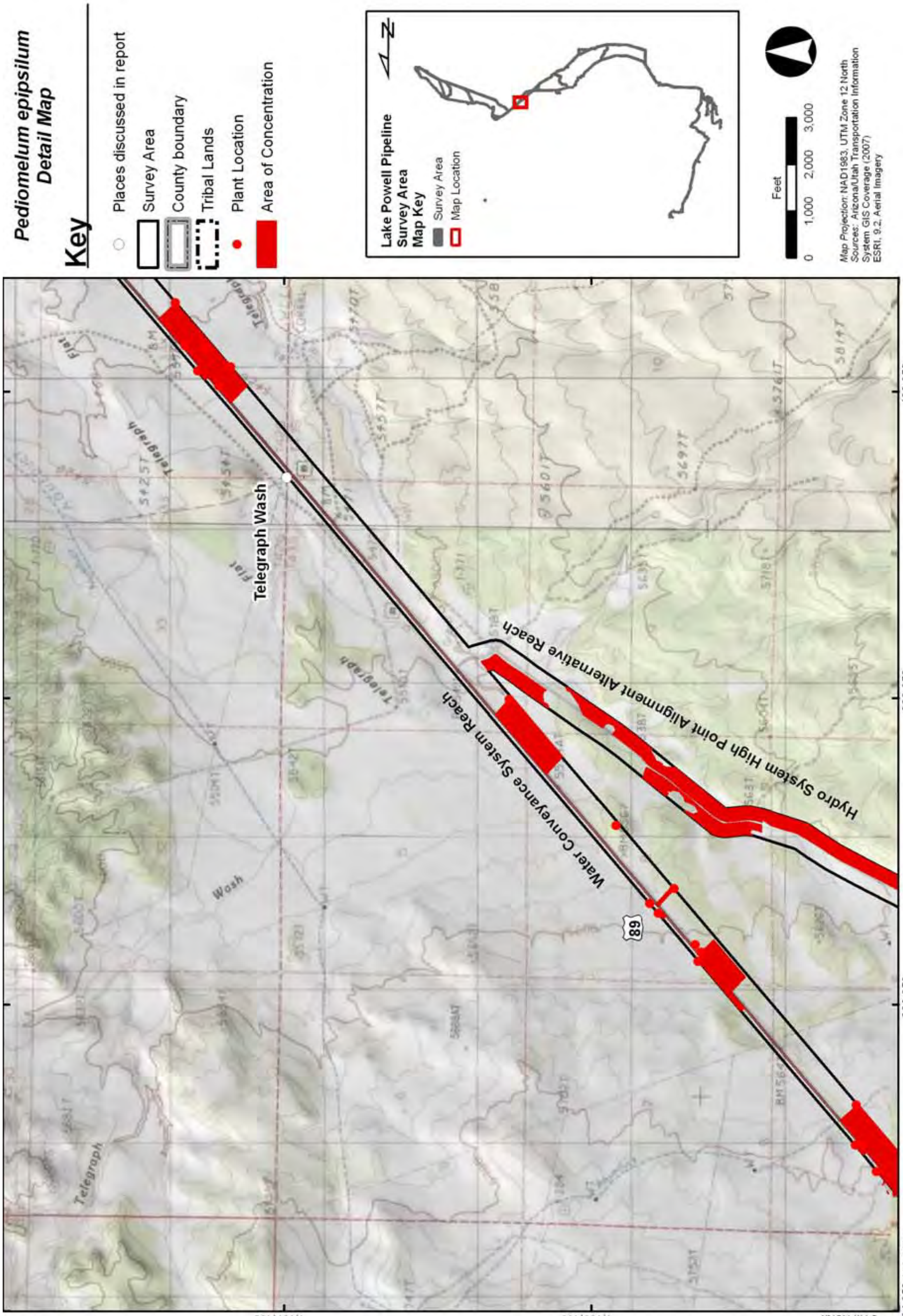
Figure 4-16
View of *Pediomelum epipsilum* and its habitat within the survey area

Pediomelum epipsilum was often observed in disturbed areas, including old road beds and areas that experience natural flooding (Figure 4-16). 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. epipsulum* 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. epipsulum*. 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. epipsulum* will mostly likely be manifested in the direct loss of individuals occurring within affected areas of the survey area.

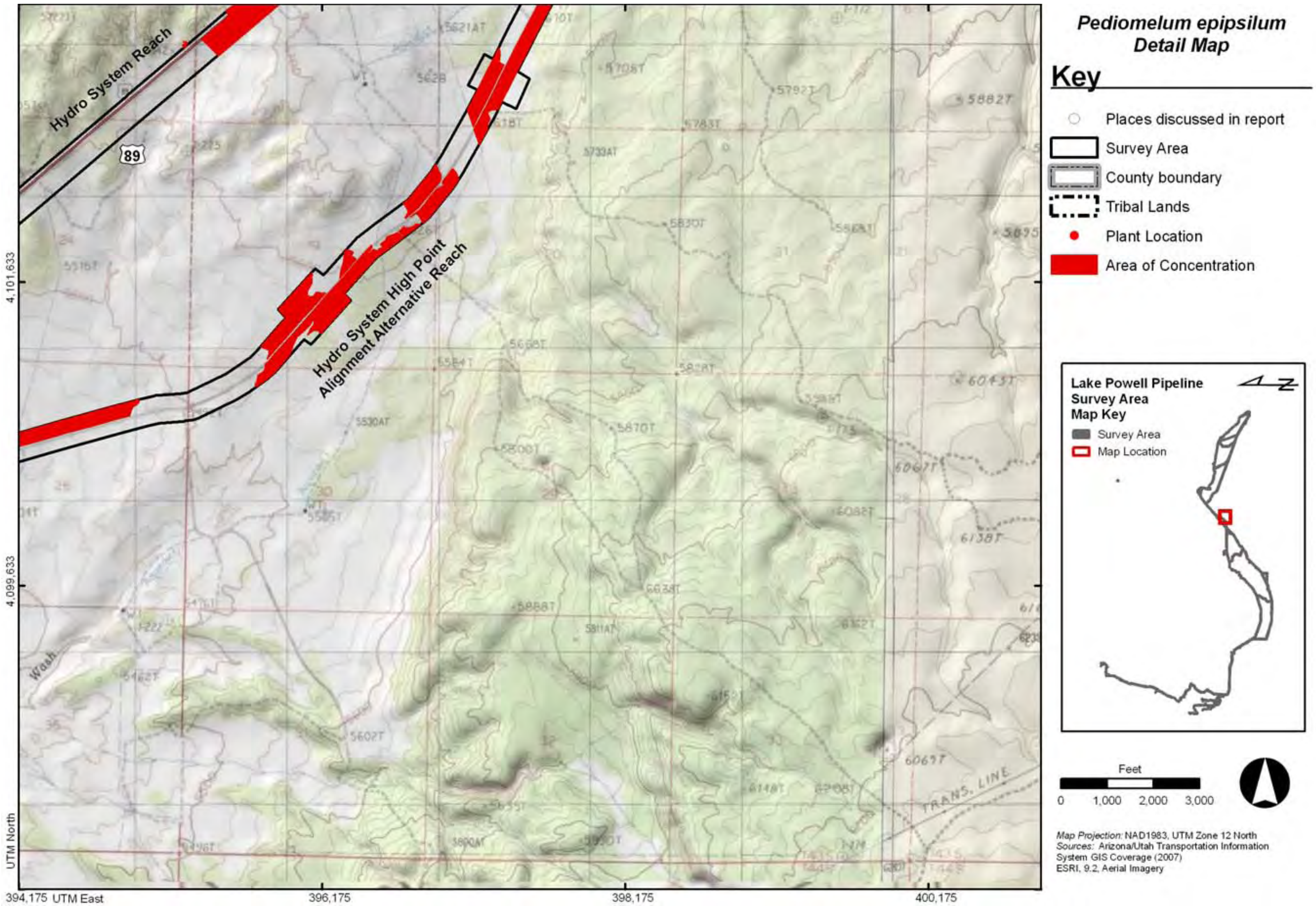
Since *Pediomelum epipsilum* appears to thrive in disturbed areas, this species is an an excellent candidate to propogate following construction. Seeds could be harvested prior to construction from existing plants and dispersed on site. Consideration could also be given to growing individuals from collected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



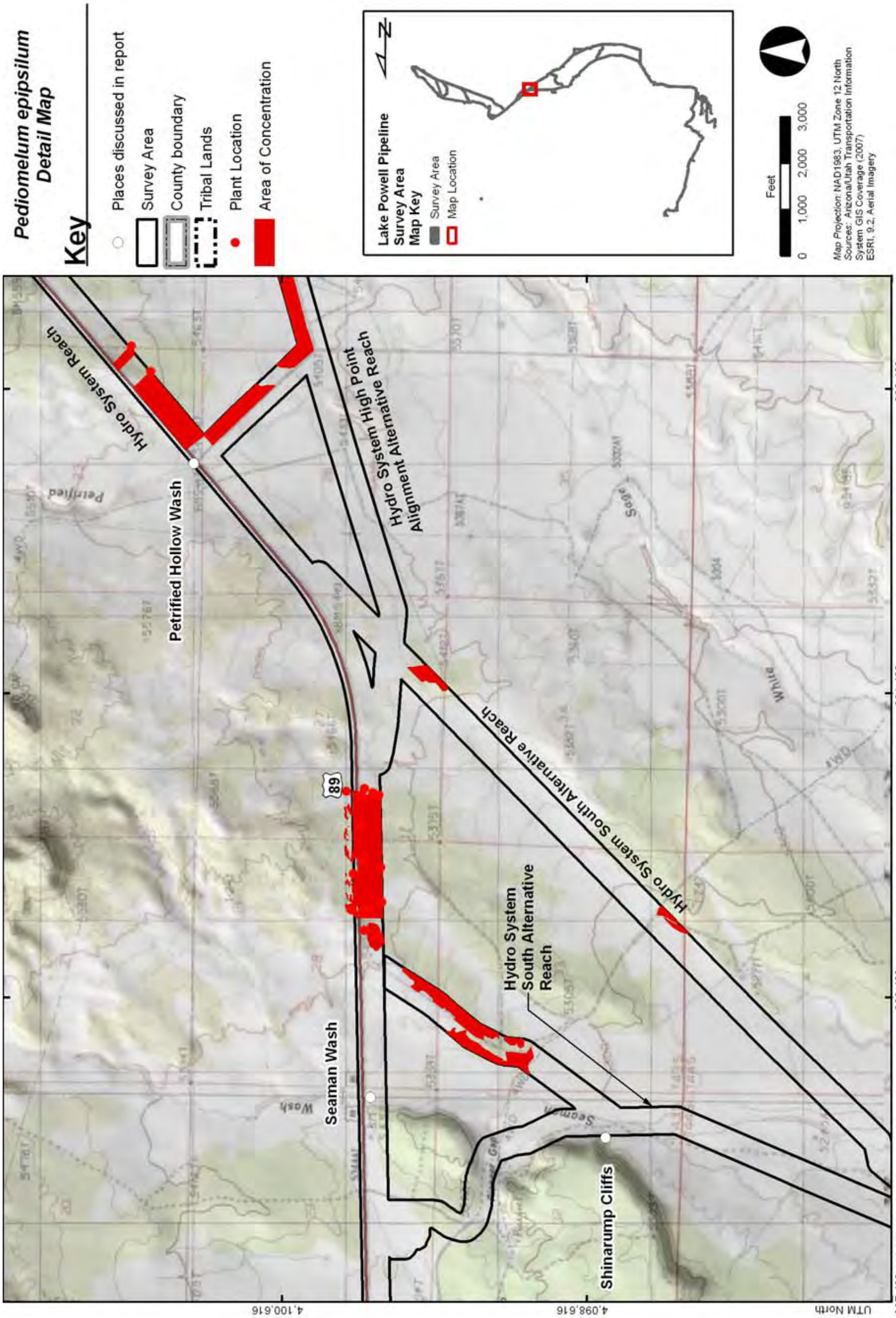
Map 4-38
***Pediomelum epipsilum* Overview Map**



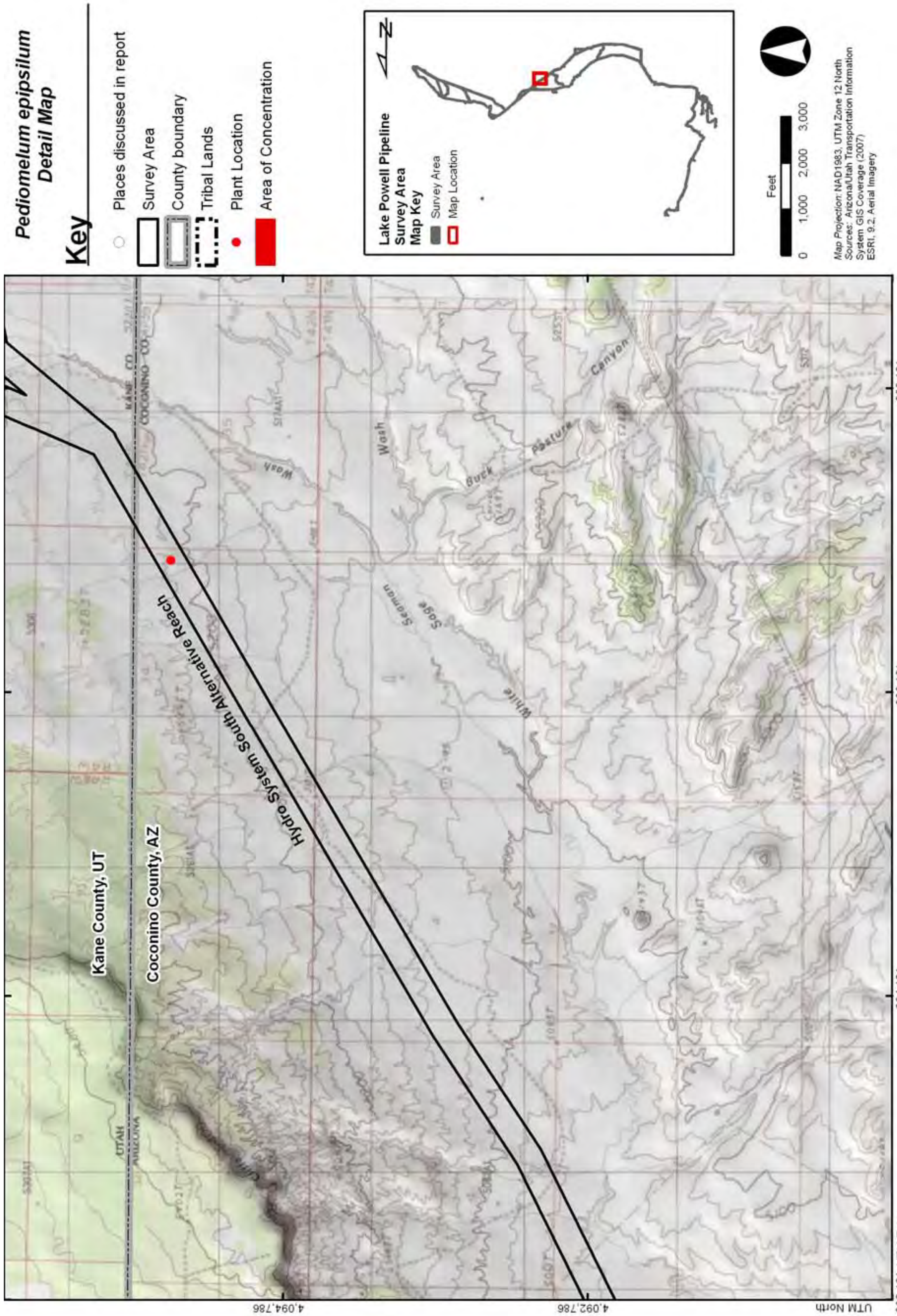
Map 4-39
***Pediomelum epipsilum* Detail Map**



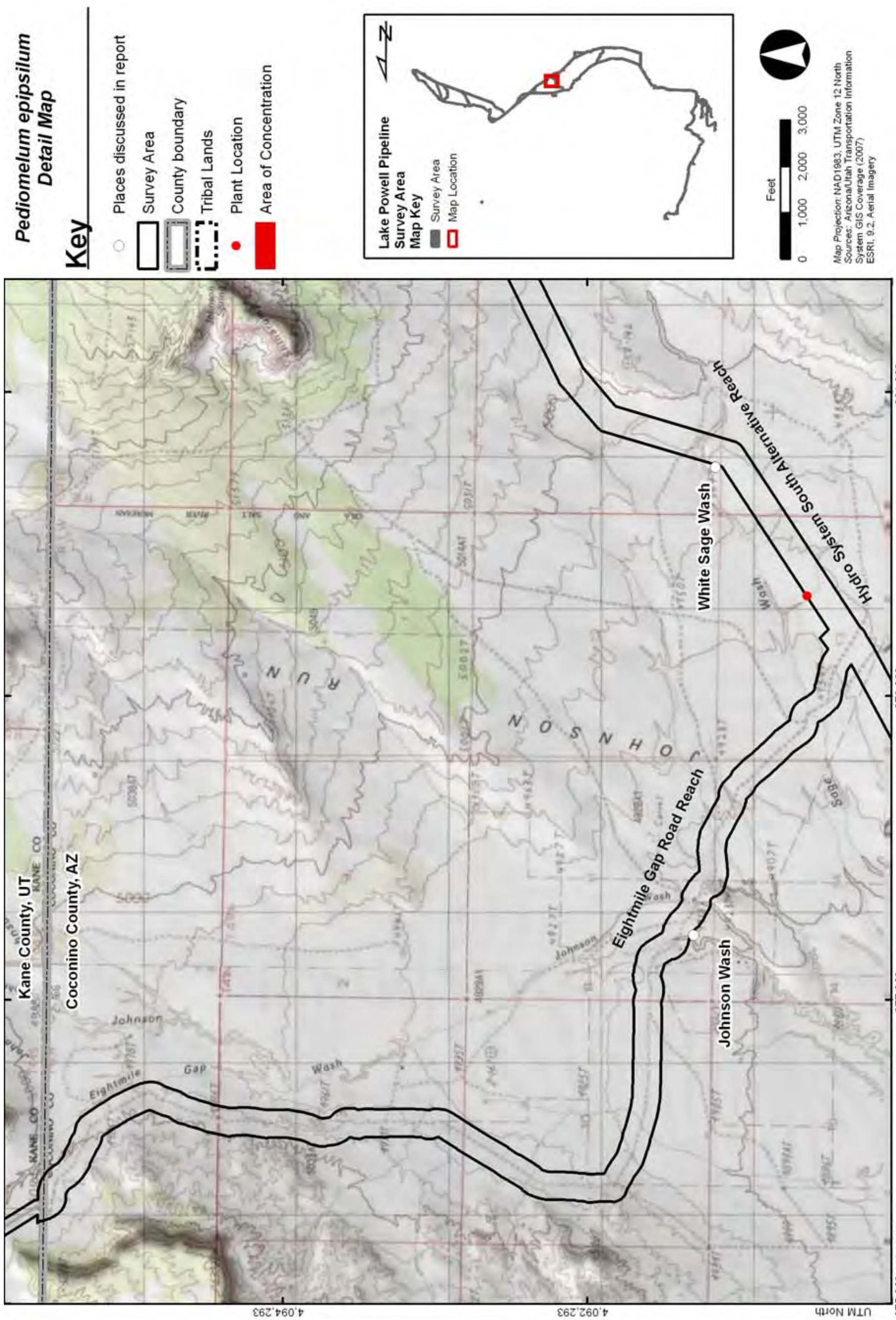
Map 4-40
***Pediomelum epipsilum* Detail Map**



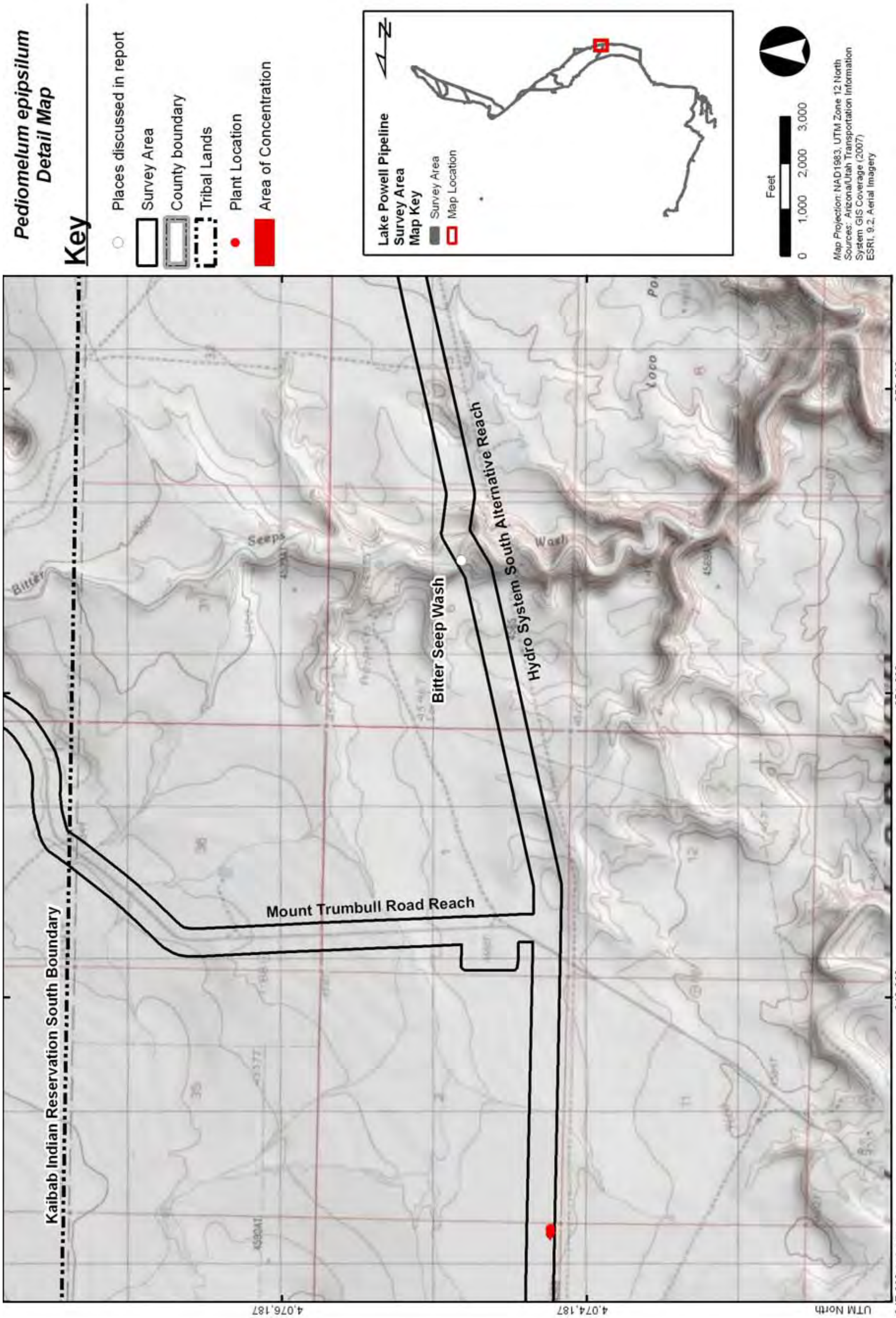
Map 4-41
***Pediomelum epipsilum* Detail Map**



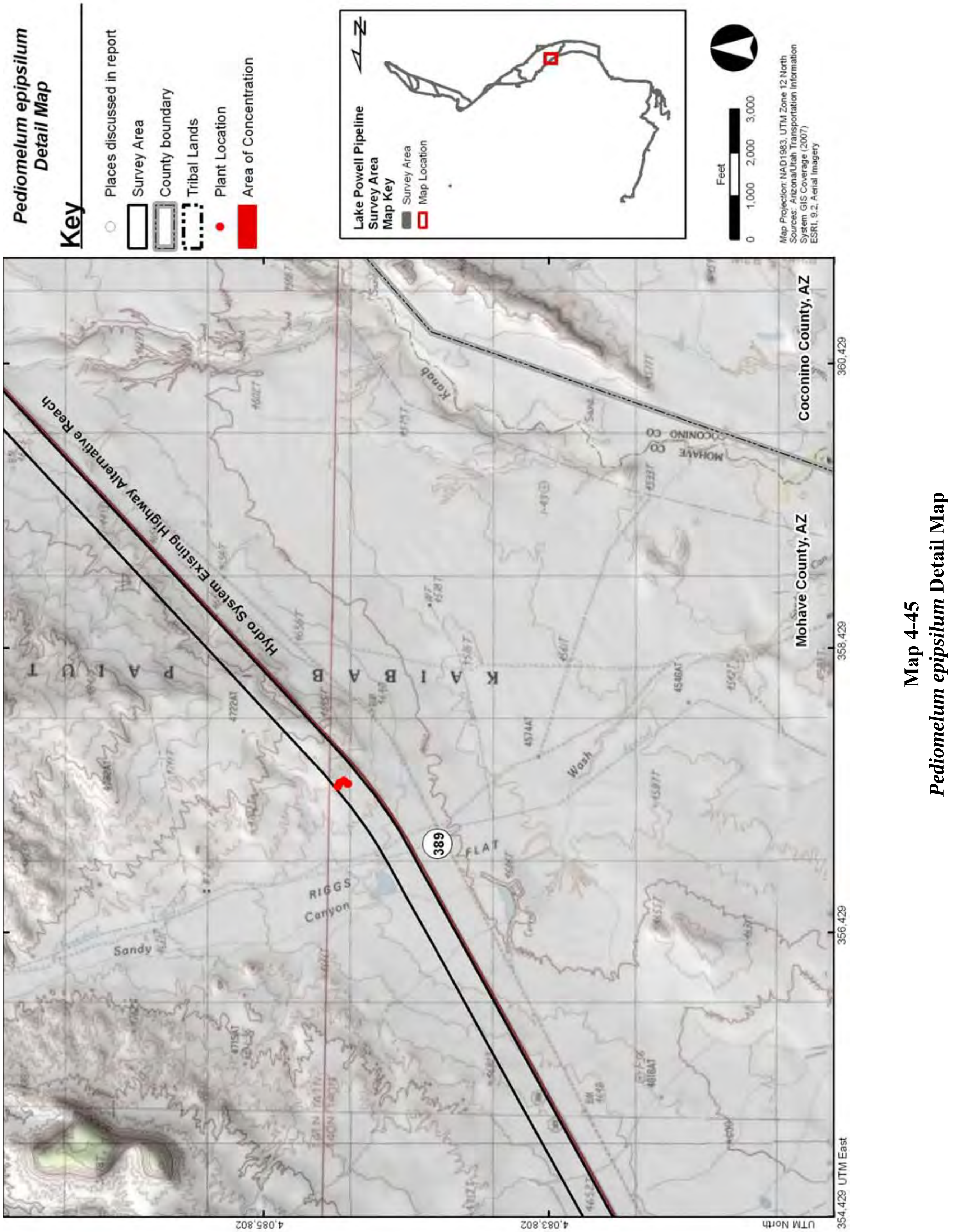
Map 4-42
***Pediomelum epipsilum* Detail Map**



Map 4-43
***Pediomelum epipsilum* Detail Map**



Map 4-44
***Pediomelum epipsilum* Detail Map**



Map 4-45
***Pediomelum epipsilum* Detail Map**

4.3.41 *Penstemon ammophilus* (Sandloving penstemon)

4.3.41.1 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.

Penstemon 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).

4.3.41.2 Survey Results

Penstemon ammophilus was not encountered during project surveys.

4.3.41.3 Discussion

Welsh et al. (2008) identified "Navajo Sandstone below the White Cliffs" as the preferred geologic substrate for *Penstemon 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 *Penstemon ammpophilus*. *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.

4.3.42 *Penstemon laevis* (Smooth penstemon)

4.3.42.1 Natural History

Penstemon laevis is a perennial herb in the Scrophulariaceae (Figwort Family) reaching 1foot (3 decimeters) to 3.3 feet (10 decimeters) tall. Erect, hairless stems arise from a stout crown, or base. Leaves are thick and entirely or slightly wavy. The plant is hairless with three to eight flowered stems, a 0.2 (0.4 centimeters) to 0.3 inches (0.7 centimeters) flower complex with blue-lobed petals (Welsh et al. 1993) (Figure 4-17).

Figure 4-17
***Penstemon laevis* observed within the survey area**

Penstemon laevis is known from a small geographic range in Utah and Arizona. In Utah, it is known to occur from east Washington County in Zion National Park, western Kane County from Orderville to Kanab, and in Garfield County. It is known from the Kaibab Plateau in Coconino County, Arizona (NatureServe 2009). *P. laevis* inhabits sandy places in pinyon-juniper, ponderosa-manzanita, and mountain brush communities from 4,920 feet (1,500 meters) to 6,560 feet (1,999 meters) in elevation across its range (NatureServe 2009, Welsh et al. 2008).

4.3.42.2 Survey Results

Penstemon laevis was found scattered across the survey area. From east to west, it was encountered between Calf Springs and Long Valley Road, just north of Five Mile Valley, west of Pipe Springs National Monument, east of Cedar Ridge, and west of Short Creek at Canaan Gap. *P. laevis* was encountered at five locations; three of these locations were on BLM lands, one was on private land, and the remaining was on the Kaibab Indian Reservation. A total of 107 *P. laevis* individuals were observed within the survey area, and occurred in the Glen Canyon to the Buckskin Transmission Line North Reach, the Buckskin to the Paria Transmission Line Reach, the Hydro System Exisiting Highway Altrenative Reach, and the Hydro System Reach. The distribution of *P. laevis* across the survey area is shown in Table 4-42 and Map 4-46 through Map 4-52.

Table 4-42
A summary of *Penstemon laevis* survey results by location

Reach Location		Land Ownership	# of Plants
Glen Canyon to Buckskin Transmission Line North	Between Calf Springs and Long Valley Road	BLM 12	
Buckskin to Paria Transmission Line	North of Five Mile Valley	BLM	3
Hydro System Existing Highway Alternative	1.14 miles west of Pipe Springs National Monument	Kaibab Indian Reservation	70
Hydro System Existing Highway Alternative	0.25 miles east of Cedar Ridge	Private	20

Hydro System Reach	133 feet south of the Utah/Arizona state line	BLM 2	
		Total 107	

Surveys located *Penstemon laevis* from between approximately 4,760 feet (1,451 meters) and 5,000 feet (1,524 meters) in elevation, which is slightly below the recorded elevation range for this plant. The species was found entirely within the Colorado Plateau Ecological Region in four ecological systems, six alliances, and seven associations. *P. laevis* was encountered primarily within the Colorado Plateau Pinyon-Juniper Woodland Ecological System within the *Juniperus osteosperma / Artemesia filifolia* Wooded Shrubland Association. All vegetation communities supporting *P. laevis* are shown in Table 4-43.

Table 4-43
A summary of *Penstemon laevis* survey results by alliance and association

COLORADO PLATEAU MIXED BEDROCK CANYON AND TABLELAND ECOLOGICAL SYSTEM		
Alliance	**Association**	**# of Plants**
Juniperus osteosperma Woodland	*Juniperus osteosperma / Shepherdia rotundifolia* Sparse Woodland [Provisional]	5
COLORADO PLATEAU PINYON-JUNIPER WOODLAND ECOLOGICAL SYSTEM		
Artemesia filifolia Shrubland	*Juniperus osteosperma / Artemesia filifolia* Wooded Shrubland	52
Juniperus osteosperma Woodland	*Juniperus osteosperma / Shepherdia rotundifolia* Sparse Woodland	7
Juniperus osteosperma Woodland	*Juniperus osteosperma / Artemisia tridentata* Woodland	2
COLORADO PLATEAU SHRUB-STEPPE		
Mixed Desert Shrub Shrubland [Provisional]	Mixed Desert Scrub / *Pleuraphis jamesii* Shrubland 18	
Achnatherum hymenoides Herbaceous	*Gutierrezia sarothrae / (Pleuraphis jamesii, Achantherum hymenoides)* Shrub Herbaceous Vegetation	20
COLORADO PLATEAU WASH ECOLOGICAL SYSTEM		
Purshia (stansburiana, glandulosa, Mexicana) Shrubland	*Juniperus osteosperma / Purshia glandulosa* Wooded Shrubland	3
	Total 107	

Penstemon laevis was identified in multiple geologic formations within the survey area. The species was primarily encountered on young mixed alluvium and eolian deposits within the Colorado Plateau Pinyon-Juniper Woodland Ecological System (Table 4-44). This geologic formation is composed of gray, light-red, and white silt and fine- to coarse-grained eolian and fluvial sand lenses (Billingsley et al. 2008).

Table 4-44 A summary of *Penstemon laevis* survey results by geologic formation	
Geologic Formation	**# of Plants**
COLORADO PLATEAU MIXED BEDROCK CANYON AND TABLELAND ECOLOGICAL SYSTEM	
Curtis Formation, Alluvial gravel*	4
Curtis Formation	1
COLORADO PLATEAU PINYON-JUNIPER WOODLAND ECOLOGICAL SYSTEM	
Young mixed alluvium and eolian deposits	52
Curtis Formation	6
Curtis Formation, Alluvial gravel *	1
Valley-fill deposits	2
COLORADO PLATEAU SHRUB-STEPPE ECOLOGICAL SYSTEM	
Navajo Sandstone Formation	20
Young alluvial deposits	18
COLORADO PLATEAU WASH ECOLOGICAL SYSTEM	
Kaibab Formation, Alluvial-gravel deposits, Lower Red Member of the Moenkopi Formation, Timpoweap Member*	3
Total	107

Penstemon laevis was found in seven soil types within the survey area, the majority of which were identified growing in Begay fine sandy loam soils. Table 4-45 provides a complete list of soils where *P. laevis* was observed.

Table 4-45 A summary of *Penstemon laevis* survey results by soil type	
Soil type	**# of Plants**
Mido-Kenzo Rock Outcrop, Carmel Formation, complex, 2 to 30 percent slopes	12
Simel-Strych, moist-Kenzo complex, 2 to 20 percent slopes	3
Begay fine sandy loam, 3 to 12 percent slopes	69
Monue fine sandy loam, 1 to 6 percent slopes	1
Barx fine sandy loam, 1 to 5 percent slopes	19
Torriorthents – Rock outcrop complex, 30 to 70 percent slopes	1
Bidonia-Bond-Rock outcrop complex, 1 to 25 percent slopes	2
Total	107

Penstemon laevis was observed during surveys in areas that have been grazed by cattle and perhaps by rabbits. Many plants exhibited signs of herbivory, as foliage was partially to mostly grazed, and often missing the inflorescence, making a positive identification of *P. laevis* difficult at times.

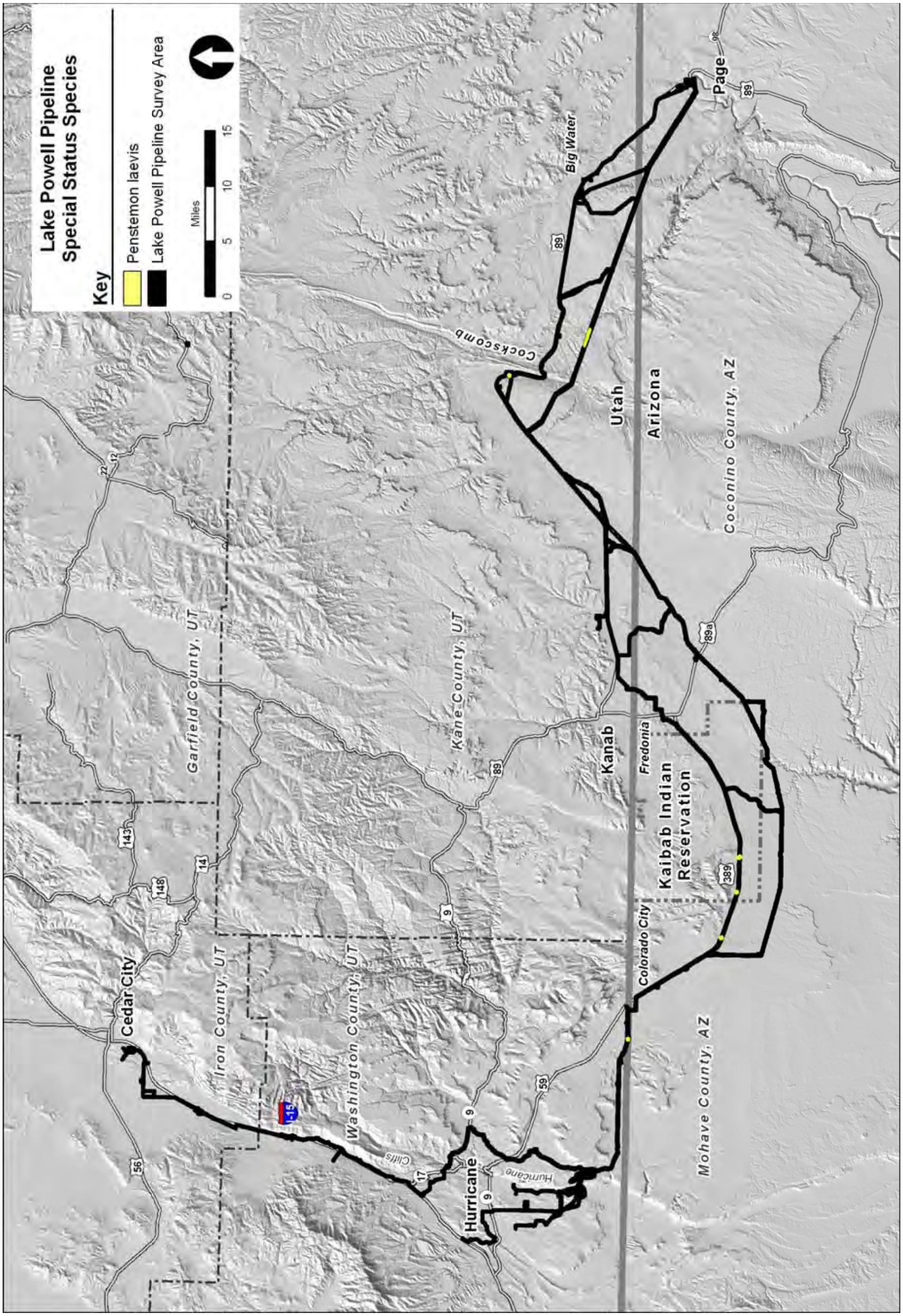
4.3.42.3 Discussion

A total of 107 *Penstemon laevis* individuals were found in the survey area, and occurred in the Glen Canyon to Buckskin Transmission Line North, the Buckskin to Paria Transmission Line, the Hydro System Existing Highway Alternative, and the Hydro System reaches. The majority of individuals were documented on the Kaibab Indian Reservation within the Hydro System Existing Highway Alternative Reach. Individuals were primarily found in *Juniperus osteosprema* woodlands on sandy or silty soils. Nearly half of the individual plants were found within the *Juniperus osteosperma / Artemesia filifolia* Wooded Shrubland Association within the *Artemesia filifolia* Shrubland Alliance of the Colorado Plateau Pinyon-Juniper Woodland Ecological System. The species was mostly encountered in young mixed alluvium and eolian deposits, in Begay fine sandy loam soils. Note that *P. laevis* is a BLM sensitive species found on BLM, private, and Kaibab Indian Reservation lands.

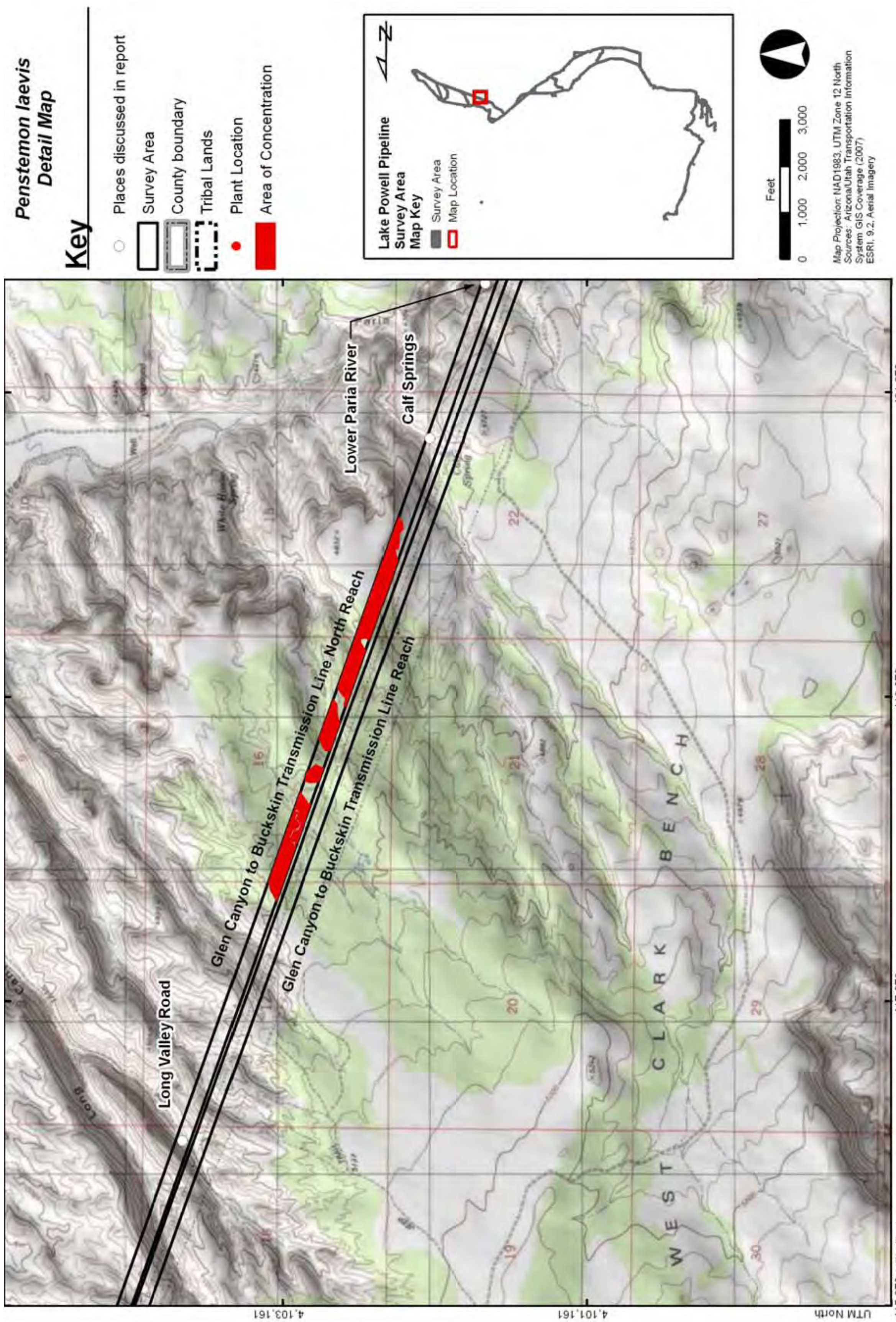
Consistent with published data regarding habitat preferences of *Penstemon laevis*, individuals were primarily found in *Juniperus osteosprema* woodlands, on sandy or silty soils. However, while current data describes the species as occurring from 4,920 feet (1,500 meters) to 6,560 feet (2,000 meters) in elevation, all encountered individuals were found at lower elevations, ranging from approximately 4,760 to 5,000 feet (1,451 to 1,524 meters). Thus, the range of the species appears to be broader than that currently documented.

Penstemon laevis was often found in areas disturbed by grazing. In addition to causing impacts to habitat supporting *P. laevis*, cattle appear to graze directly on the plant. Signs of herbivory were often present, with foliage partially to moderately grazed, and often, inflorescences were chewed off. Although *P. laevis* may be subject to grazing by other herbivores, habitat damage observed by the survey suggests that much of this is the result of cattle grazing. Moderate cattle activity appears to decrease the abundance of this species, as encounters with *P. laevis* were uncommon, despite the presence of suitable habitat. Likely, herbivory not only causes stress to individual plants, but damage to inflorescences reduces overall seed set. Although invasive weeds were commonly found in habitats supporting *P. laevis*, invasive weeds do not appear to greatly threaten the species. Therefore, project impacts to the species will mostly likely result from the direct loss of individuals within the survey area.

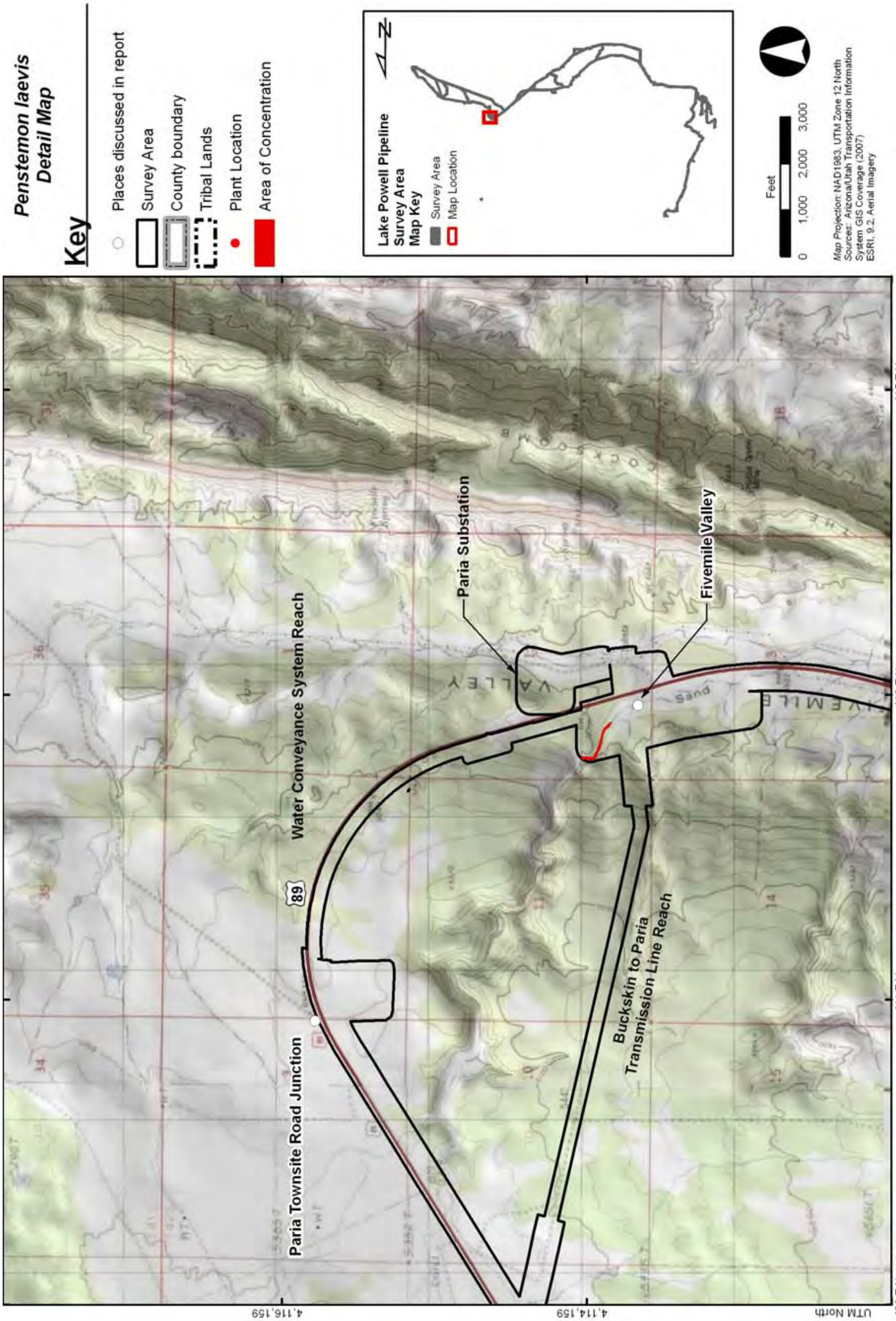
In order to best mitigate for potential impacts to *P. laevis*, seed could be collected from at-risk individuals, and re-distributed on site. Consideration could also be given to growing plants from collected seed. This would help to supplement revegetation efforts of affected areas and would provide the species a potential opportunity to recover from damage that it appears to be suffering as a result of cattle grazing. Topsoil containing potentially viable seed could also be salvaged and re-used on site.



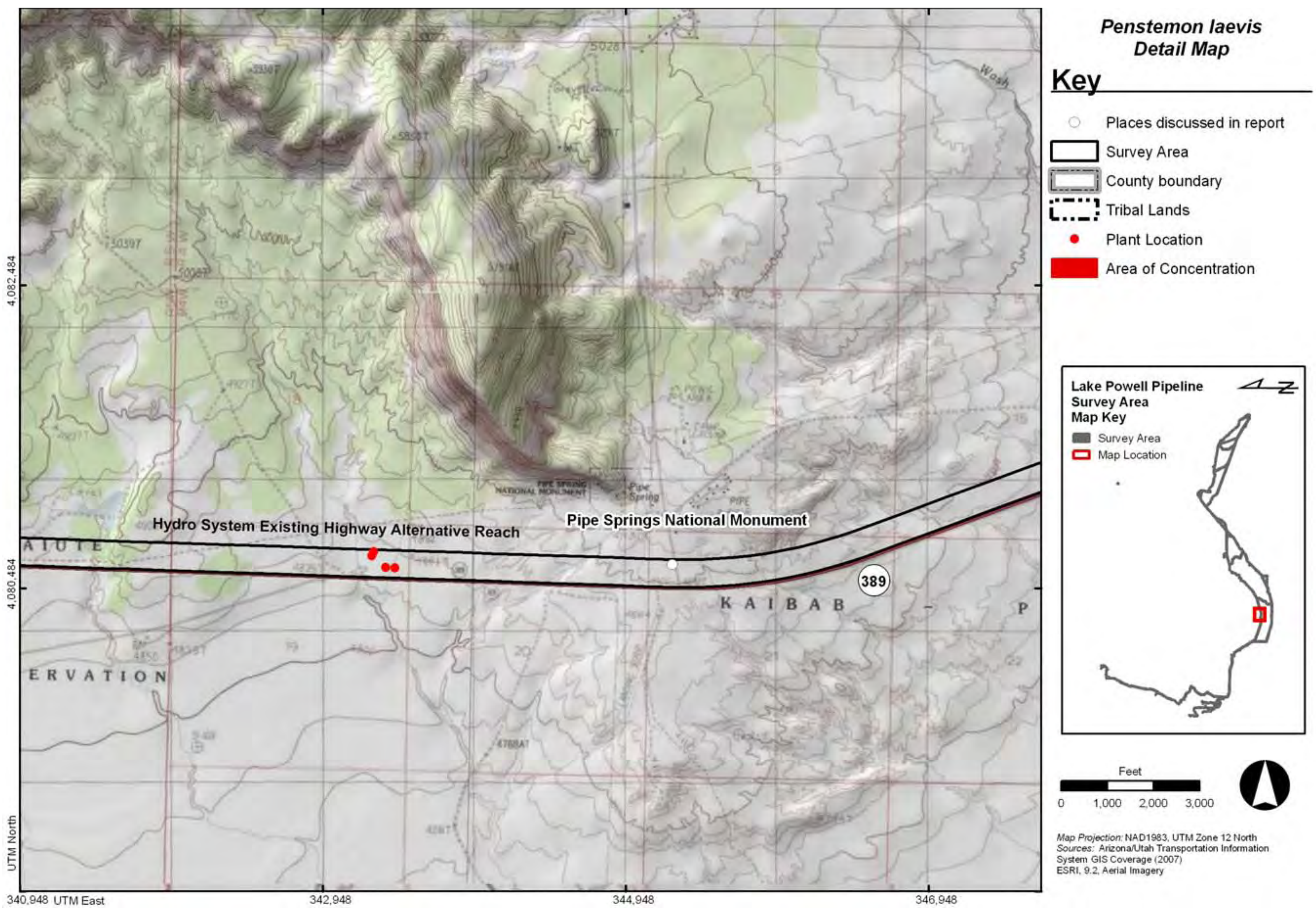
Map 4-46
***Penstemon laevis* Overview Map**



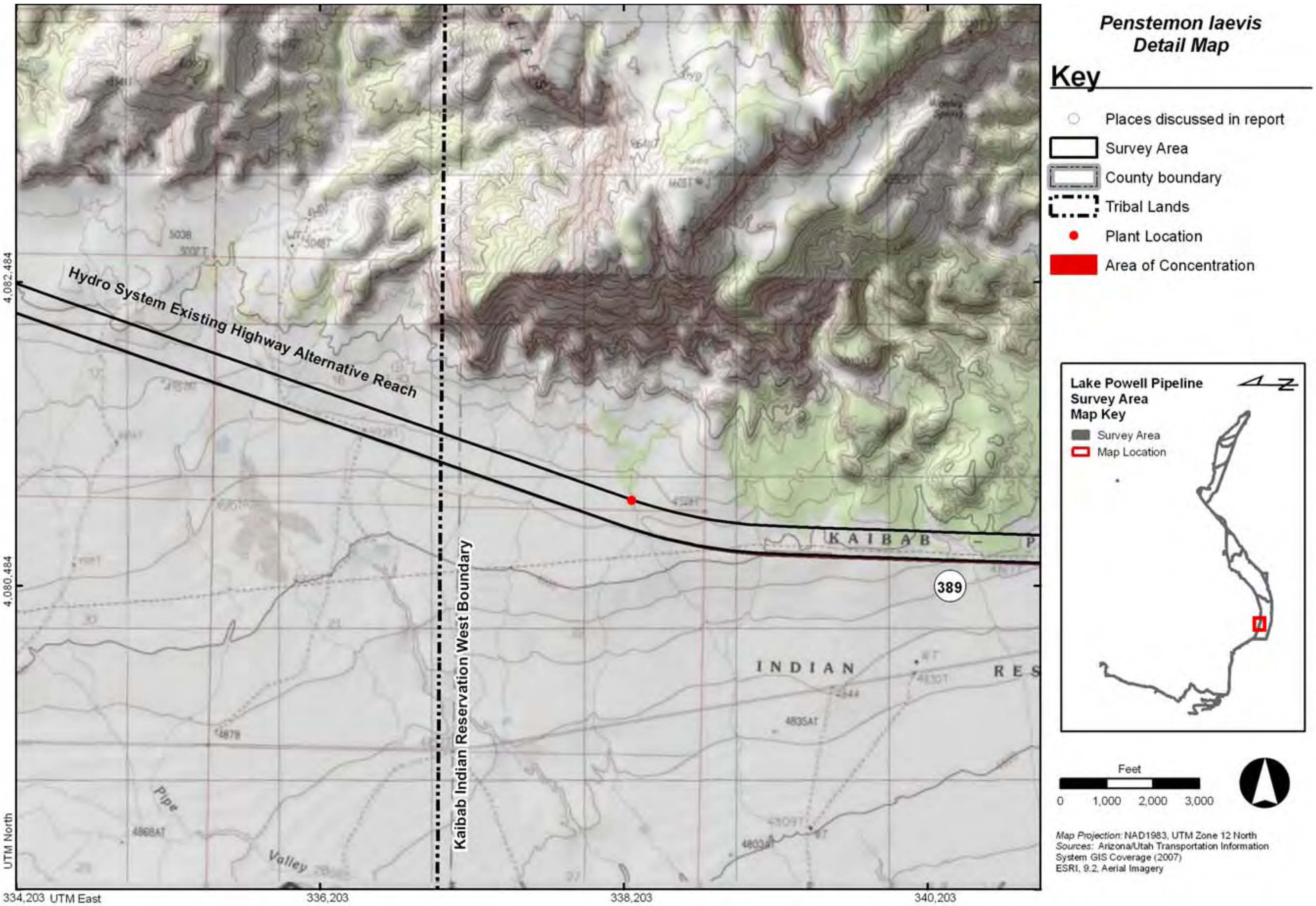
Map 4-47
***Penstemon laevis* Detail Map**



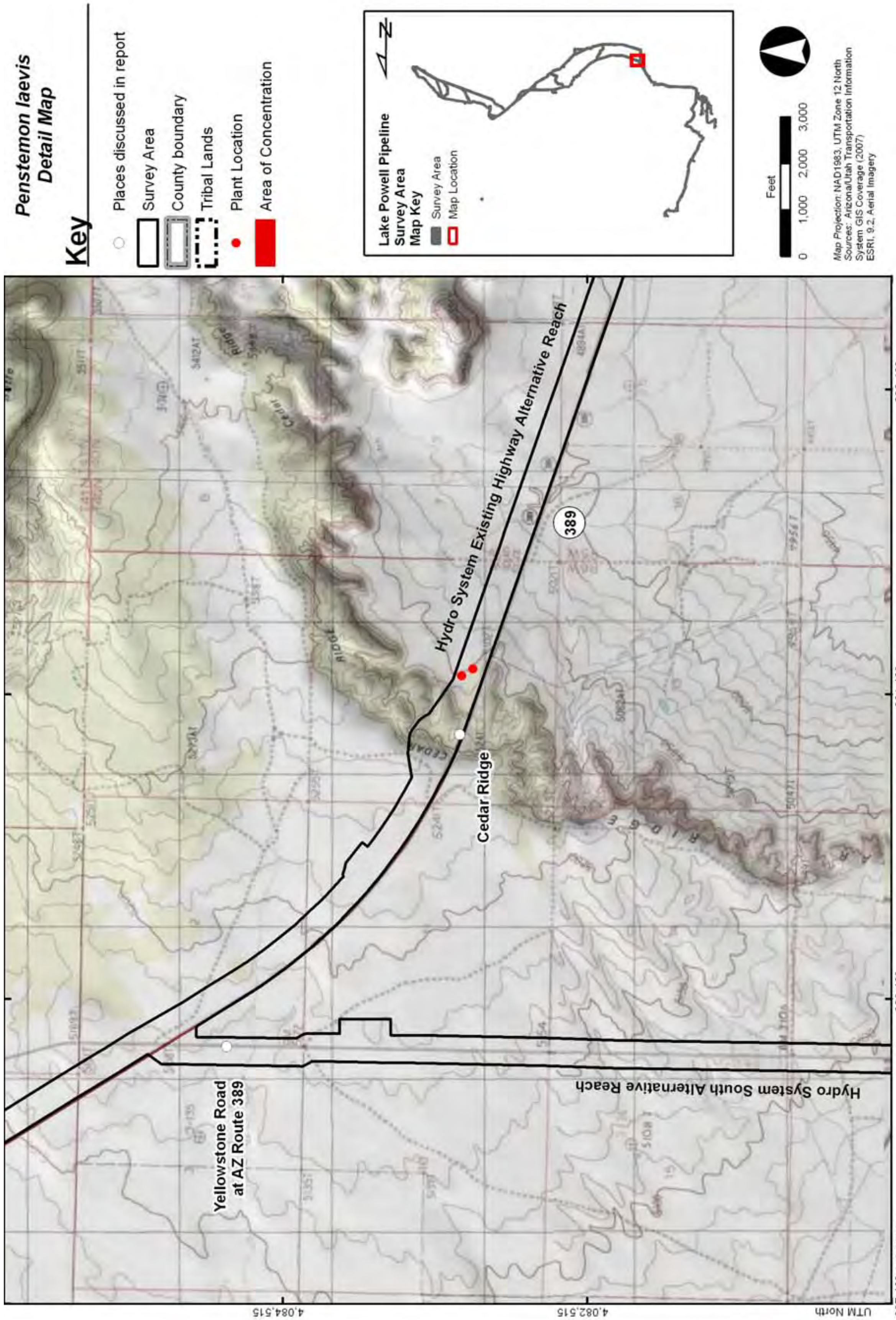
Map 4-48
***Penstemon laevis* Detail Map**



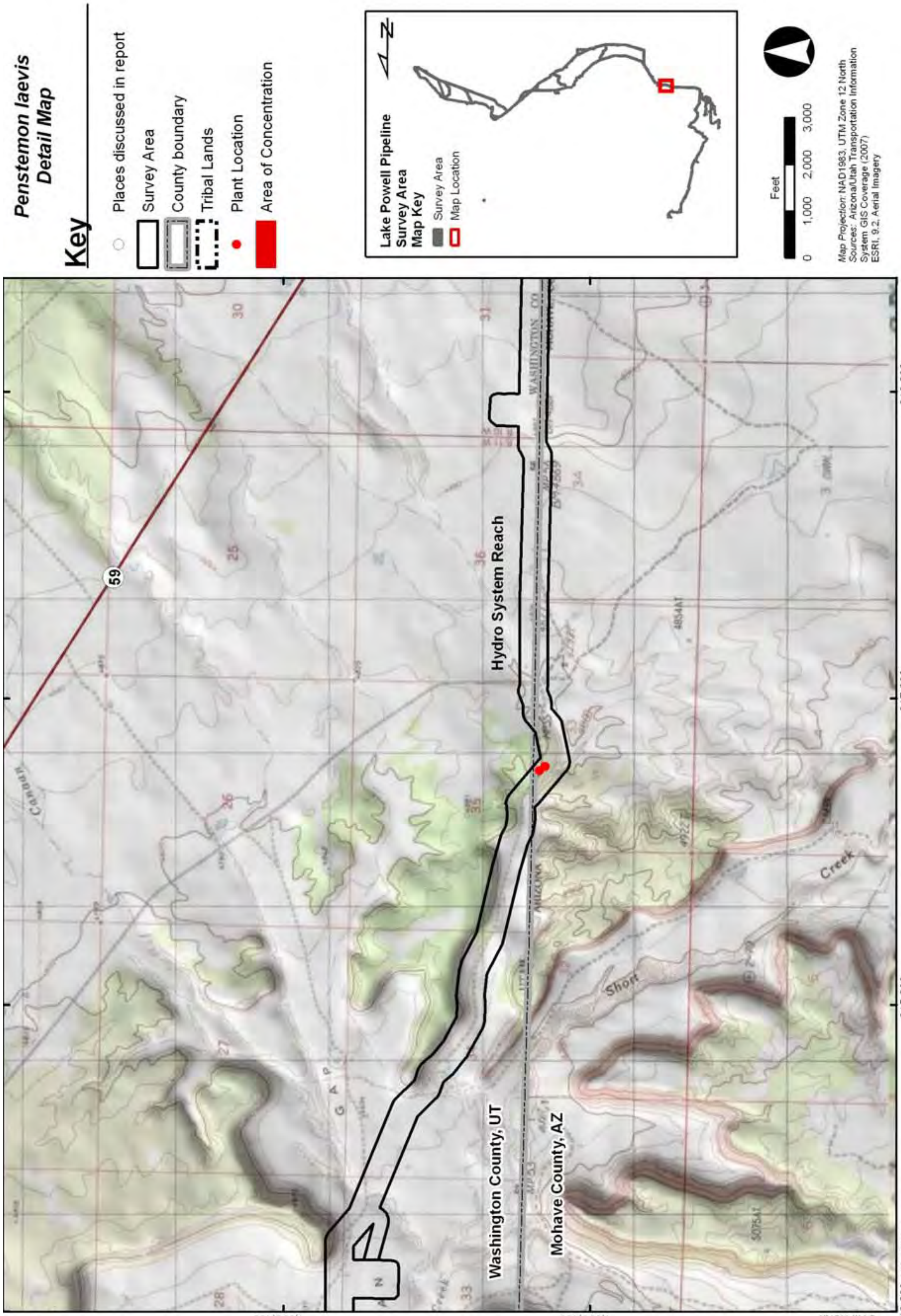
Map 4-49
***Penstemon laevis* Detail Map**



Map 4-50
***Penstemon laevis* Detail Map**



Map 4-51
***Penstemon laevis* Detail Map**



Map 4-52
***Penstemon laevis* Detail Map**

4.3.43 *Petalonyx parryi* (Parry's petalonyx)

4.3.43.1 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).

Petalonyx 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).

Figure 4-18
***Petalonyx parryi* observed within the survey area**

Petalonyx 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).

4.3.43.2 Survey Results

A total of 15 *Petalonyx parryi* plants were identified in the Hurricane West to Quail Creek Reservoir Reach on BLM lands in the vicinity of the Virgin River (just southeast of the Quail Creek Reservoir Dam). The distribution of *P. parryi* across the survey area is shown in Table 4-46 and Map 4-53 and Map 4-54.

Table 4-46 A summary of Petalonyx parryi survey results by location			
Reach	**Location**	**Land Ownership**	**# of Plants**
Hurricane West to Quail Creek Reservoir	1.5 miles southwest of Virgin River	BLM	15
		Total	15

Petalonyx parryi was only found in the Mohave Desert, where it occurred within the Gypsum Badland Ecological System, in the *Ephedra* (*nevadensis, torreyana*) Gypsum Badlands Sparsely Vegetated Alliance and in the *Ephedra torreyana* Gypsum Badlands Sparse Vegetation Association (Table 4-47). All individuals were located between 2,783 feet (848 meters) and 2,820 feet (860 meters) elevation. An incidental occurrence of *P. parryi* was observed outside of the survey area east of the Afterbay at 295675E x 4103654N on a Moenkopi outcrop on a near vertical exposure along the Hurricane Cliffs.

Table 4-47 A summary of *Petalonyx parryi* survey results by alliance and association		
Alliance	**Association**	**# of Plants**
MOHAVE DESERT GYPSUM BADLANDS ECOLOGICAL SYSTEM		
Ephedra torreyana Sparsely Vegetated	*Ephedra torreyana* Gypsum Badlands Sparse Vegetation	15
	Total	15

All plants were found on Badland soils of the Shnabkaib Member of the Moenkopi Formation. These soils tend to be white to light-gray in color, calcareous siltstone and silty gypsum, and sometimes include light-red, thin-bedded mudstone, siltstone, and sandstone (Billingsley et al. 2008). A summary of *Petalonyx parryi* occurrences by geologic formation is provided in Table 4-48.

Table 4-48 A summary of *Petalonyx parryi* survey results by geologic formation	
Geologic Formation	**# of Plants**
MOHAVE DESERT GYPSUM BADLANDS ECOLOGICAL SYSTEM	
Shnabkaib Member of the Moenkopi Formation	15
Total	15

Petalonyx parryi was observed on one soil type within the survey area: badlands (Table 4-49).

Table 4-49 A summary of *Petalonyx parryi* survey results by soil type	
Soil type	**# of Plants**
Badland	15
Total	15

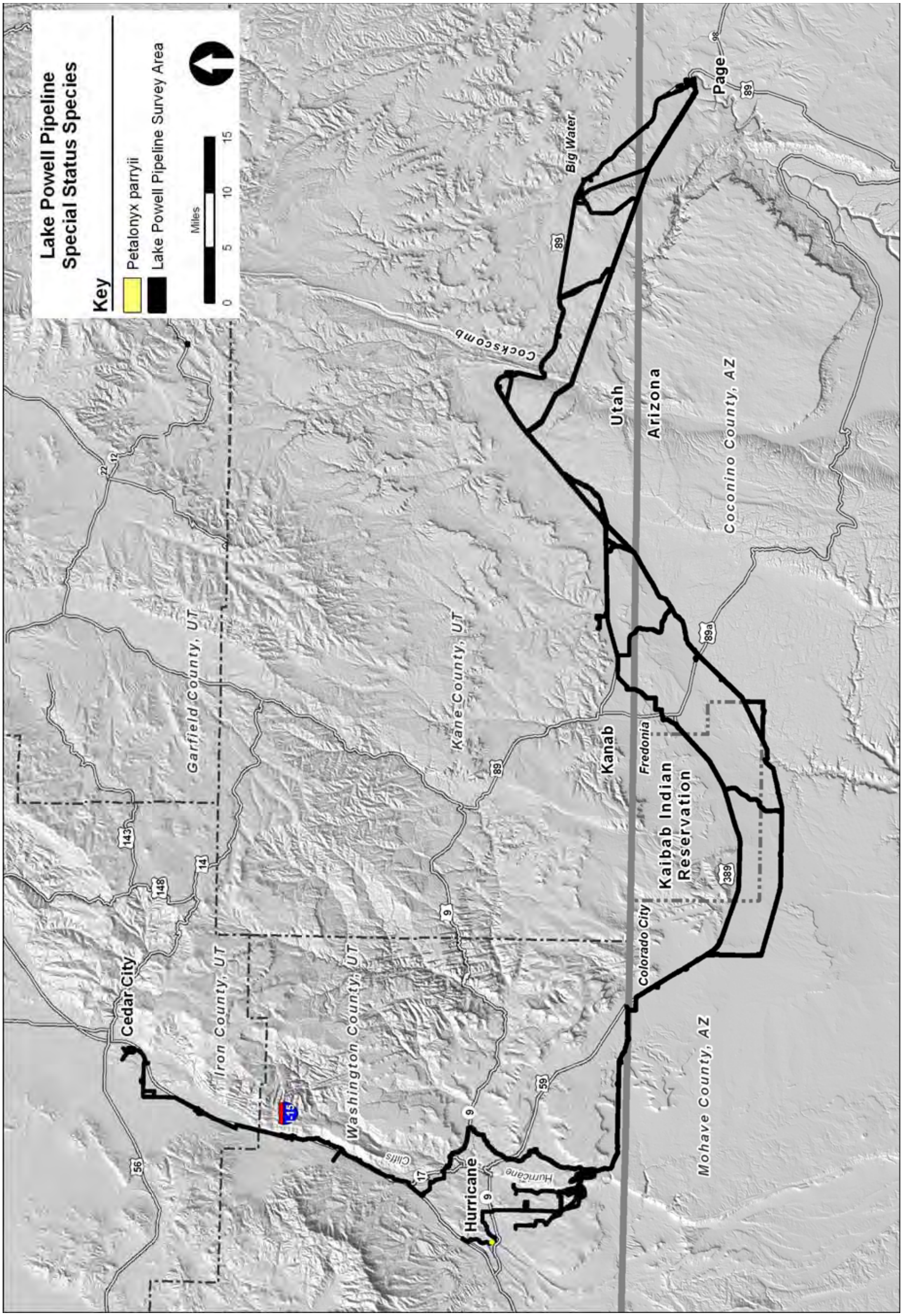
Petalonyx parryi was commonly found in association with sparsely vegetated hills and cryptobiotic soils. The only encountered group was found just southeast of the Quail Creek Reservoir Dam, on sparsely vegetated badlands. This area does not receive much use because it is within the floodplain of the Virgin River, and is downstream of the dam. However, the area is subject to recreational disturbance by Off Highway Vehicles (OHV) (many of the trails in this area were likely developed during the re-construction of the dam following a breach that occurred in 1989).

4.3.43.3 Discussion

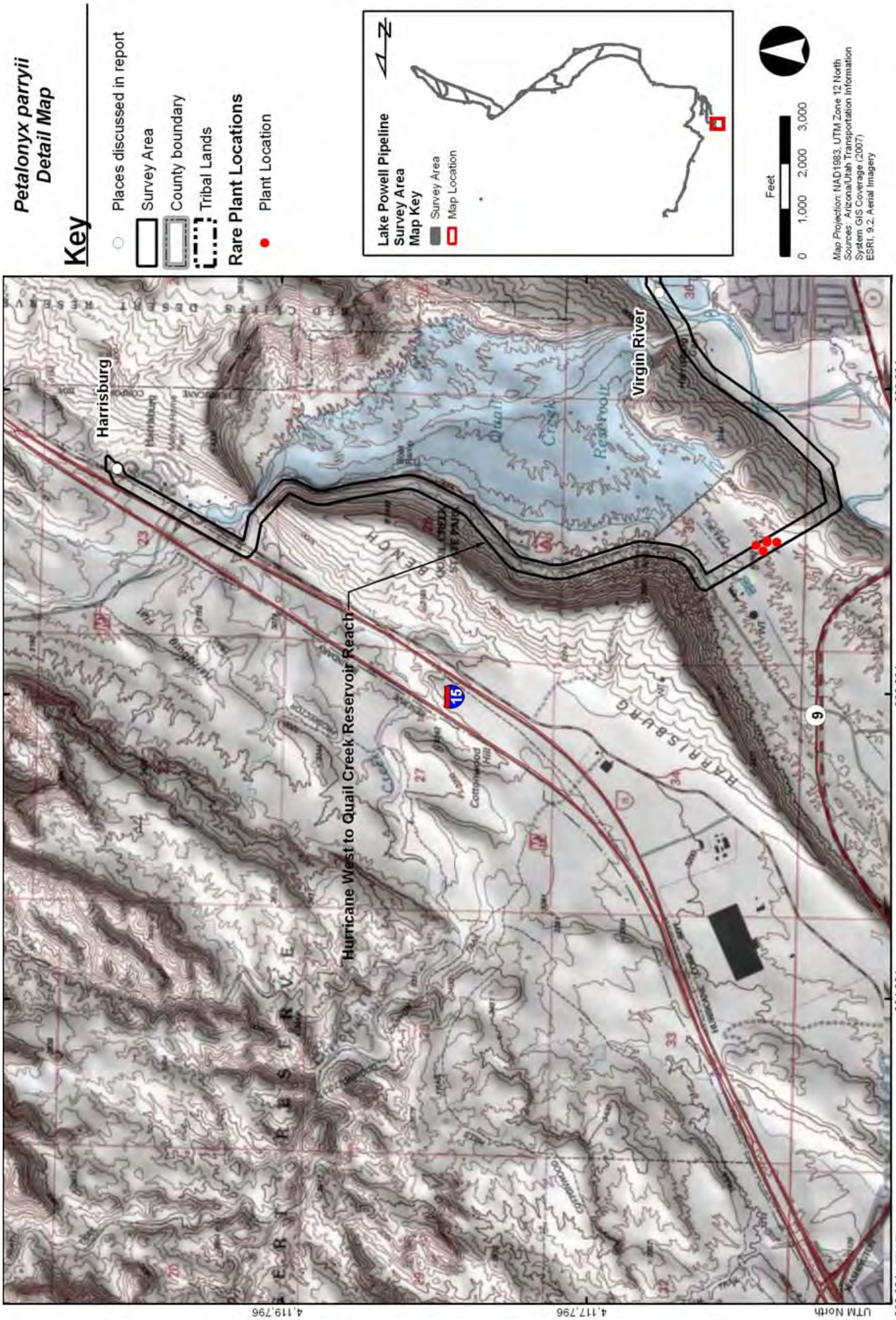
Only one small group of *Petalonyx parryi* was encountered by the survey. These 15 individuals were found in 2009 within the Hurricane West to Quail Creek Reservoir Reach. The plants were located in the vicinity of the Virgin River just southwest of Quail Creek Reservoir, and occurred on sparsely vegetated gypsum badlands commonly in association with cryptobiotic soils. All 15 *P. parryi* individuals were found in the Mohave Desert Gypsum Badlands Ecological System within the *Ephedra torreyana* Sparsely Vegetated Alliance, and the *Ephedra torreyana* Gypsum Badlands Sparse Vegetation Association. All plants ocurred on badland soils of the Shnabkaib Member of the Moenkopi Formation.

Within the survey area, the species was located in proximity to Quail Creek Reservoir. Areas with similar habitats were thoroughly surveyed, and despite the presence of suitable habitat, it is determined unlikely that undocumented groups persist within the survey area. It is probable that a breech of the south dike of Quail Creek Reservoir in 1989 destroyed previously occupied habitat adjacent to the sampled group. Existing threats to the group are perceived to be habitat destruction and continued fragmentation by OHV activity. Invasive weeds do not appear to be a current threat to the species, as any invasive weeds encountered in *P. parryi* habitat were observed at low densities (field observations suggest that invasive weeds are not well adapted to the preferred gypsum badland habitat of the species). Therefore, expected project-related impacts to the species are potential habitat loss, and direct impacts to individuals occurring within the survey area.

Petalonyx parryi was found in association with cryptobiotic soils. This microhabitat cannot be artificially created, and may take decades to re-establish. Therefore, transmission line access road routing through gypsum badlands with known special status plant groups or cryptobiotic soils should be avoided when an alternative is available. Where avoidance is not possible, individual plants could be salvaged and re-located into similar habitats outside of the area of disturbance. Additionally, topsoil containing viable seed could be salvaged from affected areas and re-used on-site.



Map 4-53
***Petalonyx parryi* Overview Map**



Map 4-54
***Petalonyx parryi* Detail Map**

4.3.44 *Phacelia howelliana* (Howell's phacelia)

4.3.44.1 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, caterpiller-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 *Phacelia 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.

4.3.44.2 Survey Results

Phacelia howelliana was not encountered during project surveys.

4.3.44.3 Discussion

All known locations for *Phacelia 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.

4.3.45 *Phacelia mammalariensis* (Nipple phacelia)

4.3.45.1 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 4-19). The plant has four brown seeds that are pitted down the back (Welsh et al. 2008).

Phacelia 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 4-19
Close up of *Phacelia mammalariensis* observed within the survey area

Phacelia 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).

4.3.45.2 Survey Results

Phacelia mammalariensis was encountered in the survey area during field surveys. Surveys located a total of 1,688 individual *Phacelia mammalariensis* plants. All but one *Phacelia 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 4-50 and Map 4-55 through Map 4-57.

Table 4-50
A summary of *Phacelia mammalariensis* survey results by location

Reach	Location	Land Ownership	# of Plants
Glen Canyon Substation and BPS-2 Transmission Line Alternative	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

Phacelia 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, 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 4-51.

Table 4-51
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	*Coleogyn ramosissima – Ephedra nevadensis* Dward-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

Phacelia mammalariensis was found most frequently on stream channel deposits; these depostis 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 wind blown sandstone (Billingsley et al. 2008). All geologic formations supporting *P. mammalariensis* are given in Table 4-52.

Table 4-52
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

Phacelia mammalariensis was found on multiple soils within the survey area. It was most commonly found on Needle-Sheppard complex soils. Table 4-53 provides a complete list of soils where *P. mammalariensis* was observed.

Table 4-53 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

Much of the areas where *Phacelia 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.

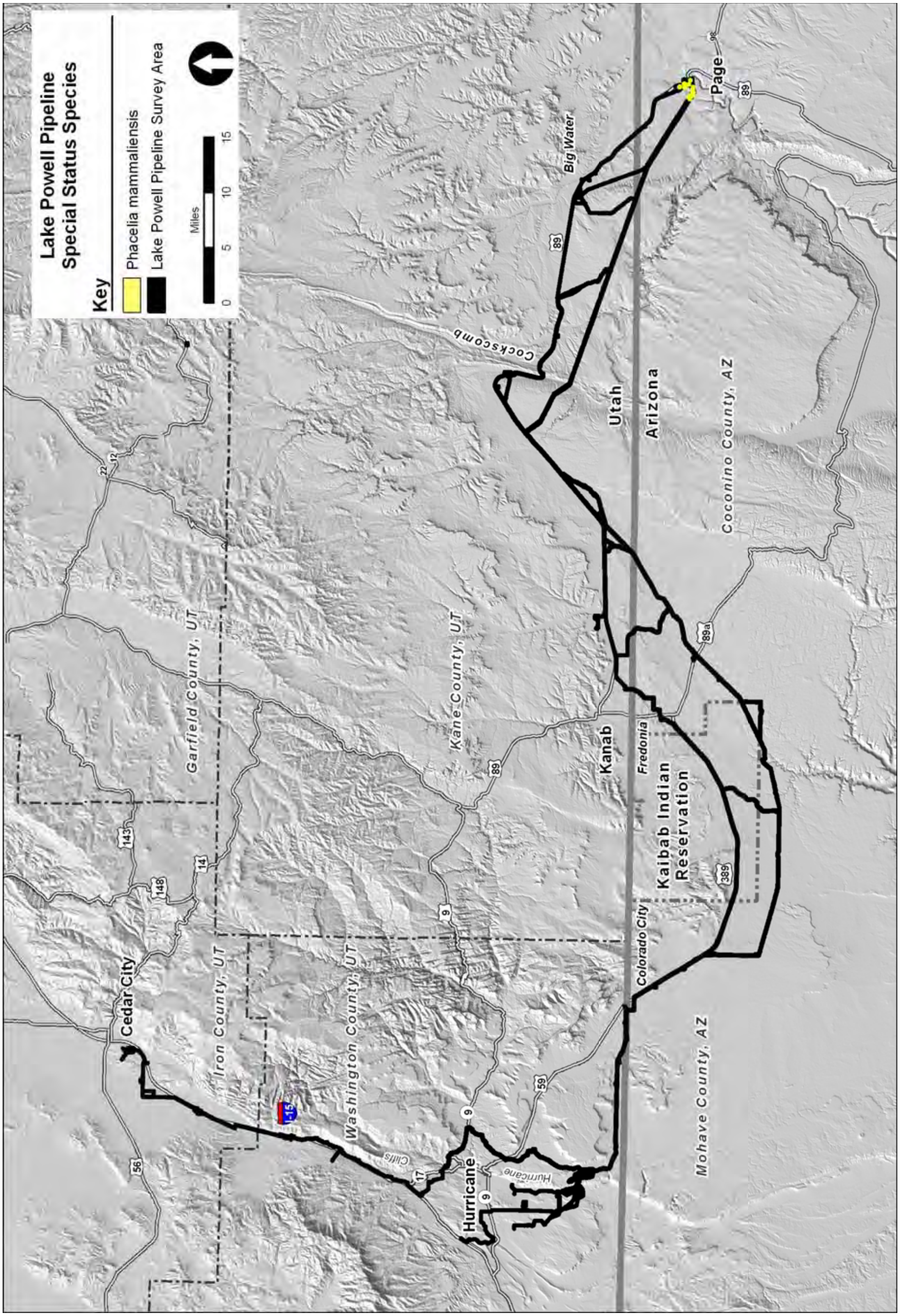
4.3.45.3 Discussion

A total of 1,688 *Phacelia 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. Note, *P. mammalariensis* is a GCNRA species of concern; however no plants were located within the GCNRA.

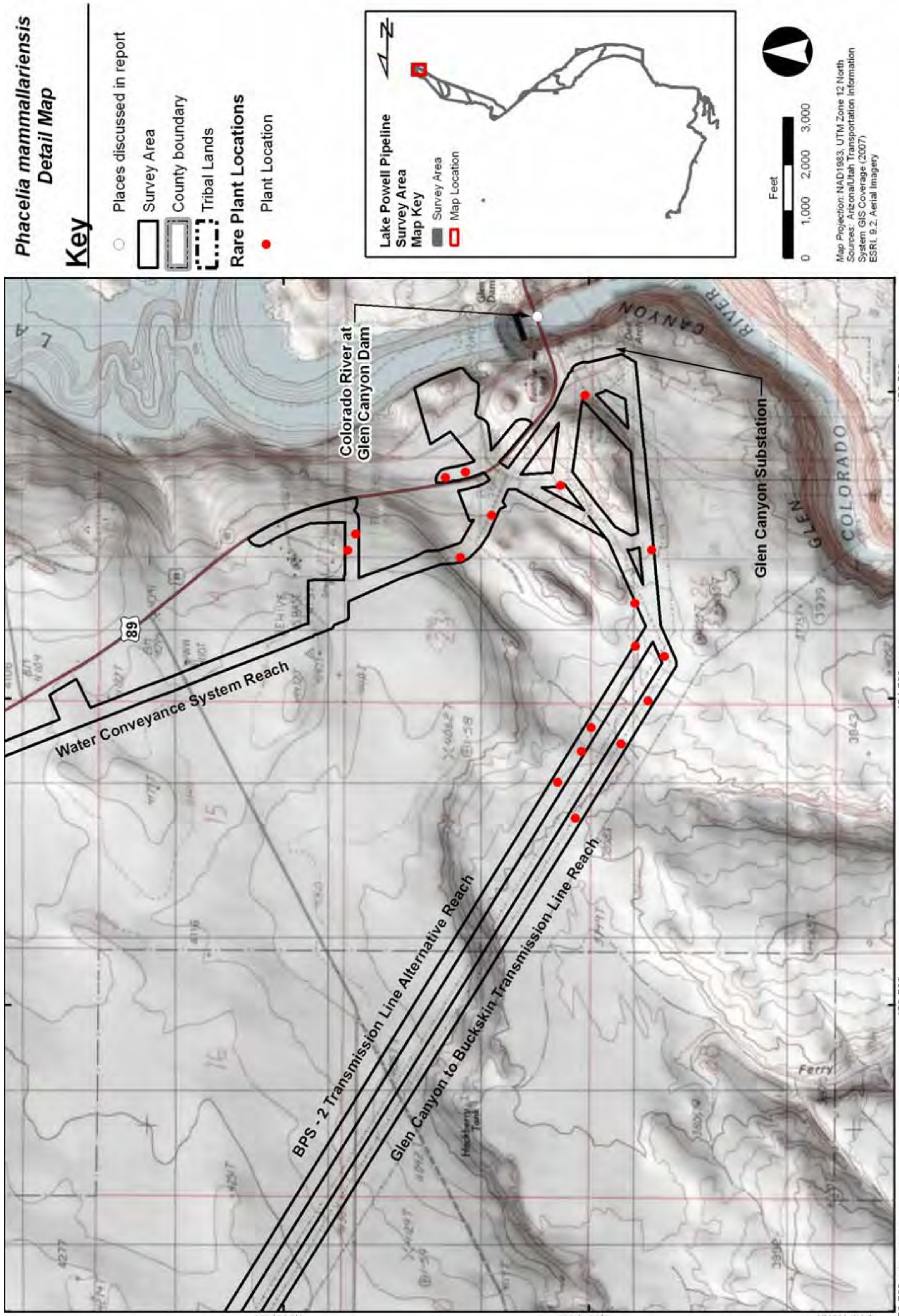
Phacelia mammalariensis individuals were encountered at elevations ranging from 3,792 feet (1,156 meters) and 4,810 feet (1,466 meters), the lower range falling slightly below the recorded range. The species was encountered infrequently, and in few habitat types. Positive identification of individuals 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.

Disturbance seems to have negatively impacted the robustness of the species. During the late 1800's, the area underwent great disturbance due to the movement of people and livestock. During the survey, signs of trampling and cattle grazing were observed within much of the habitat identified as suitable, including on GCNRA lands. 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.

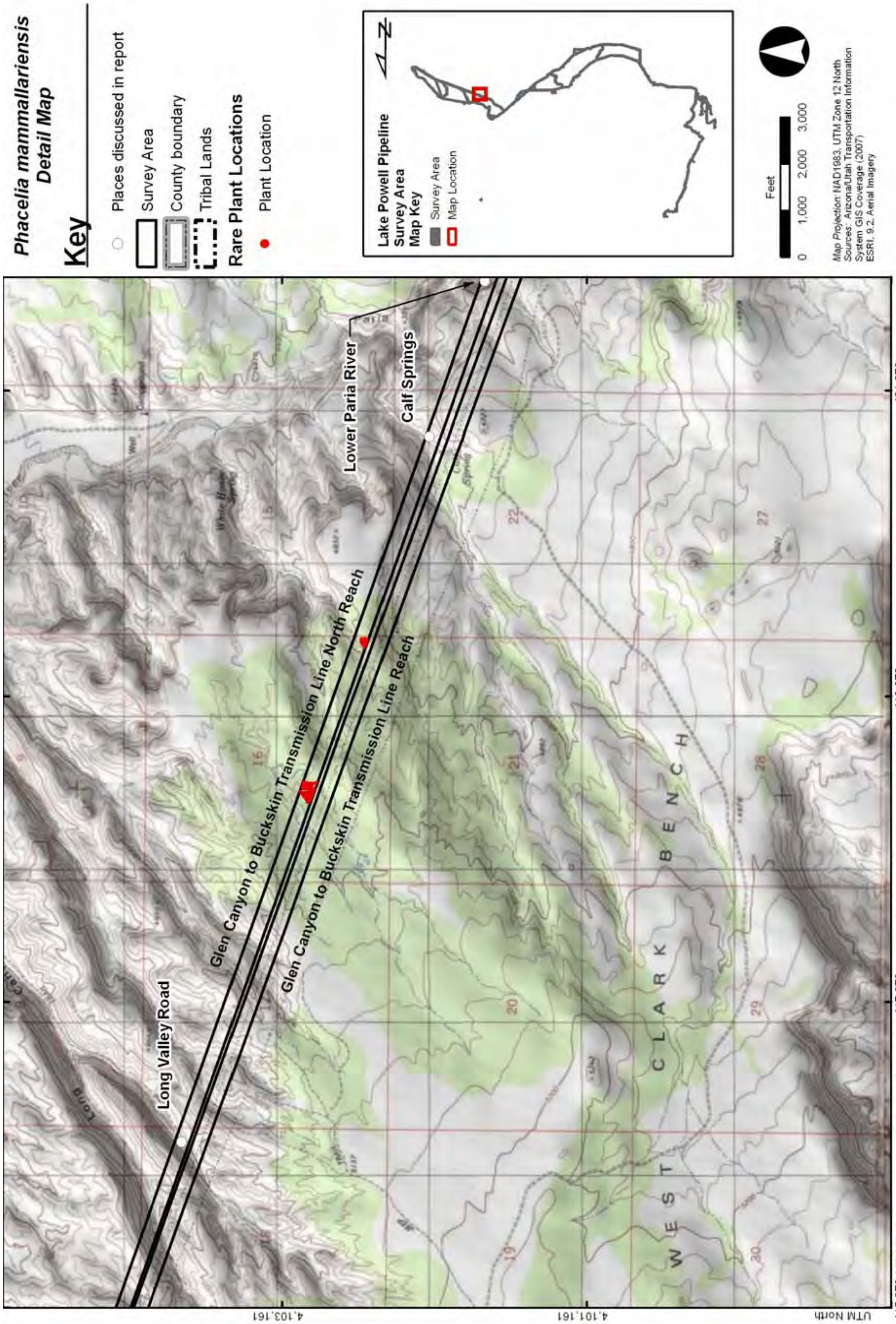
Due to taxonomic confusion of the species and the occurrence of individuals displaying a range of intermediary characteristics, it is possible that the survey did not capture all existing groups of *P. mammalariensis* occurring within the survey area. As *Phacelia mammalariensis* reproduces from seed, 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.



Map 4-55
***Phacelia mammalariensis* Overview Map**



Map 4-56
***Phacelia mammalariensis* Detail Map**



Map 4-57
***Phacelia mammalariensis* Detail Map**

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

4.3.46.1 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 4-20). 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).

Phacelia pulchella var. *atwoodii* is endemic to Kane County, Utah and is known from west of the Cockscomb to Petrified Hollow (Welsh et al. 2008). *P. phacelia* 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).

Figure 4-20
Close up of *Phacelia pulchella* var. *atwoodii* observed within the survey area

Phacelia pulchella 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 variety *gooddingii* are coarsely toothed. Also, while the leaves of variety *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 variety *atwoodii* occurring in Kane County, Utah.

4.3.46.2 Survey Results

Phacelia pulchella var. *atwoodii* was encountered in five 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 13,581,025 individuals were encountered during the surveys, the majority of which occurred within the Hydro System, Hydro System High point Alignment Alternative, and Hydro System South Alternative reaches. The greatest density of individuals was identified from the vicinity of Telegraph Wash to Petrified Hollow Wash, and large numbers of individuals were identified from the vicinity of Petrified Hollow Wash to the area around Shinarump Cliffs. 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. In the vicinity of Eightmile Gap Road, *P. pulchella* var. *atwoodii* was observed co-habitating a microhabitat with *Camissonia exilis.* The distribution of *P.pulchella* var. *atwoodii* across the survey area is shown in Table 4-54and Map 4-58 through Map 4-63.

Table 4-54
A summary of *Phacelia pulchella* var. *atwoodii* survey results by location

Reach Location		Land Ownership	Estimated # of Plants Based on Density Calcuations
Water Conveyance System and Hydro System High Point Alignment Alternative	1.05 miles to 2.6 miles southwest of Telegraph Wash	BLM 161,075*	
Hydro System and Hydro System High Point Alignment Alternative	3.1 miles southwest of Telegraph Wash to Petrified Hollow Wash	BLM 8,439,674*	
Hydro System and Hydro System High Point Alignment Alternative and Hydro System South Alternative	0.62 miles southwest of Petrified Hollow Wash to 1.45 miles southwest of Shinarump Cliffs	BLM 4,978,925*	
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 northeast of Johnson Wash	BLM and Private	5
		Total	13,581,025*

*Counts are estimates based on 50-meter transect densities

During 2009, counts of *Phacelia pulchella* 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 *Phacelia 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*.

Phacelia pulchella var. *atwoodii* was found within the Colorado Plateau Ecological Region, and occurred in a total of five ecological systems, six alliances, and 11 associations. *P. pulchella* var. *atwoodii* was found most often growing within the Colorado Plateau Big Sagebrush Shrubland and Colorado Plateau Gypsum Badlands ecological systems. The largest quantity of individuals was found in the *Artemisia tridentata* ssp. *vaseyana* Shrubland alliance, although the *Eriogonum corymbosum* Shrubland alliance also supported a high density of individuals. The two largest groups were found in the *Artemisia tridentata* ssp. *vaseyana* / Sparse Understory Shrubland (an estimated 7,894,227 individuals), and in the *Eriogonum corymbosum – Artmesia tridentata* ssp. *vaseyana* Gypsum Badlands Sparse Shrubland (an estimated 4,320,450 individuals) associations. 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. pulchella* var. *atwoodii* are shown in Table 4-55.

Table 4-55
A summary of *Phacelia pulchella* var. *atwoodii* survey results by alliance and association

Alliance Association		Estimated # of Plants Based on Density Calcuations
COLORADO PLATEAU BIG SAGEBRUSH SHRUBLAND ECOLOGICAL SYSTEM		
Artemisia tridentata ssp. *vaseyana* Shrubland	*Artemisia tridentata* ssp. *vaseyana* / Sparse Understory Shrubland	7,894,227*
Artemisia tridentata ssp. *vaseyana* Shrubland	*Artemisia tridentata* ssp. *vaseyana* Shrubland	396,243*
COLORADO PLATEAU GYPSUM BADLANDS ECOLOGICAL SYSTEM		
Artemisia tridentata ssp. *vaseyana* Shrubland	*Juniperus osteosperma / Artemisia tridentata* ssp. *vaseyana* Gypsum Badlands Wooded Shrubland	614,097*
Artemisia tridentata ssp. *vaseyana* Shrubland	*Artemisia tridentata* ssp. *vaseyana* Gypsum Badlands Sparse Shrubland	5
Eriogonum corymbosum Shrubland	*Eriogonum corymbosum - Artemisia tridentata* ssp. *vaseyana* Gypsum Badlands Sparse Shrubland	4,320,450*
Juniperus osteosperma Sparsely Vegetated	*Juniperus osteosperma / Eriogonum corymbosum / Pediomelum epipsilum* Gypsum Badlands Wooded Sparse Vegetated	67,629*
Juniperus osteosperma Woodland	*Juniperus osteosperma* Gypsum Badlands Sparse Woodland	26,800*
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*
COLORADO PLATEAU PINYON-JUNIPER WOODLAND ECOLOGICAL SYSTEM		
Artemisia tridentata ssp. *vaseyana* Shrubland	*Juniperus osteosperma / Artemisia tridentata* ssp. *vaseyana* Wooded Shrubland	260,237*
	Total	13,581,025*

*Counts are estimates based on 50-meter transect densities

Phacelia pulchella var. *atwoodii* was found on five geologic formations within the survey area. The species was primarily encountered on the Middle Red Member of the Moenkopi Formation, which are 250-256 million year old formations that typically support gypsum badlands, and on alluvial deposits dating from 1200 to 1880 AD (Billingsley et al. 2008). All geologic formations supporting *P. p.* var. *atwoodii* are given in Table 4-56.

Table 4-56 A summary of *Phacelia pulchella* var. *atwoodii* survey results by geologic formation	
Geologic Formation	**Estimated # of Plants Based on Density Calcuations**
COLORADO PLATEAU BIG SAGEBRUSH SHRUBLAND ECOLOGICAL SYSTEM	
Quarternary alluvial deposits	358,072*
Quarternary alluvial deposits, Middle Red Member of the MoenkopiMember of the Moenkopi Formation*	7,073,792*
Undivided Moenkopi Formation	9*
Middle Red Member of the MoenkopiMember of the Moenkopi Formation	727,996*
Shnabkaib Member of the Moenkopi Formation	130,601*
COLORADO PLATEAU GYPSUM BADLANDS ECOLOGICAL SYSTEM	
Quarternary alluvial deposits	124,774*
Quarternary alluvial deposits, Lower Red Member of the Moenkopi Formation*	37,258*
Quarternary alluvial deposits, Middle Red Member of the Moenkopi Formation*	2,899,415*
Quarternary alluvial deposits, Shnabkaib Member of the Moenkopi Formation *	150,228*
Undivided Moenkopi Formation	5
Lower Red Member of the Moenkopi Formation	42,110*
Middle Red Member of the Moenkopi Formation	1,473,594*
Shnabkaib Member of the Moenkopi Formation	301,597*
COLORADO PLATEAU MIXED DESERT SCRUB ECOLOGICAL SYSTEM	
Undivided Moenkopi Formation	12*
COLORADO PLATEAU SHRUB-STEPPE ECOLOGICAL SYSTEM	
Undivided Moenkopi Formation	1,325*
COLORADO PLATEAU PINYON-JUNIPER WOODLAND ECOLOGICAL SYSTEM	
Quarternary alluvial deposits	33,584*
Quarternary alluvial deposits, Middle Red Member of the Moenkopi Formation*	139,606*
Middle Red Member of the Moenkopi Formation	87,047*
Total	13,581,025*

*Counts are estimates based on 50-meter transect densities

Phacelia pulchella var. *atwoodii* were found on multiple soil types within the survey area. The majority of individuals occurred in Kenzo-Retsabal-Progresso, cool complex soils, Ruinpoint-Barx complex soils, or in combinations of Kenzo-Retsabal-Progresso, cool complex soils, Ruinpoint-Barx complex soils, and Yarts-Palma-Nelville family-Barx-Atchee soils. The species was often identified in association with well-developed cryptobiotic crusts. As with *Camissonia exilis*, *P. pulchella* var. *atwoodii* often occurred on mounds with cryptobiotic crusts; however, *P. p.* var. *atwoodii* was encountered at higher densities within the mineral soil found at the periphery of these mounds. A summary of *Phacelia p.* var. *atwoodii* occurrences by soil type is provided in Table 4-57.

Table 4-57 **A summary of *Phacelia pulchella* var. *atwoodii* survey results by soil type**	
Soil type	**Estimated # of Plants Based on Density Calcuations**
Barx gravelly loam, 1 to 6 percent slopes	3
Clayhole silty clay loam, 1 to 5 percent slopes	1,256*
Kenzo-Retsabal-Progresso, cool complex, 2 to 30 percent slopes	3,137,165*
Kenzo-Retsabal-Progresso, cool complex, 2 to 30 percent slopes Ruinpoint-Barx complex, 2 to 8 percent slopes	6,255,969*
Kenzo-Retsabal-Progresso, cool complex, 2 to 30 percent slopes Ruinpoint-Barx complex, 2 to 8 percent slopes Yarts-Palma-Neville family-Barx-Atchee	2,157,027*
Kenzo-Retsabal-Progresso, cool complex, 2 to 30 percent slopes Yarts-Palma-Neville family-Barx-Atchee	107,501*
Lemrac-Simel-Humbug, moist complex, 2 to 20 percent slopes Ruinpoint-Barx complex, 2 to 8 percent slopes	113,197*
Manikan silty clay loam, 1 to 3 percent slopes	90*
Mellenthin, moist-Bowdish complex, 2 to 30 percent slopes	67,640*
Mellenthin, moist-Bowdish complex, 2 to 30 percent slopes Ruinpoint-Barx complex, 2 to 8 percent slopes	11,728*
Ruinpoint-Barx complex, 2 to 8 percent slopes	1,442,379*
Torriorthents, 3 to 50 percent slopes	2
Yarts-Palma-Neville family-Barx-Atchee	287,068*
Total	13,581,025*

*Counts are estimates based on 50-meter transect densities

4.3.46.3 Discussion

The survey identified an estimated 13,581,025 individuals of *Phacelia pulchella* var. *atwoodii* within the survey area. The species occurred in a total of five reaches; the Water Conveyance System, the Hydro System, the Hydro System High Point Alignment Alternative, the Hydro System South Alternative, and Eightmile Gap Road. *P. p.* var. *atwoodii* was documented in five ecological systems, six alliances, and 11 associations. Most commonly, the species was encountered in Colorado Plateau Big Sagebrush and Gypsum Badlands Ecological Systems (Figure 4-21) 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 Middle Red Member of the Moenkopi Formation and on alluvial deposits, and in Kenzo-Retsabal-Progresso, cool complex soils, Ruinpoint-Barx complex soils. *P. pulchella* var. *atwoodii* was often observed to occupy the same microhabitat as *Camissonia exilis*, particularly in association with well-developed cryptobiotic crusts, and occasionally underneath shade-providing nurse shrubs. While many of these areas were

Figure 4-21
View of *Phacelia pulchella* var. *atwoodii* (and *Camissonia exilis*) habitat within the survey area

disturbed (particularly by livestock grazing), localized disturbance to the preferred microhabitats supporting *P. pulchella* var. *atwoodii* appeared to be minimal.

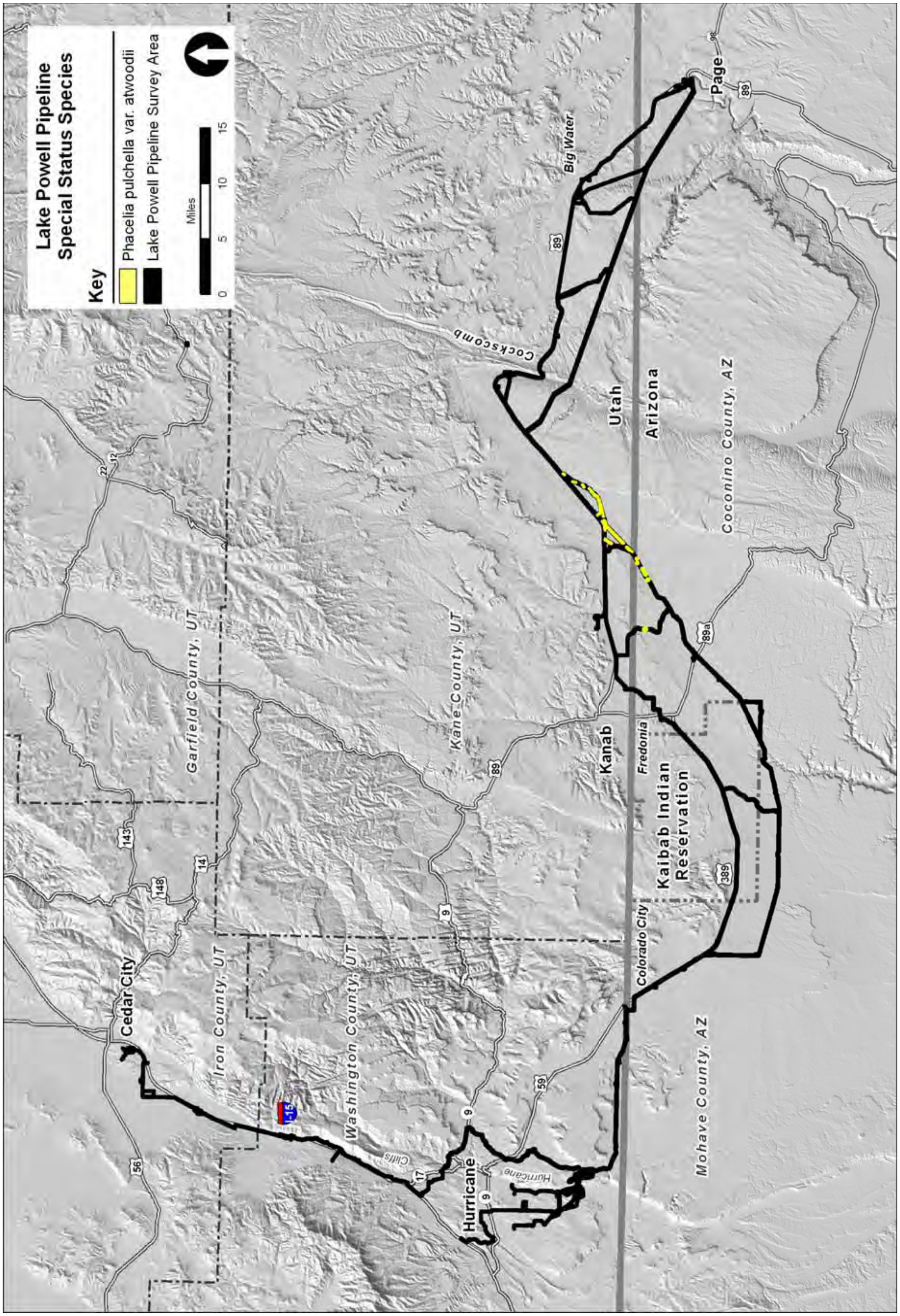
Phacelia pulchella var. *atwoodii* was found in extremely high densities in portions of the survey area, particularly from the vicinity of Telegraph Wash to Petrified Hollow Wash, and from Petrified Hollow Wash to Shinarump Cliffs. When the survey crew encountered these high-density localities, rather 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, *Phacelia pulchella* 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* can not be determined this way, the counts represented in Table 4-54 through Table 4-57 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.

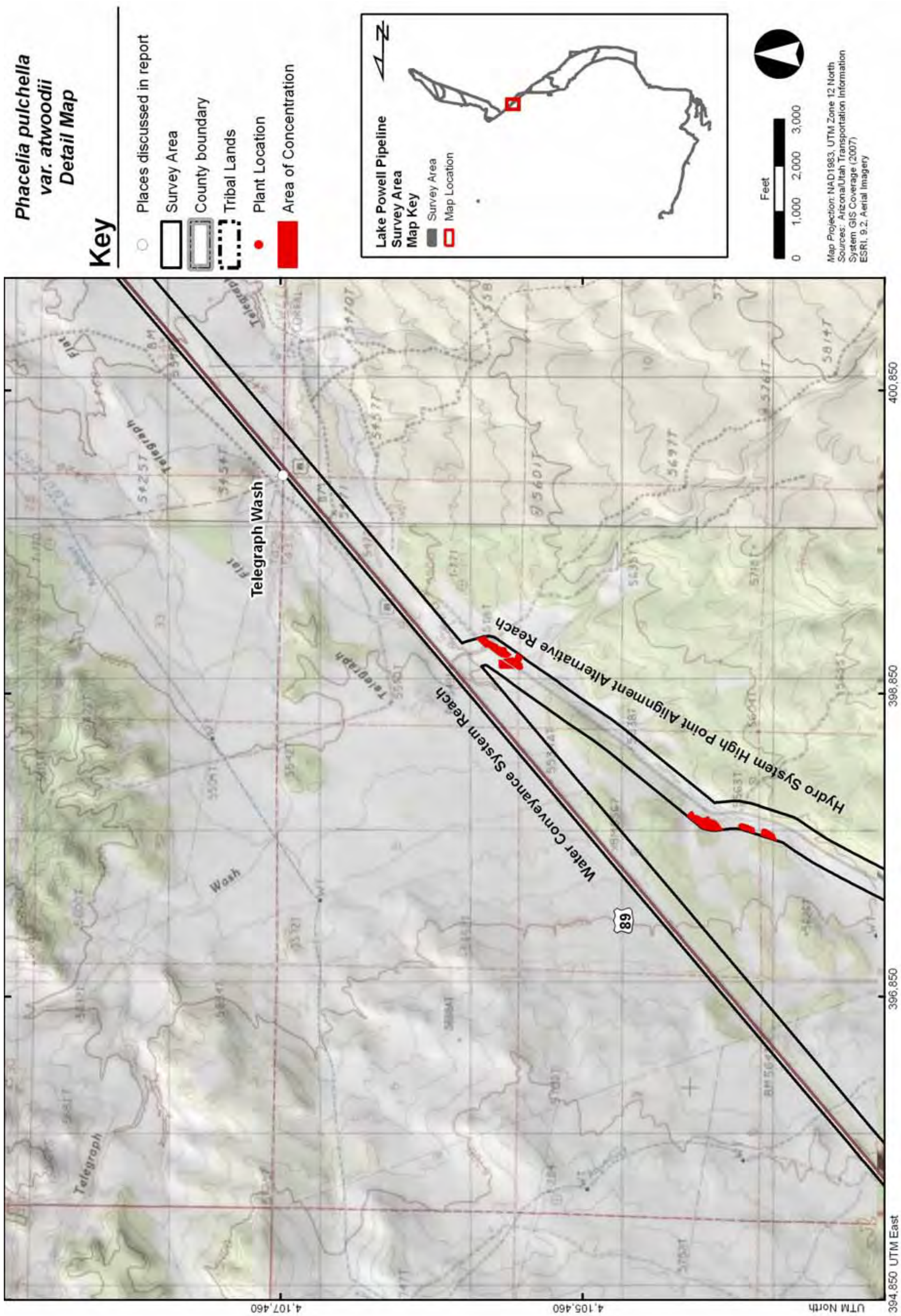
While collected data and field observations are consistent with published data regarding habitat preferences, the survey identified *Phacelia pulchella* var. *atwoodii* as far west as Johnson Canyon, which is outside of the known range of the species (currently documented by Welsh et al. [2008] as occurring from west of the Cockscomb to Petrified Hollow). With regard to climate, field observations suggest that the species is highly influenced by climactic factors. The survey area in the vicinity of Hurricane was surveyed for vegetation in 2009 and for desert tortoise in 2010. While surveying the area in 2009, the survey crew encountered very limited quantities of *P. p.* var. *atwoodii*, contrasting sharply with the extremely high densities observed while conducting tortoise surveys in 2010. Additionally, despite the occurrence of suitable habitat between Telegraph Flat and Seaman Wash, the species was not encountered in this segment during the 2009 survey, further suggesting depressed groups during the 2009 growing season. While appropriate data were not collected that would allow for an empirical conclusion regarding variation in densities due to climactic conditions, antectdotal evidence would suggest that germination of *P. p.* var. *atwoodii* is highly responsive to precipitation.

Phacelia pulchella 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 natural 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 may also result in a negative, although indirect, impact on the species.

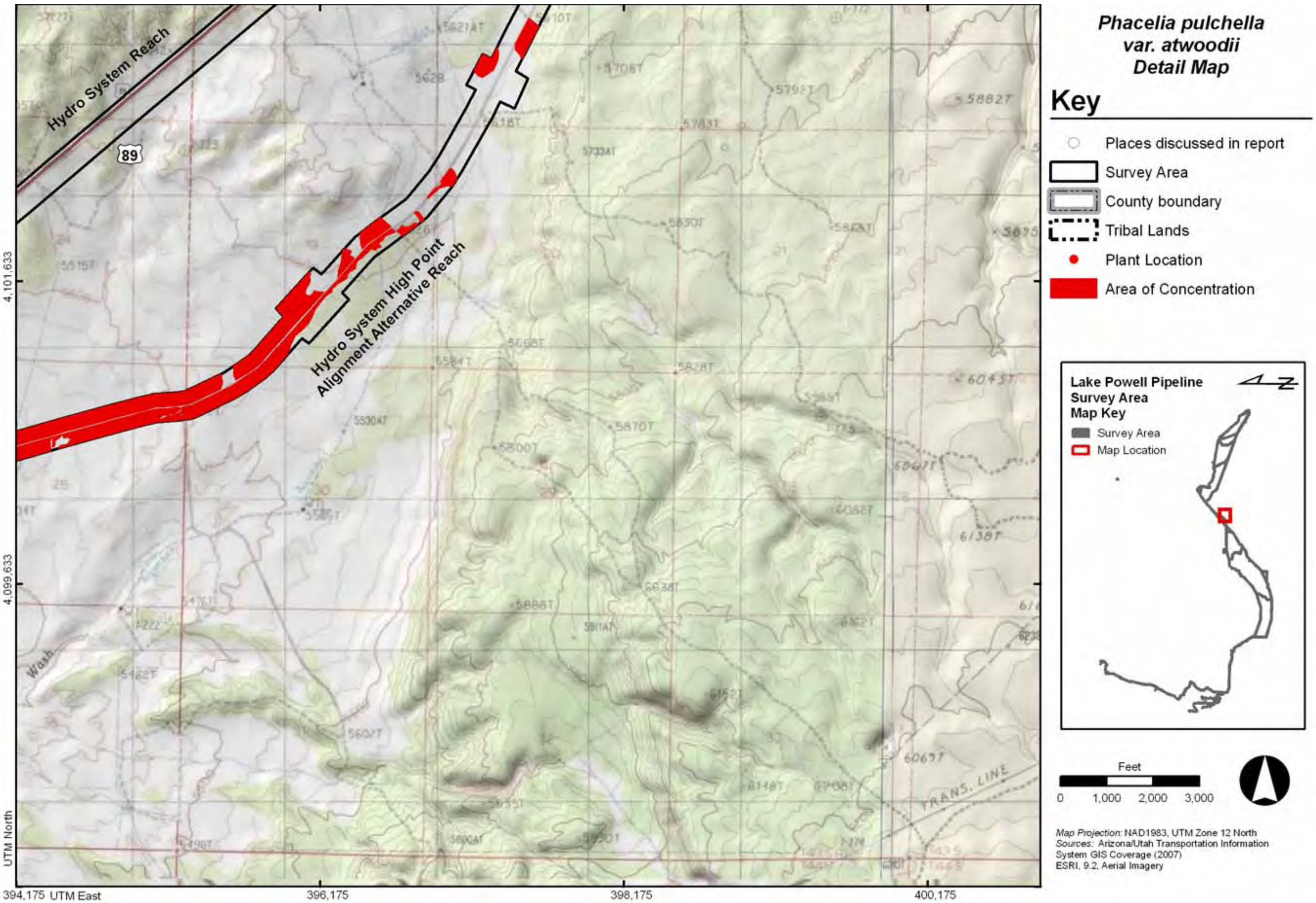
As *Phacelia pulchella* var. *atwoodii* reproduces from seed, the number of individuals identified during the survey may represent relative distribution of the plant at various locations where *P. p.* var. *atwoodii* is present within the seed bank. Additionally, it is likely that seed is present within adjacent habitats containing soils derived from the Middle Red Member of the Moenkopi Formation, where localized 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. p.* var. *atwoodii* seed. The presence of individuals identified along the Water Conveyance System, the Hydro System, the Hydro System High Point Alignment Alternative, 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.



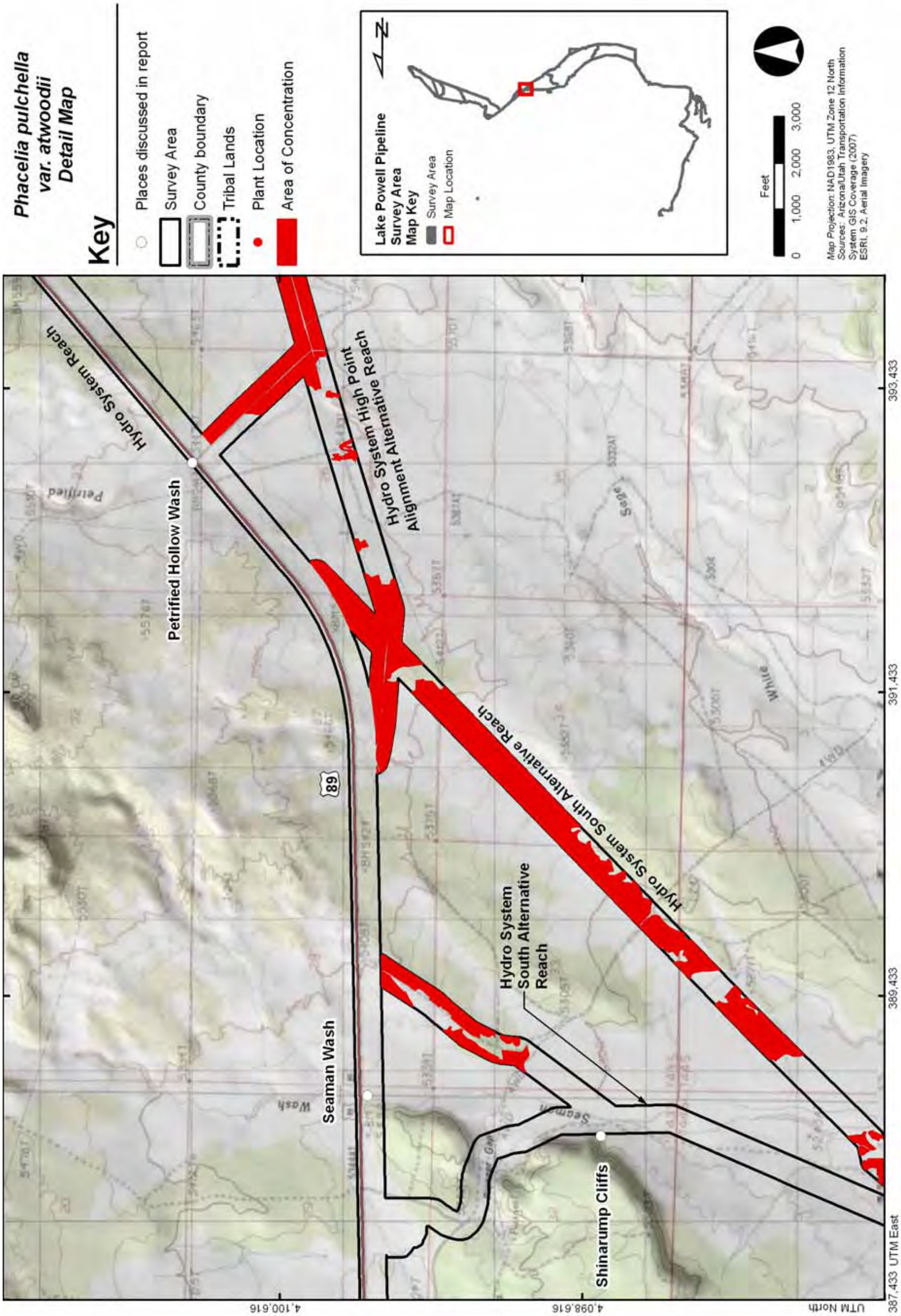
Map 4-58
***Phacelia pulchella* var. *atwoodii* Overview Map**



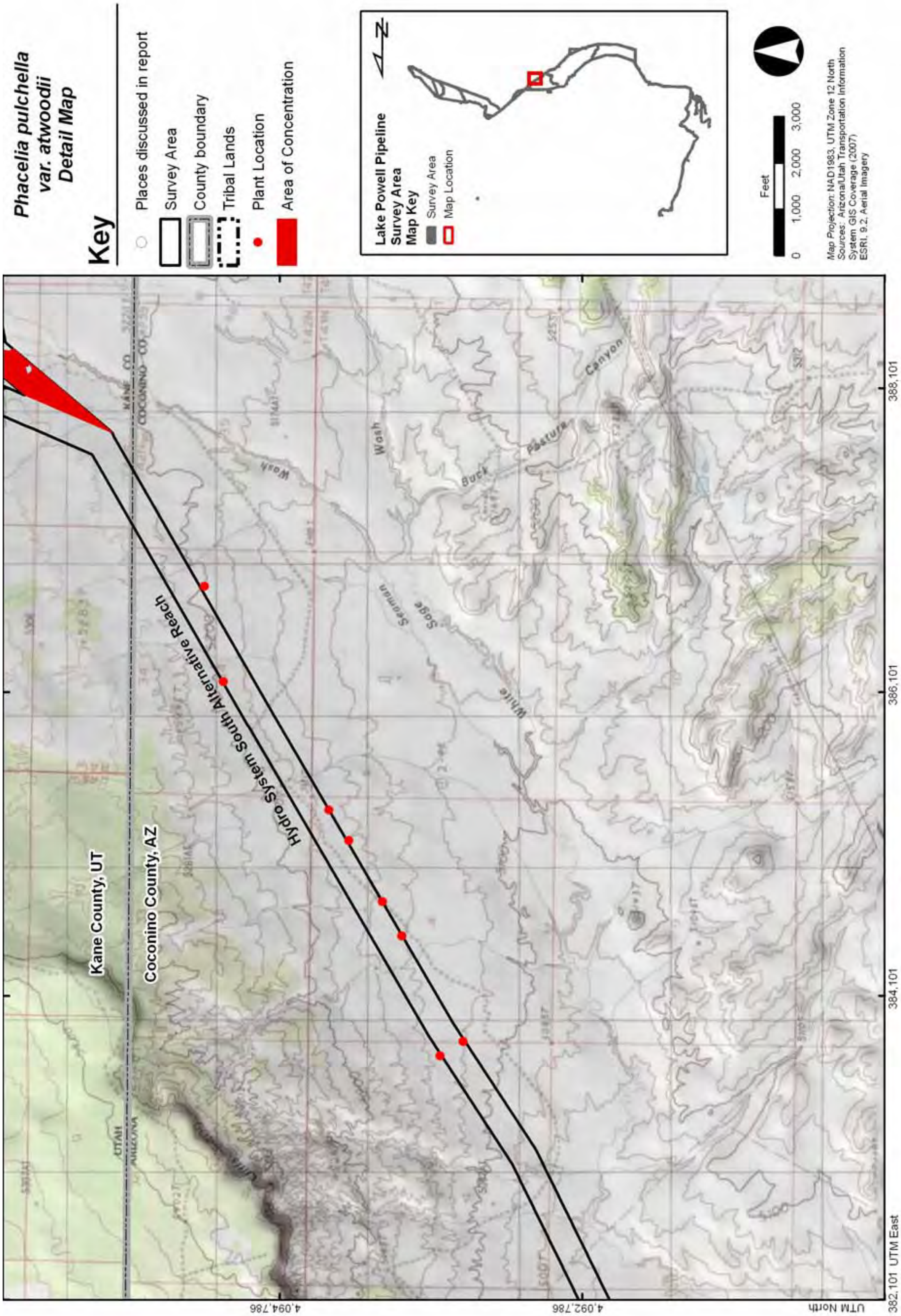
Map 4-59
***Phacelia pulchella* var. *atwoodii* Detail Map**



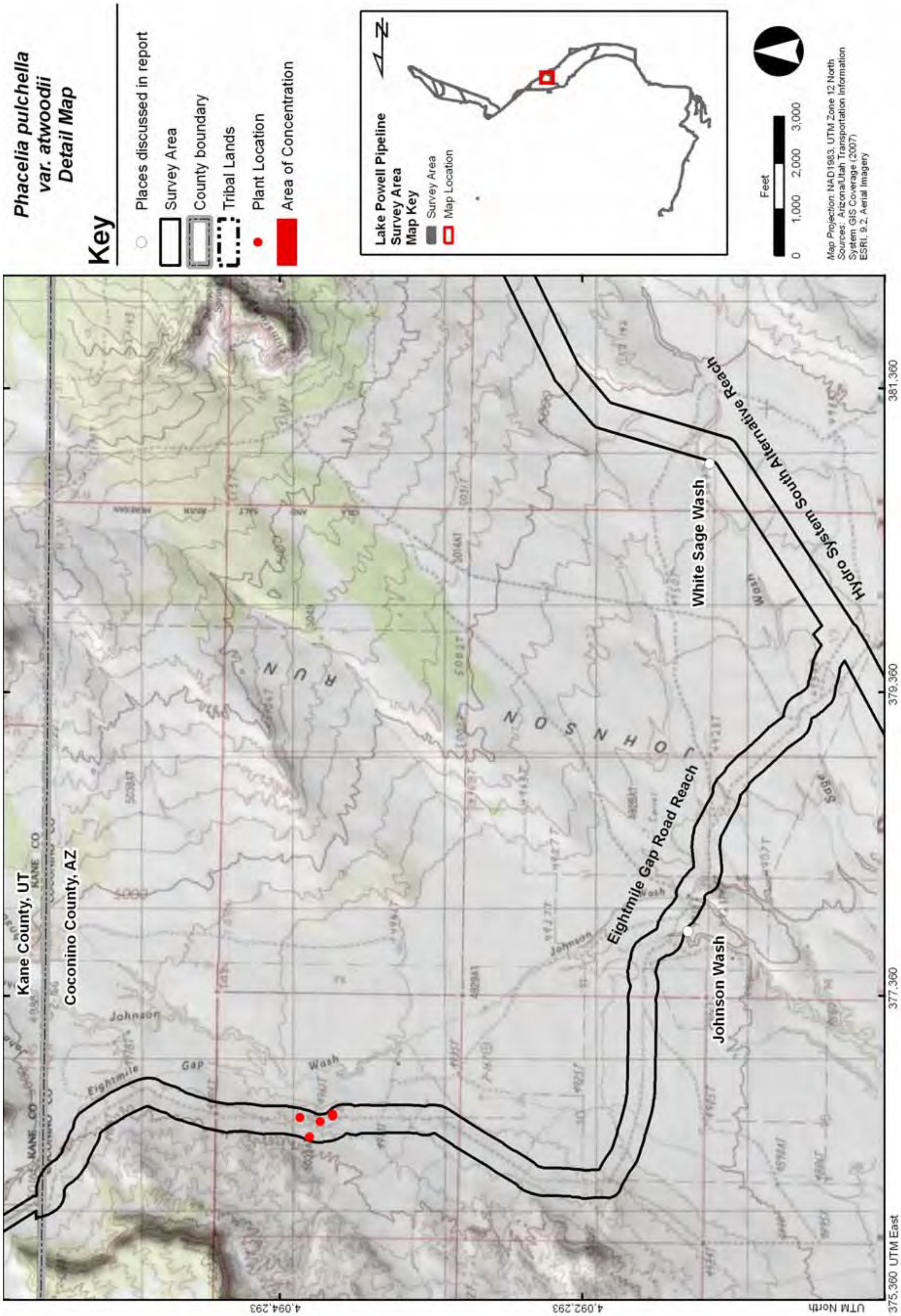
Map 4-60
***Phacelia pulchella* var. *atwoodii* Detail Map**



Map 4-61
***Phacelia pulchella* var. *atwoodii* Detail Map**



Map 4-62
***Phacelia pulchella* var. *atwoodii* Detail Map**



Map 4-63
***Phacelia pulchella* var. *atwoodii* Detail Map**

4.3.47 *Pinus ponderosa* (Ponderosa pine)

4.3.47.1 Natural history

Pinus ponderosa is a large, evergreen tree in the Pinaceae (Pine Family) reaching up to 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.

Pinus 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 counties (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.

4.3.47.2 Survey Results

Pinus ponderosa was not encountered during project surveys.

4.3.47.3 Discussion

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

4.3.48 *Pseudotsuga menziesii* (Douglas fir)

4.3.48.1 Natural history

Pseudotsuga menziessi 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).

Pinus menziessi 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. menziessi* 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 *Abies concolor, Populus* spp., and *Picea-Abies* communities (Welsh et al. 1993). In Arizona, *Pseudotsuga. menziessi* occurs in large stands with *Pinus ponderosa,* and with *Picea pungens* and *Picea engelmanni* in cool, moist habitats (Steinberg 2002).

4.3.48.2 Survey Results

Pseudotsuga menziesii was not encountered during project surveys.

4.3.48.3 Discussion

Pseudotsuga 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.

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

4.3.49.1 Natural history

Psorothamnus thompsoniae var. *whitingii* is small round shrub in the Fabaceae (Pea Family) reaching up to 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).

Psorothamnus thompsoniae 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. thompsoniae* var. *whitingii* occurs in Great Basin desertscrub 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. thompsoniae* var. *whitingii* from *P. thompsoniae* 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).

4.3.49.2 Survey Results

Psorothamnus thompsoniae var. *whitingii* was not encountered during project surveys.

4.3.49.3 Discussion

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

4.3.50 *Ptelea trifoliata ssp. pallida* (Hoptree)

4.3.50.1 Natural History

Ptelea trifoliata ssp. *pallida* is a perennial shrub from the Rutaceae (Rue Family) up to 20 feet (6 meters) 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.

Ptelea trifoliate occurs in Arizona, Utah, Colorado, New Mexico, Oklahoma, and Texas (Natureserve 2010). Two subspecies occur in Utah; *Ptelea trifoliata* 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).

4.3.50.2 Survey Results

A suspected *Ptelea trifoliata* 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. trifoliata* ssp. *pallida* or *P. trifoliata* ssp. *trifoliata*. This plant was located at UTM Zone 12S 357895mE and 4076768mN, NAD 83.

4.3.50.3 Discussion

Suitable limestone habitat for *Ptelea trifoliata* 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.

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

4.3.51.1 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).

Rosa stellata 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).

4.3.51.2 Survey Results

Rosa stellata var. *abyssa* was not encountered during project surveys.

4.3.51.3 Discussion

The only potential location where *Rosa stellata* 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.

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

4.3.52.1 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), *Salvia columbariae* 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 from 4,250 feet (1,295 meters) to 5,600 feet (1,707 meters) (UNPS 2003-08).

4.3.52.2 Survey Results

Salvia columbariae var. *argillacea* was not encountered during project surveys.

4.3.52.3 Discussion

All potentially suitable habitat for *Salvia columbariae* 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 has a high potential of finding *S. c.*var. *argillacea* if permission to access the Kanab site is obtained in the future.

4.3.53 *Sclerocactus sileri* (Paria Plateau fishhook cactus)

4.3.53.1 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 nches (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).

Sclerocactus sileri is known from House Rock Valley and the Paria Plateau in Coconino County, Arizona (AGFD 2003). *Sclerocactus 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.

4.3.53.2 Survey Results

Sclerocactus 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 reminents during a follow up visit in 2010.

4.3.53.3 Discussion

Tentitive identification of *Sclerocactus 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 *P. sileri*.

4.3.54 *Sisyrinchium demissum* (Blue-eyed grass)

4.3.54.1 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).

Sisyrinchium 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, 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 from 5,000 feet (1,525 meters) to 9,500 feet (2,895 meters) (Kearney and Peebles 1960).

Diagnostic features of *Sisyrinchium 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).

4.3.54.2 Survey Results

Sisyrinchium demissum was not encountered during project surveys.

4.3.54.3 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.

4.3.55 *Sphaeralcea gierischii* (Gierisch globemallow)

4.3.55.1 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 toothed. 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 *Sphaeralcea 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 western Washington County, Utah (UNPS 2003-08, Welsh et al. 2008) and from 3,000 feet (915 meters) to 4,300 feet (1,310 meters) in Arizona (AGFD 2003)

4.3.55.2 Survey Results

Sphaeralcea gierischii was not encountered during project surveys.

4.3.55.3 Discussion

The elevations within the survey area are higher than the reported range for *Sphaeralcea gierischii a*nd 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.

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

4.3.56.1 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).

Spiranthes diluvialis is known from Utah, Colorado, Wyoming, Idaho, Nebraska, and possibly Nevada (UNPS 2003-2008). Across its range, *S. demissum* 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 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. demissum* occurs in wet meadows, stream banks, abandoned oxbow meanders, marshes, and raised bogs from 4,500 feet (1,372 meters) to 6,800 feet (2,073 meters) (UNPS 2003-2008).

Spiranthes 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).

4.3.56.2 Survey Results

Spiranthes diluvialis was not encountered during project surveys.

4.3.56.3 Discussion

No seeps or hanging gardens were encountered within the survey area. **Spiranthes 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.

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

4.3.57.1 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.

Thelypodiopsis ambigua 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.

4.3.57.2 Survey Results

Thelypodiopsis ambigua var. *erecta* was not encountered during project surveys.

4.3.57.3 Discussion

Potential habitat for *Thelypodiopsis ambigua* var. *erecta* in the survey area may be found unsurveyed, private landsdiscussed 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.

4.3.58 *Tricardia watsonii* (Three hearts)

4.3.58.1 Natural History

Tricardia watsonii (Three hearts) is a low herbaceous desert perennial from the Hydrophyllaceae (Waterleaf Family). Stems reach 4 inches (10 centimeters) to 11.8 inches (30 centimeters) in height and baring few leaves. Simple leaves occur in a basal rosette and are elliptic, smooth, and attached to the stem. Upper leaves are smaller, oval, and smooth. Bell-shaped flowers occur in loose clusters at the end of stems. Petals are white or cream with lavender marks. The leaf structure below the flower is strongly dimorphic with three outer broad heart-shaped lobes and two inner narrow lobes. The flowering and fruiting period is from April to May (SEINet 2010).

Tricardia watsonii is confined to western North America, where it occurs in Arizona, California, Nevada, and Utah. Welsh et al. (2008) describes it as occurring in Washington County, Utah and the species is known from Beaver Dam, Grand Gulch Wash, and near the Muav Caves on the south side of the Grand Canyon in Arizona (AGFD 2005). *T. watsonii* inhabits dry, rocky canyons and slopes in desert ranges where it is associated with blackbush, barrel-cactus, muhly, and the Mojave yucca (AGFD 2005). In Utah, *T. watsonii* is known from within Joshua tree, creosote bush, other warm and cold desert shrub communities. In Arizona, the species is described as growing in Joshua tree woodland and creosote bush scrub. The species ranges from 2,395 feet (730 meters) to 4,120 feet (1,256 meters) in elevation in Utah and primarily from 2,000 feet (610 meters) to 3,500 feet (107 meters) in Arizona, observations have been recorded from 1,400 feet (427 meters) to 4,600 feet (1,402 meters) (ARPC 2001, AGFD 2005).

4.3.58.2 Survey Results

Tricardia watsonii was not encountered during project surveys.

4.3.58.3 Discussion

All potentially suitable habitat was surveyed for *Tricardia watsonii* during the survey seasons. No further surveys are warranted within the survey area for this plant.

4.3.59 *Viguiera soliceps* (Tropic goldeneye)

4.3.59.1 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).

Viguiera 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 from 4,600 feet to 4,800 feet (UNPS 2003-08).

4.3.59.2 Survey Results

Viguiera soliceps was not encountered during project surveys.

4.3.59.3 Discussion

Tropic Shale formations with *Viguiera 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.

Chapter 5
Noxious Weed and Invasive Species Assessment Results

5.1 Weed Occurrence within Survey Area

The survey for noxious weeds confirmed the presence of 18 taxa within the LPP survey area (Table 5-1). The most broadly-distributed taxa were *Bromus rubens*, *Bromus tectorum*, *Erodium cicutarium*, and *Salsola tragus*. *Tamarix* species was relatively widespread. Exhibiting moderate abundance throughout the survey area were *Asclepias subverticillata*, *Convolvulus arvensis*, *Elaeagnus angustifolia*, *Halogeton glomeratus*, *Onopordum acanthium*, *Portulaca oleracea*, and *Tribulus terrestris*. Limited occurrences were noted for *Aegilops cylindricus*, *Brassica tournefortii*, *Cardaria draba*, *Centaurea solstitialis*, *Sorghum halepense*, and *Ulmus pumila*.

Table 5-1
Noxious and Invasive Weed Species Encountered during Surveys for the LPP Project
Page 1 of 2

Species		USDA[1]	USFWS[2]	State of Arizona[3]	State of Utah[4]	Iron Co., UT	Washington Co., UT	BLM (Arizona Strip)	BLM (St. George)	BLM (Kanab)	BLM (Grand Staircase-Escalante)	Glen Canyon N.R.A.
Scientific Name	**Common Name**											
Aegilops cylindrica Jointed	goatgrass			PNW, RNW								
Asclepias subverticillata	Poison milkweed					N N			N		N	
Brassica tournefortii	African mustard, Sahara mustard		I									I
Bromus rubens	Red brome		I					I				
Bromus tectorum	Cheatgrass		I					I		I		
Cardaria draba	Hoary cress			PNW, RNW				N N N			N	
Centaurea solstitialis	Yellow starthistle			PNW, RNW	NA				N N			
Convolvulus arvensis	Field bindweed			PNW, RGNW	NC				N N		N	
Elaeagnus angustifolia	Russian olive							I				I
Erodium cicutarium	Red stem filaree, Stork's bill		I									
Halogeton glomeratus	Halogeton			PNW, RNW				N				
Onopordum acanthium	Scotch thistle			PNW, RNW	NB			N N N			N	
Portulaca oleracea	Common purslane			PNW, RGNW								

Table 5-1
Noxious and Invasive Weed Species Encountered during Surveys for the LPP Project

Page 2 of 2

Species		USDA[1]	USFWS[2]	State of Arizona[3]	State of Utah[4]	Iron Co., UT	Washington Co., UT	BLM (Arizona Strip)	BLM (St. George)	BLM (Kanab)	BLM (Grand Staircase-Escalante)	Glen Canyon N.R.A.
Scientific Name	**Common Name**											
Salsola tragus[5] Russian	thistle											
Sorghum halepense	Johnsongrass				NA	N				N	N	
Tamarix spp. Tamarisk								N				
Tribulus terrestris	Puncturevine			PNW, RGNW		N		N				
Ulmus pumila	Siberian elm											I

Notes:
[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 considerable concern to land managers

5.2 Weed Occurrence by Ecological System and Anthropogenic Lands

The vegetation community survey conducted in conjunction with the noxious and special status species surveys provided a base of information upon which to analyze the findings of noxious and invasive weed occurrences. The vegetation classification process determined that the LPP project spans three Ecological Regions: Colorado Plateau, Great Basin, and Mohave Desert.

5.2.1 Ecological Systems

Progressing from the broad scale of Ecological Region to a finer scale, ecological systems are the next level with which to categorize vegetation. Ecological systems 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. They are intended to provide a classification system that is readily mappable, often from remote imagery, and readily identifiable by conservation and resource managers in the field (Comer, et al 2003). Within the LPP survey area, 38 ecological systems were identified by the survey team, 15 within the Colorado Plateau, 11 within the Great Basin, and 12 within the Mohave Desert.

The occurrence of noxious and invasive weeds varied greatly between ecological systems within the LPP survey area (Table 5-2). Within the Colorado Plateau Ecological Region, the Colorado Plateau Big Sagebrush Shrubland, the Colorado Plateau Mixed Desert Scrub, and the Colorado Plateau Wash ecological systems each contained 13 of the 18 weed species observed within the survey area, while the lowest occurrence of weed species was documented for the Colorado Plateau Juniper Savanna Ecological System. In the Great Basin Ecological Region, the Great Basin Big Sagebrush Shrubland and the Great Basin Mixed Desert Scrub ecological systems contained the highest number (tied at eight each) of weed species. Four of the ecological systems (Great Basin Active and Stabilized Dune, Great Basin Gambel Oak-Mixed Montane Shrubland, Great Basin Greasewood Flat, and Great Basin Volcanic Rock and Cinder Land) had no observations of noxious weed occurrences. Within the Mohave Desert Ecological Region, the Mohave Desert Lower Montane Riparian Woodland and Shrubland and the Mohave Desert Mixed Desert Scrub ecological systems each had seven noxious weed species. No noxious weed species were detected in the Mohave Desert Pinyon-Juniper Woodland ecological system.

5.2.2 Anthropogenic Lands

In addition to classification of natural and semi-natural plant communities into ecological systems, the survey team classified some areas within the LPP survey area as anthropogenic (impacted by human activity) lands. These areas contain neither natural nor semi-natural plant communities; rather, they include Agricultural Lands, Developed Roads, Developed Lands, areas of Invasive Upland Vegetation (where the original plant community is no longer extant), quarries, reservoirs, and Ruderal Vegetation (occurring where the natural vegetation cover has been disturbed). Anthropogenic lands compose 3,831 acres of the LPP survey area. The largest number of noxious and invasive weed species was found in Invasive Upland vegetation (14), Agricultural Land (13), and Ruderal Vegetation (13). Significant numbers of weed species were also found on Developed Roads and Developed Lands (nine species each).

The concentration of noxious and invasive weeds throughout the LPP survey area is illustrated by Map 5-1 through Map 5-5, where it is clearly shown that highways and roads provide not only the means of transport for weed propagules, but also the disturbed soils upon which they thrive. The greatest concentrations of weeds are also found in relatively close association with population centers.

Table 5-2
Noxious and Invasive Weed Species Occurrences by Ecological System and Anthropogenic Lands
Page 1 of 4

	Acres*	***Aegilops cylindrica***	***Asclepias subverticillata***	***Brassica tournefortii***	***Bromus rubens***	***Bromus tectorum***	***Cardaria draba***	***Centaurea solstitialis***	***Convolvulus arvensis***	***Elaeagnus angustifolia***	***Erodium cicutarium***	***Halogeton glomeratus***	***Onopordum acanthium***	***Portulaca oleracea***	***Salsola tragus***	***Sorghum halepense***	***Tamarix* spp.**	***Tribulus terrestris***	***Ulmus pumila***
Ecological Systems																			
Colorado Plateau Active and Stabilized Dune	840				x	x			x		x				x		x	x	x
Colorado Plateau Big Sagebrush Shrubland	3759 x		x	x	x	x			x x		x	x	x	x	x		x		

Table 5-2
Noxious and Invasive Weed Species Occurrences by Ecological System and Anthropogenic Lands

	Acres*	***Aegilops cylindrica***	***Asclepias subverticillata***	***Brassica tournefortii***	***Bromus rubens***	***Bromus tectorum***	***Cardaria draba***	***Centaurea solstitialis***	***Convolvulus arvensis***	***Elaeagnus angustifolia***	***Erodium cicutarium***	***Halogeton glomeratus***	***Onopordum acanthium***	***Portulaca oleracea***	***Salsola tragus***	***Sorghum halepense***	***Tamarix* spp.**	***Tribulus terrestris***	***Ulmus pumila***
Colorado Plateau Blackbrush-Mormon-tea Shrubland	1828			x		x					x	x		x	x		x	x	
Colorado Plateau Grassland	541				x x						x				x			x	
Colorado Plateau Greasewood Flat	186					x				x	x	x		x	x		x		
Colorado Plateau Gypsum Badland	908				x x				x		x	x			x		x		
Colorado Plateau Juniper Savanna	31			x		x									x				
Colorado Plateau Lower Montane Riparian Woodland and Shrubland	114		x		x x				x x x			x	x	x	x		x		
Colorado Plateau Mixed Bedrock Canyon and Tableland	841				x x						x				x		x	x	x
Colorado Plateau Mixed Desert Scrub	4329		x x		x	x			x x x			x x x			x		x	x	
Colorado Plateau Mixed Low Sagebrush Shrubland	64				x	x					x				x		x		
Colorado Plateau Pinyon-Juniper Woodland	2416			x x		x					x		x	x x			x x		
Colorado Plateau Shrub-Steppe	1920		x		x x						x	x	x	x	x	x	x	x	x
Colorado Plateau Volcanic Rock and Cinder Land	85				x x						x				x				
Colorado Plateau Wash	191		x		x x				x	x	x	x	x	x	x	x	x	x	
Great Basin Active and Stabilized Dune	3																		

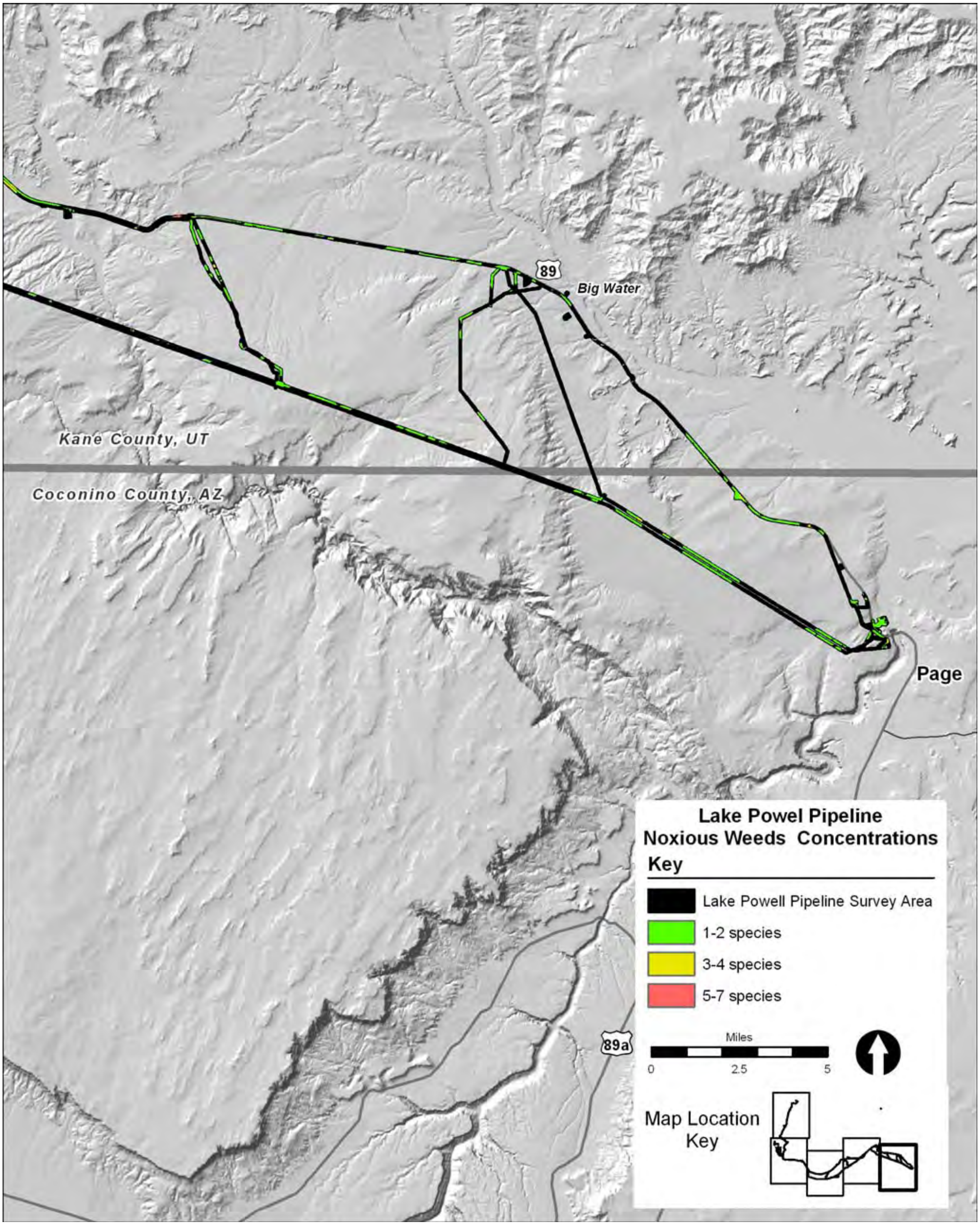
Table 5-2
Noxious and Invasive Weed Species Occurrences by Ecological System and Anthropogenic Lands
Page 3 of 4

	Acres*	***Aegilops cylindrica***	***Asclepias subverticillata***	***Brassica tournefortii***	***Bromus rubens***	***Bromus tectorum***	***Cardaria draba***	***Centaurea solstitialis***	***Convolvulus arvensis***	***Elaeagnus angustifolia***	***Erodium cicutarium***	***Halogeton glomeratus***	***Onopordum acanthium***	***Portulaca oleracea***	***Salsola tragus***	***Sorghum halepense***	***Tamarix* spp.**	***Tribulus terrestris***	***Ulmus pumila***
Great Basin Big Sagebrush Shrubland	360				x	x	x		x		x	x	x		x				
Great Basin Chapparal	39					x													
Great Basin Gambel Oak-Mixed Montane Shrubland	6																		
Great Basin Greasewood Flat	65																		
Great Basin Lower Montane Riparian Woodland and Shrubland	18					x				x					x		x		
Great Basin Mixed Desert Scrub	92		x		x x					x	x	x	x		x				
Great Basin Pinyon-Juniper Woodland	475				x	x			x		x		x		x				
Great Basin Semi-Desert Grassland	3					x					x								
Great Basin Shrub-Steppe	13									x									
Great Basin Volcanic Rock and Cinder Land	2																		
Mohave Desert Active and Stabilized Dune	194				x x						x				x				
Mohave Desert Bedrock Cliff and Outcrop	26				x x														
Mohave Desert Blackbrush-Mormon-tea Shrubland	120			x x		x					x	x					x		
Mohave Desert Creosote-White Bursage Desert Scrub	709			x x		x					x	x			x				

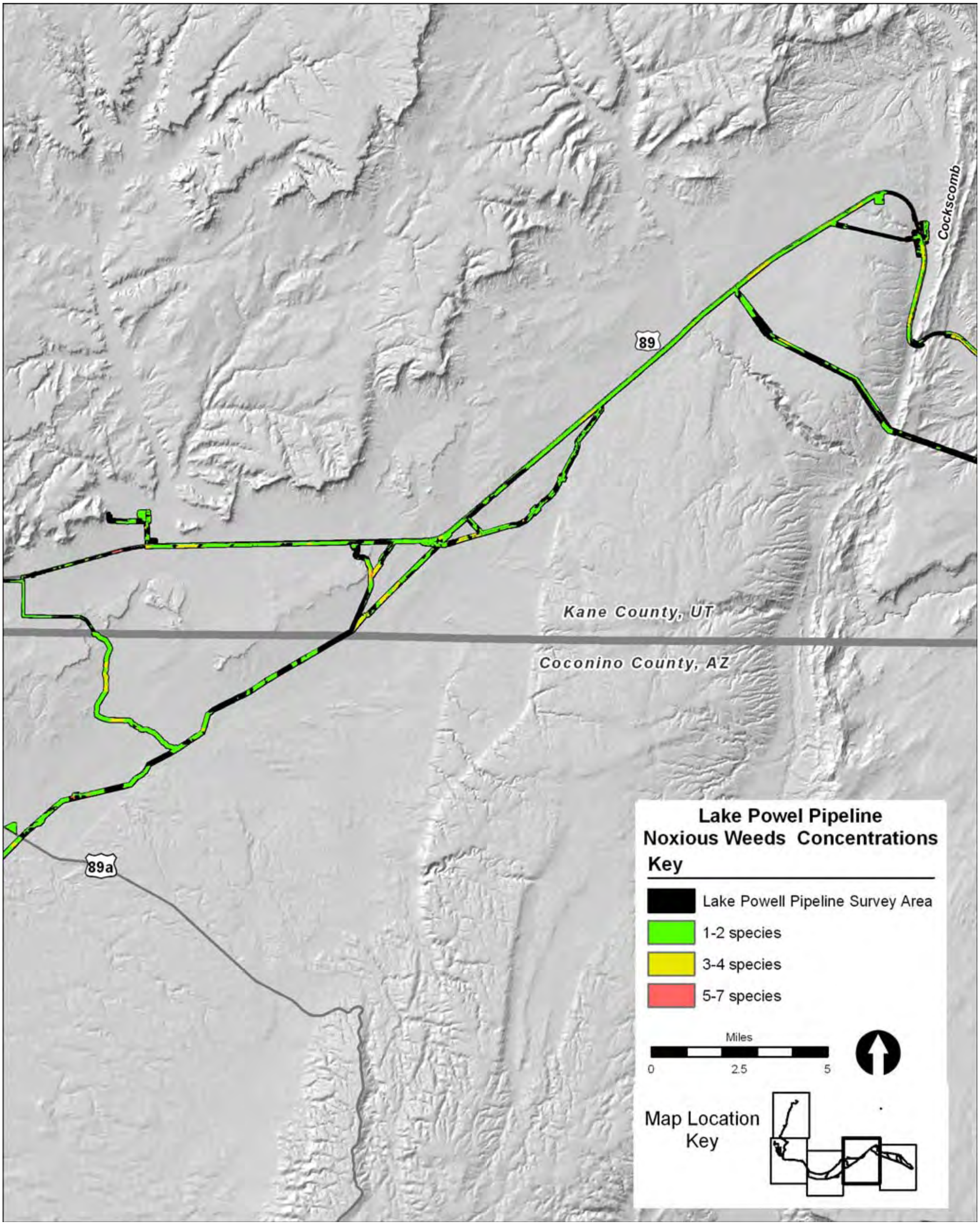
Table 5-2
Noxious and Invasive Weed Species Occurrences by Ecological System and Anthropogenic Lands

	Acres* ***Aegilops cylindrica***	***Asclepias subverticillata***	***Brassica tournefortii***	***Bromus rubens***	***Bromus tectorum***	***Cardaria draba***	***Centaurea solstitialis***	***Convolvulus arvensis***	***Elaeagnus angustifolia***	***Erodium cicutarium***	***Halogeton glomeratus***	***Onopordum acanthium***	***Portulaca oleracea***	***Salsola tragus***	***Sorghum halepense***	***Tamarix* spp.**	***Tribulus terrestris***	***Ulmus pumila***	
Mohave Desert Grassland	40				x x						x				x				
Mohave Desert Gypsum Badland	29				x														
Mohave Desert Lower Montane Riparian Woodland and Shrubland	18				x x				x	x	x				x		x		
Mohave Desert Mixed Desert Scrub	364			x x		x		x			x				x		x		
Mohave Desert Pinyon-Juniper Woodland	5.2.3 3																		
Mohave Desert Shrub-Steppe	249				x	x					x				x				
Mohave Desert Volcanic Rock and Cinder Land	144				x	x					x				x				
Mohave Desert Wash	13				x	x					x								
Anthropogenic Lands Agricultural Land	654		x		x	x	x	x	x	x	x	x		x	x	x	x		
Developed - Road	712				x			x	x		x		x		x		x	x	x
Developed Land	360		x		x	x				x	x			x	x		x	x	
Invasive Upland Vegetation	1157		x	x x		x	x	x	x x		x	x x		x	x		x		
Quarry 48															x				
Reservoir 5																			
Ruderal Vegetation	895		x	x	x	x			x	x	x	x		x	x x x			x	

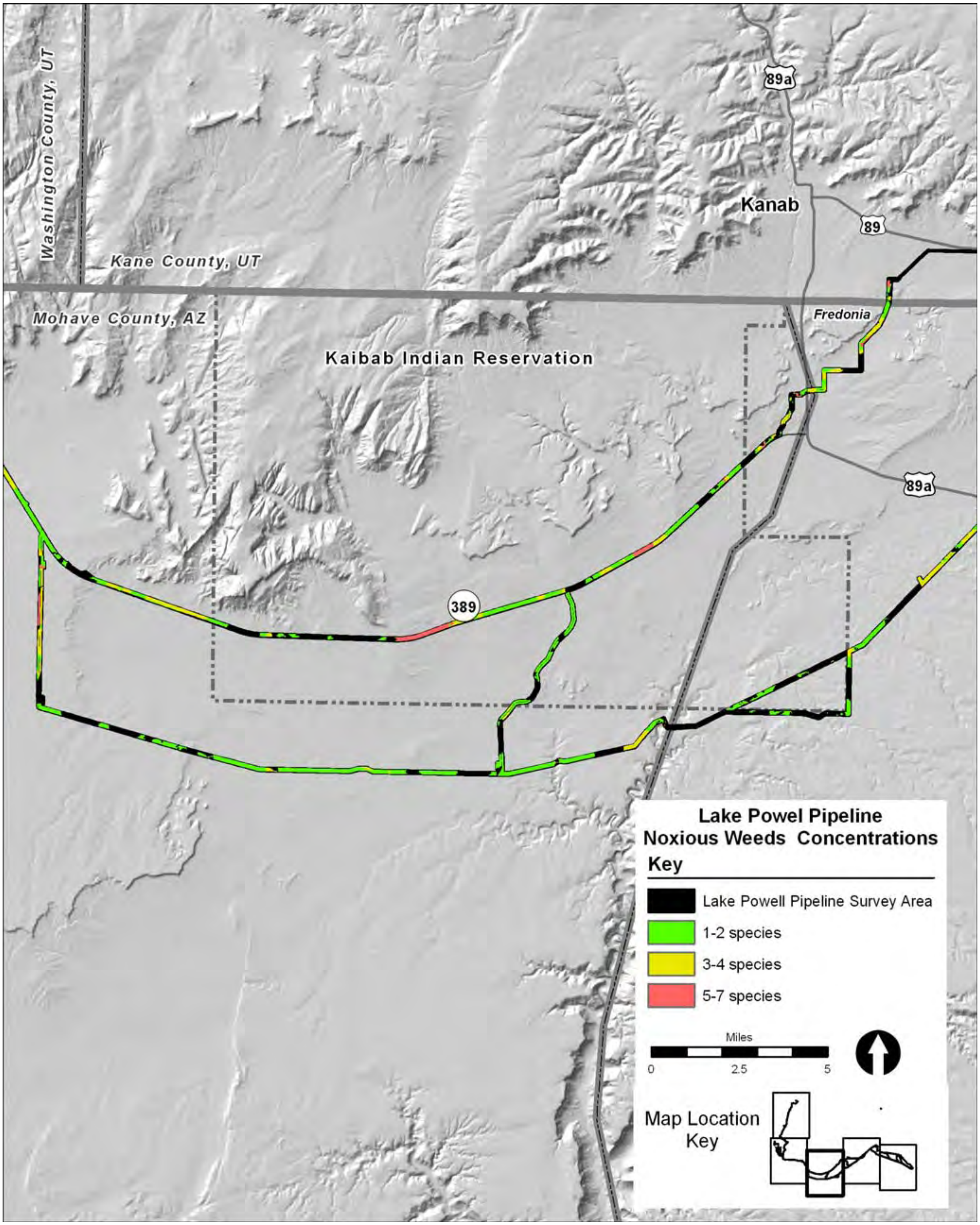
*Total acres for each ecological system in the survey area



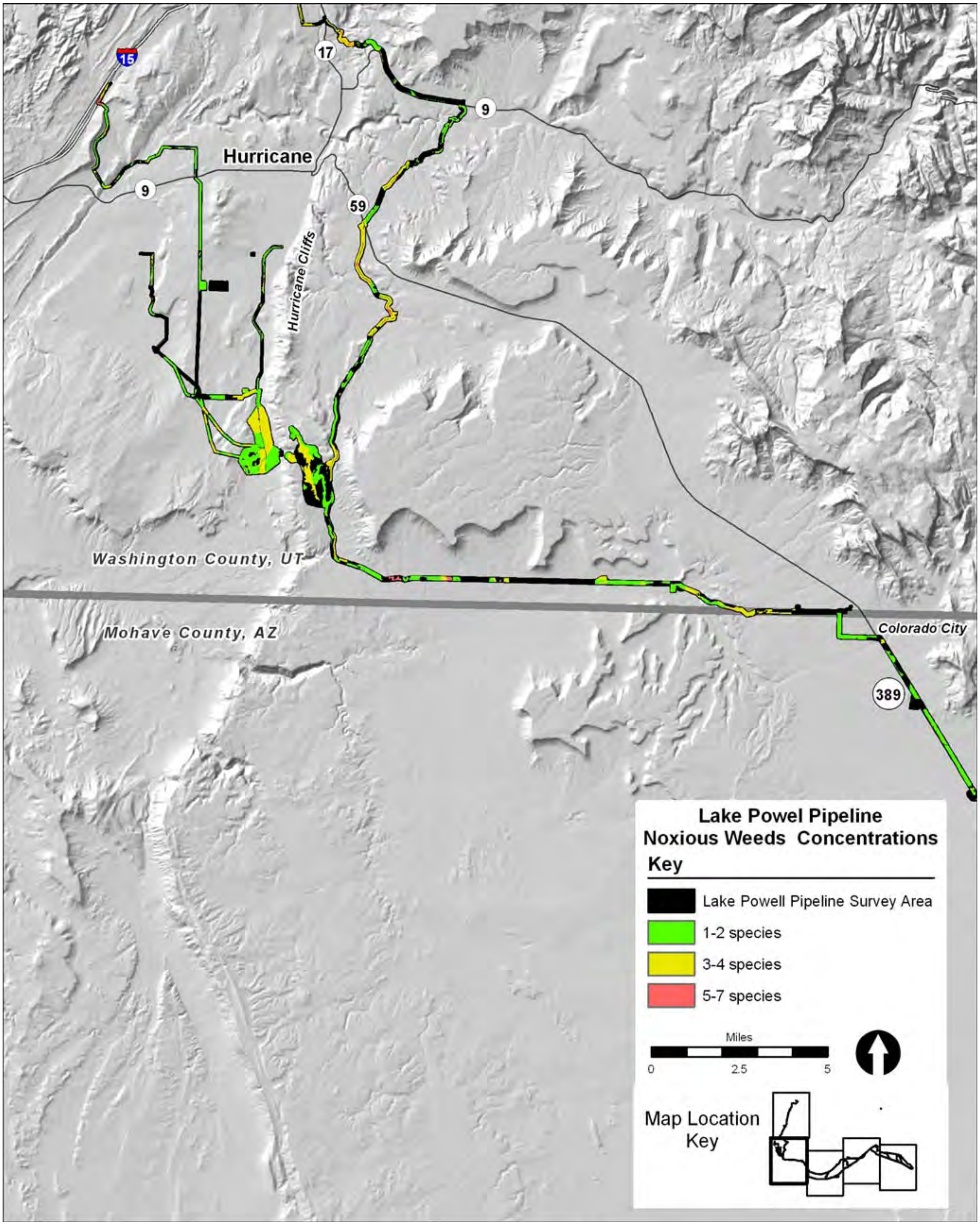
Map 5-1
Noxious Weeds Concentrations Map



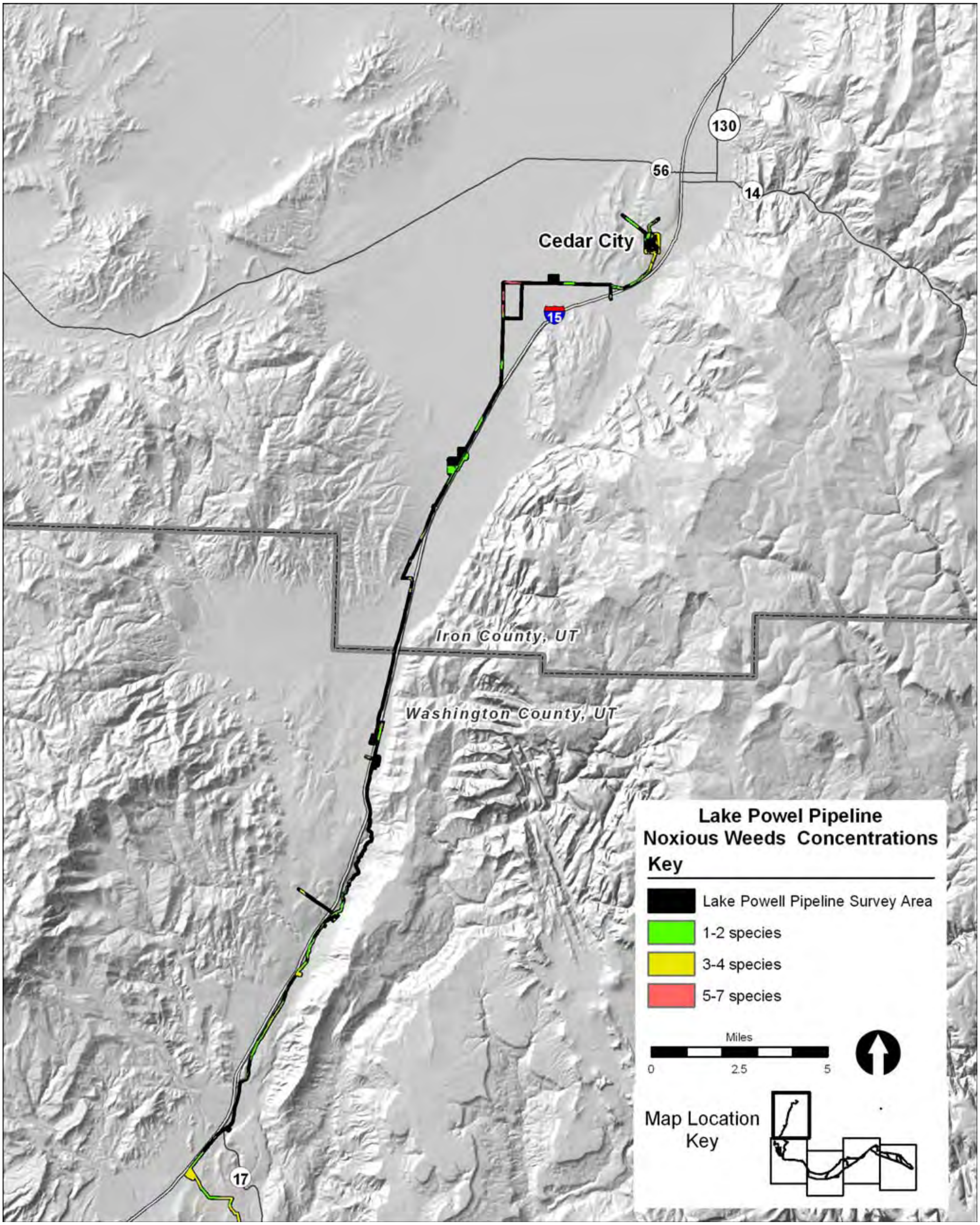
Map 5-2
Noxious Weeds Concentrations Map



Map 5-3
Noxious Weeds Concentrations Map



Map 5-4
Noxious Weeds Concentrations Map



Map 5-5
Noxious Weeds Concentrations Map

5.3 50-meter Transects

5.3.1 Weed Species Occurrences

Five hundred transects measuring 50 meters by 1 meter were established throughout the LPP survey area (Appendix E). All plants within these transects, including noxious and invasive weeds, were counted or otherwise classified according to relative abundance (Table 5-3) for noxious and invasive weeds. Weeds were observed in 309 of the 500 transects. The most occurrences of noxious weeds within the transects were recorded for *Salsola tragus* (199). Other weed species that occurred in numerous transects were: *Bromus tectorum* (108), *Bromus rubens* (84), and *Erodium cicutarium* (84). Occurring in a limited number of transects were *Aegilops cylindrica* (2), *Asclepias subverticillata* (1), *Cardaria draba* (5), *Convolvulus arvensis* (2), *Elaeagnus angustifolia* (1), *Halogeton glomeratus* (3), *Sorghum halepense* (3), *Tamarix* spp. (9), and *Tribulus terrestris* (2). Five of the 18 noxious weed species recorded as occurring in the LPP survey area were not found in the 50-meter transects. Those species included *Brassica tournefortii*, *Centaurea solstitialis*, *Onopordum acanthium*, *Portulaca oleracea*, and *Ulmus pumila*.

5.4 Special Status Plant Species

5.4.1 Weeds in Association with Special Status Plant Species

The broad distribution of noxious weed species across the LPP survey area inevitably resulted in their association with special status plant species. Noxious weeds compete with native species for resources, and of particular concern is their invasion of areas inhabited by special status plant species. *Bromus rubens, B. tectorum, Erodium cicutarium,* and *Salsola tragus* all occurred as co-dominant species in two associations supporting *Camissonia exilis*, a special status species. Despite the broad distribution of *Tamarix* spp., this species was not observed in sufficient abundance to be considered a dominant element in any alliance in which special status species occurred. The occurrences of all other encountered noxious weeds, including *Asclepias subverticillata, Brassica tournefortii, Cardaria draba, Centaurea solstitialis, Convolvulus arvensis, Eleagnus angustifolia, Halogeton glomeratus, Onopordum acanthium, Portulaca oleracea, Sorghum halapense, Tribulus terrestris,* and *Ulmus pulmila*, were more localized and/or sporadic within the survey area; none of these species occurred in sufficient abundance to be considered a dominant member of any vegetation communities supporting special status species.

Table 5-3
Belt Transect Data

Transect Number	LPP Code	Ecological System	*Aegilops cylindrica*	*Asclepias subverticillata*	*Bromus rubens*	*Bromus tectorum*	*Cardaria draba*	*Convolvulus arvensis*	*Elaeagnus angustifolia*	*Erodium cicutarium*	*Halogeton glomeratus*	*Salsola tragus*	*Sorghum halepense*	*Tamarix spp.*	*Tribulus terrestris*
1 L	PP082709TMB3	C.P. Shrub-Steppe													
2 L	PP082709TMB4	C.P. Shrub-Steppe													
3	LPP082709TMC3E	C.P. Blackbrush-Mormon-tea Shrubland													
4	LPP082709TMA3	C.P. Blackbrush-Mormon-tea Shrubland													
5	LPP082709TMC4S	C.P. Blackbrush-Mormon-tea Shrubland													
6 L	PP082709TMB2	C.P. Blackbrush-Mormon tea-Shrubland (outside of survey area)													
7	LPP082709TMC2E	C.P. Mixed Desert Scrub													
8	LPP082709TMA2	C.P. Blackbrush-Mormon-tea Shrubland													
9	LPP082709TMC1E	C.P. Active and Stabilized Dune													
10	LPP082709TMB1	C.P. Mixed Desert Scrub													
11	LPP082709TMA1	C.P. Blackbrush-Mormon-tea Shrubland													
12	LPP082709TMC5E	C.P. Blackbrush-Mormon-tea Shrubland										2			
13	LPP082709TMA4	C.P. Blackbrush-Mormon-tea Shrubland													
14	LPP082709TMC6S	C.P. Blackbrush-Mormon-tea Shrubland										298			
15	LPP082709TMA5	C.P. Blackbrush-Mormon-tea Shrubland													
16	LPP082709TMC7E	C.P. Blackbrush-Mormon-tea Shrubland													
17	LPP082709TMA6	C.P. Active and Stabilized Dune										1			
18	LPP082709TMB5	C.P. Active and Stabilized Dune										2			
19	LPP082809TMC13S	C.P. Blackbrush-Mormon-tea Shrubland													
20 L	PP082809TMC11E	C.P. Mixed Bedrock Canyon and Tableland													
21 L	PP082809TMC10E	C.P. Pinyon-Juniper Woodland													
22 L	PP082809TMC9S	C.P. Shrub-Steppe													
23 L	PP082809TMC8S	C.P. Pinyon-Juniper Woodland													

Table 5-3
Belt Transect Data

Transect Number	LPP Code	Ecological System	*Aegilops cylindrica*	*Asclepias subverticillata*	*Bromus rubens*	*Bromus tectorum*	*Cardaria draba*	*Convolvulus arvensis*	*Elaeagnus angustifolia*	*Erodium cicutarium*	*Halogeton glomeratus*	*Salsola tragus*	*Sorghum halepense*	*Tamarix spp.*	*Tribulus terrestris*
24 L	PP082809TMC7E	C.P. Shrub-Steppe													
25 L	PP082809TMC15E	C.P. Pinyon-Juniper Woodland													
26	LPP082809TMC17S	C.P. Active and Stabilized Dune													
27	LPP082809TMC16S	C.P. Mixed Bedrock Canyon and Tableland													
28 L	PP082909TMA4	C.P. Mixed Bedrock Canyon and Tableland													
29 L	PP082909TMA3	C.P. Pinyon-Juniper Woodland													
30 L	PP082909TMA5	C.P. Pinyon-Juniper Woodland													
31 L	PP082909TMA6	C.P. Pinyon-Juniper Woodland													
32	LPP061910TMB2	Colorado Plateau Pinyon-Juniper Woodland													
33	LPP061910TMB1	Colorado Plateau Pinyon-Juniper Woodland													
34	LPP082909TMA7	C.P. Big Sagebrush Shrubland													
35 L	PP082909TMA8	C.P. Pinyon-Juniper Woodland													
36 L	PP082909TMA9	C.P. Pinyon-Juniper Woodland													
37 L	PP082809TMA18	C.P. Pinyon-Juniper Woodland				R									
38 L	PP082809TMA17	C.P. Pinyon-Juniper Woodland										8			
39 L	PP082809TMA16	C.P. Pinyon-Juniper Woodland													
40	LPP082809TMA15	C.P. Big Sagebrush Shrubland										1			
41 L	PP082809TMC14S	C.P. Pinyon-Juniper Woodland													
42 L	PP082809TMC12S	C.P. Pinyon-Juniper Woodland													
43	LPP082809TMC6	C.P. Blackbrush-Mormon-tea Shrubland													
44 L	PP082809TMC5	C.P. Shrub-Steppe													
45 L	PP082809TMC3	C.P. Pinyon-Juniper Woodland													
46 L	PP082809TMC2	C.P. Shrub-Steppe													
47 L	PP082809TMC1	C.P. Shrub-Steppe													

Table 5-3
Belt Transect Data

Transect Number	LPP Code	Ecological System	*Aegilops cylindrica*	*Asclepias subverticillata*	*Bromus rubens*	*Bromus tectorum*	*Cardaria draba*	*Convolvulus arvensis*	*Elaeagnus angustifolia*	*Erodium cicutarium*	*Halogeton glomeratus*	*Salsola tragus*	*Sorghum halepense*	*Tamarix spp.*	*Tribulus terrestris*
48	LPP082709TMC8S	C.P. Active and Stabilized Dune										1[a]			
49	LPP082709TMA7	C.P. Blackbrush-Mormon-tea Shrubland													
50	LPP082709TMC9S	C.P. Blackbrush-Mormon-tea Shrubland								1		3			
51	LPP082709TMA8	C.P. Blackbrush-Mormon-tea Shrubland										55			
52	LPP082709TMC10	C.P. Blackbrush-Mormon-tea Shrubland													
53	LPP082709TMA9	C.P. Blackbrush-Mormon-tea Shrubland										4			
54	LPP082709TMC11E	C.P. Active and Stabilized Dune										72			
55	LPP082709TMA10	C.P. Active and Stabilized Dune										651			
56	LPP082709TMC12S	C.P. Blackbrush-Mormon-tea Shrubland										441			
57	LPP082709TMA11	C.P. Blackbrush-Mormon-tea Shrubland										14			
58	LPP082709TMC13E	C.P. Blackbrush-Mormon-tea Shrubland										19			
59	LPP082709TMA12	C.P. Mixed Desert Scrub										138			
60 L	PP082709TMC14E	C.P. Wash[b]												10	
61 L	PP082709TMA13	C.P. Greasewood Flat										3			
62	LPP082709TMC15S	C.P. Blackbrush-Mormon-tea Shrubland										104			
63	LPP082709TMA14	C.P. Mixed Desert Scrub										90			
64 L	PP082709TMC16E	C.P. Greasewood Flat										42			
65 L	PP082709TMA15	C.P. Wash							3			52	P		
66	LPP082709TMC17E	C.P. Blackbrush-Mormon-tea Shrubland				P[a]									
67 L	PP082809TMA1	C.P. Shrub-Steppe										39	2		
68 L	PP082809TMA2	C.P. Shrub-Steppe										21			
69 L	PP082809TMA3	C.P. Pinyon-Juniper Woodland													
70 L	PP060710TME2	Colorado Plateau Active and Stabilized Dune													

Table 5-3
Belt Transect Data

Transect Number	LPP Code	Ecological System	*Aegilops cylindrica*	*Asclepias subverticillata*	*Bromus rubens*	*Bromus tectorum*	*Cardaria draba*	*Convolvulus arvensis*	*Elaeagnus angustifolia*	*Erodium cicutarium*	*Halogeton glomeratus*	*Salsola tragus*	*Sorghum halepense*	*Tamarix spp.*	*Tribulus terrestris*
71 L	PP060710TMB2	Colorado Plateau Mixed Bedrock Canyon and Tableland													
72	LPP082809TMA4	C.P. Active and Stabilized Dune				C						5			
73 L	PP082809TMA8	C.P. Pinyon-Juniper Woodland				C						C			
74	LPP082809TMA7	C.P. Big Sagebrush Shrubland													
75	LPP060710TMB1	Colorado Plateau Wash				5						2			
76	LPP060710TME1	Colorado Plateau Pinyon-Juniper Woodland													
77 L	PP082809TMA5	C.P. Pinyon-Juniper Woodland													
78	LPP082809TMA6	Invasive Upland Vegetation				A						A			
79 L	PP082809TMA9	C.P. Pinyon-Juniper Woodland													
80	LPP082809TMA10	C.P. Big Sagebrush Shrubland													
81 L	PP082909TMA11	C.P. Pinyon-Juniper Woodland													
82 L	PP082909TMA10	C.P. Pinyon-Juniper Woodland													
83	LPP082809TMA11	C.P. Big Sagebrush Shrubland										28			
84	LPP082809TMA12	C.P. Big Sagebrush Shrubland													
85	LPP082809TMA13	C.P. Big Sagebrush Shrubland										48			
86	LPP082809TMA14	C.P. Big Sagebrush Shrubland													
87	LPP082809TMA19	C.P. Big Sagebrush Shrubland								C		13			
88	LPP082809TMA20	C.P. Big Sagebrush Shrubland													
89	LPP082809TMA21	C.P. Big Sagebrush Shrubland													
90	LPP060710TMD2	Colorado Plateau Big Sagebrush Shrubland													
91	LPP060710TMD3	Colorado Plateau Pinyon-Juniper Woodland													
92	LPP060710TMD4	Colorado Plateau Pinyon-Juniper Woodland													
93	LPP060710TMD5	Colorado Plateau Pinyon-Juniper Woodland													

Table 5-3
Belt Transect Data

Transect Number	LPP Code	Ecological System	*Aegilops cylindrica*	*Asclepias subverticillata*	*Bromus rubens*	*Bromus tectorum*	*Cardaria draba*	*Convolvulus arvensis*	*Elaeagnus angustifolia*	*Erodium cicutarium*	*Halogeton glomeratus*	*Salsola tragus*	*Sorghum halepense*	*Tamarix spp.*	*Tribulus terrestris*
94 L	PP082809TMA22	C.P. Pinyon-Juniper Woodland													
95	LPP060710TMD6	Colorado Plateau Big Sagebrush Shrubland				5									
96 L	PP082809TMA23	C.P. Pinyon-Juniper Woodland													
97	LPP060710TMD1	Colorado Plateau Big Sagebrush Shrubland													
98	LPP060510TMD4	Colorado Plateau Big Sagebrush Shrubland													
99	LPP060510TMD1	Colorado Plateau Big Sagebrush Shrubland			1										
100	LPP060210TMA1	Colorado Plateau Gypsum Badlands													
101	LPP060210TMB2	Colorado Plateau Gypsum Badlands													
102	LPP060210C2	Colorado Plateau Big Sagebrush Shrubland													
103	LPP060210TMA2	Colorado Plateau Gypsum Badlands													
104	LPP060210TMB1	Colorado Plateau Gypsum Badlands													
105	LPP060510TMD2	Colorado Plateau Gypsum Badlands													
106	LPP060210C1	Colorado Plateau Big Sagebrush Shrubland													
107	LPP060510TMD3	Colorado Plateau Gypsum Badlands													
108	LPP082909TMA2	C.P. Big Sagebrush Shrubland										5			
109	LPP082909TMA1	Invasive Upland Vegetation								A		A			
110	LPP082909TMA12	C.P. Big Sagebrush Shrubland				C						87			
111	LPP082909TMA13	Invasive Upland Vegetation										A			
112 L	PP082909TMB1	Ruderal Vegetation													
113	LPP082909TMc1S	C.P. Big Sagebrush Shrubland													
114	LPP082909TMA14	C.P. Big Sagebrush Shrubland										1			
115	LPP082909TMB2	C.P. Big Sagebrush Shrubland										10			
116	LPP082909TMc2S	Ruderal Vegetation										13			
117	LPP082909TMA15	Developed - Road										8			

Table 5-3
Belt Transect Data

Transect Number	LPP Code	Ecological System	*Aegilops cylindrica*	*Asclepias subverticillata*	*Bromus rubens*	*Bromus tectorum*	*Cardaria draba*	*Convolvulus arvensis*	*Elaeagnus angustifolia*	*Erodium cicutarium*	*Halogeton glomeratus*	*Salsola tragus*	*Sorghum halepense*	*Tamarix spp.*	*Tribulus terrestris*
118	LPP082909TMB3	C.P. Big Sagebrush Shrubland										A			
119	LPP082909TMc3S	C.P. Big Sagebrush Shrubland	C									A			
120	LPP082909TMA16	C.P. Big Sagebrush Shrubland										1			
121	LPP082909TMc4E	C.P. Pinyon-Juniper Woodland				C				A		A			
122 L	PP082909TMB4	C.P. Pinyon-Juniper Woodland													
123 L	PP082909TMA17	C.P. Pinyon-Juniper Woodland													
124 L	PP082909TMc6S	C.P. Pinyon-Juniper Woodland													
125 L	PP082909TMB6	C.P. Pinyon-Juniper Woodland													
126	LPP082909TMc5S	C.P. Big Sagebrush Shrubland	6									A			
127 L	PP082909TMB5	Ruderal Vegetation										A			5
128	LPP061810TMB1	Colorado Plateau Mixed Desert Scrub				4				2		55			
129	LPP083009TMB3	C.P. Mixed Desert Scrub										55			
130	LPP061810TMA1	Colorado Plateau Mixed Desert Scrub				525						1650			
131	LPP083009TMB2	C.P. Mixed Desert Scrub										A			
132 L	PP083009TMB1	C.P. Pinyon-Juniper Woodland													
133	LPP083009TMB4	C.P. Gypsum Badlands													
134	LPP083009TMB5	C.P. Big Sagebrush Shrubland													
135	LPP083009TMc1E	Invasive Upland Vegetation										A			
136	LPP083009TMA1	Invasive Upland Vegetation										A			
137	LPP082909TMc15E	C.P. Mixed Desert Scrub				4				C		38			
138 L	PP082909TMB15 C.	P. Mixed Desert Scrub										A			
139 L	PP082909TMB11 C.	P. Gypsum Badlands										5			
140 L	PP082909TMc14E	C.P. Greasewood Flat										2			
141 L	PP082909TMB14 C.	P. Greasewood Flat													

Table 5-3
Belt Transect Data

Transect Number	LPP Code	Ecological System	*Aegilops cylindrica*	*Asclepias subverticillata*	*Bromus rubens*	*Bromus tectorum*	*Cardaria draba*	*Convolvulus arvensis*	*Elaeagnus angustifolia*	*Erodium cicutarium*	*Halogeton glomeratus*	*Salsola tragus*	*Sorghum halepense*	*Tamarix spp.*	*Tribulus terrestris*
142	LPP082909TMC12S	C.P. Gypsum Badlands													
143	LPP082909TMB12	C.P. Big Sagebrush Shrubland													
144 L	PP082909TMc13E	C.P. Shrub-Steppe										2			
145 L	PP082909TMB13 C.	P. Shrub-Steppe													
146	LPP082909TMB10	C.P. Big Sagebrush Shrubland													
147	LPP082909TMc10S	C.P. Big Sagebrush Shrubland													
148	LPP082909TMc9E	Invasive Upland Vegetation										A			
149	LPP082909TMB9	C.P. Big Sagebrush Shrubland										A			
150	LPP082909TMc7S	C.P. Big Sagebrush Shrubland										16			
151	LPP082909TMc8S	C.P. Big Sagebrush Shrubland										14			
152	LPP082909TMB7	C.P. Big Sagebrush Shrubland										6			
153	LPP082909TMB8	C.P. Big Sagebrush Shrubland										A			
154	LPP083009TMA2	C.P. Big Sagebrush Shrubland													
155	LPP083009TMc2E	C.P. Big Sagebrush Shrubland													
156	LPP083009TMA3	C.P. Big Sagebrush Shrubland										C			
157	LPP083009TMc3E	C.P. Mixed Desert Scrub										O			
158	LPP061710TMA1	Colorado Plateau Mixed Desert Scrub										350			
159 L	PP061710TMC1	Invasive Upland Vegetation										8000			
160	LPP083009TMA4	Invasive Upland Vegetation										A			
161 L	PP083009TMc4S	Invasive Upland Vegetation										C			
162	LPP083009TMA5	C.P. Mixed Desert Scrub										87		2	
163	LPP083009TMc5S	C.P. Mixed Desert Scrub										C		8	
164 L	PP061710TMB1	Invasive Upland Vegetation										1450			
165	LPP083109TMA1	C.P. Big Sagebrush Shrubland										5			

Table 5-3
Belt Transect Data

Transect Number	LPP Code	Ecological System	*Aegilops cylindrica*	*Asclepias subverticillata*	*Bromus rubens*	*Bromus tectorum*	*Cardaria draba*	*Convolvulus arvensis*	*Elaeagnus angustifolia*	*Erodium cicutarium*	*Halogeton glomeratus*	*Salsola tragus*	*Sorghum halepense*	*Tamarix spp.*	*Tribulus terrestris*
166	LPP083109TMc1E	C.P. Big Sagebrush Shrubland													
167	LPP083109TMA2	C.P. Mixed Desert Scrub										A			
168	LPP083109TMc2S	C.P. Mixed Desert Scrub										A			
169 L	PP083109TMc3S	C.P. Shrub-Steppe										O			
170 L	PP083109TMA3	C.P. Shrub-Steppe										O			
171 L	PP083109TMA4	C.P. Shrub-Steppe										C			
172 L	PP083109TMc4E	C.P. Shrub-Steppe										O			
173	LPP083109TMA5	C.P. Big Sagebrush Shrubland													
174	LPP083109TMc5S	C.P. Big Sagebrush Shrubland													
175	LPP083109TMA6	C.P. Big Sagebrush Shrubland													
176	LPP083109TMc6E	C.P. Big Sagebrush Shrubland													
177	LPP083009TMB6	C.P. Big Sagebrush Shrubland													
178 L	PP083009TMB7	C.P. Big Sagebrush Shrubland (outside of survey area)													
179	LPP083009TMB8	C.P. Mixed Desert Scrub													
180 L	PP083009TMB10 C.	P. Mixed Desert Scrub													
181	LPP083009TMB9	C.P. Mixed Desert Scrub										A			
182	LPP083009TMB11	C.P. Big Sagebrush Shrubland													
183	LPP083009TMB12	C.P. Big Sagebrush Shrubland										3			
184	LPP083009TMB13	C.P. Big Sagebrush Shrubland													
185 L	PP091009TMA5	C.P. Shrub-Steppe													
186 L	PP091009TMc5E	C.P. Shrub-Steppe													
187 L	PP091009TMB2	C.P. Shrub-Steppe													
188 L	PP091009TMA4	C.P. Shrub-Steppe													

Table 5-3
Belt Transect Data

Transect Number	LPP Code	Ecological System	*Aegilops cylindrica*	*Asclepias subverticillata*	*Bromus rubens*	*Bromus tectorum*	*Cardaria draba*	*Convolvulus arvensis*	*Elaeagnus angustifolia*	*Erodium cicutarium*	*Halogeton glomeratus*	*Salsola tragus*	*Sorghum halepense*	*Tamarix spp.*	*Tribulus terrestris*
189 L	PP091009TMc4S	C.P. Shrub-Steppe													
190	LPP091009TMA3	C.P. Big Sagebrush Shrubland													
191	LPP091009TMc3S	C.P. Big Sagebrush Shrubland													
192	LPP091009TMA2	C.P. Big Sagebrush Shrubland													
193	LPP091009TMc2S	C.P. Big Sagebrush Shrubland													
194	LPP091009TMc1E	C.P. Big Sagebrush Shrubland													
195	LPP091009TMA1	C.P. Big Sagebrush Shrubland										2			
196	LPP091009TMB1	C.P. Big Sagebrush Shrubland													
197 L	PP083109TMc11E	C.P. Shrub-Steppe													
198 L	PP083109TMA11	C.P. Shrub-Steppe										C			
199 L	PP083109TMA12	C.P. Grassland										C			
200 L	PP083109TMc12S	C.P. Grassland										A			
201 L	PP083109TMA13	C.P. Grassland										A			
202 L	PP083109TMc13E	C.P. Grassland										C			
203 L	PP083109TMA14	C.P. Grassland										O			
204 L	PP083109TMc14E	C.P. Grassland													
205 L	PP083109TMA20	C.P. Grassland										A			
206 L	PP083109TMc20E	C.P. Shrub-Steppe										C			
207	LPP083109TMA19	C.P. Mixed Desert Scrub										C			
208	LPP083109TMc19S	C.P. Mixed Desert Scrub										C			
209	LPP083109TMA18	C.P. Mixed Desert Scrub										C			
210	LPP083109TMc18E	C.P. Mixed Desert Scrub				19						C			
211 L	PP083109TMA17	C.P. Greasewood Flat									42	83			
212 L	PP083109TMc17S	C.P. Greasewood Flat										C			

Table 5-3
Belt Transect Data

Transect Number	LPP Code	Ecological System	*Aegilops cylindrica*	*Asclepias subverticillata*	*Bromus rubens*	*Bromus tectorum*	*Cardaria draba*	*Convolvulus arvensis*	*Elaeagnus angustifolia*	*Erodium cicutarium*	*Halogeton glomeratus*	*Salsola tragus*	*Sorghum halepense*	*Tamarix spp.*	*Tribulus terrestris*
213	LPP083109TMc16E	C.P. Mixed Desert Scrub										P			
214	LPP083109TMA16	C.P. Mixed Desert Scrub										A			
215	LPP083109TMc15E	C.P. Mixed Desert Scrub										A			
216	LPP083109TMA15	C.P. Mixed Desert Scrub										A			
217 L	PP083109TMB13 C.	P. Shrub-Steppe								P		C-A			
218 L	PP083109TMB12	C.P. Pinyon-Juniper Woodland (outside of survey area)													
219 L	PP083109TMB11	C.P. Blackbrush-Mormon-tea Shrubland (outside of survey area)								A		C			
220	LPP083109TMB10	C.P. Shrub-Steppe (outside of survey area)													
221 L	PP083109TMB9	C.P. Mixed Desert Scrub (outside of survey area)										C			1
222	LPP083109TMB8	C.P. Shrub-Steppe (outside of survey area)								C		C			
223	LPP083109TMB5	C.P. Mixed Desert Scrub													
224	LPP083109TMB4	C.P. Mixed Desert Scrub													
225	LPP083109TMB6	C.P. Mixed Desert Scrub				O				A		1			
226	LPP083109TMB7	C.P. Blackbrush-Mormon-tea Shrubland			P	P				P					
227	LPP083009TMc11E	C.P. Mixed Desert Scrub										P			
228	LPP083009TMA11	C.P. Big Sagebrush Shrubland										4			
229	LPP083009TMc10S	C.P. Mixed Desert Scrub				7						C			
230 L	PP083009TMA10	C.P. Wash										A			
231	LPP083009TMc9S	C.P. Big Sagebrush Shrubland													
232	LPP083009TMA9	C.P. Big Sagebrush Shrubland													
233	LPP083009TMc12S	Invasive Upland Vegetation										C			
234	LPP083009TMA12	C.P. Big Sagebrush Shrubland										37			

Table 5-3
Belt Transect Data

Transect Number	LPP Code	Ecological System	*Aegilops cylindrica*	*Asclepias subverticillata*	*Bromus rubens*	*Bromus tectorum*	*Cardaria draba*	*Convolvulus arvensis*	*Elaeagnus angustifolia*	*Erodium cicutarium*	*Halogeton glomeratus*	*Salsola tragus*	*Sorghum halepense*	*Tamarix spp.*	*Tribulus terrestris*
235	LPP083009TMA13	C.P. Mixed Desert Scrub										C			
236	LPP083009TMc13E	C.P. Mixed Desert Scrub				2				C		C			
237	LPP083009TMc14E	C.P. Mixed Desert Scrub				1				C		P			
238	LPP083009TMA14	C.P. Mixed Desert Scrub				28						C-A			
239	LPP083009TMA8	C.P. Gypsum Badlands													
240	LPP083009TMc8E	C.P. Gypsum Badlands													
241	LPP062210TMB50	Colorado Plateau Gypsum Badlands				36									
242	LPP062210TMG1	Colorado Plateau Gypsum Badlands													
243	LPP083009TMc7E	C.P. Mixed Desert Scrub				6						A			
244 L	PP083009TMA7	C.P. Greasewood Flat										C-A			
245 L	PP083009TMc6E	C.P. Greasewood Flat										C			
246 L	PP083009TMA6	C.P. Greasewood Flat										3			
247 L	PP091009TMc11E	C.P. Greasewood Flat													
248	LPP091009TMA11	C.P. Gypsum Badlands										O			
249	LPP090909TMB7	C.P. Gypsum Badlands										3			
250	LPP090909TMA15	C.P. Gypsum Badlands													
251	LPP090909Tmc15E	C.P. Gypsum Badlands													
252 L	PP091009TMC6S	Ruderal Vegetation				12						A			
253	LPP091009TMA6	Invasive Upland Vegetation										O			
254	LPP091009TMB4	C.P. Gypsum Badlands													
255	LPP091009TMB3	C.P. Gypsum Badlands													
256 L	PP090909TMB6	C.P. Shrub-Steppe				13						75			
257	LPP090809TMA3	C.P. Gypsum Badlands													
258	LPP090809TMA2	C.P. Gypsum Badlands													

Table 5-3
Belt Transect Data

Transect Number	LPP Code	Ecological System	*Aegilops cylindrica*	*Asclepias subverticillata*	*Bromus rubens*	*Bromus tectorum*	*Cardaria draba*	*Convolvulus arvensis*	*Elaeagnus angustifolia*	*Erodium cicutarium*	*Halogeton glomeratus*	*Salsola tragus*	*Sorghum halepense*	*Tamarix spp.*	*Tribulus terrestris*
259	LPP090809TMc2E	C.P. Gypsum Badlands													
260	LPP090809TMA1	C.P. Gypsum Badlands													
261	LPP090809TMc1	C.P. Gypsum Badlands													
262	LPP090809TMc3S	C.P. Gypsum Badlands													
263 L	PP090809TMA4	C.P. Gypsum Badlands (outside of survey area)[c]													
264 L	PP090809TMA5	C.P. Gypsum Badlands (outside of survey area)										30			
265 L	PP090809TMA6	C.P. Gypsum Badlands (outside of survey area)										1			
266	LPP090909TMB3	C.P. Gypsum Badlands				24						26			
267	LPP090909TMB4	C.P. Gypsum Badlands				20				2		7			
268	LPP090909TMB5	C.P. Gypsum Badlands										15			
269	LPP090909TMB1	C.P. Gypsum Badlands										6			
270 L	PP090809TMA7	C.P. Shrub-Steppe										18			
271	LPP090809TMc4E	C.P. Mixed Desert Scrub													
272	LPP090909TMB2	C.P. Gypsum Badlands													
273	LPP090909TMc8E	C.P. Mixed Desert Scrub										44			
274	LPP090909TMA8	C.P. Big Sagebrush Shrubland													
275	LPP090909TMc7E	C.P. Gypsum Badlands													
276	LPP090909TMA7	C.P. Gypsum Badlands													
277	LPP090909TMc6E	C.P. Gypsum Badlands													
278	LPP090909TMA6	C.P. Gypsum Badlands													
279 L	PP090909TMA5	C.P. Lower Montane Riparian Woodland and Shrubland				14						2		9	
280	LPP090909TMc5E	C.P. Active and Stabilized Dune				1									

Table 5-3
Belt Transect Data

Transect Number	LPP Code	Ecological System	*Aegilops cylindrica*	*Asclepias subverticillata*	*Bromus rubens*	*Bromus tectorum*	*Cardaria draba*	*Convolvulus arvensis*	*Elaeagnus angustifolia*	*Erodium cicutarium*	*Halogeton glomeratus*	*Salsola tragus*	*Sorghum halepense*	*Tamarix spp.*	*Tribulus terrestris*
281	LPP090909TMc4E	C.P. Gypsum Badlands													
282	LPP090909TMA4	C.P. Gypsum Badlands													
283	LPP090909TMc3E	C.P. Gypsum Badlands													
284	LPP090909TMA3	C.P. Gypsum Badlands													
285	LPP090909TMA2	C.P. Gypsum Badlands									3	71			
286	LPP090909TMc2E	C.P. Gypsum Badlands									1	41		6	
287	LPP090909TMc1S	C.P. Gypsum Badlands													
288	LPP090909TMA1	C.P. Gypsum Badlands										49			
289	LPP090909TMA9	C.P. Mixed Desert Scrub										18			
290 L	PP090909TMc9S	C.P. Shrub-Steppe		1											
291 L	PP090909TMc10E	C.P. Pinyon-Juniper Woodland													
292 L	PP090909TMA10	C.P. Pinyon-Juniper Woodland													
293 L	PP090909TMA11	C.P. Pinyon-Juniper Woodland										3			
294 L	PP090909TMC11 Ruder	al Vegetation				2						38			
295 L	PP090909TMA12	C.P. Pinyon-Juniper Woodland													
296 L	PP090909Tmc12S	C.P. Pinyon-Juniper Woodland				A						26			
297	LPP090909Tmc13E	C.P. Mixed Desert Scrub				1						A			
298 L	PP090909TMA13	C.P. Shrub-Steppe										38			
299 L	PP090909TMA14	C.P. Shrub-Steppe										A			
300 L	PP090909Tmc14S	C.P. Shrub-Steppe				A						A			
301 L	PP083109TMB1	C.P. Shrub-Steppe										2			
302 L	PP083109TMB3	C.P. Pinyon-Juniper Woodland													
303	LPP083109TMB2	C.P. Blackbrush-Mormon-tea Shrubland													
304 L	PP083109TMc10E	C.P. Shrub-Steppe				P						C			

Table 5-3
Belt Transect Data

Transect Number	LPP Code	Ecological System	*Aegilops cylindrica*	*Asclepias subverticillata*	*Bromus rubens*	*Bromus tectorum*	*Cardaria draba*	*Convolvulus arvensis*	*Elaeagnus angustifolia*	*Erodium cicutarium*	*Halogeton glomeratus*	*Salsola tragus*	*Sorghum halepense*	*Tamarix spp.*	*Tribulus terrestris*
305 L	PP083109TMA10	C.P. Shrub-Steppe										C			
306	LPP083109TMc9E	C.P. Gypsum Badlands										O			
307	LPP083109TMA9	C.P. Gypsum Badlands										8			
308	LPP083109TMc8E	C.P. Mixed Low Sagebrush Shrubland				1						4			
309	LPP083109TMA8	C.P. Mixed Low Sagebrush Shrubland										6			
310	LPP083109TMA7	C.P. Mixed Desert Scrub										C			
311	LPP083109TMc7S	C.P. Mixed Desert Scrub				10						C			
312	LPP091009TMc9E	C.P. Mixed Desert Scrub										A			
313	LPP091009TMA9	C.P. Mixed Low Sagebrush Shrubland										C			
314	LPP091009TMA10	C.P. Active and Stabilized Dune										C-A		3	
315	LPP091009TMc10E	C.P. Mixed Desert Scrub				1						A			
316	LPP091009TMc8S	C.P. Mixed Desert Scrub										13			
317	LPP091009TMA8	C.P. Mixed Desert Scrub				O						65			
318	LPP091009TMA7	C.P. Mixed Desert Scrub				42						2			
319	LPP091009TMc7E	C.P. Mixed Desert Scrub				6									
320	LPP083109TMB16	C.P. Big Sagebrush Shrubland				P									
321 L	PP083109TMB15 C.	P. Mixed Desert Scrub													
322 L	PP083109TMB14 C.	P. Pinyon-Juniper Woodland													
323 L	PP083109TMB19 C.	P. Pinyon-Juniper Woodland													
324 L	PP083109TMB18 Devel	oped- Road								A		A			
325 L	PP083109TMB17 C.	P. Mixed Desert Scrub			O					A		A			
326	LPP062210TMB2	Colorado Plateau Mixed Desert Scrub				1250				53		20			
327	LPP062210TMB1	Colorado Plateau Mixed Desert Scrub				700				25		50			
328	LPP091109TMB2	C.P. Mixed Desert Scrub				22						7			

Table 5-3
Belt Transect Data

Transect Number	LPP Code	Ecological System	*Aegilops cylindrica*	*Asclepias subverticillata*	*Bromus rubens*	*Bromus tectorum*	*Cardaria draba*	*Convolvulus arvensis*	*Elaeagnus angustifolia*	*Erodium cicutarium*	*Halogeton glomeratus*	*Salsola tragus*	*Sorghum halepense*	*Tamarix spp.*	*Tribulus terrestris*
329 L	PP091109TMB1	C.P. Shrub-Steppe										3			
330 L	PP082509TMB20 C.	P. Shrub-Steppe										3			
331 L	PP082509TMA21	C.P. Pinyon-Juniper Woodland													
332 L	PP082509TMB19 C.	P. Mixed Desert Scrub													
333	LPP082509TMA20	C.P. Mixed Desert Scrub													
334	LPP082509TMA19	C.P. Mixed Desert Scrub													
335 L	PP082509TMB18 C.	P. Mixed Desert Scrub													
336 L	PP082509TMA18	C.P. Pinyon-Juniper Woodland													
337 L	PP082509TMB17 C.	P. Pinyon-Juniper Woodland				P									
338 L	PP090109TMc6E	C.P. Pinyon-Juniper Woodland													
339 L	PP090109TMA6	C.P. Pinyon-Juniper Woodland (outside of survey area)													
340 L	PP082509TMA17	C.P. Pinyon-Juniper Woodland (but mostly outside of survey area)													
341 L	PP082509TMB16 C.	P. Pinyon-Juniper Woodland										1			
342 L	PP082509TMB15 C.	P. Pinyon-Juniper Woodland													
343 L	PP082509TMA16	C.P. Pinyon-Juniper Woodland													
344	LPP090109TMc5E	C.P. Mixed Desert Scrub				1				P					
345	LPP090109TMA5	C.P. Mixed Desert Scrub			6										
346	LPP090109TMA4	C.P. Mixed Desert Scrub													
347	LPP090109TMc4E	C.P. Blackbrush-Mormon-tea Shrubland													
348 L	PP090109TMA3	C.P. Shrub-Steppe				6									
349 L	PP090109TMc3E	C.P. Shrub-Steppe			P	20									
350	LPP052410TMC1	Colorado Plateau Mixed Desert Scrub				1184				2384		2			
351	LPP052410TMC2	Colorado Plateau Mixed Desert Scrub				134				967		29			

Table 5-3
Belt Transect Data

Transect Number	LPP Code	Ecological System	*Aegilops cylindrica*	*Asclepias subverticillata*	*Bromus rubens*	*Bromus tectorum*	*Cardaria draba*	*Convolvulus arvensis*	*Elaeagnus angustifolia*	*Erodium cicutarium*	*Halogeton glomeratus*	*Salsola tragus*	*Sorghum halepense*	*Tamarix spp.*	*Tribulus terrestris*
352	LPP052410TMC3	Colorado Plateau Mixed Desert Scrub				1534				3984		1734			
353	LPP052410TMB2	Colorado Plateau Mixed Desert Scrub			1600	350				7000		102			
354	LPP052410TMB1	Colorado Plateau Mixed Desert Scrub			150	600				1450		33			
355 L	PP090109TMc2S	C.P. Shrub-Steppe				18				C		O			
356	LPP090109TMA2	C.P. Shrub-Steppe		C		C						O			
357	LPP090109TMA1	C.P. Volcanic Rock and Cinder Land			C							A			
358	LPP090109TMc1E	C.P. Volcanic Rock and Cinder Land			4	C						C			
359	LPP052210TMA3	Mojave Desert Mixed Desert Scrub			2700	2				1003					
360 L	PP052210TMA5	Mojave Desert Blackbrush-Mormon-tea Shrubland		163						3					
361	LPP052310TMA6	Mojave Desert Mixed Desert Scrub			1450					1600					
362	LPP052210TMA4	Mojave Desert Mixed Desert Scrub			6500	177				1443					
363 L	PP052210TMA6	Mojave Desert Blackbrush-Mormon-tea Shrubland		287						26					
364	LPP052310TMA10	Mojave Desert Mixed Desert Scrub			1600					2688					
365 L	PP052210TMA2	Mojave Desert Creosotebush-White Bursage Desert Scrub		1500						3876					
366	LPP052210TMA7	Mojave Desert Mixed Desert Scrub			1800					5000					
367 L	PP052310TMA9	Mojave Desert Creosotebush-White Bursage Desert Scrub		506		6				612		1			
368	LPP052310TMA7	Mojave Desert Mixed Desert Scrub			3743	1523				282					
369	LPP052310TMA8	Mojave Desert Mixed Desert Scrub			500					4250					
370	LPP052210TMA8	Mojave Desert Mixed Desert Scrub			952					5400					
371	LPP052310TMA5	Mojave Desert Mixed Desert Scrub			850					1100					
372 L	PP052310TMA4	Mojave Desert Volcanic Rock and Cinder Land		5550						2750					

Table 5-3
Belt Transect Data

Transect Number	LPP Code	Ecological System	*Aegilops cylindrica*	*Asclepias subverticillata*	*Bromus rubens*	*Bromus tectorum*	*Cardaria draba*	*Convolvulus arvensis*	*Elaeagnus angustifolia*	*Erodium cicutarium*	*Halogeton glomeratus*	*Salsola tragus*	*Sorghum halepense*	*Tamarix spp.*	*Tribulus terrestris*
373 L	PP052310TMA3	Mojave Desert Volcanic Rock and Cinder Land		6250						2650					
374 L	PP052210TMA1	Mojave Desert Creosotebush-White Bursage Desert Scrub		5500						753					
375 L	PP052310TMA1	Mojave Desert Blackbrush-Mormon-tea Shrubland		4250						614					
376 L	PP052310TMA2	Mojave Desert Blackbrush-Mormon-tea Shrubland		1750						557					
377	LPP090109TMA8	M.D. Creosote-White Bursage Desert Scrub													
378	LPP090109TMc8S	M.D. Creosote-White Bursage Desert Scrub								P					
379	LPP090109TMc7S	M.D. Creosote-White Bursage Desert Scrub			P	P				O					
380	LPP090109TMA7	M.D. Creosote-White Bursage Desert Scrub										2			
381 L	PP052410TMA1	Mojave Desert Volcanic Rock and Cinder Land		5500						267					
382 L	PP052410TMA2	Mojave Desert Volcanic Rock and Cinder Land		1150						4600					
383 L	PP052410TMA3	Mojave Desert Volcanic Rock and Cinder Land		1700						352					
384 L	PP052210TMB7	Mojave Desert Volcanic Rock and Cinder Land		1650		125				2750					
385 L	PP052210TMB6	Mojave Desert Volcanic Rock and Cinder Land		1075		2875				1450					
386 L	PP052210TMB5	Mojave Desert Blackbrush-Mormon-tea Shrubland		2550						2600					
387 L	PP052210TMB4	Mojave Desert Creosotebush-White Bursage Desert Scrub		1355		15				3125					
388 L	PP052210TMB3	Mojave Desert Volcanic Rock and Cinder Land		3213		1056				850		32			
389	LPP052210TMB2	Mojave Desert Grassland			50	75				25		225			

Table 5-3
Belt Transect Data

Transect Number	LPP Code	Ecological System	*Aegilops cylindrica*	*Asclepias subverticillata*	*Bromus rubens*	*Bromus tectorum*	*Cardaria draba*	*Convolvulus arvensis*	*Elaeagnus angustifolia*	*Erodium cicutarium*	*Halogeton glomeratus*	*Salsola tragus*	*Sorghum halepense*	*Tamarix spp.*	*Tribulus terrestris*
390	LPP052210TMB1	Mojave Desert Active and Stabilized Dune			465	267						45			
391	LPP042210TMA250M	Mojave Desert Shrub-Steppe			1300					5000					
392	LPP042210TMB250M	Mojave Desert Grassland			2317					5066					
393 L	PP042210TMB350M	Mojave Desert Creosotebush-White Bursage Desert Scrub		1983						2033					
394 L	PP052210TMB10	Mojave Desert Creosotebush-White Bursage Desert Scrub		3350						1600					
395 L	PP042210TMA350M	Mojave Desert Shrub-Steppe			1884	5				2052					
396	LPP042210TMA150M	Mojave Desert Grassland			432					461		1			
397	LPP042210TMB150M	Mojave Desert Grassland			2467					6716					
398 L	PP052210TMB8	Mojave Desert Creosotebush-White Bursage Desert Scrub		1350		100				2775					
399	LPP052210TMB9	Mojave Desert Shrub-Steppe			2850					1450		2			
400	LPP052210TMC1	Mojave Desert Shrub-Steppe			4550					9800					
401	LPP052210TMC2	Mojave Desert Shrub-Steppe			269	74				1500					
402	LPP052210TMC3	Mojave Desert Shrub-Steppe			1450	200				1300					
403	LPP052210TMC4	Mojave Desert Shrub-Steppe			800					1850					
404	LPP052210TMC5	Mojave Desert Active and Stabilized Dune													
405	LPP052210TMC6	Mojave Desert Active and Stabilized Dune													
406	LPP090109TMB1	M.D. Active and Stabilized Dune													
407	LPP090109TMB2	M.D. Active and Stabilized Dune													
408	LPP090109TMB3	M.D. Creosote-White Bursage Desert Scrub													
409 L	PP090109TMB4	M.D. Creosote-White Bursage Desert Scrub (outside of survey area)													
410 L	PP052210TMC7	Mojave Desert Creosotebush-White Bursage Desert Scrub		1400						2850					

Table 5-3
Belt Transect Data

Transect Number	LPP Code	Ecological System	*Aegilops cylindrica*	*Asclepias subverticillata*	*Bromus rubens*	*Bromus tectorum*	*Cardaria draba*	*Convolvulus arvensis*	*Elaeagnus angustifolia*	*Erodium cicutarium*	*Halogeton glomeratus*	*Salsola tragus*	*Sorghum halepense*	*Tamarix spp.*	*Tribulus terrestris*
411	LPP052210TMC8	Mojave Desert Shrub-Steppe			5350					1950					
412 L	PP052210TMC9	Mojave Desert Creosotebush-White Bursage Desert Scrub		800						1050					
413 L	PP052210TMC10 Ruder	al Vegetation			2200					850		350			
414 L	PP052210TMC11	Mojave Desert Creosotebush-White Bursage Desert Scrub		1300						1300					
415	LPP090109TMB5	M.D. Blackbrush-Mormon-tea Shrubland				A									
416	LPP090109TMB6	M.D. Gypsum Badlands													
417	LPP090109TMB7	M.D. Creosote-White Bursage Desert Scrub			A	C									
418	LPP090109TMB8	M.D. Mixed Desert Scrub			C					C					
419	LPP082509TMA15	C.P. Gypsum Badlands													
420 L	PP082509TMB14 C.	P. Pinyon-Juniper Woodland													
421 L	PP082509TMB13 C.	P. Gypsum Badlands													
422	LPP082509TMA14	C.P. Gypsum Badlands													
423	LPP082509TMA13	C.P. Gypsum Badlands													
424 L	PP082509TMB12 C.	P. Pinyon-Juniper Woodland													
425 L	PP082509TMA12	C.P. Pinyon-Juniper Woodland													
426 L	PP082509TMB11 C.	P. Blackbrush-Mormon-tea Shrubland													
427 L	PP082509TMA11	C.P. Mixed Bedrock Canyon and Tableland				P									
428 L	PP082509TMB10 C.	P. Mixed Bedrock Canyon and Tableland			1										
429	LPP082509TMA10	C.P. Blackbrush-Mormon-tea Shrubland				C									
430	LPP082509TMB8	C.P. Blackbrush-Mormon-tea Shrubland			1	1									
431 L	PP082509TMA9	C.P. Lower Montane Riparian Woodland and Shrubland (and some outside of survey area)												10	
432	LPP082509TMA8	C.P. Big Sagebrush Shrubland										19			

Table 5-3
Belt Transect Data

Transect Number	LPP Code	Ecological System	*Aegilops cylindrica*	*Asclepias subverticillata*	*Bromus rubens*	*Bromus tectorum*	*Cardaria draba*	*Convolvulus arvensis*	*Elaeagnus angustifolia*	*Erodium cicutarium*	*Halogeton glomeratus*	*Salsola tragus*	*Sorghum halepense*	*Tamarix spp.*	*Tribulus terrestris*
433	LPP082509TMB7	C.P. Big Sagebrush Shrubland				P									
434	LPP082509TMA7	C.P. Big Sagebrush Shrubland										2			
435 L	PP082509TMA6	C.P. Lower Montane Riparian Woodland and Shrubland												18	
436 L	PP082509TMB6	C.P. Lower Montane Riparian Woodland and Shrubland and small part in C.P. Mixed Desert Scrub		P								12		5	
437 L	PP082509TMB5	C.P. Shrub-Steppe				P						1			
438 L	PP082509TMA5	C.P. Shrub-Steppe			P										
439	LPP082509TMB4	C.P. Blackbrush-Mormon-tea Shrubland			P										
440	LPP082509TMA4	C.P. Blackbrush-Mormon-tea Shrubland										1			
441	LPP082509TMB3	C.P. Gypsum Badlands			P										
442	LPP082509TMA3	C.P. Blackbrush-Mormon-tea Shrubland			R										
443 L	PP082509TMA2	C.P. Shrub-Steppe			C							C			
444	LPP082509TMB2	C.P. Blackbrush-Mormon-tea Shrubland				1				1		24			
445	LPP082509TMA1	C.P. Blackbrush-Mormon-tea Shrubland			C										
446	LPP082509TMB1	C.P. Blackbrush-Mormon-tea Shrubland			1	1				1		7			
447	LPP082409TMA1	C.P. Mixed Desert Scrub			O										
448	LPP082409TMA3	C.P. Mixed Desert Scrub			R										
449	LPP082409TMA2	C.P. Mixed Desert Scrub				R									
450	LPP082409TMB1	C.P. Blackbrush-Mormon-tea Shrubland			R							2			
451	LPP082409TMB2	C.P. Blackbrush-Mormon-tea Shrubland			R					R			4		
452	LPP082409TMA4	C.P. Blackbrush-Mormon-tea Shrubland			C										
453 L	PP082409TMA5	Ruderal Vegetation			P	P						6			
454	LPP082409TMB3	C.P. Mixed Desert Scrub			1	2						44			

Table 5-3
Belt Transect Data

Transect Number	LPP Code	Ecological System	*Aegilops cylindrica*	*Asclepias subverticillata*	*Bromus rubens*	*Bromus tectorum*	*Cardaria draba*	*Convolvulus arvensis*	*Elaeagnus angustifolia*	*Erodium cicutarium*	*Halogeton glomeratus*	*Salsola tragus*	*Sorghum halepense*	*Tamarix spp.*	*Tribulus terrestris*
455	LPP082409TMA6	C.P. Gypsum Badlands			P										
456	LPP082409TMB5	C.P. Mixed Desert Scrub			1	1				1		1			
457	LPP082409TMA7	C.P. Blackbrush-Mormon-tea Shrubland			P										
458	LPP082409TMB4	C.P. Blackbrush-Mormon-tea Shrubland			C					1					
459	LPP082409TMA9	C.P. Mixed Desert Scrub			C										
460	LPP082409TMA8	C.P. Mixed Desert Scrub			C										
461	LPP091109TMc6S	M.D. Mixed Desert Scrub				1				A					
462	LPP091109TMA6	M.D. Mixed Desert Scrub				O									
463	LPP091109TMA5	M.D. Blackbrush-Mormon-tea Shrubland				O									
464	LPP091109TMc5S	M.D. Blackbrush-Mormon-tea Shrubland				O				O					
465	LPP091109TMc3S	M.D. Active and Stabilized Dune				P									
466	LPP091109TMA3	M.D. Active and Stabilized Dune				12									
467	LPP091109TMA4	G.B. Pinyon-Juniper Woodland				C									
468	LPP091109TMc4E	G.B. Pinyon-Juniper Woodland								R					
469 L	PP091109TMc2E	G.B. Pinyon-Juniper Woodland				P									
470	LPP091109TMA2	G.B. Pinyon-Juniper Woodland				O									
471	LPP082609TMA7	Developed Land (outside of survey area)				C									
472	LPP082609TMB6E	G.B. Big Sagebrush Shrubland				1									
473 L	PP091109TMc1S	G.B. Pinyon-Juniper Woodland				A									
474 L	PP091109TMA1	G.B. Pinyon-Juniper Woodland				C									
475 L	PP082609TMA6	Ruderal Vegetation				A		1		2		3			
476	LPP082609TMB5S	G.B. Mixed Desert Scrub			A					A					
477 L	PP082609TMB4S	Invasive Upland Vegetation (outside of survey area)		A											

Table 5-3
Belt Transect Data

Transect Number	LPP Code	Ecological System	*Aegilops cylindrica*	*Asclepias subverticillata*	*Bromus rubens*	*Bromus tectorum*	*Cardaria draba*	*Convolvulus arvensis*	*Elaeagnus angustifolia*	*Erodium cicutarium*	*Halogeton glomeratus*	*Salsola tragus*	*Sorghum halepense*	*Tamarix spp.*	*Tribulus terrestris*
478 L	PP082609TMA5	G.B. Lower Montane Riparian Woodland and Shrubland				C						16			
479	LPP052310TMC10	Great Basin Mixed Desert Scrub				3700				1100					
480	LPP052310TMC9	Great Basin Pinyon-Juniper Woodland				152									
481 L	PP082609TMA3	G.B. Pinyon-Juniper Woodland													
482 L	PP082609TMb2	G.B. Pinyon-Juniper Woodland													
483	LPP052310TMC8	Great Basin Big Sagebrush Shrubland					486								
484	LPP052310TMC7	Great Basin Big Sagebrush Shrubland				29	817								
485 L	PP052310TMC6	Invasive Upland Vegetation					2067								
486 L	PP052310TMC5	Agricultural land				800	250	32							
487 L	PP052310TMC4	Agricultural land					136								
488	LPP082609TMB3	G.B. Big Sagebrush Shrubland													
489 L	PP082609TMA4	G.B. Gambel Oak – Mixed Montane Shrubland													
490	LPP052310TMC3	Invasive Upland Vegetation													
491	LPP052310TMC2	Great Basin Mixed Desert Scrub													
492	LPP052310TMC1	Great Basin Mixed Desert Scrub				225									
493	LPP082609TMA2	G.B. Greasewood Flat													
494	LPP052310TMB4	Great Basin Big Sagebrush Shrubland				151									
495	LPP082609TMB1	G.B. Big Sagebrush Shrubland				2						1			
496	LPP082609TMA1	C.P. Pinyon-Juniper Woodland				C									
497	LPP052310TMB3	Great Basin Big Sagebrush Shrubland													
498	LPP052310TMB5	Great Basin Big Sagebrush Shrubland				345						1			
499	LPP052310TMB2	Great Basin Pinyon-Juniper Woodland				25									
500	LPP052310TMB1	Great Basin Big Sagebrush Shrubland				1175									

5.5 Weed Species Descriptions

5.5.1 *Aegilops cylindrica* (Jointed goatgrass)

5.5.1.1 Natural History

Aegilops cylindrica is a winter annual in the Poaceae (Grass family) that reproduces by seed. Stems are erect and grow to 15 to 30 inches (40 to 80 centimeters) in height (Figure 5-1). Leaf blades are 1/8 to 1/4 inch (3 to 6 millimeters) wide, simple, and alternate, with auricles at the base. On immature individuals, hairs occur on the margins of the leaves, at the juncture with the stem. Inflorescences are spikes, which are cylindrical and contain two to 12 jointed spikelets, each producing one to three viable seeds. Glumes are keeled on one side. When mature, the spike falls and the spikelets separate, with a segment of the rachis attached. From May to June, spikes appear reddish to yellow in color (The Sonoran Institute 2008). Seeds fall near the parent plant but can be dispersed into other areas by humans, livestock, wind, water, or vehicles (DiTomaso & Healy 2007). Flowering and seed production may occur from May to July (Whitson et al. 1996).

Figure 5-1
Close-up view of *Aegilops cylindrica*

Aegilops cylindrica has an appearance similar to winter wheat. *Aegilops cylindrica* can be distinguished from winter wheat, though, as the spikelets of winter wheat do not separate into joints, as they do in *A. cylindrical* (Figure 5-2). The two taxa are closely related, and can cross to form hybrids which are intermediate in form, and often sterile.

Aegilops cylindrica is native to Eurasia. The species was introduced to the United States around 1930 (Welsh et al. 2008) as a seed contaminant; it is now widely established, and present in the majority of winter wheat growing areas in North America. In Utah, *A. cylindrica* occurrences have been documented from 2,690 to 7,040 feet in elevation (Welsh et al. 1993), and in Arizona, individuals have been found at elevations between 800 and 6,000 feet, in areas that receive less than 10 to 20 inches of rain (The Sonoran Institute 2008). Although it is mostly found in wheat fields, *A. cylindrica* is also associated with roadsides, alfalfa fields, pastures, and waste areas (Whitson et al. 2009).

Aegilops cylindrica is associated with a variety of management issues. Roadside populations of *A. cylindrica* are known to serve as fire survey areas into wildlands. Above 4,000 feet in elevation, in areas where native herbaceous vegetation and shrubs are removed, *A. cylindrica* is known to replace indigenous vegetation (AZ-WIPWG 2005). *Aegilops cylindrica* is particularly problematic for growers of winter wheat, as it can serve as an overwintering host for pests of winter wheat, and can reduce wheat yields significantly (DiTomaso & Healy 2007). The competitiveness of *A. cylindrica* is enhanced by its long-term seed viability; it produces seeds that can remain viable in the soil for five or more years (The Sonoran Institute 2008).

5.5.1.1 Survey Results

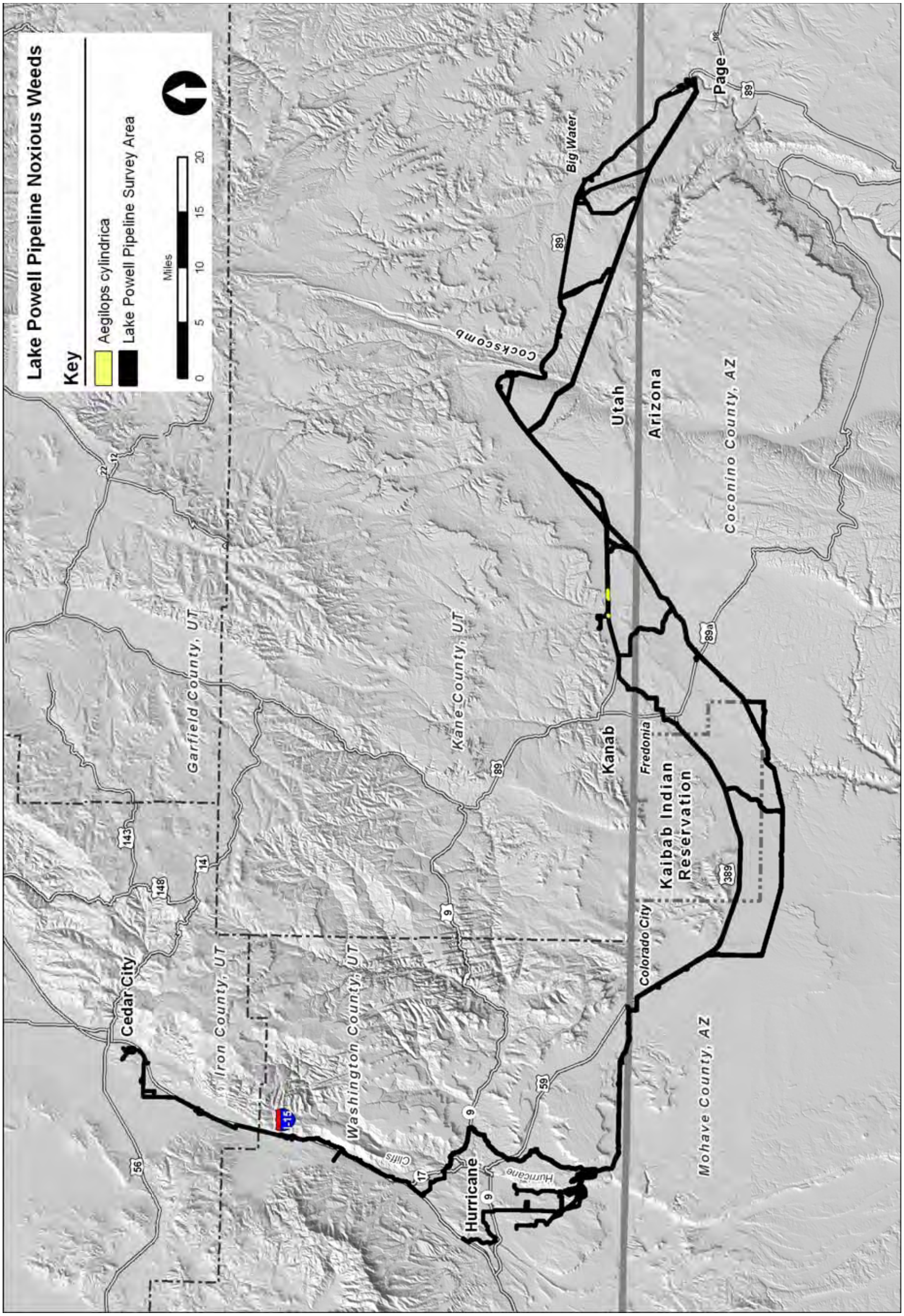
Aegilops cylindrica was encountered at two locations within the survey area (Map 5-6), both within the Hydro System Existing Highway Alternative Reach. At one location, between Seaman Wash and the turn-off to Johnson Canyon, the species occurred as a co-dominant member of a vegetation community and was identified in a 50-meter transect located within that same vegetation community. Six individuals were also detected within a 50-meter transect at the intersection of US 89 and the turn-off to Johnson Canyon (Transects # 119 and 126).

Aegilops cylindrica was found only in the Colorado Plateau Ecological Region, and both occurrences were within the Colorado Plateau Big Sagebrush Shrubland Ecological System, in shrubland communities dominated in part by *Artemisia tridentata* ssp. *vaseyana*. *Aegilops cylindrica* was a co-dominant species in the vegetation community where the larger population occurred. The areas were lightly to moderately disturbed from agricultural activities, primarily from grazing. Both occurrences were located in proximity to US 89 (Map 5-7 and Map 5-8).

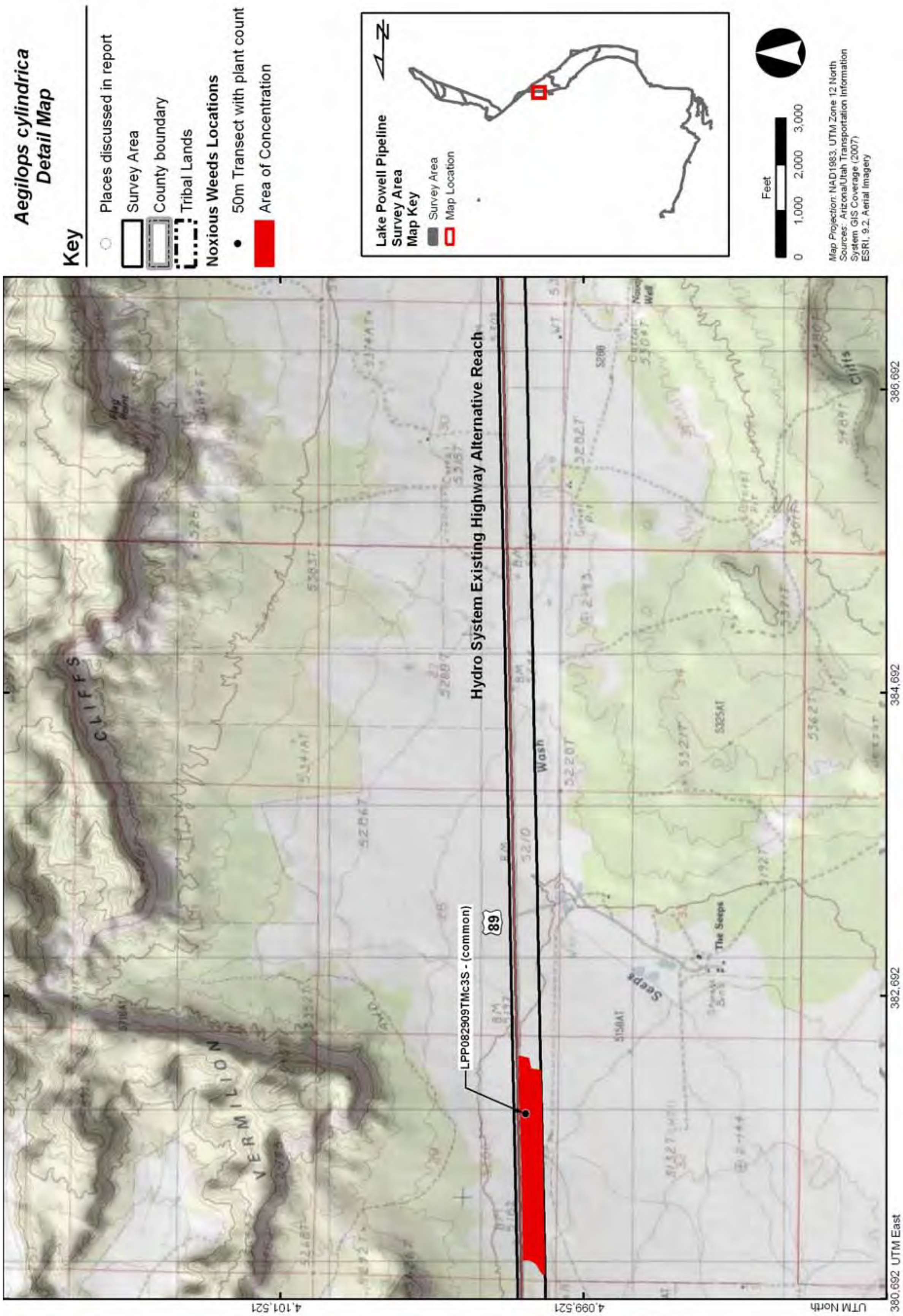
Figure 5-2
Aegilops cylindrica

5.5.1.2 Discussion

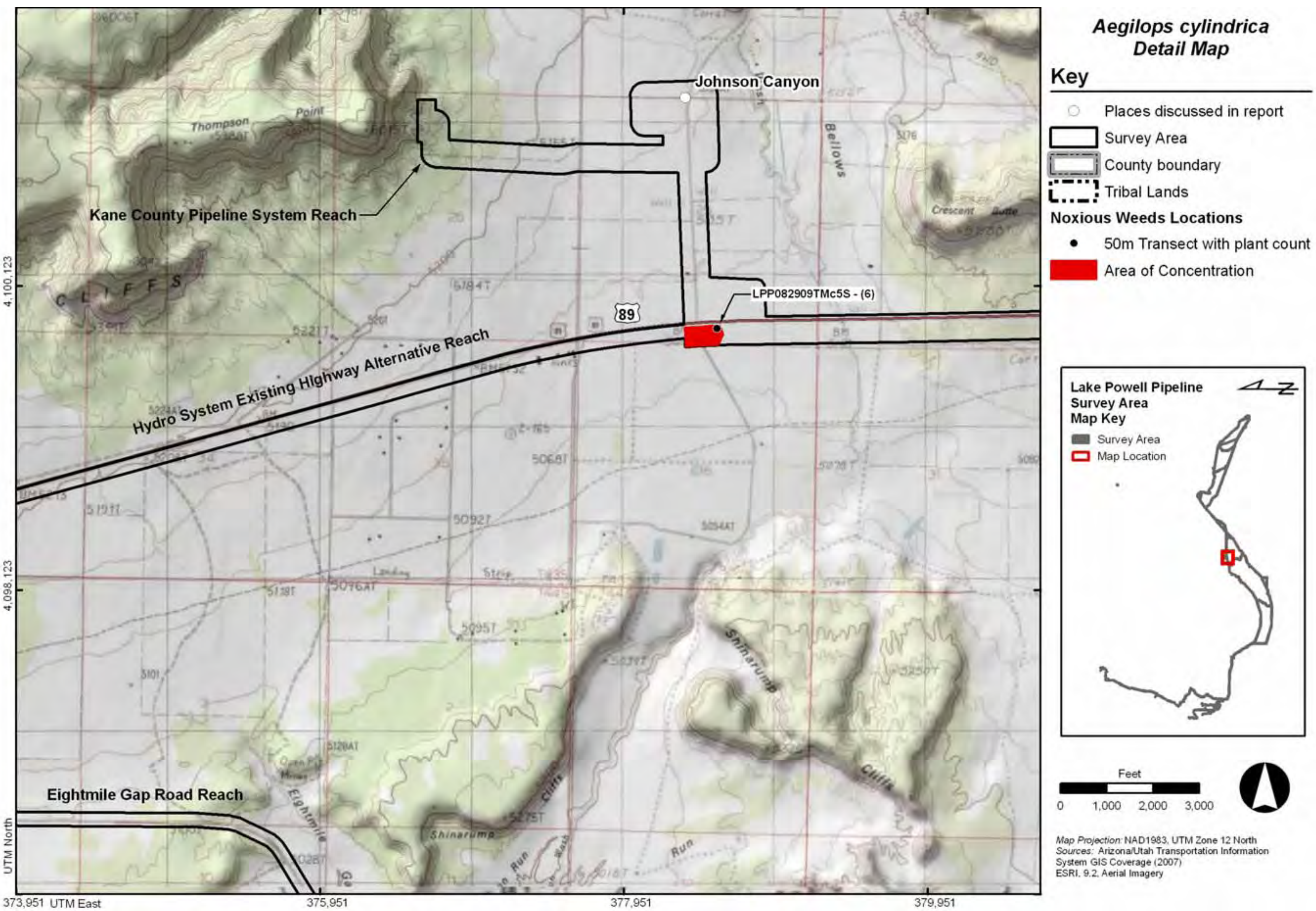
The survey identified only two occurrences of *Aegilops cylindrica*; an indication that the species is not widespread within the survey area. However, literature describes the ability of *A. cylindrica* to displace native species when native shrubs and herbaceous vegetation are removed. Due to the nature of the project and the presence of *A. cylindrica* within the survey area, the project may create ideal conditions for the species to invade habitats within, and adjacent to, the survey area. In order to reduce the likelihood of dispersing seeds, vehicle tires could be washed when departing areas where the species has been identified. Additionally, due to the probability of viable seed in the seed bank, topsoil from areas where *A. cylindrica* occurs should not be re-used, if at all possible.



Map 5-6
***Aegilops cylindrica* Overview Map**



Map 5-7
***Aegilops cylindrica* Detail Map**



Map 5-8
***Aegilops cylindrica* Detail Map**

Figure 5-3
Close up view of *Asclepias subverticillata* within the survey area

5.5.2 *Asclepias subverticillata* (Poison milkweed)

5.5.2.1 Natural History

Asclepias subverticillata is an herbaceous perennial in the *Asclepiadaceae* (Milkweed family). *Asclepias subverticillata* can have a shrubby appearance due to the development of many slender, un-branched stems (Figure 5-3), each one to three feet (30 to 90 cm) tall, which arise from horizontal, deep-set roots. The leaves are narrow, up to 3/8 inch (10 millimeters) wide, 2 to 5 inches (5 to 13 centimeters) long, and occur in whorls of 3 or 4 per node. Some of the axils contain secondary clusters of small leaves. Greenish-white flowers appear in umbrella-like clusters at the top of the branches and in upper leaf axils. The fruit is a seedpod 2 to 4 inches (5 to 10 centimeters) long, narrow and pointed. Upon maturity the seedpods open to release brown, flat seeds that are attached to tufts of silky hair, allowing them to be wind-disseminated (Whitson et al. 2009).

Asclepias subverticillata is very similar in appearance to *A. verticillata*, which occurs more commonly in other regions of the United States. The two species can be distinguished by the presence of small leaf clusters within the leaf axils that are characteristic of *A. subverticillata* and absent in *A. verticillata*.

Asclepias subverticillata is native to the western United States and Mexico (Whitson et al. 2009), and is found throughout Utah and Arizona. In Utah, *A. subverticillata* is found from 2,700 to 7,200 feet along roadsides and other disturbed sites within a variety of native vegetation types, including creosotebush, rabbitbrush, pinyon-juniper, and sagebrush. The species occurs in Beaver, Emery, Garfield, Grand, Iron, Kane, Millard, San Juan, Sampete, and Washington Counties (Welsh et al. 2008). In Arizona, *A. subverticillata* is found at elevations ranging from 2,500 to 8,500 feet in dryish soils along roadsides, field edges, pastures, ditches, plains, mesas, and slopes, in all types of habitats, from desert to spruce fir (Parker 2003).

Although native to the western United States, *Asclepias subverticillata* is invasive in disturbed areas, where its wind-born seeds are able to establish easily. *Asclepias subverticillata* can be a management concern, as all parts of the above-ground growth are poisonous to all types of livestock, sheep in particular (Parker 2003).

5.5.2.2 Survey Results

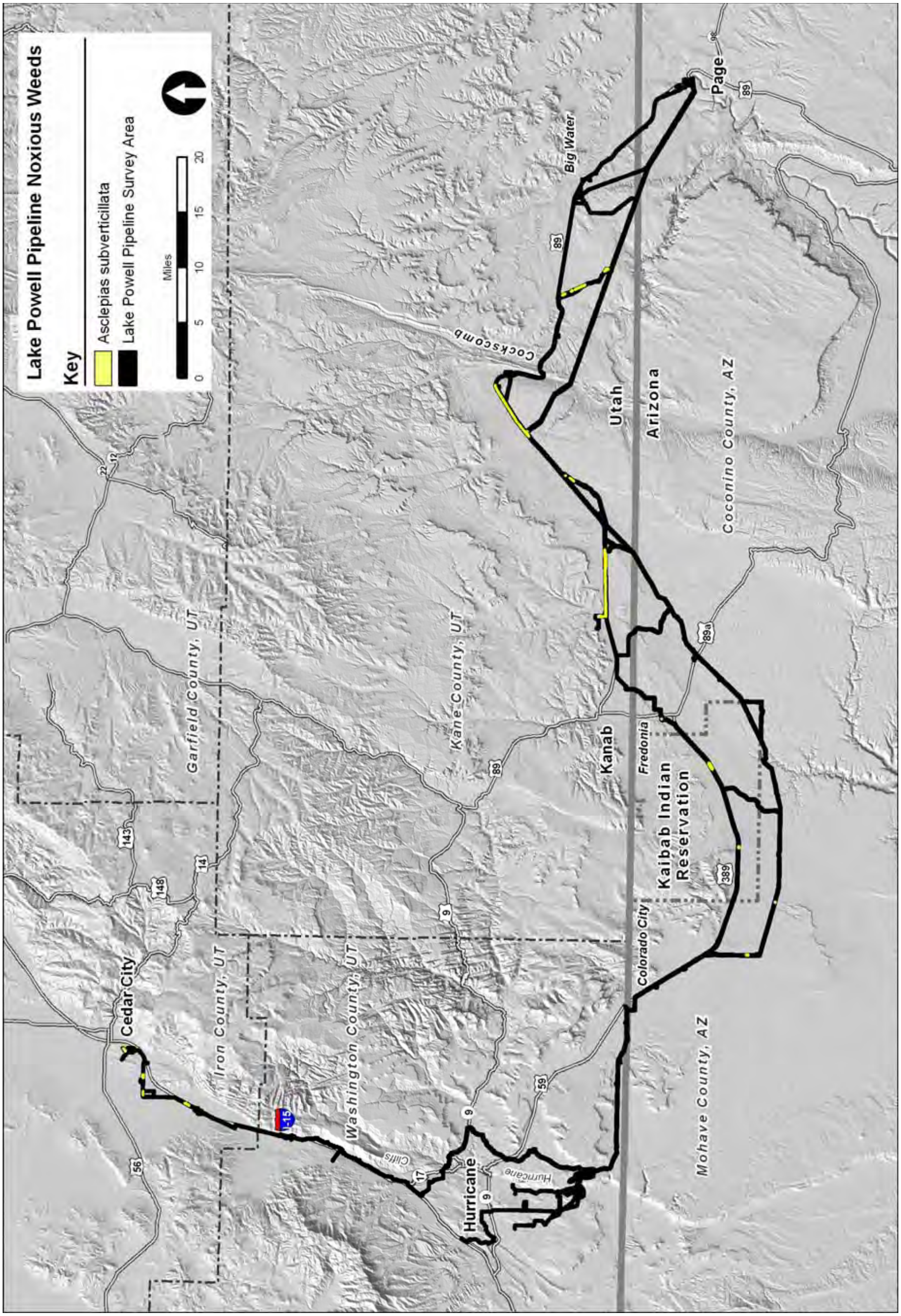
The survey identified *Asclepias subverticillata* occasionally throughout the survey area (Map 5-9). Individuals were located in eight reaches of the survey area (Map 5-10 to Map 5-27). In the BPS-3 Transmission Line South Reach, *A. subverticillata* was encountered at several locations between Flat Top and Cottonwood Canyon Road, and in the Water Conveyance System Reach the species was encountered between the Paria Townsite Road Junction and the vicinity of Fivemile Mountain Road at US 89. *Asclepias subverticillata* was also identified at the Buckskin Substation. In the Hydro System High Point Alignment Alternative Reach, individuals were encountered in two locations southwest of Telegraph Wash, and in the Kane County Pipeline System Reach it was encountered from Johnson Canyon south to US 89. In the Hydro System Existing Highway Alternative Reach the species was encountered between Seaman Wash and the intersection of US 89 and Johnson Canyon Road; at a location east of Kanab Creek; midway between Cottonwood Wash and Two Mile Wash; and at Pipe Springs National Monument. *Asclepias subverticillata* also occurred in the Hydro System South Alternative Reach at a location just east of Moonshine Ridge, and again midway between Moonshine Ridge and Yellowstone Road at AZ Route 389. In the Cedar Valley Pipeline System Reach it was found along US 89 north of Kanarraville; in an area east of the Bottoms; and in two locations in the vicinity of Cedar City. All occurrences of *A. subverticillata* were detected while conducting special status species and noxious weed surveys, with the exception of one individual that was encountered on a 50-meter belt transect (Transect # 290).

Asclepias subverticillata was found in the Colorado Plateau and Great Basin Ecological Regions, in six ecological systems and four anthropogenic lands. On the Colorado Plateau, *A. subverticillata* was encountered in Big Sagebrush Shrubland, Lower Montane Riparian Woodland and Shrubland, Mixed Desert Scrub, Shrub-Steppe, and Colorado Plateau Wash. In the Great Basin it was identified in Mixed Desert Scrub. *Asclepias subverticillata* was also encountered in four anthropogenic lands: Agricultural Land, Developed Land, Invasive Upland Vegetation, and Ruderal Vegetation. Individuals were found in vegetative communities dominated by *Achnatherum hymenoides*, *Artemisia* spp, *Ephedra nevadensis, Ericameria teretifolia, and Gutierrezia sarothrae*. Other habitats supporting *A. subverticillata* were dominated by invasive species, or were classified as ruderal vegetation. Most occurrences were located adjacent to paved or graded roads, agricultural land, or otherwise developed lands. However, at one location, *A. subverticillata* was found growing in a dry wash that had been minimally disturbed by anthropogenic causes. Most often, the species was encountered in small quantities, either as individuals or in small clusters.

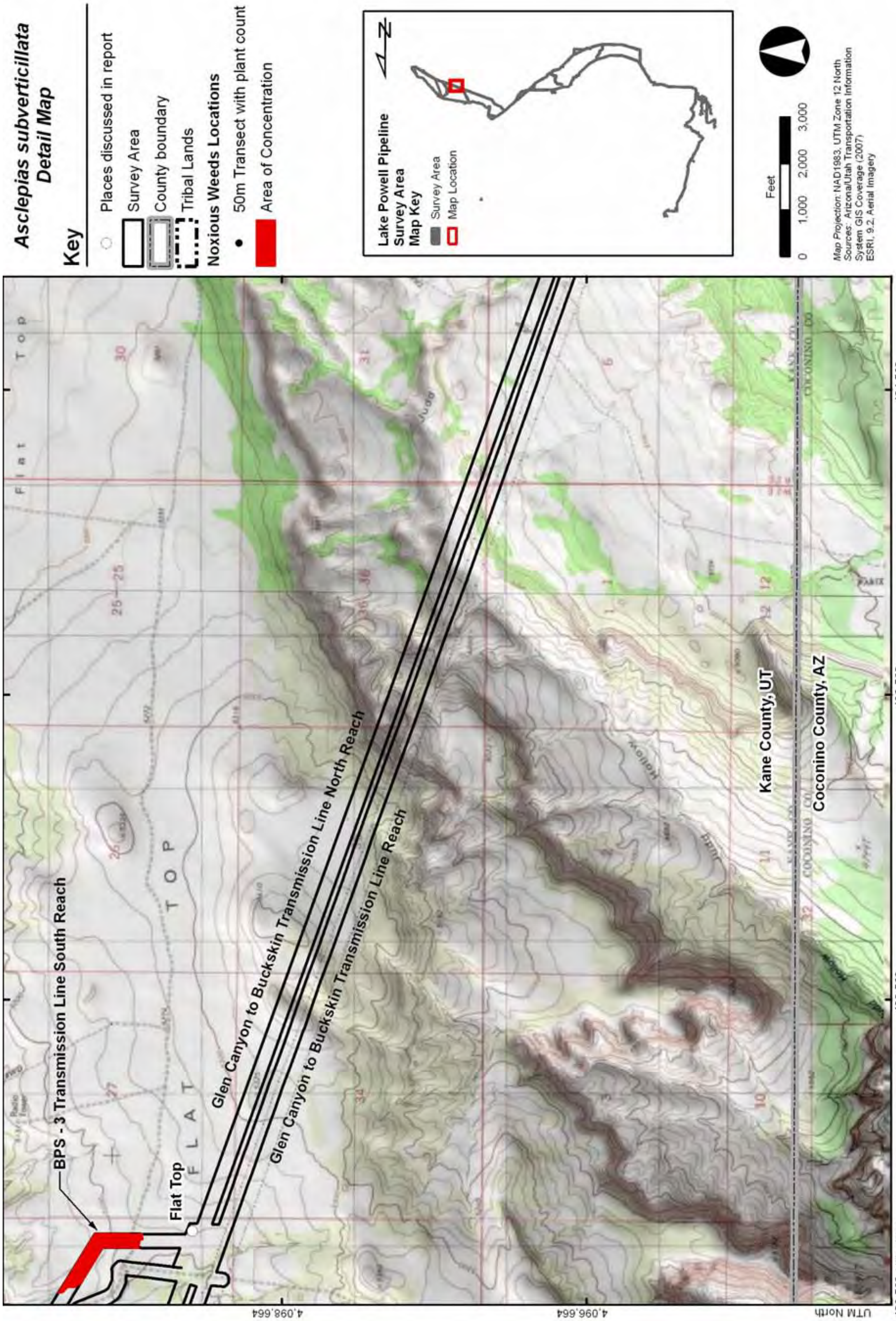
5.5.2.1 Discussion

The survey identified the presence of *Asclepias subverticillata* at various locations throughout the survey area. Individuals were encountered in habitats that ranged from minimally to heavily disturbed (Figure 5-4), and were found growing in association with both native and non-native species. The disturbance associated with the project will likely create opportunities for *A. subverticillata* to spread, particularly given that its seeds are wind-borne, and therefore able to disperse far from the parent plant. In order to minimize the spread of the species, it is suggested that individuals be removed from identified infested areas. As the species produces deep-set roots that are able to produce new shoots, chemical treatment is recommended.

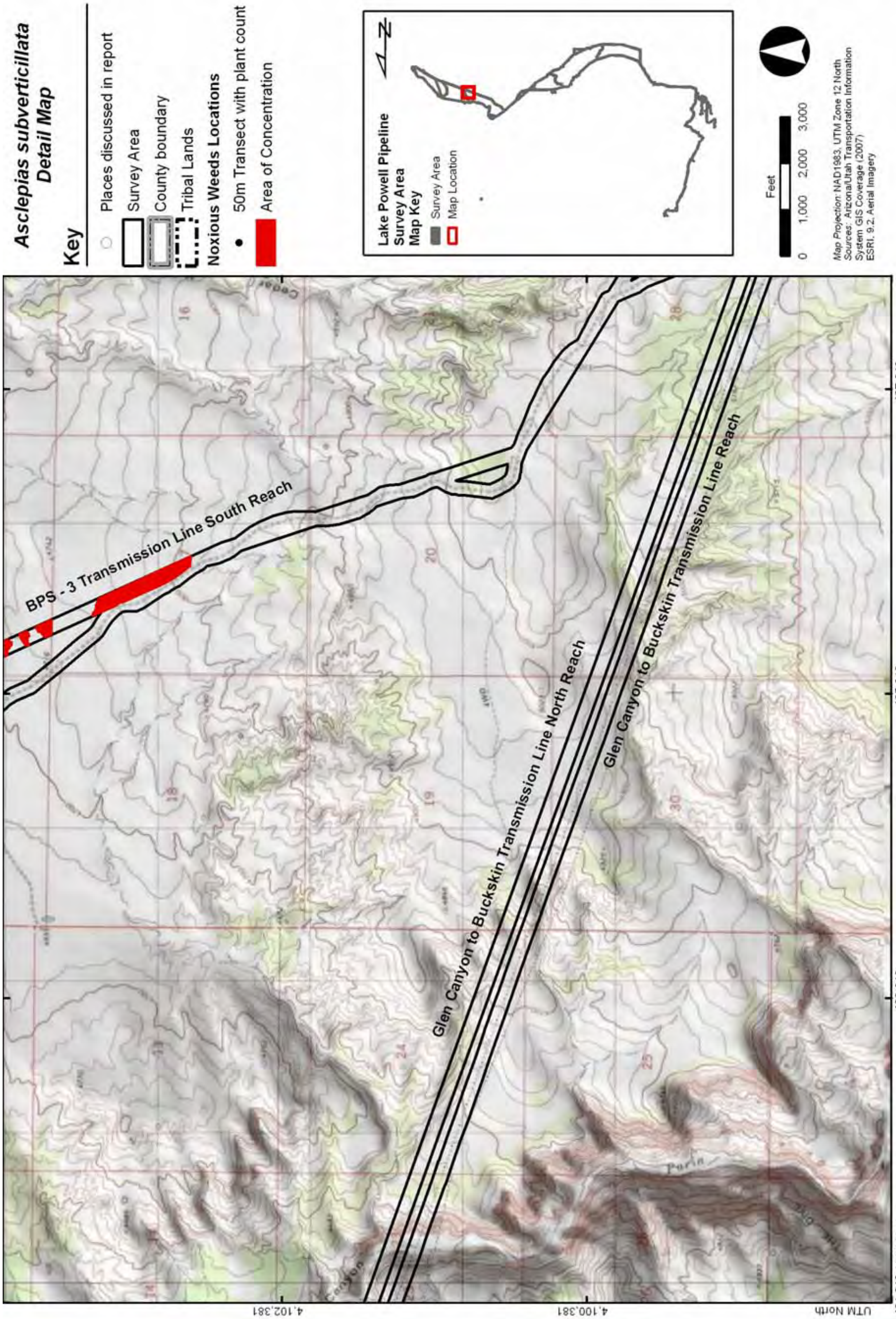
Figure 5-4
***Asclepias subverticillata* growing in disturbed habitat within the survey area**



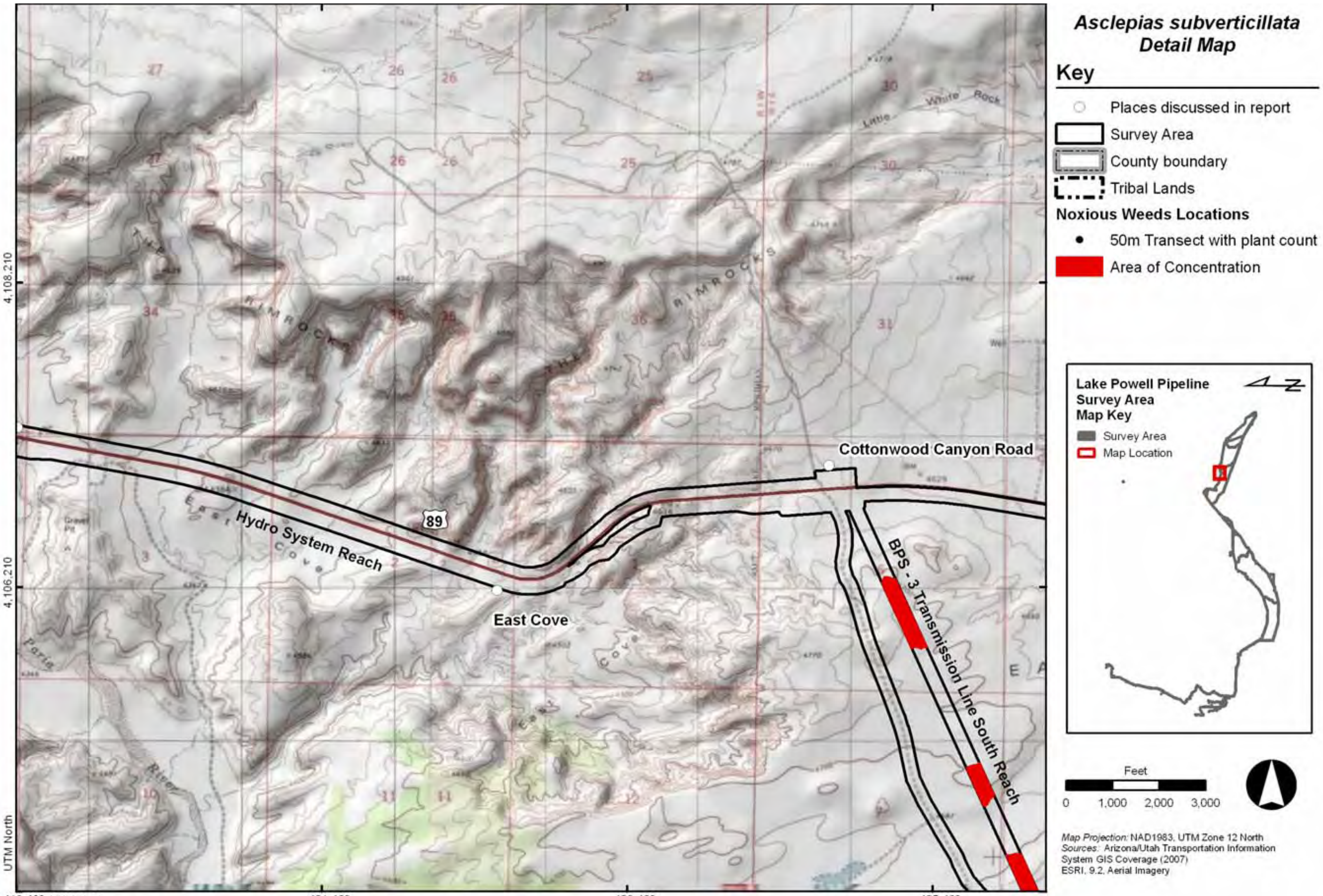
Map 5-9
***Asclepias subverticillata* Overview Map**



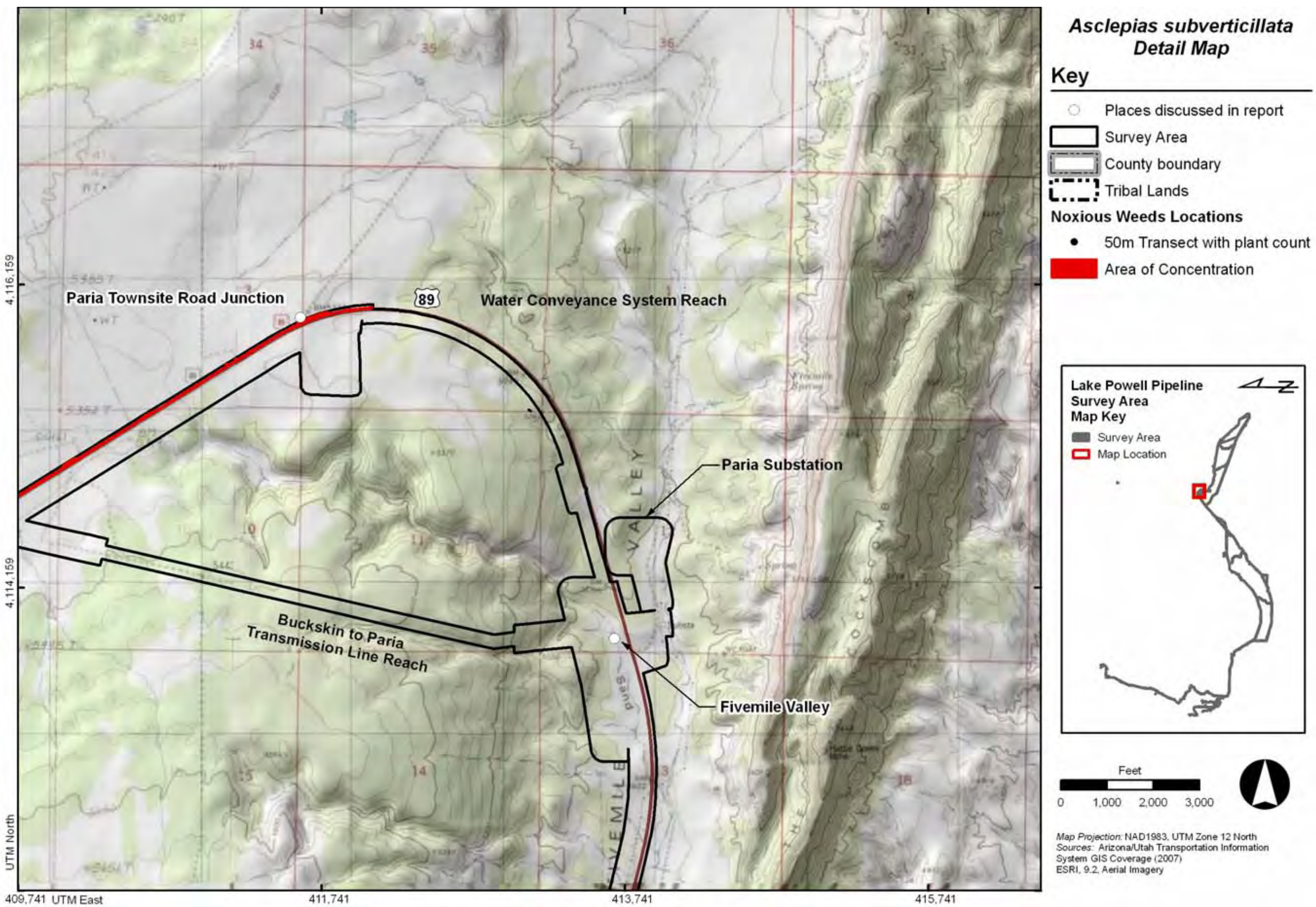
Map 5-10
***Asclepias subverticillata* Detail Map**



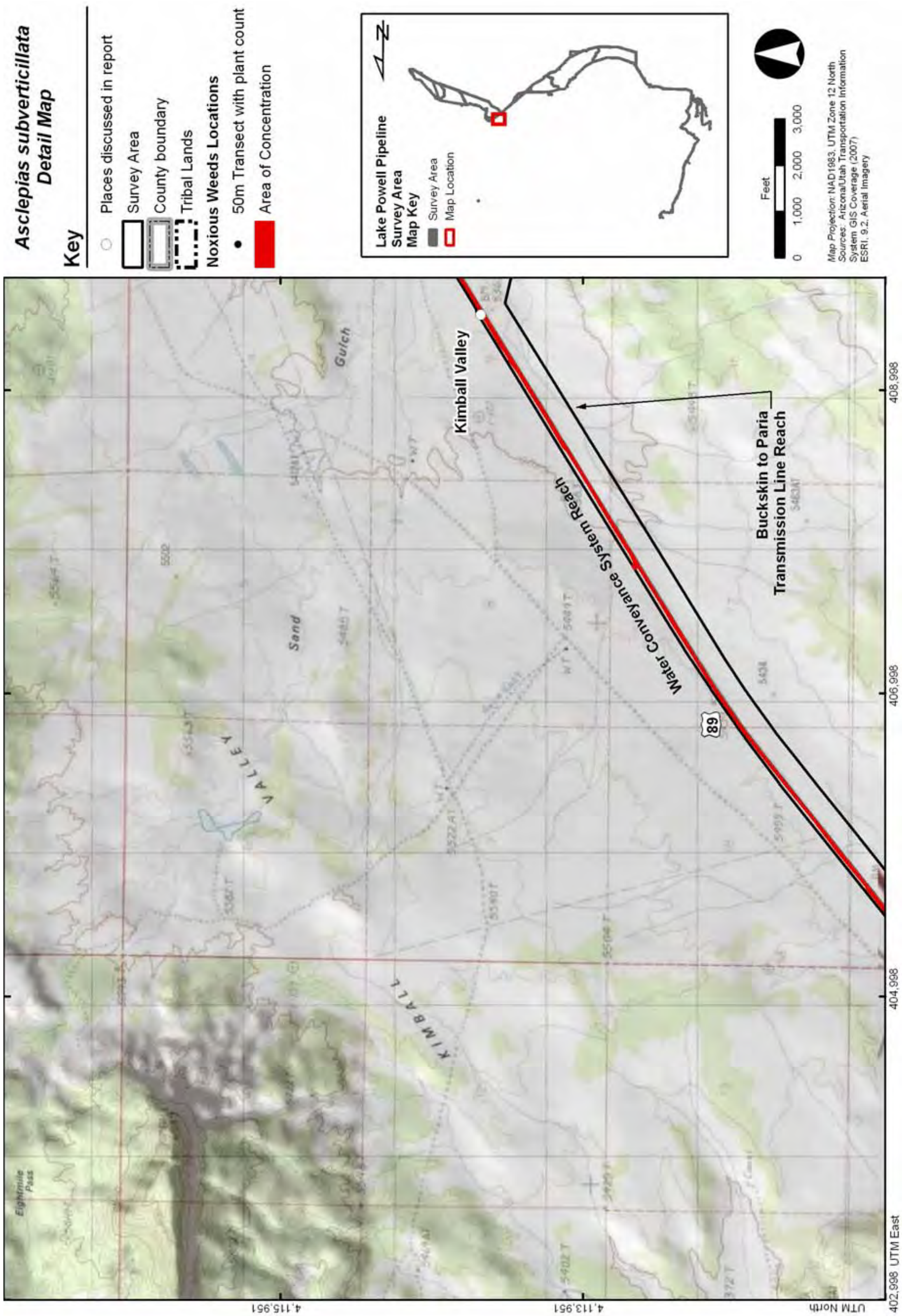
Map 5-11
***Asclepias subverticillata* Detail Map**



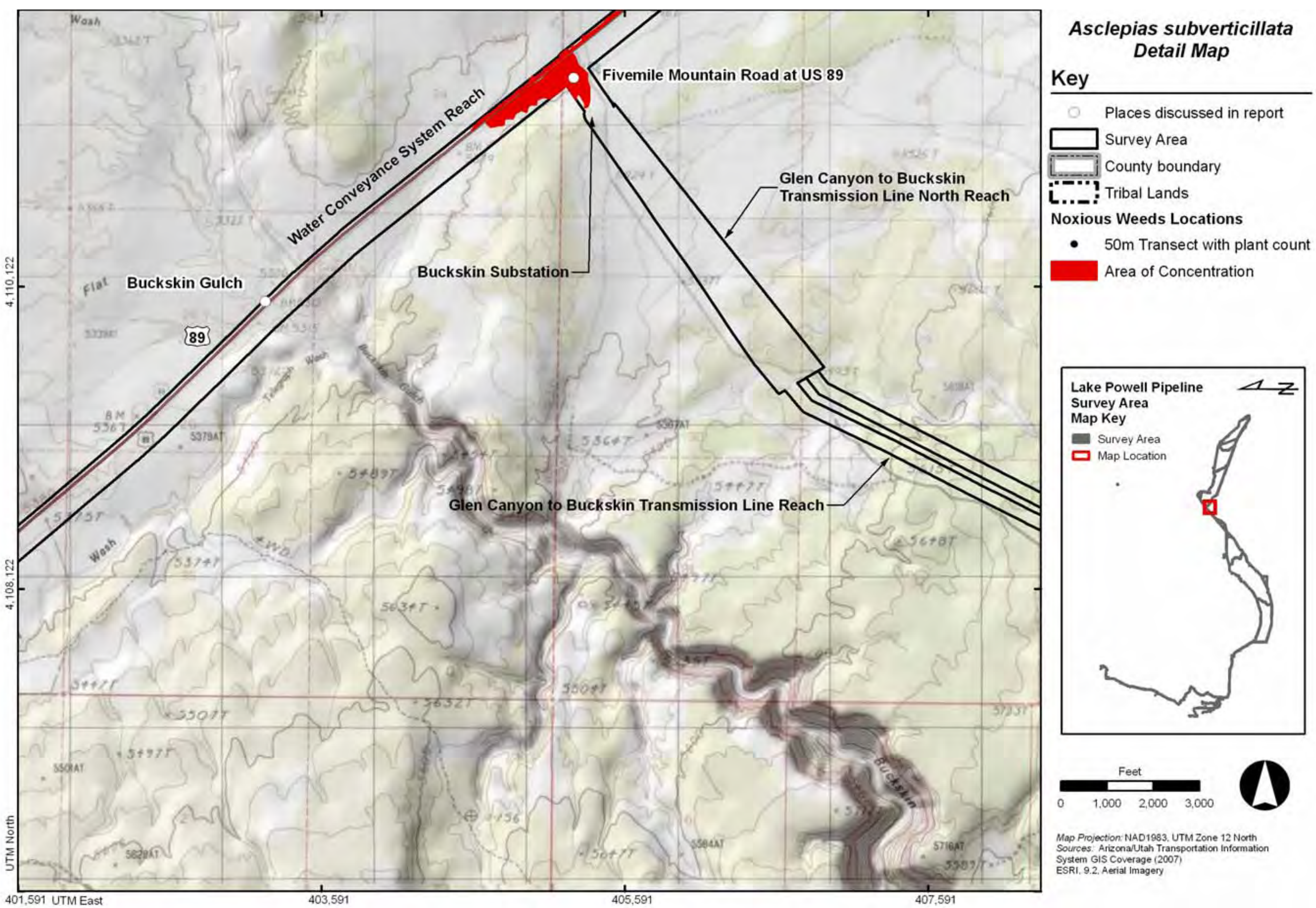
Map 5-12
***Asclepias subverticillata* Detail Map**



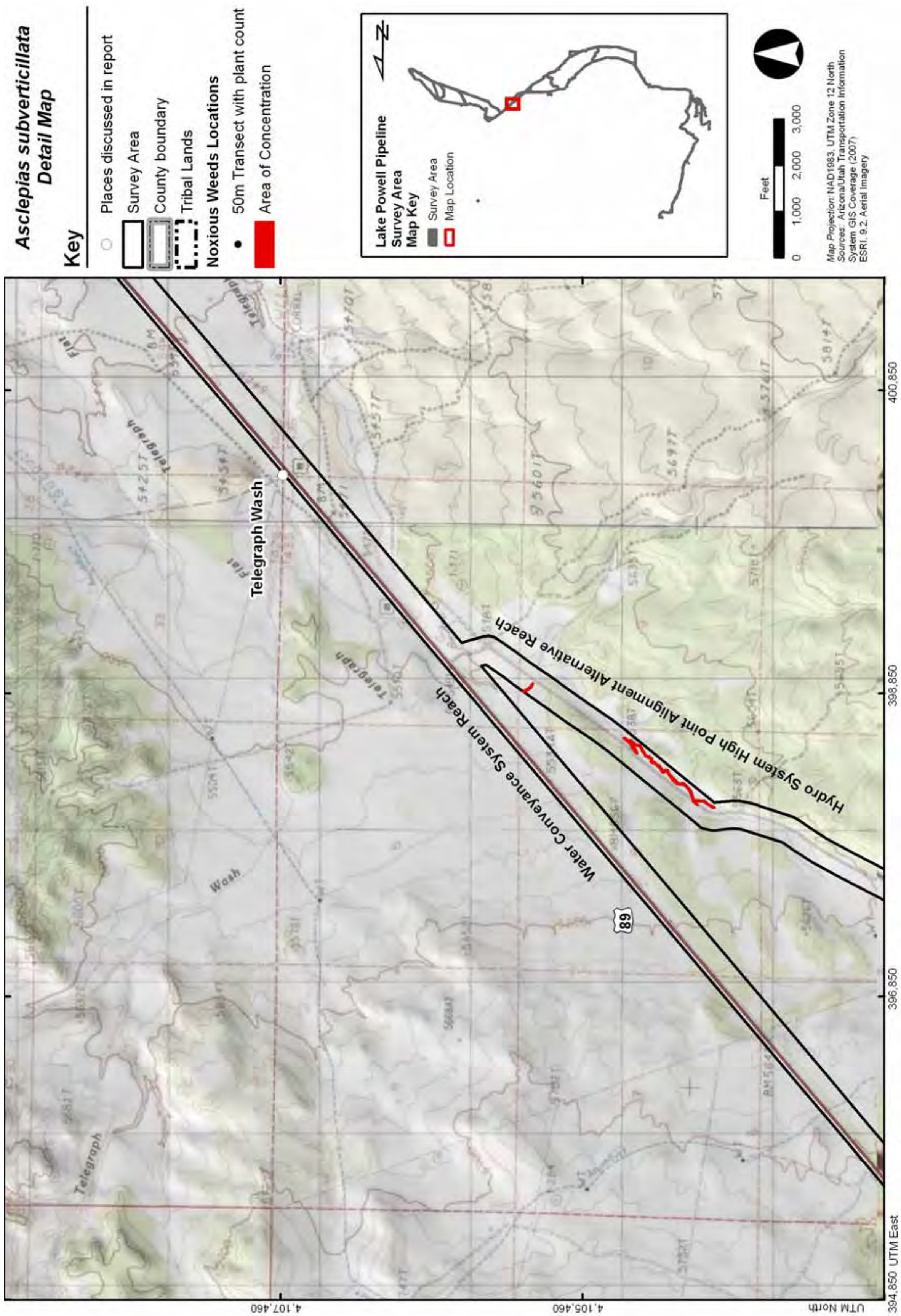
Map 5-13
***Asclepias subverticillata* Detail Map**



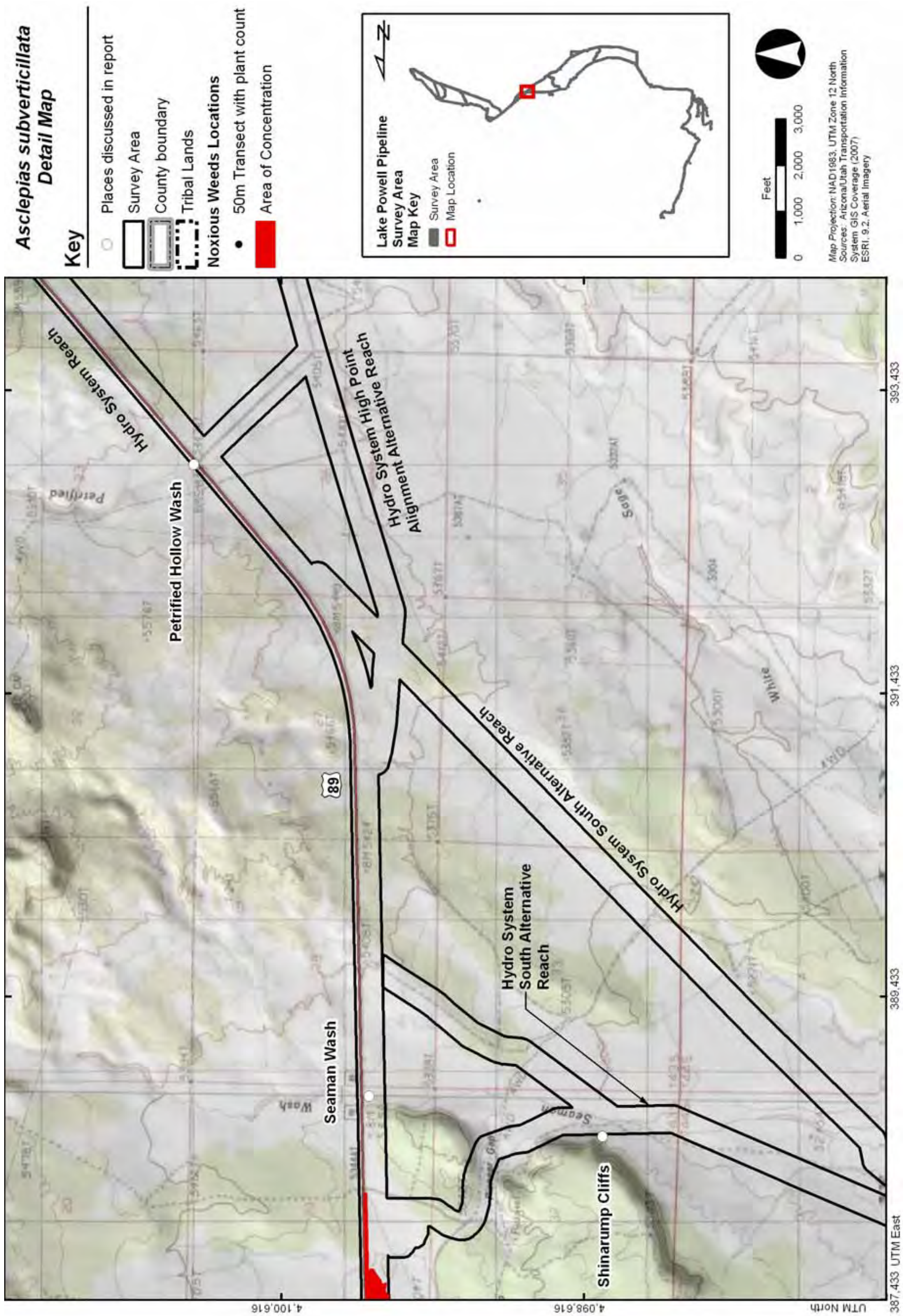
Map 5-14
***Asclepias subverticillata* Detail Map**



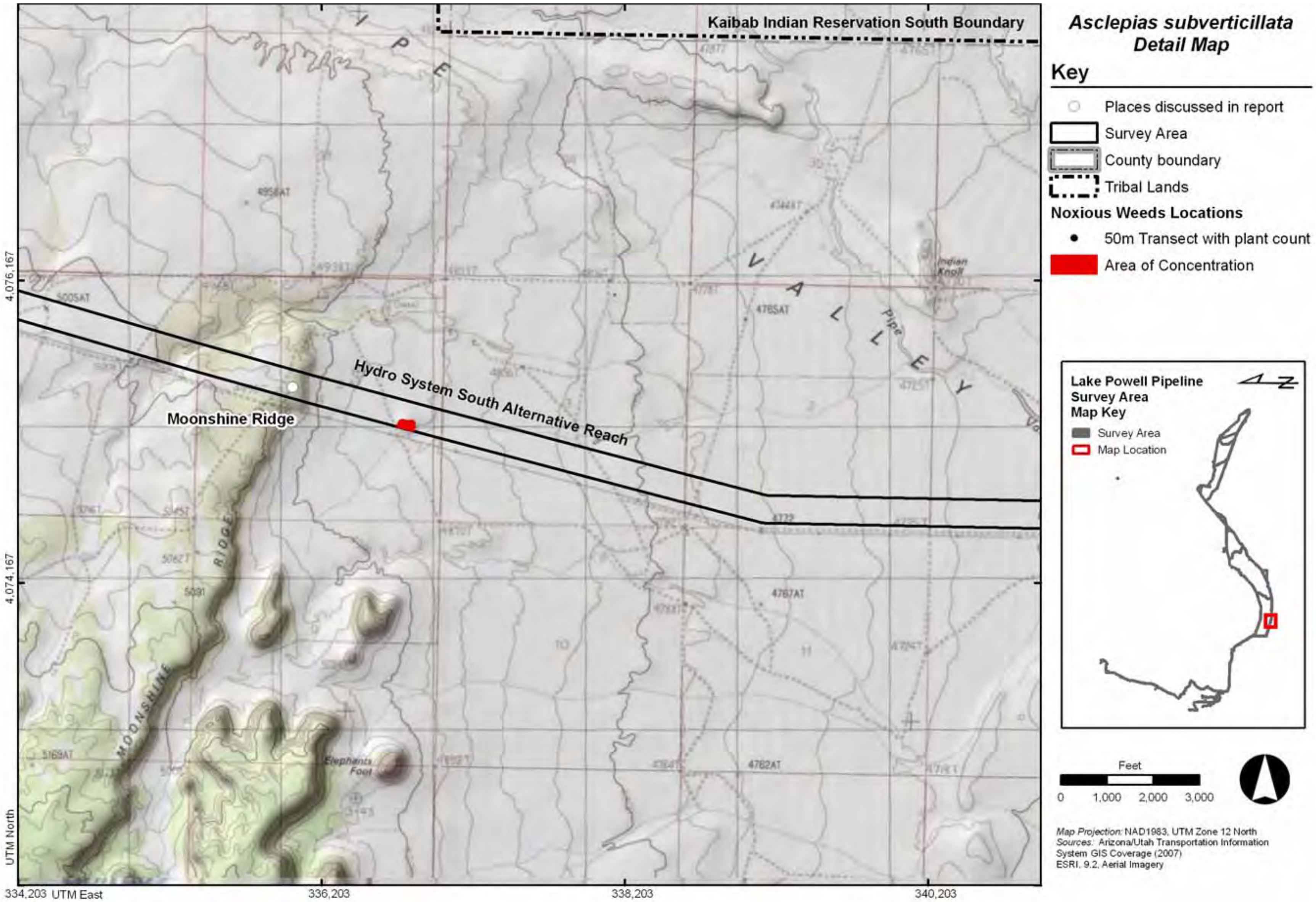
Map 5-15
***Asclepias subverticillata* Detail Map**



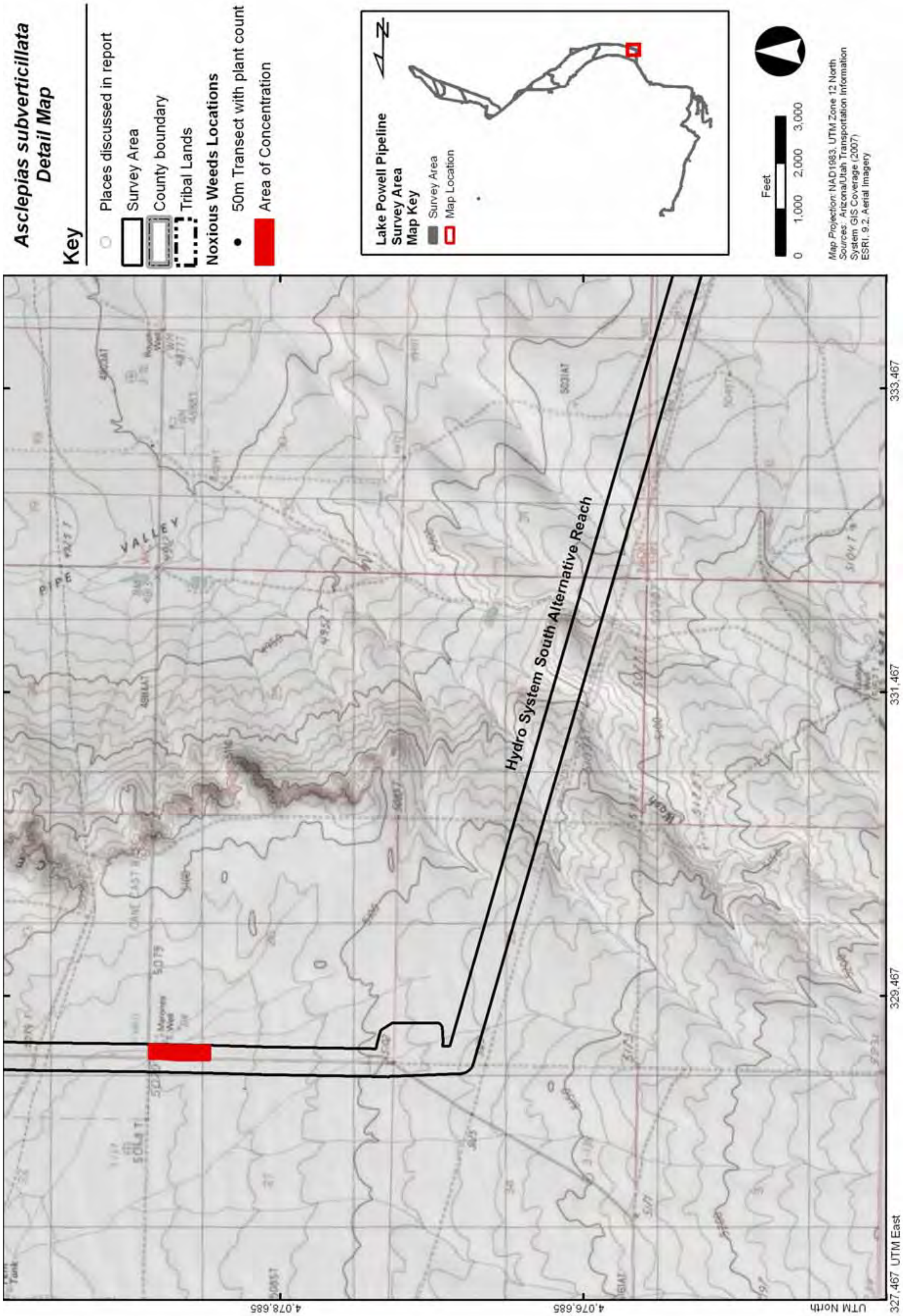
Map 5-16
***Asclepias subverticillata* Detail Map**



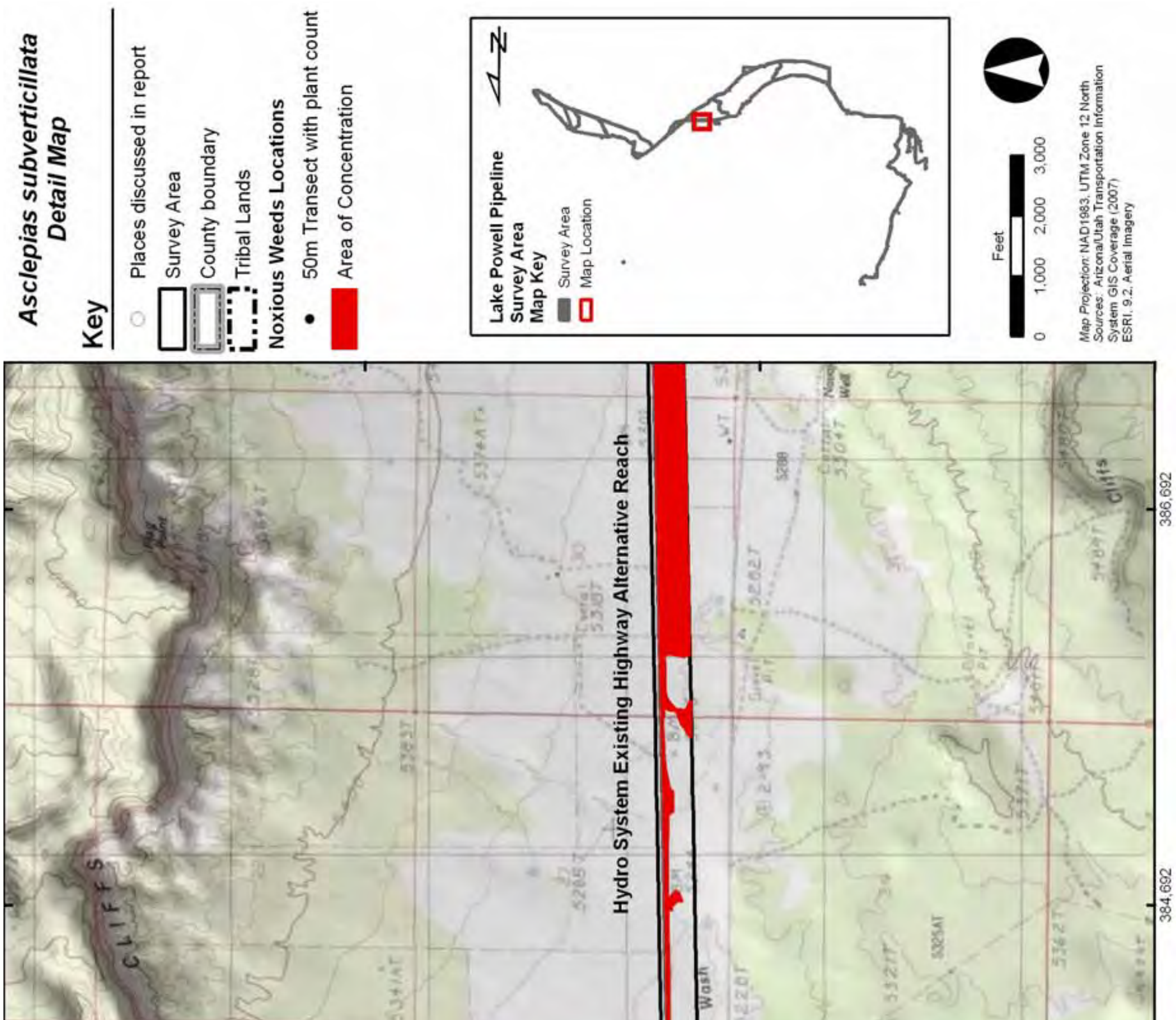
Map 5-17
***Asclepias subverticillata* Detail Map**



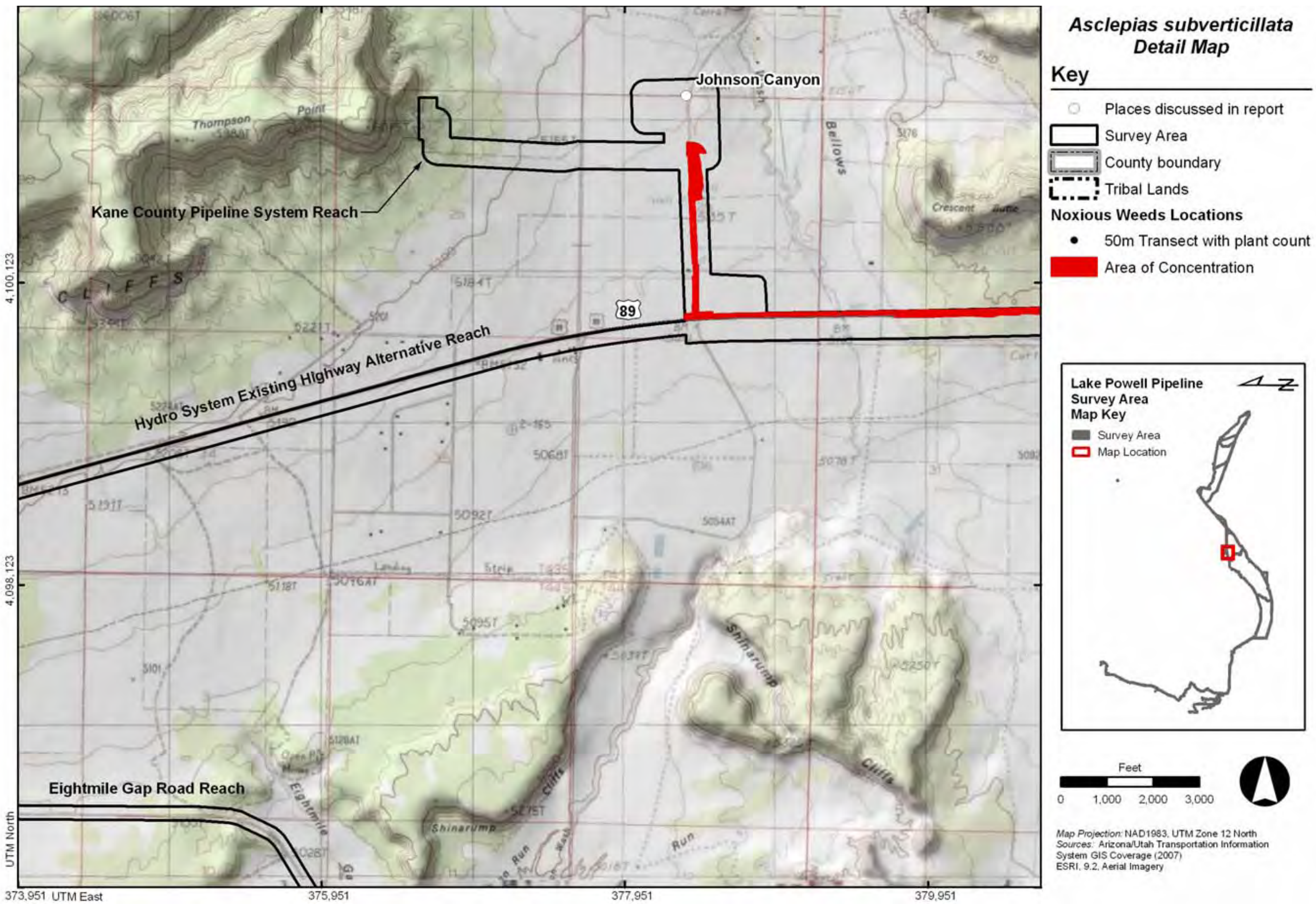
Map 5-18
***Asclepias subverticillata* Detail Map**



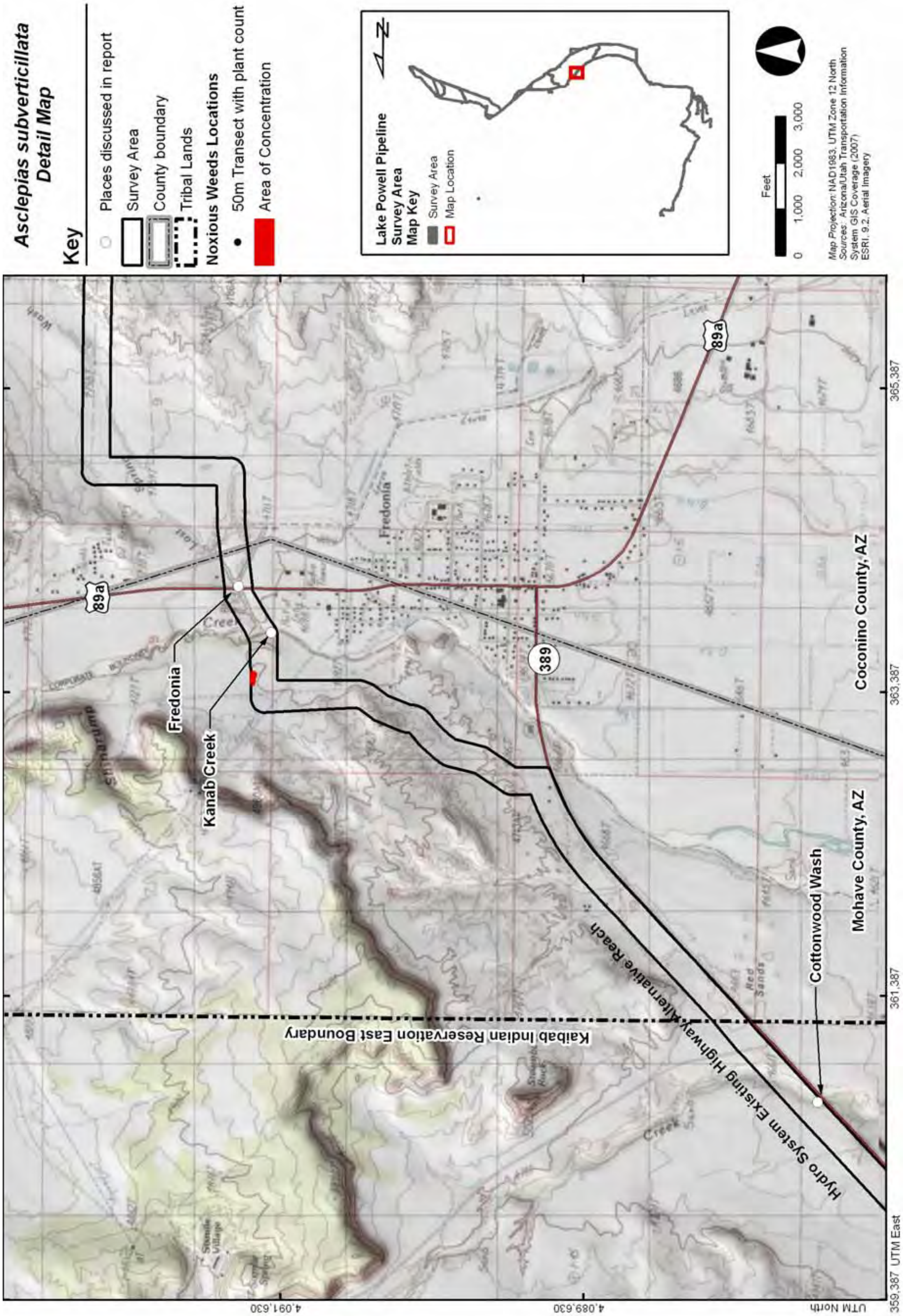
Map 5-19
***Asclepias subverticillata* Detail Map**



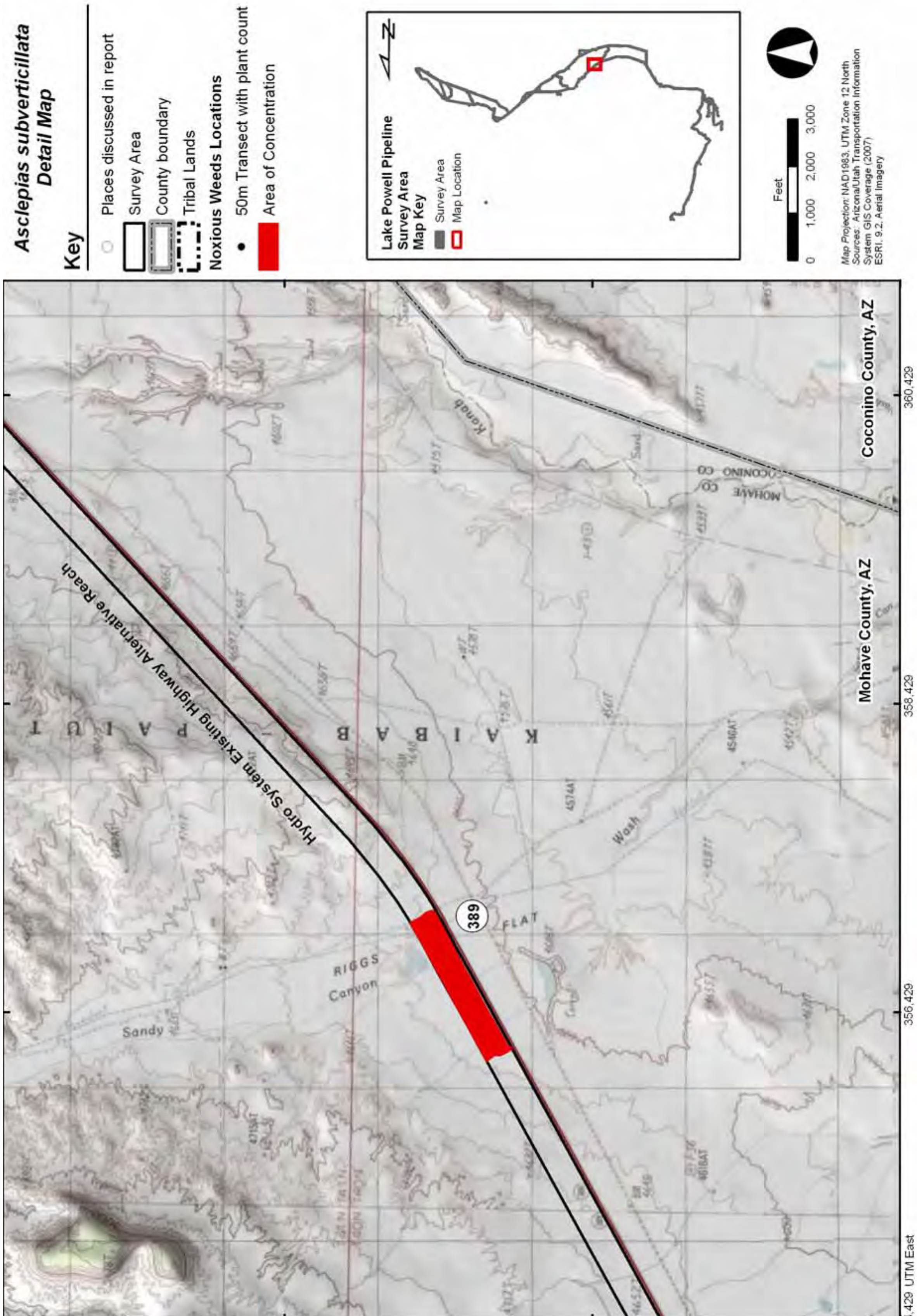
Map 5-20
***Asclepias subverticillata* Detail Map**



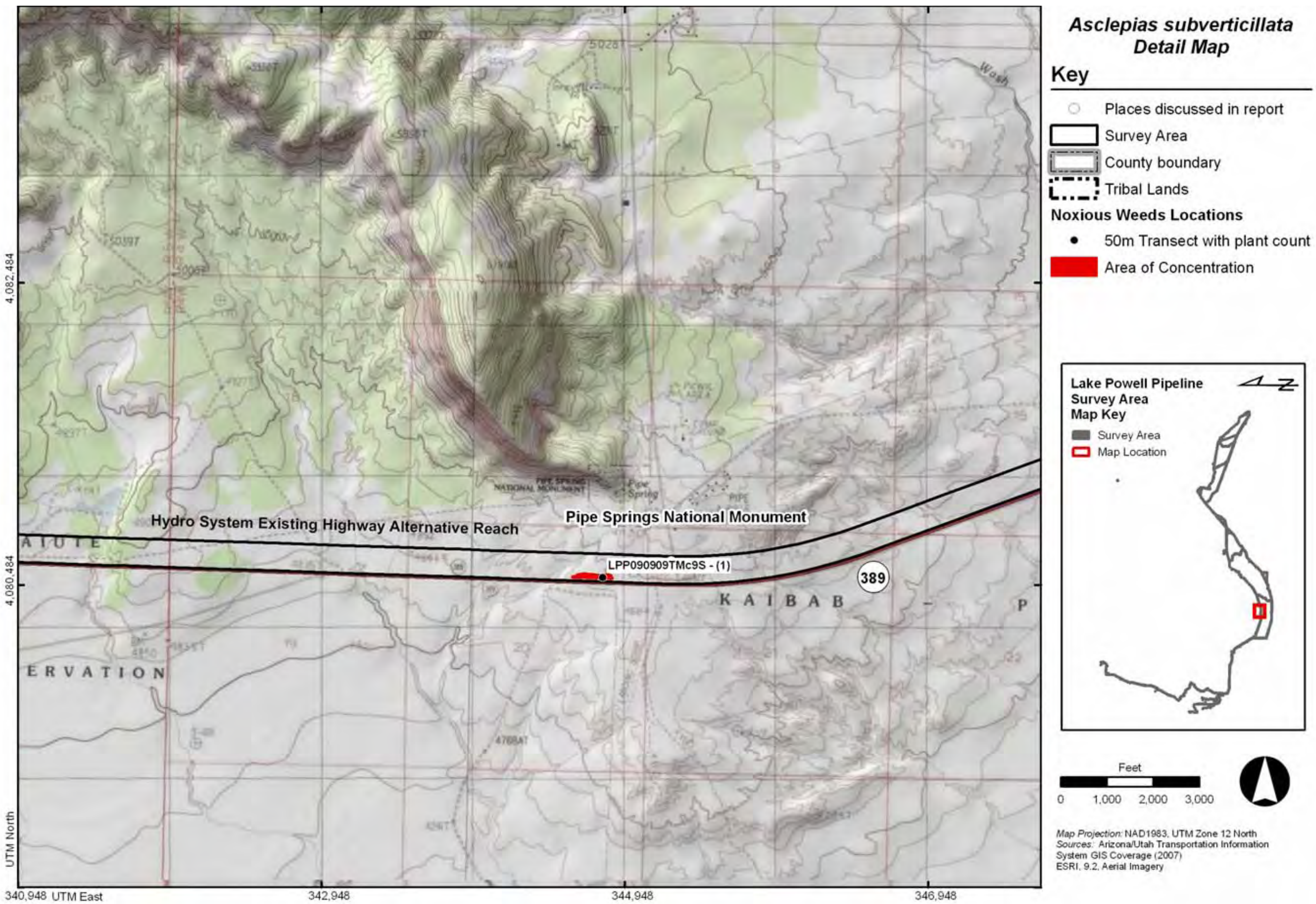
Map 5-21
***Asclepias subverticillata* Detail Map**



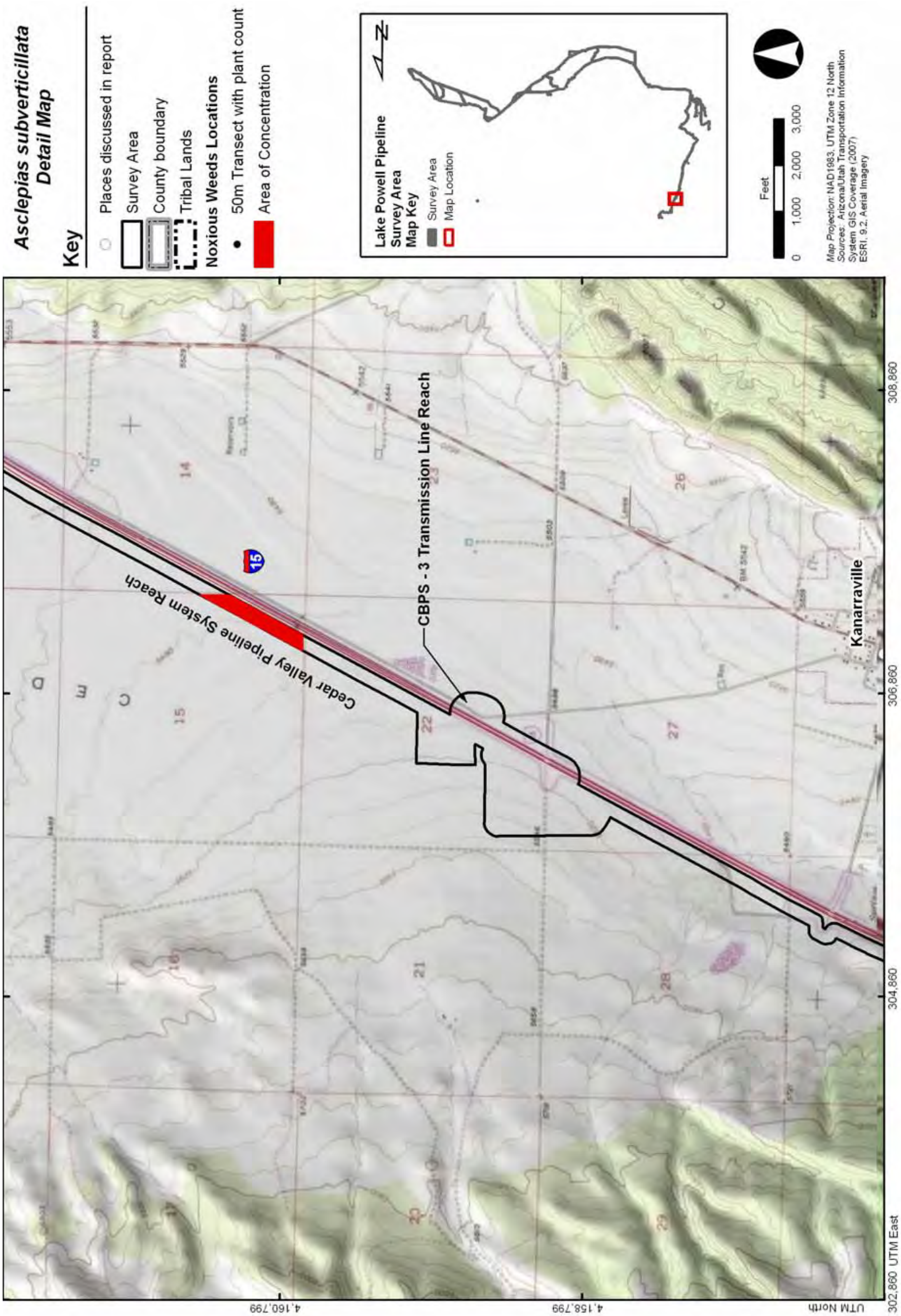
Map 5-22
***Asclepias subverticillata* Detail Map**



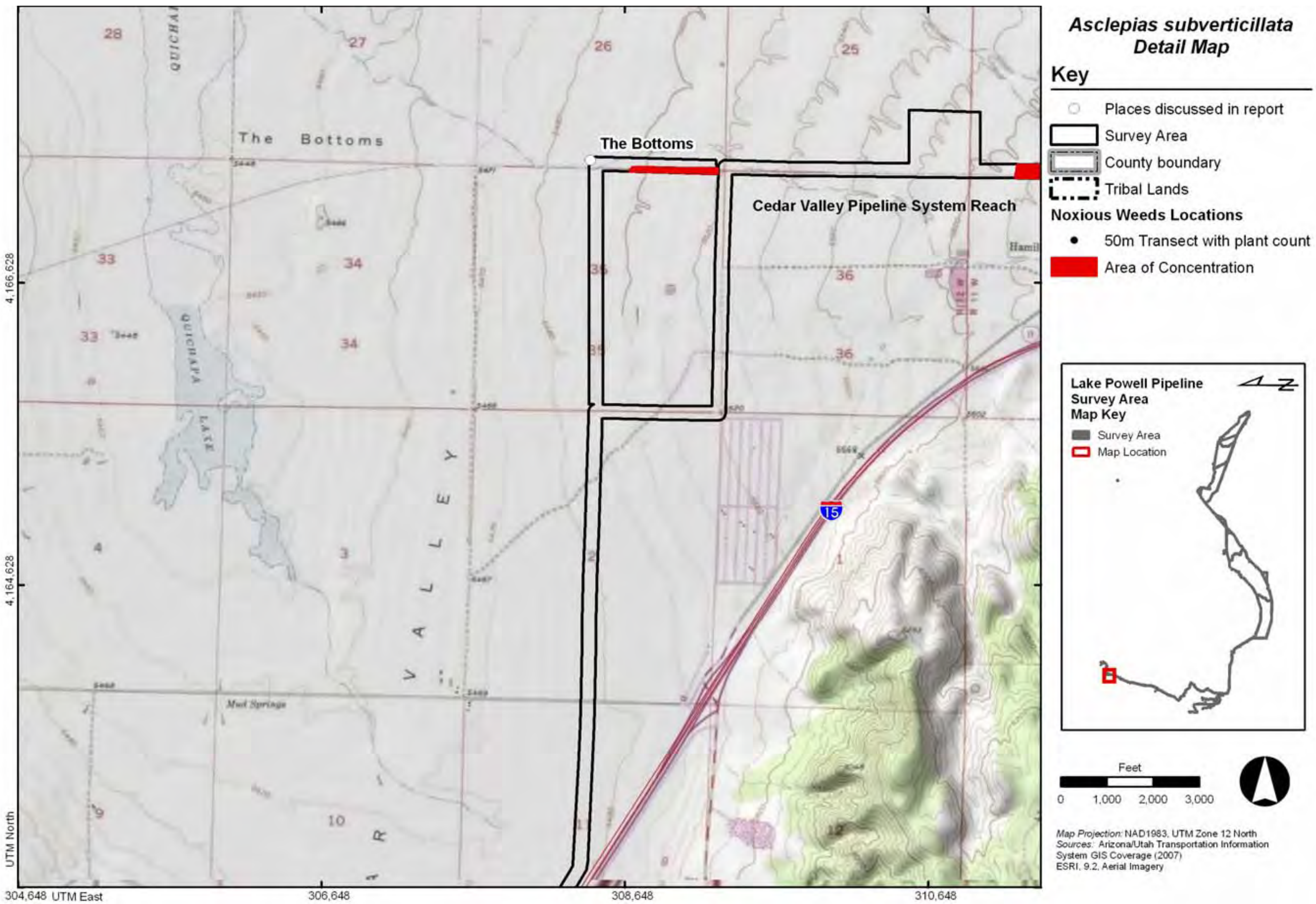
Map 5-23
***Asclepias subverticillata* Detail Map**



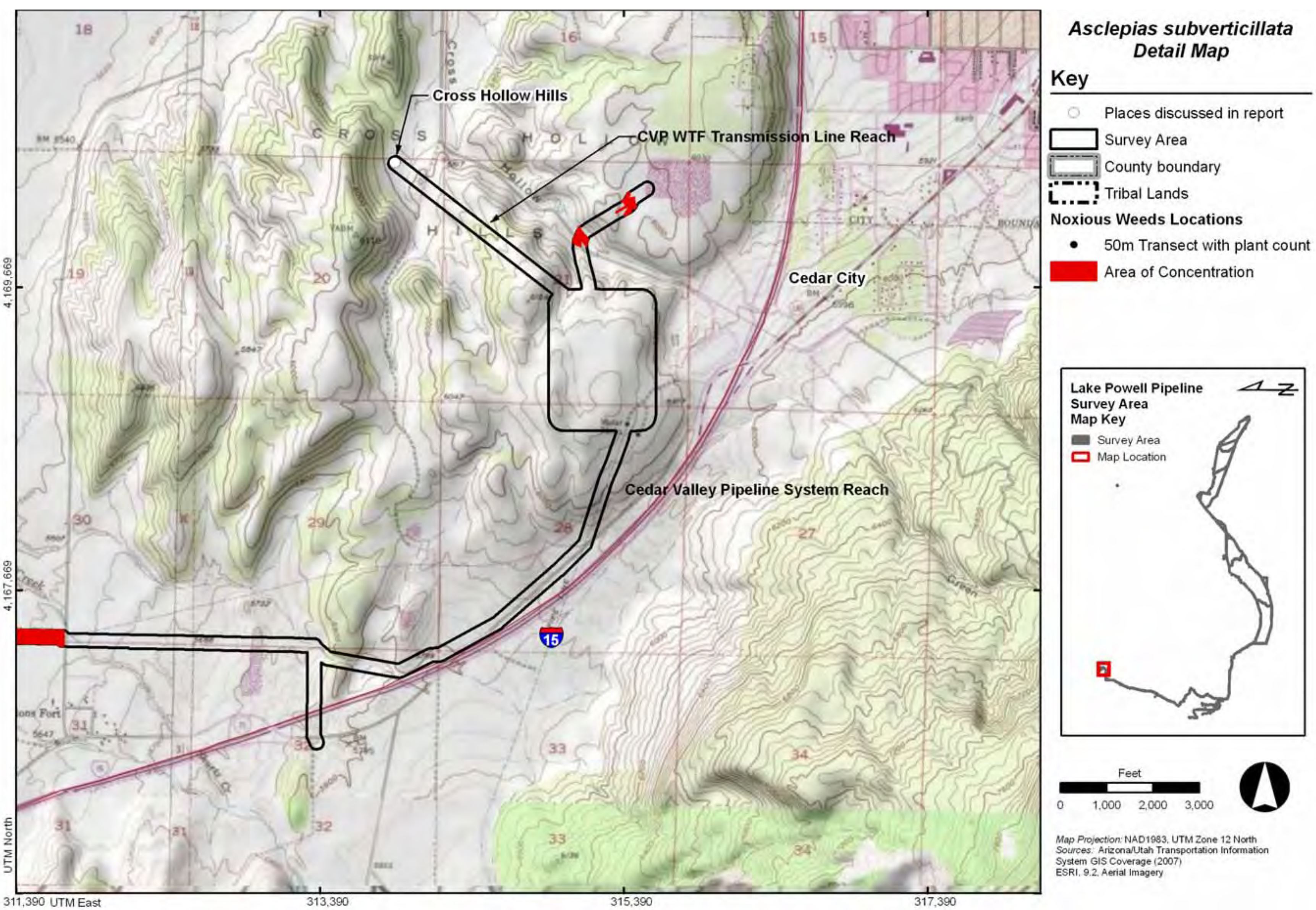
Map 5-24
***Asclepias subverticillata* Detail Map**



Map 5-25
***Asclepias subverticillata* Detail Map**



Map 5-26
***Asclepias subverticillata* Detail Map**



Map 5-27
***Asclepias subverticillata* Detail Map**

5.5.3 *Brassica tournefortii* (Sahara mustard)

5.5.3.1 Natural History

Brassica tournefortii is an annual in the Brassicaceae (Mustard family). *Brassica tournefortii* produces branching stems more than 3 feet (1 meter) in height, with downward-turning hairs at their bases. The stems arise from basal rosettes of leaves that are deeply lobed with serrate edges (Figure 5-5). Upper stem leaves are oblong to linear, tapered at the base, with finely toothed to lobed margins. In the winter, *B. tournefortii* produces light yellow, four-petaled flowers that are 0.15 to 0.30 inch (4 to 8 millimeters) long, and 0.04 to 0.08 inch (1 to 2 millimeters) wide. Fruits are siliques between 2 and 4 inches (3 and 7 centimeters) long, have a conical beak, and are strongly constricted between seeds, creating a beaded appearance. When mature, fruits open to release seeds that are round, 0.04 to 0.06 inch (1 to 1.5 millimeter) in diameter, and brownish-purple. Individual plants may produce up to 16,000 seeds, which fall near the parent plant but can be dispersed further by water, soil movement, and human activities (DiTomaso & Healy 2007). Additionally, when mature, dry plants break off and tumble in the wind, dispersing seeds along their path. In Utah and Arizona, *B. tournefortii* flowers early. In Arizona it is known to bloom as early as December or January, and to set seed in February (Welsh et al. 2008).

Figure 5-5
Close up view of *Brassica tournefortii* within the survey area

Brassica tournefortii appears similar to other yellow-flowered mustards, including other *Brassica* species and *Sinapsis* species. *Brassica tournefortii* can most easily be distinguished from these other taxa by the presence of hairs on the lower stems, and by the length and shape of the fruit beak (DiTomaso & Healy 2007).

Brassica tournefortii is native to North Africa, the Middle East, and the Mediterranean portions of southern Europe. *Brassica tournefortii* was first collected in the United States in 1927 and is believed to have been introduced into California with date palms brought from the Middle East (Sanders and Minnich 2000). The species spread into Utah sometime in the 1980s (Sanders and Minnich 2000), where it initially only occurred near the border along the road north of Littlefield, Arizona. However, more recently it has spread into Washington County (Welsh et al. 2008). The spread of *B. tournefortii* into Arizona occurred earlier, by the 1950s (Sanders and Minnich 2000), and it now is found in diverse natural and disturbed habitats at low elevations. *Brassica tournefortii* is common at disturbed sites, roadsides, and abandoned fields. It occurs throughout southwestern deserts in sandy soils, gravelly washes, low dunes, and rocky slopes (The Sonoran Institute 2008).

Brassica tournefortii can adversely affect desert tortoise, lizard, and mammal food sources, as it competes with or displaces native annual species through competition for soil moisture and nutrients. *Brassica tournefortii* is adapted to periodic fire, and contributes to increased fuel load and fire frequency (DiTomaso & Healy). The species can cause the conversion of desert scrub to grassland by increasing fire frequency, and by displacing native species that are not fire adapted (DiTomaso & Healy). *Brassica tournefortii*, along with other wild mustards, can harbor pests and diseases which may affect closely related crops. Additionally, *B. tournefortii* may become toxic to livestock if large quantities of seeds are ingested over time, or if eaten in large quantities with other species of mustards (DiTomaso & Healy).

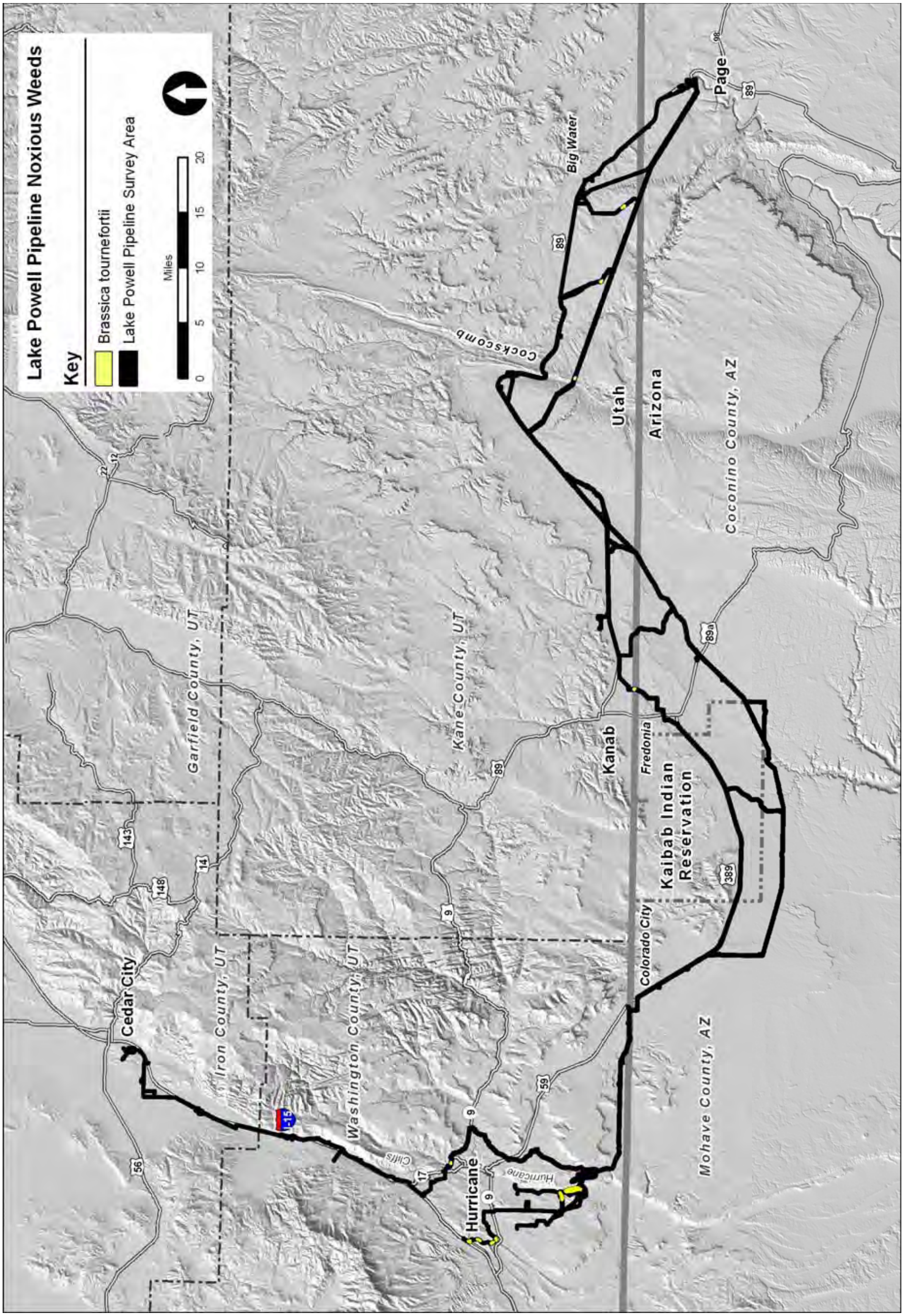
5.5.3.2 Survey Results

Brassica tournefortii occurred occasionally throughout the survey area (Map 5-28). The survey identified *B.tournefortii* in a total of eight reaches within the survey area (Map 5-29 to Map 5-36). In the BPS-2 Transmission Line Reach the species was identified northwest of Cedar Mountain; in the BPS-3 Transmission Line South Reach it was encountered northwest of Flat Top; in the Glen Canyon to Buckskin Transmission Line Reach it was located east of House Rock Valley Road; and in the Hydro System Existing Highway Alternative Reach it was found at the border of Kane County, Utah and Coconino County, Arizona (south of Lost Spring Gap). The species was also identified throughout much of the northeast portion of the Afterbay Reach. In the Penstock from Afterbay to Sand Hollow Hydro for Peaking Option Reach, the species was encountered in a large area west of the Sky Ranch Airport Community. In the Hurricane West to Quail Creek Reservoir Reach, *B. tournefortii* was encountered at several locations between Virgin River and Harrisburg; and in the Cedar Valley Pipeline System Reach the species was identified east of La Verkin Creek. *Brassica tournefortii* was not detected in any 50-meter belt transects; all encounters occurred while conducting special status species and noxious weed surveys.

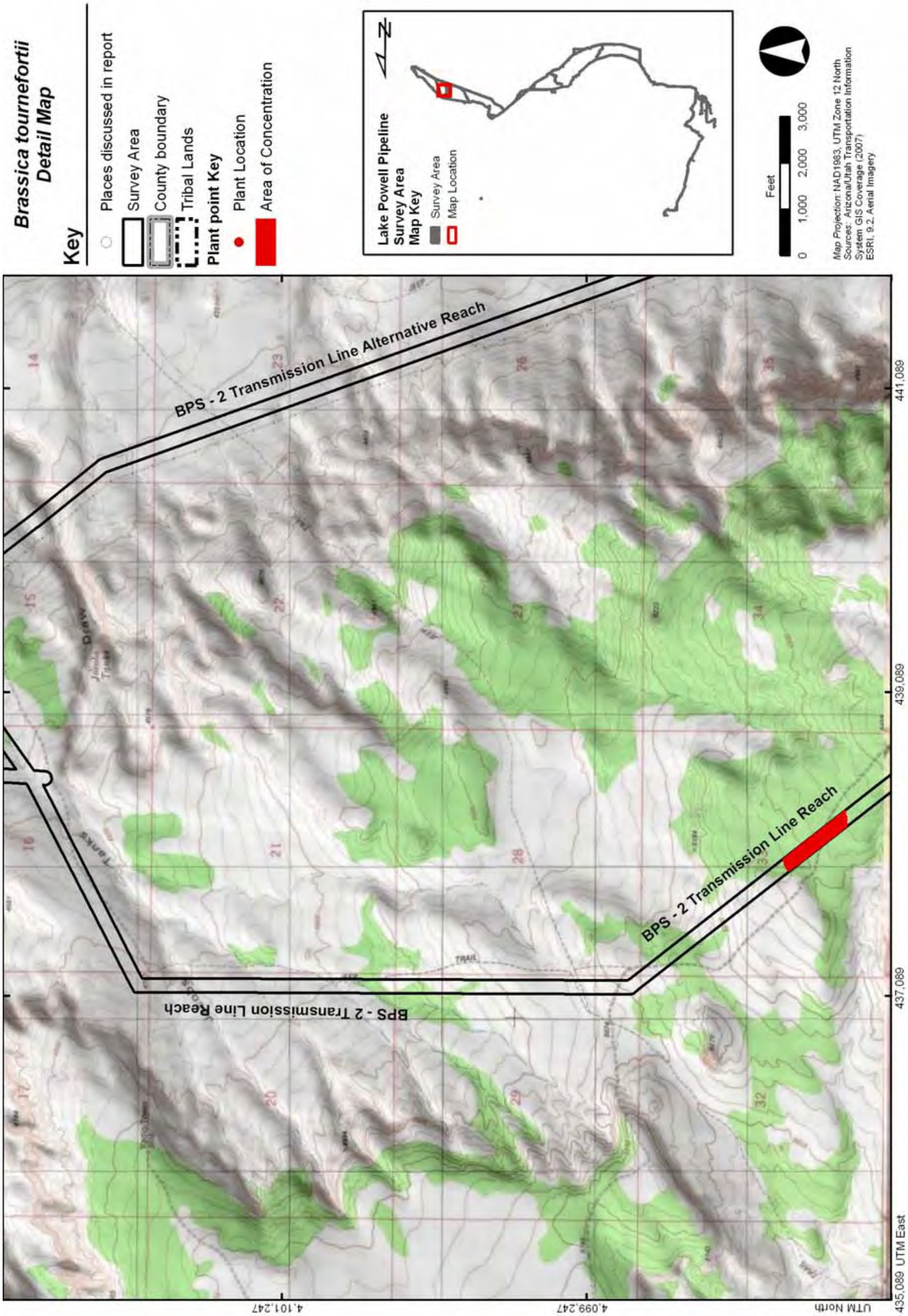
Brassica tournefortii was encountered in the Colorado Plateau and Mohave Desert Ecological Regions, where it occurred in seven ecological systems and two anthropogenic lands. On the Colorado Plateau *B. tournefortii* was identified in Big Sagebrush Shrubland, Juniper Savanna, Mixed Desert Scrub, and Pinyon-Juniper Woodland. In the Mohave Desert it was encountered in Blackbrush-Mormon-tea Shrubland, Creosote-White Bursage Desert Scrub, and Mixed Desert Scrub. Anthropogenic lands that provided habitat for *B. tournefortii* included those classified as Invasive Upland Vegetation and Ruderal Vegetation. In most instances, *B. tournefortii* was found in lands dominated or co-dominated by other non-native species such as *Bromus rubens, B. tectorum*, and *Erodium cicutarium*, although it was also found in habitats dominated by native species, including *Chrysothamnus viscidiflorus*, *Coleogyne ramosissima*, and *Eriogonum* spp. Populations were frequently encountered adjacent to disturbed areas, including agricultural and ruderal lands, and paved or graded roads. Encounters with *B. tournefortii* ranged from individuals to moderately-sized populations.

5.5.3.3 Discussion

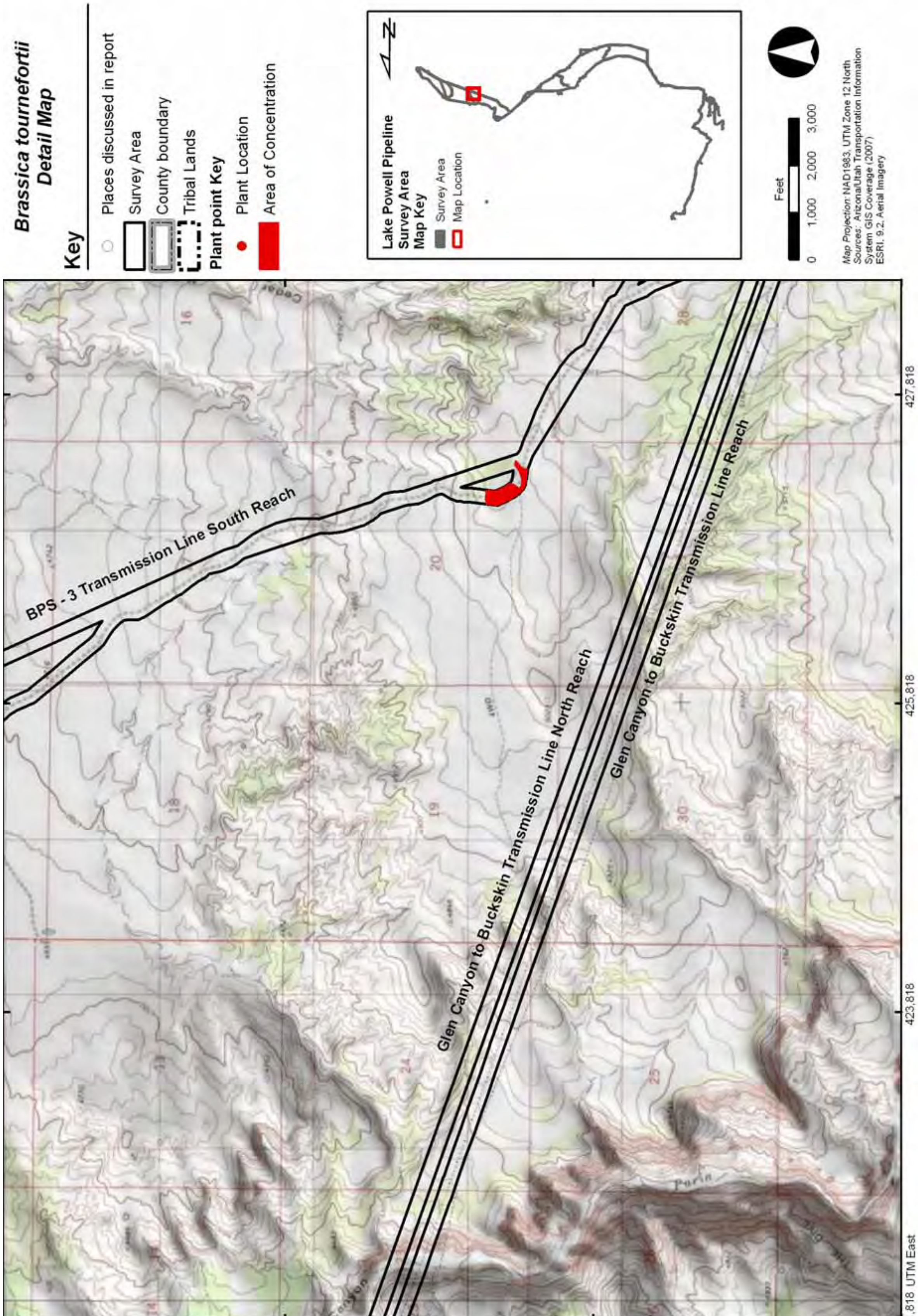
The survey identified *Brassica tournefortii* growing in numerous locations throughout the survey area, and in a wide range of ecological systems. Occurrences generally correlated with disturbance; individuals were encountered either within anthropogenic lands, or adjacent to disturbed areas, which likely served as travel survey areas for the species to spread into native-dominated habitats. Due to the ability of *B. tournefortii* to easily invade disturbed areas, it is expected that the project will contribute to the spread of *B. tournefortii* within and adjacent to the survey area. In order to reduce the likelihood of dispersing seeds, vehicle tires could be washed when departing sites where *B. tournefortii* has been identified. Skeletons of plants that are encountered could be removed from the survey area and destroyed, if possible, in order to limit the dispersal of seeds that may be retained on the dead plants. Additionally, due to the probability of viable seeds within the seed bank, topsoil from those areas should not be re-used, if at all possible.



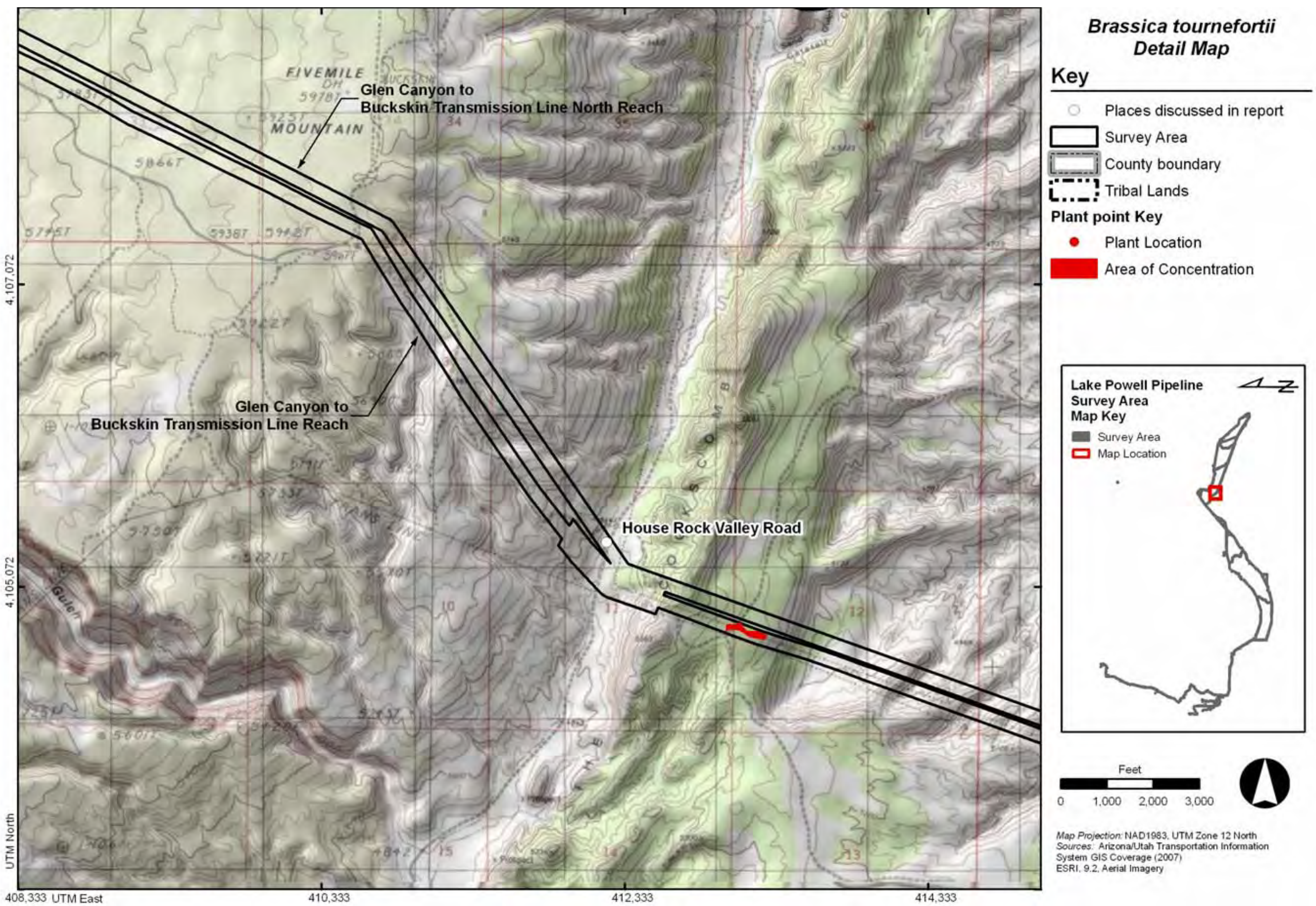
Map 5-28
***Brassica tournefortii* Overview Map**



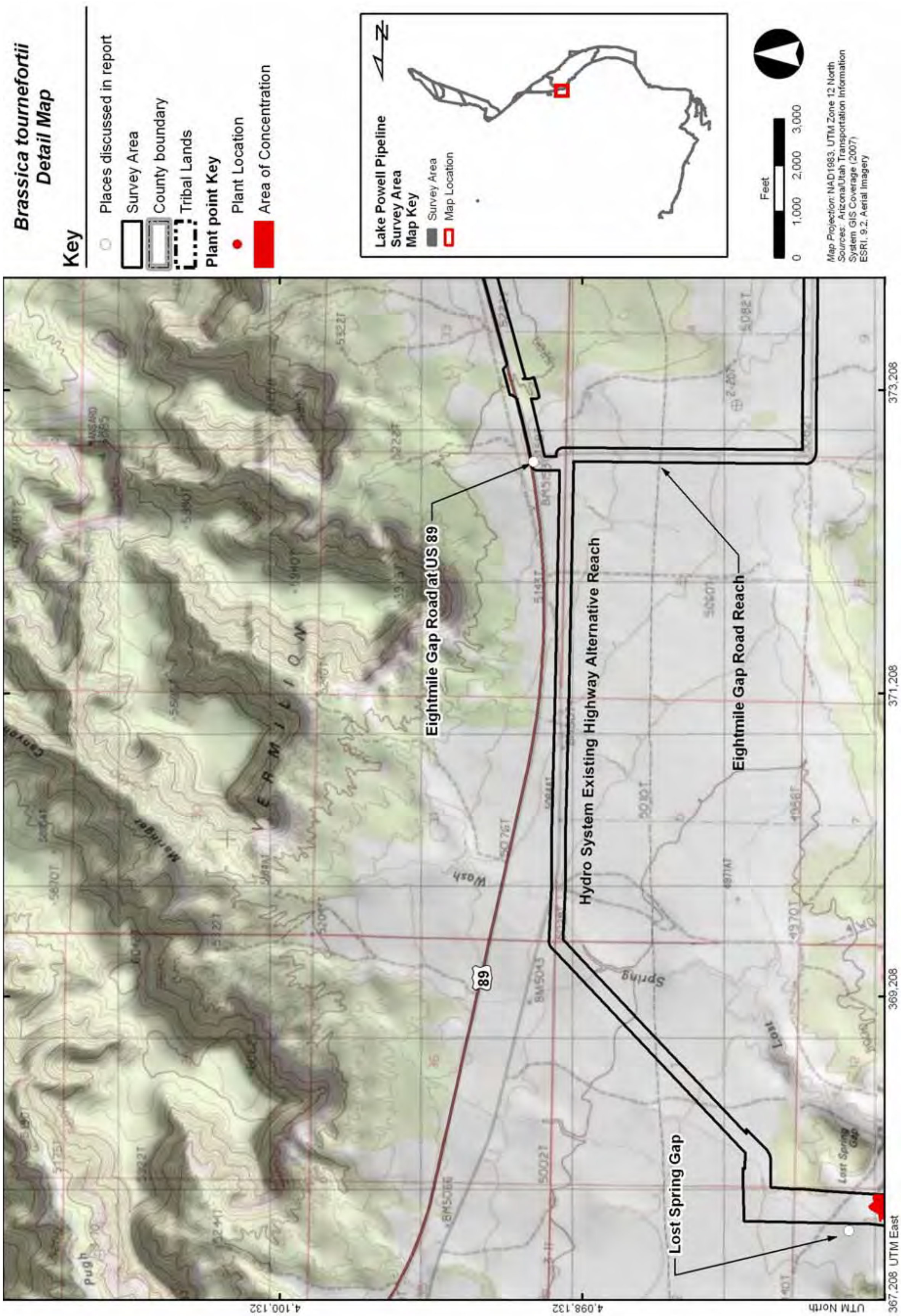
Map 5-29
***Brassica tournefortii* Detail Map**



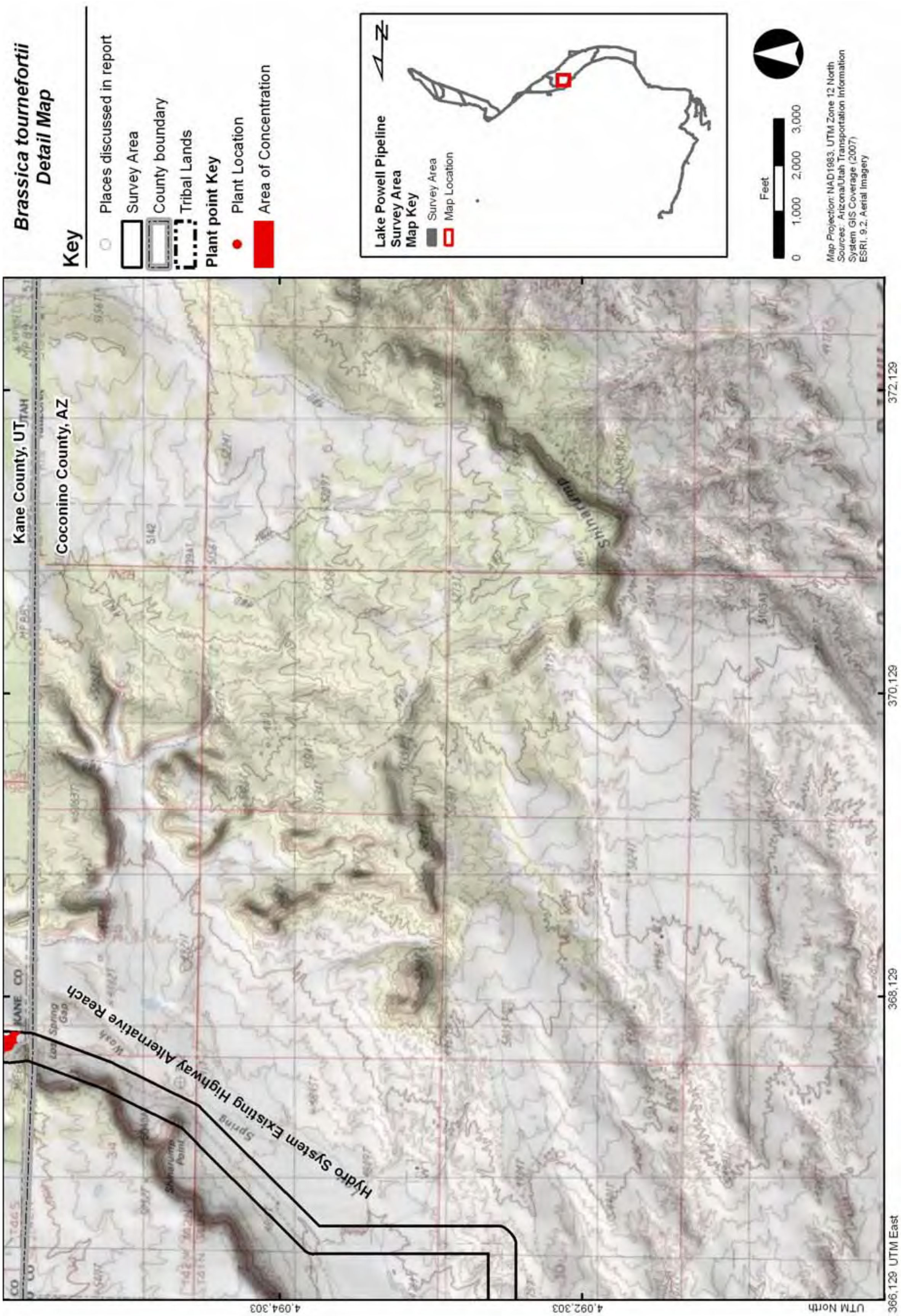
Map 5-30
***Brassica tournefortii* Detail Map**



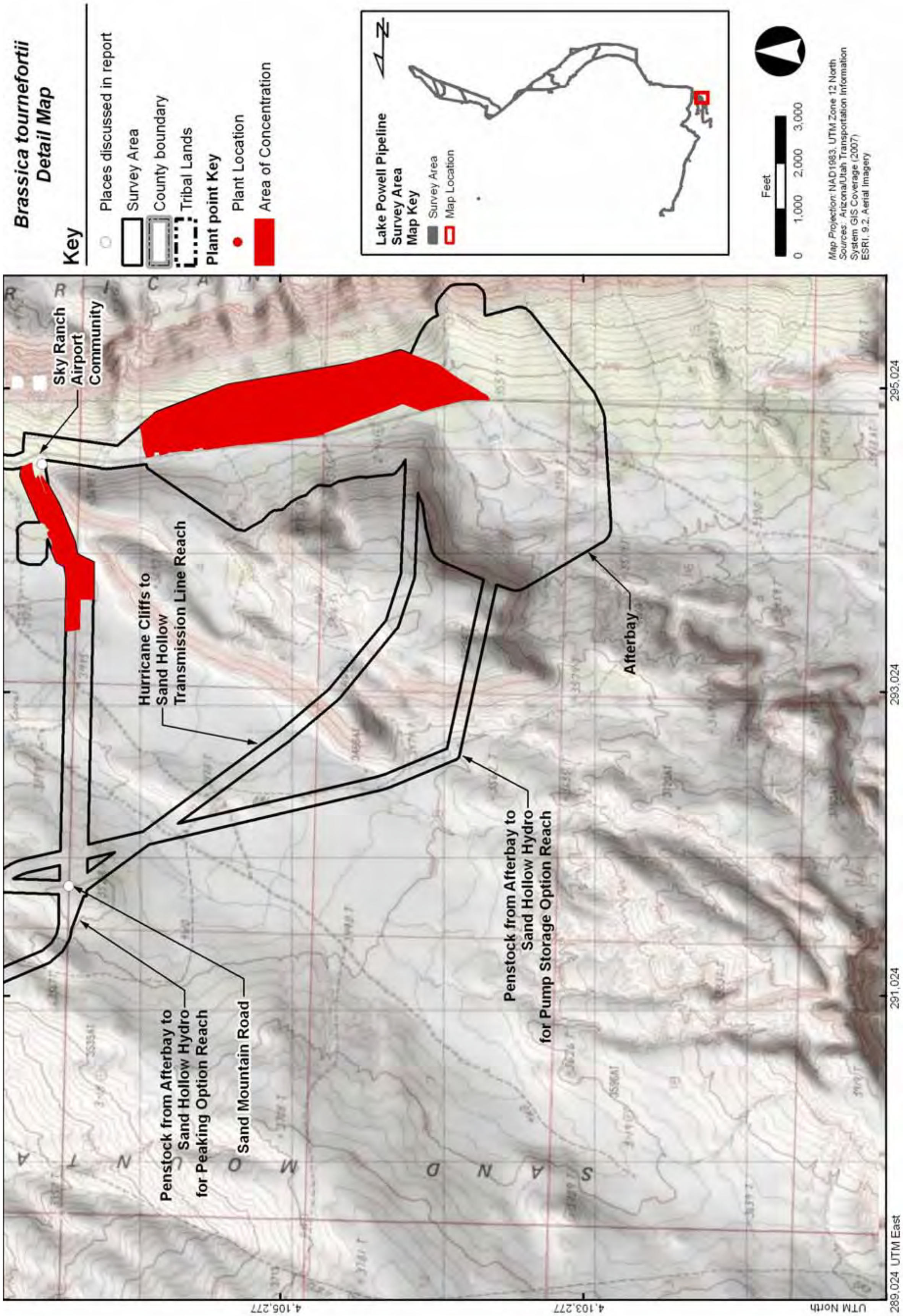
Map 5-31
***Brassica tournefortii* Detail Map**



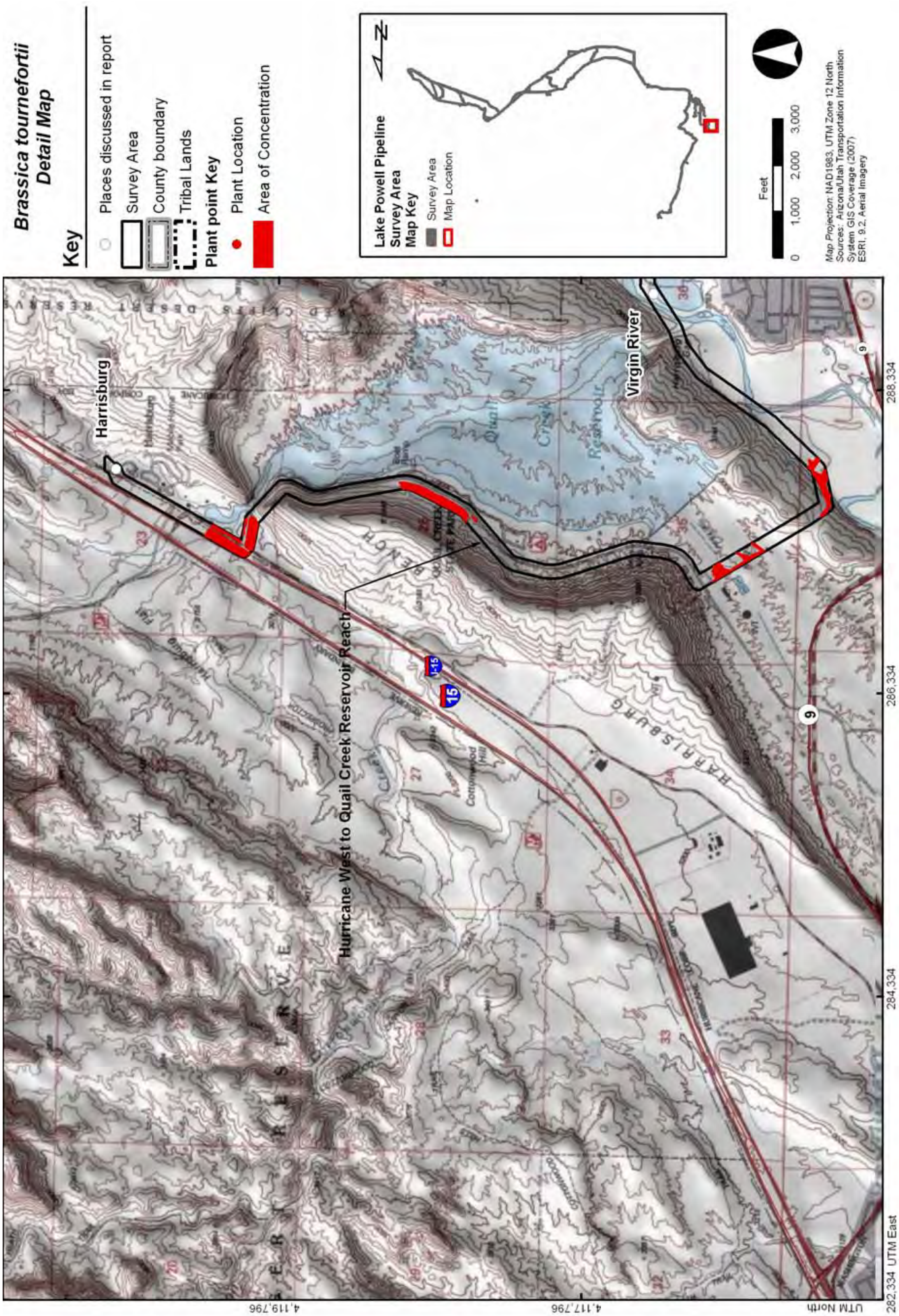
Map 5-32
Brassica tournefortii **Detail Map**



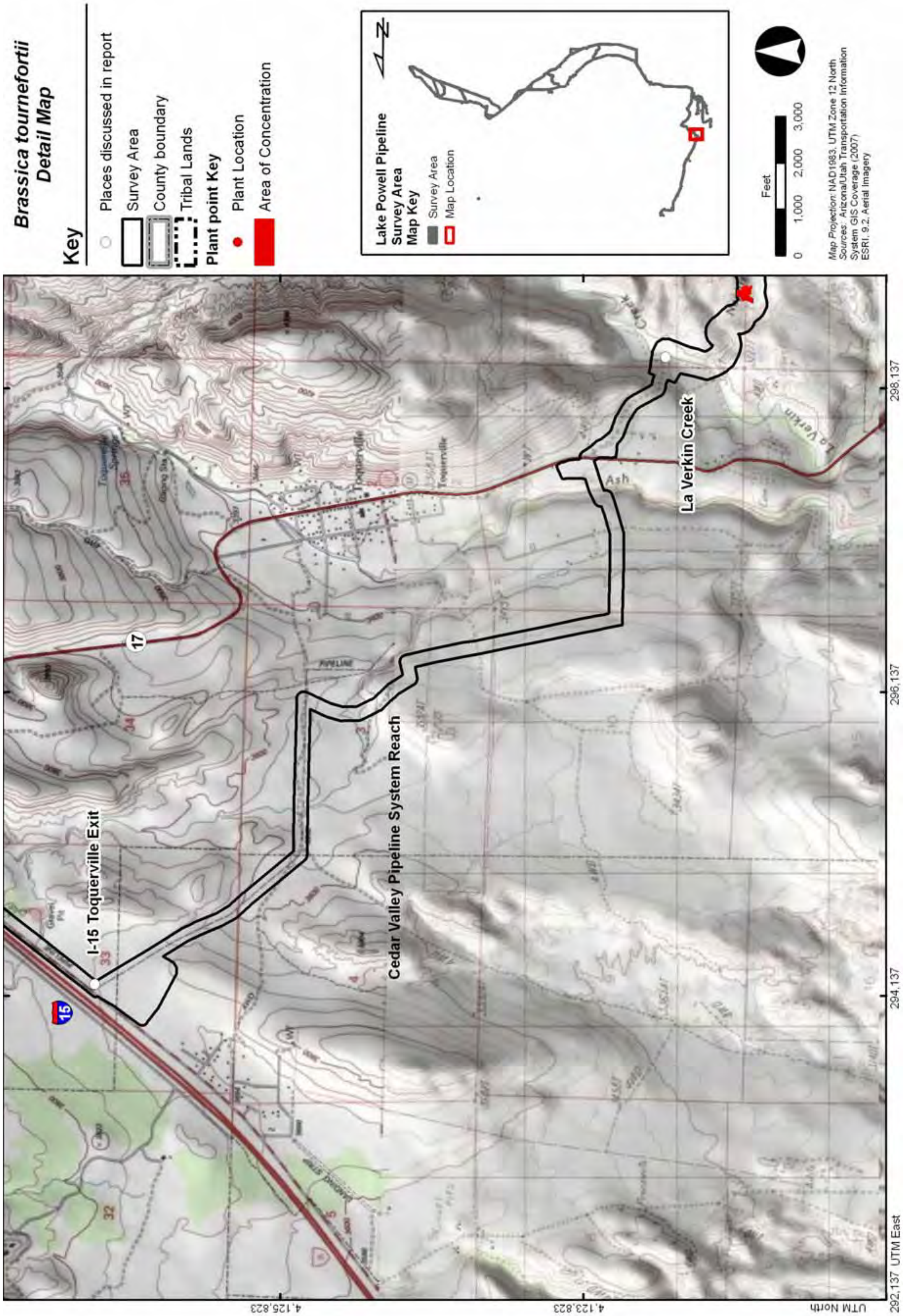
Map 5-33
***Brassica tournefortii* Detail Map**



Map 5-34
***Brassica tournefortii* Detail Map**



Map 5-35
***Brassica tournefortii* Detail Map**



Map 5-36
***Brassica tournefortii* Detail Map**

Figure 5-6
***Bromus rubens* within the survey area**

5.5.4 *Bromus rubens* (Red brome)

5.5.4.1 Natural History

Bromus rubens is a cool season annual in the Poaceae (Grass family). Stems are erect, typically pubescent, and grow to 20 inches (50 centimeters) tall (Figure 5-6). Leaf blades are also pubescent, flat, and 0.04 to 0.16 inch (1 to 4 millimeters) wide. Sheaths are closed for more than half their length, and often pubescent at the base. Ligules are 0.04 to 0.20 inch (1 to 5 millimeters) long. Roots are fibrous, and concentrated within the top 6 inches (15 centimeters) of the soil. *Bromus rubens* produces dense, head-like panicles 0.80 to 3.15 inches (2 to 8 centimeters) long that are often dark red, and contain mostly-hidden spikelets. Lemma awns are 0.40 to 1 inch (10 to 25 millimeters) long. The entire plant becomes purplish in color as it matures (Figure 5-7), eventually turning straw-colored. The seed heads also turn purplish, dispersing seeds soon after maturation. Seeds are dispersed short distances from the parent by wind or food-caching rodents, but can be disseminated further by water and soil movement, or by clinging to humans and animals. Seeds typically germinate quickly, following rain events, but may also remain dormant for up to 3 years in the seed bank (DiTomaso & Healy 2007).

Bromus rubens may be distinguished from other similar-looking brome grasses, including *B. diandrus, B. tectorum*, *B. madtritensis* ssp. *madritensis*, and *B. sterilis*, all of which are cool season annuals that occur throughout the west. Unlike *B. rubens*, *B. madritensis* produces panicles with visible spikelet stalks, and glabrous leaf sheaths. *Bromus sterilis*, *B. diandrus*, and *B. tectorum* all produce inflorescences which are open and loose panicles, which contrast with the dense panicles that are characteristic of *B. rubens*.

Bromus rubens is native to Eurasia, but since its introduction into British Columbia, has spread south throughout most of the western United States and Mexico (Welsh et al. 1993). *Bromus rubens* was reported in Utah in 1935, and occurs in blackbrush, creosotebush, and other mixed desert shrub communities from 2,295 to 5,610 feet in elevation. In Arizona, *B. rubens* invades scrublands, desertlands, grasslands, riparian habitats, and woodlands (The Sonoran Institute 2008). The species inhabits open disturbed areas, rangelands, fields, roadsides, forestry sites, and many natural plant communities. In desert communities, *B. rubens* often grows in dry sandy soils, where competition with other vegetation may be reduced (DiTomaso & Healy 2007).

Bromus rubens is highly invasive in natural Ecological Systems and in agricultural lands. Additionally, *B. rubens* is exceptionally slow to decay, which results in an abundance of dead stalks, and ultimately enhances the potential for the start and spread of fires (NatureServe 2009). The spread of *B. rubens* into desert shrubland and pinyon pine-juniper communities can cause the conversion of these communities into annual grasslands, as it increases the frequency and spread of wildfires which kill trees and shrubs. When mature, the sharp awns and florets of *B. rubens* can injure the digestive tracts, eyes, nostrils, and mouths of grazing animals (DiTomaso & Healy 2007). Infrequent soil disturbance and overgrazing can greatly increase the dominance of *B. rubens* by reducing the frequency of other species, giving them a competitive advantage.

5.5.4.2 Survey Results

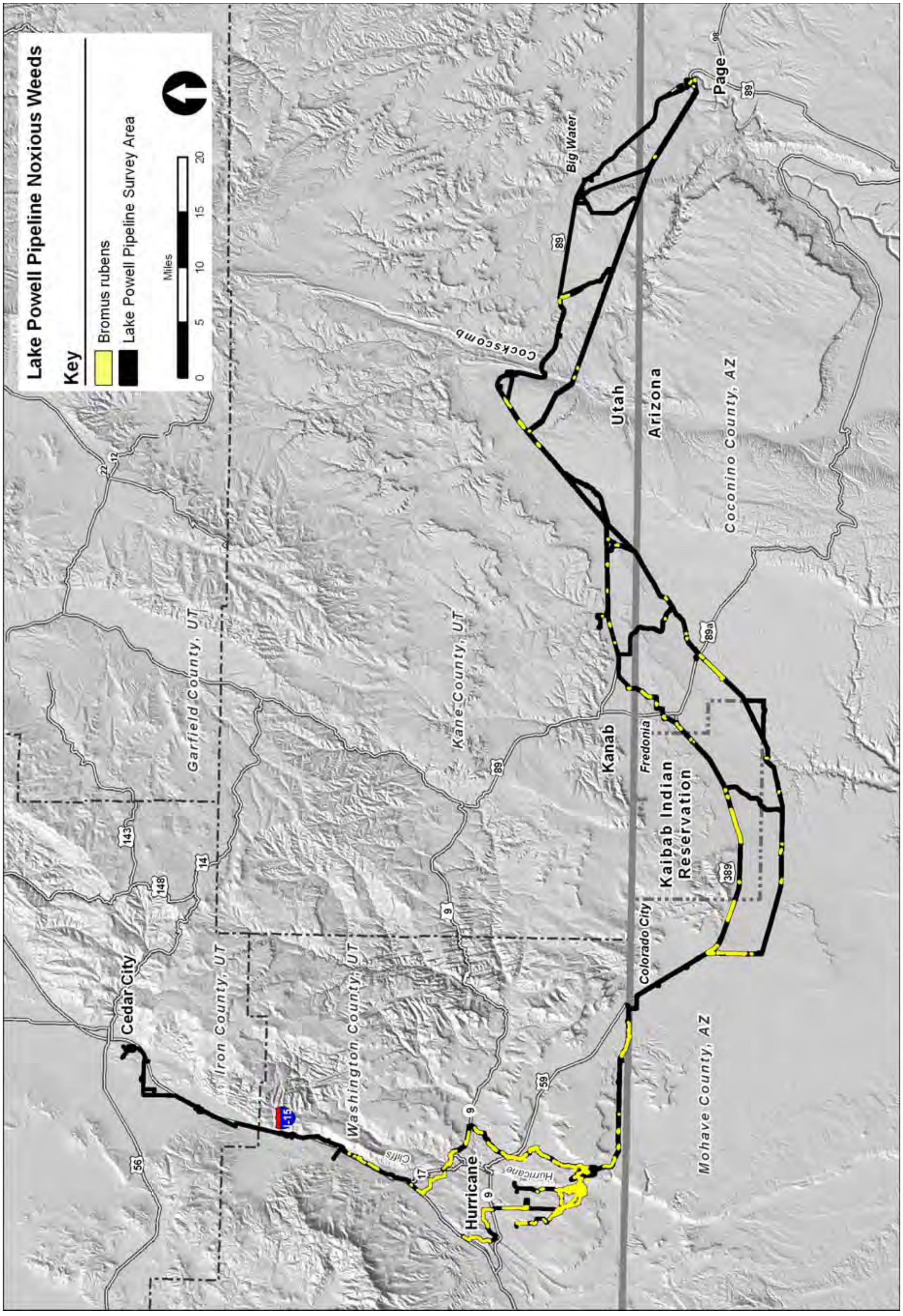
Figure 5-7
View of *Bromus rubens* and its habitat within the survey area

The survey identified *Bromus rubens* throughout the survey area, from the Colorado River at Glen Canyon Dam to the vicinity of Ash Creek Reservoir (Map 5-37). *Bromus rubens* occurrences were least frequent in the eastern portion of the survey area, with only sporadic occurrences in the vicinity of the Colorado River at Glen Canyon Dam, and increased in frequency moving toward the west. In all, *B. rubens* occurred in a total of 21 reaches. In the Glen Canyon Substation, the species was encountered in several locations near the Colorado River at Glen Canyon Dam. In the BPS-2 Transmission Line Reach, individuals were identified at one location southeast of Upper Blue Pool Wash; and in the BPS-3 Transmission Line South Reach it was encountered near Cottonwood Canyon Road. In the Hydro System Reach the species was found west of Cottonwood Canyon Road, and also at several locations near the border of Washington County, Utah and Mohave County, Arizona (between Colorado City and the area around Honeymoon Trail). In the Glen Canyon to Buckskin Transmission Line Reach, *B. rubens* was identified near House Rock Valley Road; and in the Water Conveyance System Reach, it was found at several locations between Kimball Valley and Buckskin Gulch. *Bromus rubens* was also encountered at the Buckskin Substation. In the Hydro System South Alternative Reach, individuals were encountered near Shinarump Cliffs, sporadically between White Sage Wash and Moonshine Ridge, and in a large area south of Yellowstone Road at AZ Route 389. In the Hydro System Existing Highway Alternative Reach it was encountered occasionally between Seaman Wash and Twomile Wash, and in several large areas between Twomile Wash and Yellowstone Road at AZ Route 389. The species was also identified near Johnson Canyon in the Kane County Pipeline System Reach and at Johnson Wash in the Eightmile Gap Road Reach. *Bromus rubens* occurred in several locations in the Forebay and throughout much of the Afterbay Reach. It also occurred in the Hurricane Cliffs to Sand Hollow Transmission Line Reach, and the Penstock from Afterbay to Sand Hollow Hydro for Pump Storage Option Reach. Individuals were encountered in the Hurricane Cliffs Afterbay to Hurricane West Transmission Line Reach. It was also found at the Hurricane West Substation, throughout much of the Hurricane West to Quail Creek Reservoir Reach, and near the Sand Hollow Reservoir in the Sand Hollow to Dixie Springs Transmission Line Reach. In the Cedar Valley Pipeline System Reach, *B. rubens* occurred throughout much of the area from the Divide to the vicinity of Pintura. Encounters with *B. rubens* occurred while conducting surveys for special status species and noxious weeds, but the species also was prevalent in many 50-meter belt transects, occurring in a total of 84.

Bromus rubens was encountered in all three Ecological Regions, in a total of 27 ecological systems and five anthropogenic lands. On the Colorado Plateau, *B. rubens* occurred in 13 ecological systems: Active and Stabilized Dune, Big Sagebrush Shrubland, Blackbrush-Mormon-tea Shrubland, Grassland, Gypsum Badland, Lower Montane Riparian Woodland and Shrubland, Mixed Bedrock Canyon and Tableland, Mixed Desert Scrub, Mixed Low Sagebrush Shrubland, Pinyon-Juniper Woodland, Shrub-Steppe, Volcanic Rock and Cinder Land, and Colorado Plateau Wash. In the Great Basin, *B. rubens* was encountered in three ecological systems: Big Sagebrush Shrubland, Mixed Desert Scrub, and Pinyon-Juniper Woodland. In the Mohave Desert, *B. rubens* was identified in 11 ecological systems: Active and Stabilized Dune, Bedrock Cliff and Outcrop, Blackbrush-Mormon-tea Shrubland, Creosote-White Bursage Desert Scrub, Grassland, Gypsum Badland, Lower Montane Riparian Woodland and Shrubland, Mixed Desert Scrub, Shrub-Steppe, Volcanic Rock and Cinder Land, and Mohave Desert Wash. Anthropogenic lands which supported *B. rubens* included Agricultural Land, Developed Road, Developed Land, Invasive Upland Vegetation, and Ruderal Vegetation. Of all ecological systems, the species was most commonly found in Colorado Plateau Mixed Desert Scrub. In nearly all locations where individuals were encountered, *B. rubens* was common or abundant, occurring in large quantities. Often, *B. rubens* was co-dominant with other invasive species, particularly *B. tectorum* and *Erodium cicutarium*, and frequently was a dominant groundcover amongst native shrubs, including *Artemisia* spp., *Atriplex* spp., *Coleogyne ramosissima, Ephedra* spp., *Gutierrezia sarothrae,* or *Larrea tridentata*.

5.5.4.3 Discussion

Bromus rubens was found to be widespread throughout much of the survey area, and was encountered in large quantities within a wide range of ecological systems. *Bromus rubens* thrives on newly disturbed areas, easily able to invade these habitats once they are cleared of established vegetation; additionally, its seed is easily transported via human activities and vehicles. Therefore, it is highly likely that the project will enhance the spread of the species within and adjacent to the survey area. In order to minimize this impact, prior to departing work areas where infestations of *B. rubens* exist, vehicle tires could be washed, and care should be taken to check clothing for embedded seeds. Additionally, seeding areas with native herbaceous species promptly after completion of earthwork will further reduce the establishment of *B. rubens*.



Map 5-37
***Bromus rubens* Overview Map**

5.5.5 *Bromus tectorum* (Cheatgrass)

5.5.5.1 Natural History

Figure 5-8
Close-up view of *Bromus tectorum* (with *B. rubens*)

Bromus tectorum is a cool-season annual in the Poaceae (Grass family). The stems of *B. tectorum* are erect, and grow to 15 inches (40 centimeters) tall (Figure 5-8). Leaf blades are 0.04 to 0.24 inch (1 to 6 millimeters) wide, nearly glabrous to pubescent. Like *B. rubens*, sheaths are closed for more than half their length, and lower sheaths are generally pubescent. Ligules are 0.06 to 0.12 inch (1.5 to 3 millimeters) long. Roots are fibrous, and typically concentrated within the top 6 inches (15 centimeters) of the soil, although in some areas, including the Great Basin, mature roots may reach a depth of more than 3 feet (1 meter). *Bromus tectorum* produces open, loose panicles between 2and 9 inches (6 and 22 centimeters) long, which often droop on one side. Panicles are branched, each branch containing between 4 and 8 spikelets. Lemma awns are 0.30 to 0.70 inch (8 to 18 millimeters) long. As with *B. rubens*, *B. tectorum* may become purplish as it matures, producing seeds which are dispersed by wind, water, or soil movement. Seeds are also easily dispersed by human activities, upland birds and small mammals, and may remain viable in the soil for up to 5 years (DiTomaso & Healy 2007).

Bromus tectorum may be distinguished from other similar-looking brome grasses, including *B. rubens*, *B. diandrus*, and *B. sterilis*. *Bromus tectorum* is very similar in appearance to *B. diandrus*, as both species produce open and loose panicles that droop. However, *B. diandrus* can grow to nearly double the height of *B. tectorum*, and produces awns that are double the length of those produced by *B. tectorum*. *Bromus tectorum* can be distinguished from *B. sterilis* by its spikelets, which are fewer in number (only 1 to 3 spikelets per branch rather than 4 to 8), and its awns, which, like *B. diandrus*, are nearly double the length of *B. tectorum*. The open, loose panicles of *B. tectorum* differentiate the species from *B. rubens*, which has dense, tight panicles.

Bromus tectorum is native to much of Europe, the northern rim of Africa, and southwestern Asia, but has been introduced to North America, temperate South America, Japan, South Africa, Australia, New Zealand, and Iceland (Zouhar 2003). *Bromus tectorum* entered North America via ship ballast, contaminated crop seed, and packing material, and now occurs throughout most of the United States, Canada, and northern Mexico. In the United States the species is present in a variety of ecological systems including pinyon-juniper, sagebrush, desert shrub, southwestern shrubsteppe, and desert grasslands. *Bromus tectorum* is most widespread in sagebrush steppe communities of the Intermountain West, but is also common in black greasewood-shadscale and salt-desert shrub communities (Zouhar 2003). Found throughout Utah and Arizona, *B. tectorum* is common in recently burned rangeland and wildlands, roadsides, waste areas, cultivated crop areas, and overgrazed grasslands (Whitson et al. 1996). In Utah, the species is especially invasive in sagebrush steppe and bunchgrass regions, where it occurs in and often dominates large acreages of rangeland where native dominants include big sagebrush (*Artemisia* *tridentata*), needle-and-thread grass (*Hesperostipa comata*), spiny hopsage (*Grayia spinosa*), and rabbitbrush (*Chrysothamnus* spp) (Zouhar 2003). In Arizona, *B. tectorum* is found from salt-desert shrub communities which receive six inches of precipitation annually, to high-elevation coniferous forests that exceed 25 inches of rain annually (The Sonoran Institute 2008).

Bromus tectorum presents many of the problems associated with *B. rubens*. As with *B. rubens*, the spread of *B. tectorum* into desert shrubland and pinyon pine-juniper communities can cause the conversion of these communities into annual grasslands by increasing frequency and spread of wildfires, which kills trees and shrubs. When mature, the sharp awns and florets of *B. tectorum* can injure the digestive tracts, eyes, nostrils, and mouths of grazing animals (DiTomaso & Healy 2007). Infrequent soil disturbance and overgrazing can greatly increase the dominance of *B. rubens* by reducing the frequency of other species.

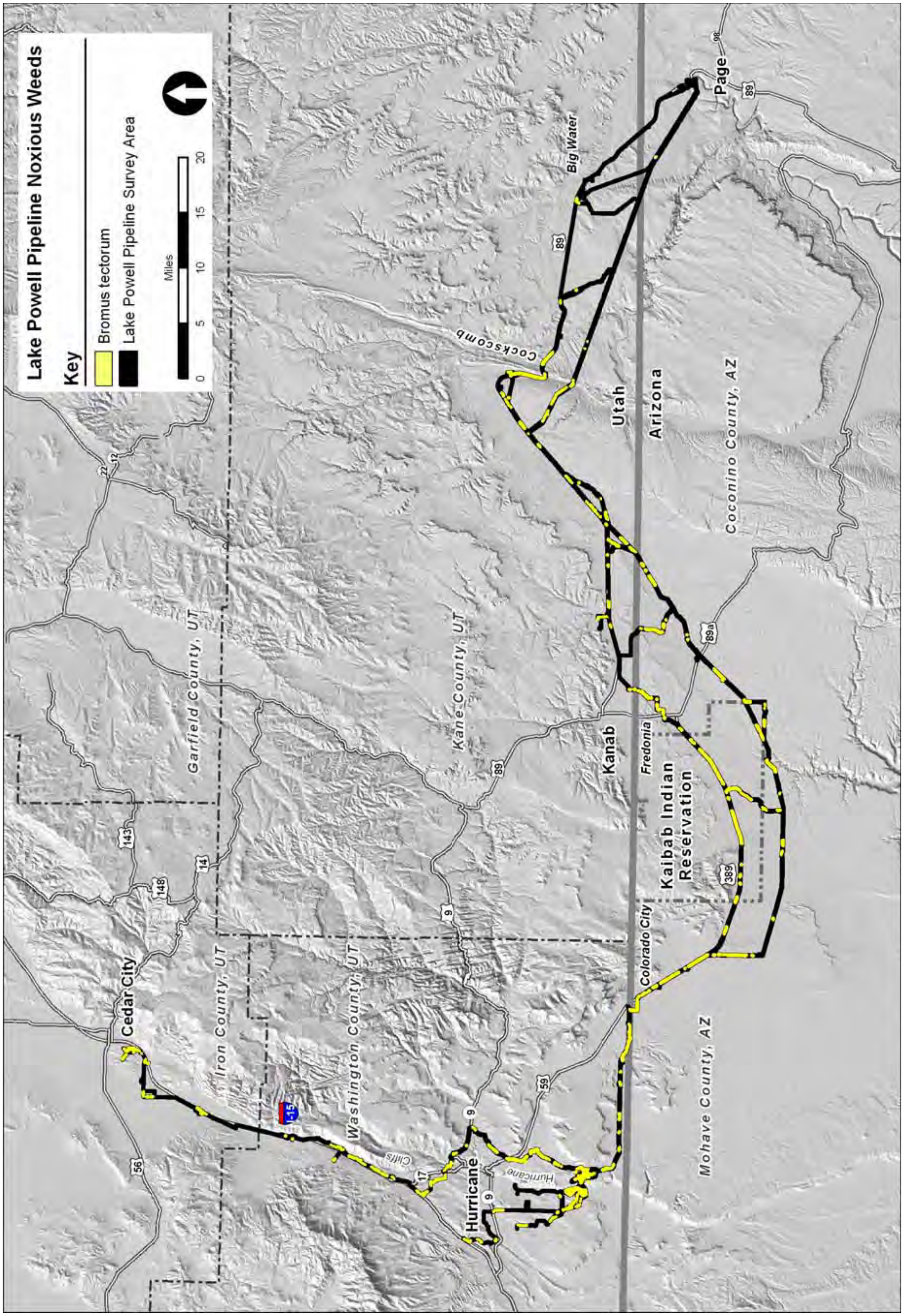
5.5.5.2 Survey Results

The survey identified *Bromus tectorum* throughout much of the survey area, from the vicinity of Upper Blue Pool Wash to Cedar City (Map 5-38). Occurrences of *B. tectorum* were most frequent in the central and western portions of the survey area, from the Cockscomb and extending to the area around Hurricane. From Blue Pool Wash to the Cockscomb, encounters were more sporadic. In total, *B. tectorum* occurred in 17 reaches. The species was found southeast of Upper Blue Pool Wash and north of Jacob's Tank Road at US 89 in the BPS-2 Transmission Line Alternative Reach, and also in the Water Conveyance System Reach near Jacob's Tank Road at US 89. It was encountered south of Cottonwood Canyon Road in the BPS-3 Transmission Line South Reach. In the Hydro System Reach the species was found east of East Cove, at several locations between Upper Paria River and the Cockscomb, in the vicinity of Petrified Hollow Wash, in much of the area from Yellowstone Road at AZ Route 389 to east of Short Creek at Canaan Gap, and at sporadic locations between Short Creek at Canaan Gap and the area around Honeymoon Trail. *Bromus tectorum* was identified in much of the central portion of the Forebay and throughout much of the Afterbay Reach. It was observed at several locations in the Hurricane Cliffs to Sand Hollow Transmission Line Reach, and in the Penstock from Afterbay to Sand Hollow Hydro for Pump Storage Option Reach. In the Penstock from Afterbay to Sand Hollow Hydro for Peaking Option Reach, it was encountered west of the Sky Ranch Airport Community. In the Hurricane Cliffs Afterbay to Hurricane West Transmission Line Reach it was found northwest of the Hurricane Airport. *Bromus tectorum* was identified at several locations between the Virgin River and Harrisburg in the Hurricane West to Quail Creek Reservoir Reach, and in the area north of Sand Hollow Reservoir in the Sand Hollow to Dixie Springs Transmission Line Reach. The species was found in the Cedar Valley Pipeline System Reach, in multiple locations from the Divide to the vicinity of Ash Creek Reservoir, sporadically from Ash Creek Reservoir to the Bottoms, and in multiple locations around Cedar City. It was encountered in the northwest portion of the CBPS-Transmission Line Reach, at one location in the CPBS-2 Transmission Line Reach, and in much of the CPBS-3 Transmission Line Reach and CVP WTF Transmission Line Reach. The species was also found at the Henrieville Substation. Encounters with *B. tectorum* occurred while conducting surveys for special status species and noxious weeds, but the species was also prevalent in many 50-meter belt transects, occurring in a total of 108.

Bromus tectorum was encountered in all three Ecological Regions, in a total of 31 ecological systems and four anthropogenic lands. On the Colorado Plateau, *B. tectorum* occurred in 15 ecological systems: Active and Stabilized Dune, Big Sagebrush Shrubland, Blackbrush-Mormon-tea Shrubland, Grassland, Greasewood Flat, Gypsum Badland, Juniper Savanna, Lower Montane Riparian Woodland and Shrubland, Mixed Bedrock Canyon and Tableland, Mixed Desert Scrub, Mixed Low Sagebrush Shrubland, Pinyon-Juniper Woodland, Shrub-Steppe, Volcanic Rock and Cinder Land, and Colorado Plateau Wash. In the Great Basin, *B. tectorum* was encountered in six ecological systems: Big Sagebrush Shrubland, Chaparral, Lower Montane Riparian Woodland and Shrubland, Mixed Desert Scrub, Pinyon-Juniper Woodland, and Semi-Desert Grassland. In the Mohave Desert, *B. tectorum* was identified in ten ecological systems: Active and Stabilized Dune, Bedrock Cliff and Outcrop, Blackbrush-Mormon-tea Shrubland, Creosotebush-White Bursage Desert Scrub, Grassland, Lower Montane Riparian Woodland and Shrubland, Mixed Desert Scrub, Shrub-Steppe, Volcanic Rock and Cinder Land, and Mohave Desert Wash. Anthropogenic lands which supported *B. tectorum* included Agricultural Land, Developed Land, Invasive Upland Vegetation, and Ruderal Vegetation. Individuals occurred most commonly in Colorado Plateau Big Sagebrush Shrubland and Colorado Plateau Mixed Desert Scrub. In nearly all locations where encountered, *B. tectorum* was common or abundant, occurring in large quantities, and was often a dominant member of the vegetative community. *Bromus tectorum* was often co-dominant with other invasive species, *B. tectorum* and *Erodium cicutarium* in particular, and also was a dominant groundcover amongst native shrubs, including *Larrea tridentata, Gutierrrezia sarothrae, Coleogyne ramosissima, Purshia stansburiana, Artemisia* spp., *Ephedra* spp., or *Atriplex* spp.

5.5.5.3 Discussion

Bromus tectorum was identified as widespread throughout much of the survey area, and was one of the most abundant noxious weeds encountered. The species was found in a wide range of ecological systems and in many anthropogenic lands. Like *B. rubens*, *B. tectorum* is able to easily invade newly disturbed habitats, and its seed is easily transported by humans and vehicles. Therefore, the project will undoubtedly enhance the spread of the species within and adjacent to the survey area. In order to minimize this impact, prior to departing work areas where infestations of *B. tectorum* exist, vehicle tires could be washed, and care should be taken to check clothing for embedded seeds. Additionally, seeding areas with native herbaceous species promptly after completion of earthwork is suggested, as it will further reduce the establishment of *B. tectorum*.



Map 5-38
***Bromus tectorum* Overview Map**

5.5.6 *Cardaria draba* (Hoary cress)

5.5.6.1 Natural History

Cardaria draba is an herbaceous perennial in the Brassicaceae (Mustard family). *Cardaria draba* produces erect stems up to 2 feet (60 cm) tall (Whtison et. al 2009) that can be sparsely to densely covered with short hairs. Leaves are gray-green, attached alternately, 3.5 inches (9 centimeters) long and 1.5 inch (4 centimeters) wide, and have rounded-acute lobes at the base that clasp the stem. Both the upper and lower leaf surfaces are covered with short hairs. Roots are extensive, deep (up to 6.5 feet [2 meters]), and run both vertically and horizontally. Horizontal roots produce new shoots and are able to generate new plants from fragments. The inflorescences of *C. draba* are compound, flat-topped to rounded corymbs which produce numerous white flowers, each 4-petaled and 0.08 to 0.16 inch (2 to 4 millimeters) long. Fruits are glabrous, 2-chambered inflated pods shaped like upside-down hearts. A single plant may produce up to 4,800 seeds, which remain viable for short periods of time (DiTomaso & Healy 2007). Above-ground growth emerges in the spring, and plants generally flower and set seed by the middle of summer (Whitson et al. 2009).

Cardaria draba may be confused with other *Cardaria* spp., but the species may be differentiated by their fruit. In contrast to the heart-shaped seed pods of *C. draba, C. chalepensis* produces disk-shaped or kidney-shaped pods, while *C. pubescens* seed pods are spherical or ovoid in shape.

Cardaria draba was introduced to the United States from Europe and Western Asia. *Cardaria draba* is common in the Great Basin and Southwest, and has spread throughout western states, with the exception of New Mexico. In Utah, *C. draba* has been identified in cultivated places and waste areas in many counties, including Iron and Washington, from 4,200 to 8,800 feet in elevation (Welsh et al. 1993). In Arizona, *C. draba* is common on ranches in Apache, Yavapai, and Coconino Counties, including the Fredonia area, but is found on occasion in other areas of the state, from 3,500 to 7,000 feet in elevation (Parker 2003). *Cardaria draba* inhabits disturbed open sites, pastures, fields, grain and vegetable crops, roadsides, and ditches, and generally grows in saline or alkaline soils, but is tolerant of a range of soil types (DiTomaso & Healy 2007).

Cardaria draba can be a threat to both natural communities and irrigated crops. In natural communities, *C. draba* competes poorly with established shrubs. However, once established, *C. draba* spreads quickly through vegetative means, and is difficult to eliminate because its deep roots are difficult to remove. Cultivation can also spread *C. draba*, as individuals propagate by root fragments. The species is particularly problematic to alfalfa and sugar beet crops (DiTomaso & Healy 2007).

5.5.6.2 Survey Results

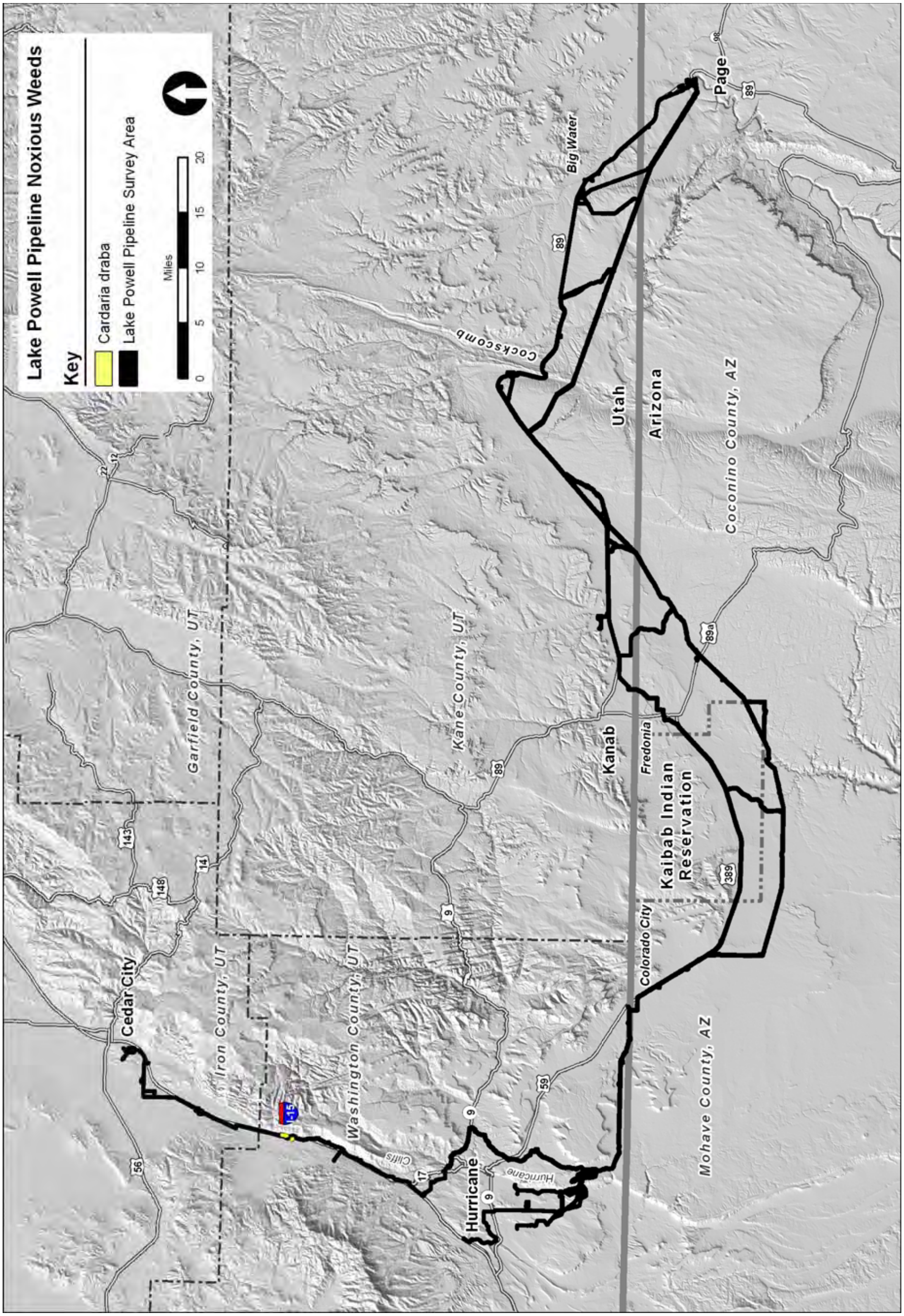
The survey encountered *Cardaria draba* infrequently (Map 5-39). *Cardaria draba* was found within only two reaches, both in the northern portion of the survey area (Map 5-40). The encounters were south of the border between Iron County and Washington County (north of Ash Creek Reservoir), in the CBPS-2 Transmission Line Reach and the Cedar Valley Pipeline System Reach. Individuals were detected in a total of five 50-meter belt transects (Transects # 483, 484, 485, 486, and 487; Figure 5-9).

Cardaria draba was identified in the Great Basin Ecological Region, and all occurrences were within the Big Sagebrush Shrubland ecological system, in Agricultural Land and in Invasive Upland Vegetation. *Cardaria draba* was a co-dominant member of vegetation communities within the Big Sagebrush Shrubland ecological system, and was a prominent feature on the landscape within invasive upland vegetation. In agricultural lands, the abundance of *C. draba* was somewhat less, occurring in vegetative communities dominated by *Elymus trachycaulus* and *Gutierrezia sarothrae*. All occurrences were adjacent to, or near, agricultural fields, in moderate to heavy densities.

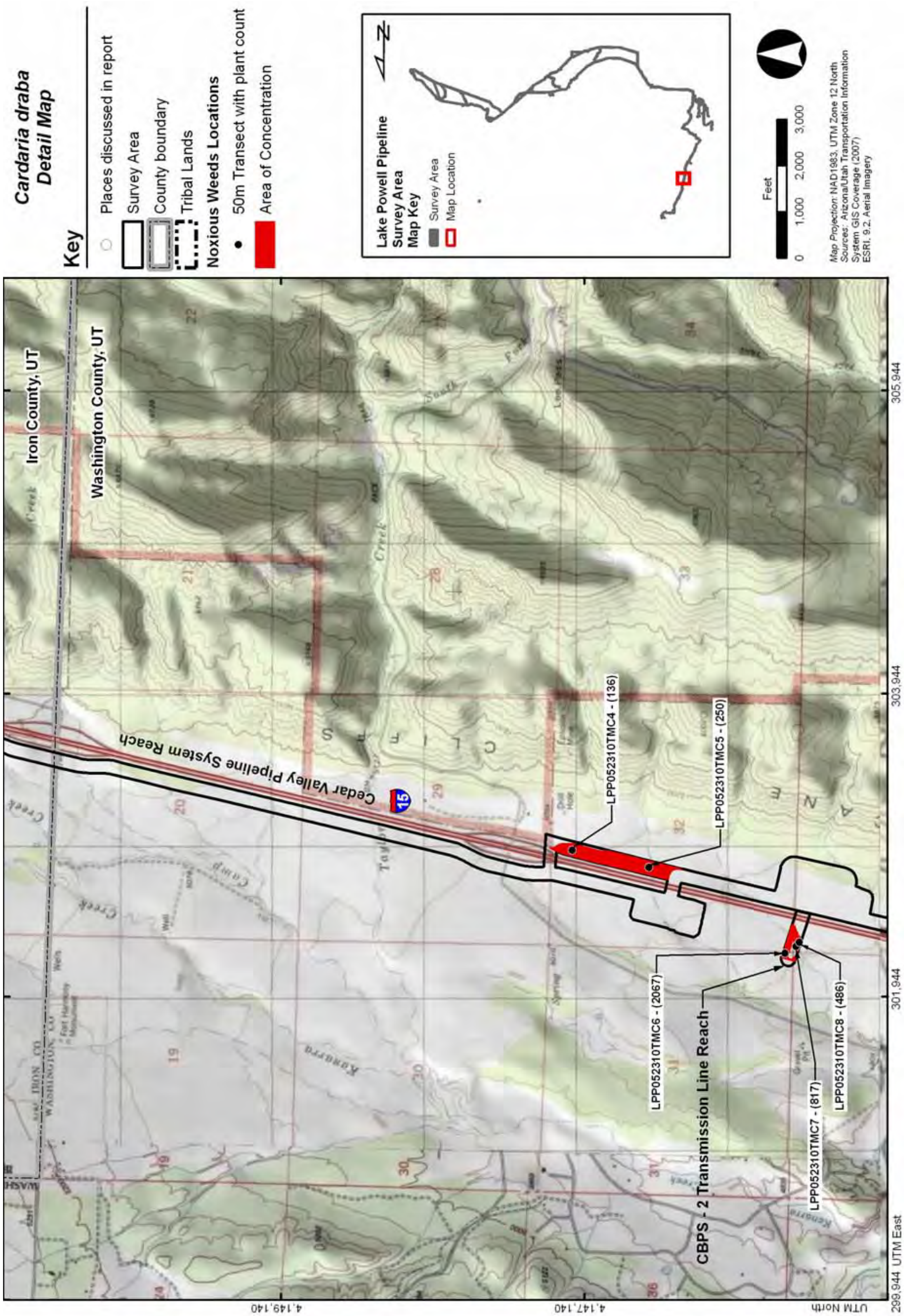
Figure 5-9
View of *Cardaria draba* and its habitat within the survey area

5.5.6.3 Discussion

Cardaria draba was encountered rarely within the survey area. The species was found in localized areas near Cedar City, and generally, in disturbed habitat occurring in proximity to agricultural lands. *Cardaria draba* has a competitive advantage by spreading successfully via rootstock and by seed. Given the current localized presence of the species within the survey area, it is highly recommended that measures be taken to minimize the potential for the species to spread. In order to reduce the probability of transporting seeds, vehicle tires could be washed when departing infested work areas. Additionally, due to the successful re-vegetation of rootstock, soil from contaminated areas could be disposed of, rather than re-used on site. Given the localized occurrence of the species, it is also recommended that herbicidal treatments be applied in areas within the survey area where the species occurs.



Map 5-39
***Cardaria draba* Overview Map**



Map 5-40
***Cardaria draba* Detail Map**

5.5.7 *Centaurea solstitialis* (Yellow starthistle)

5.5.7.1 Natural History

Figure 5-10
Close-up view of *Centaurea solstitialis* within the survey area

Centaurea solstitialis is a winter annual or biennial herb in the Asteraceae (Sunflower family). *Centaurea solstitialis* grows to 6.5 feet (2 meters) tall, and produces stiff, branching stems. Upper leaves are alternate, linear to narrowly oblong or oblanceolate, and have leaf bases up to 0.20 inch (5 millimeters) wide extending down the stem, giving the stems a winged appearance. Leaves on the lower stems and in basal rosettes can be deeply pinnately lobed. Foliage is densely covered with fine white cottony hairs, giving it a grayish to bluish green color. *Centaurea solstitialis* produces taproots which grow to depths of more than 6.5 feet (2 meters), allowing it to access deep soil moisture. Flower heads are composed of numerous yellow disk flowers (Figure 5-10). Corollas are 0.50 to 0.80 inch (13 to 20 millimeters) long, and involucres are 0.50 to 0.70 inch (12 to 18 millimeters) long. Phyllaries contain central spines that are 0.40 to 0.90 inch (10 to 22 millimeters) long and yellowish to straw-colored, and lateral spines that occur in pairs of 2 to 3 at the base of the central spine. *Centaurea solstitialis* produces two types of achenes: the outer ring is dull dark brown and lacks pappus bristles, while inner achenes are glossy, gray or tan with slender white pappus bristles. Large plants can produce up to 75,000 seeds, and under ideal environmental conditions seeds can survive in the soil for up to 10 years. Seeds fall close to the parent plant but can be dispersed short distances by wind, and to greater distances by human activities, animals, water, and soil movement (DiTomaso & Healy 2007).

Centaurea solstitialis appears similar to other yellow flowered starthistles, including *C. melitensis* and *C. sulphurea*. In contrast to *C. solstitialis*, which has pappus bristles only on its inner achenes, all achenes have pappus bristles on the other two species. *Centaurea melitensis* can be further differentiated from *C. solstitialis* by the purplish, rather than yellow, central spines found on its phyllaries. In contrast to *C. solstitialis* which produces white pappus bristles, the pappus bristles of *C. melitensis* are light tan, and dark brown to black on *C. sulphurea*. (DiTomaso & Healy 2007).

Centaurea solstitialis is native to Europe. It was introduced into California around 1850, where the species has become established, and has spread throughout the western United States. In Utah its spread has been sporadic, occurring in abandoned fields and roadsides from 3,000 to 6,233 feet (Welsh et al. 2008). *Centaurea solstitialis* inhabits open hillsides, disturbed sites, grassland, rangeland, fields, roadsides, pastures, and waste areas. In Arizona the species is less common, but is known to occur in Coconino, Mohave, Yuma, and Pima Counties (Parker 2003).

Centaurea solstitialis is considered one of the most serious rangeland weeds within the western part of the United States. The species is highly competitive, and can develop dense stands that displace desirable vegetation

(DiTomaso & Healy 2007). *Centaurea solstitialis* can be problematic in grain fields, where seeds can contaminate grain harvest, and in pastures, where it can cause “chewing disease” (Whitson, et al. 2009). The species produces a compound which damages the part of the brain that controls movements of the lip and mouth, and can be toxic when ingested over time (DiTomaso & Healy 2007).

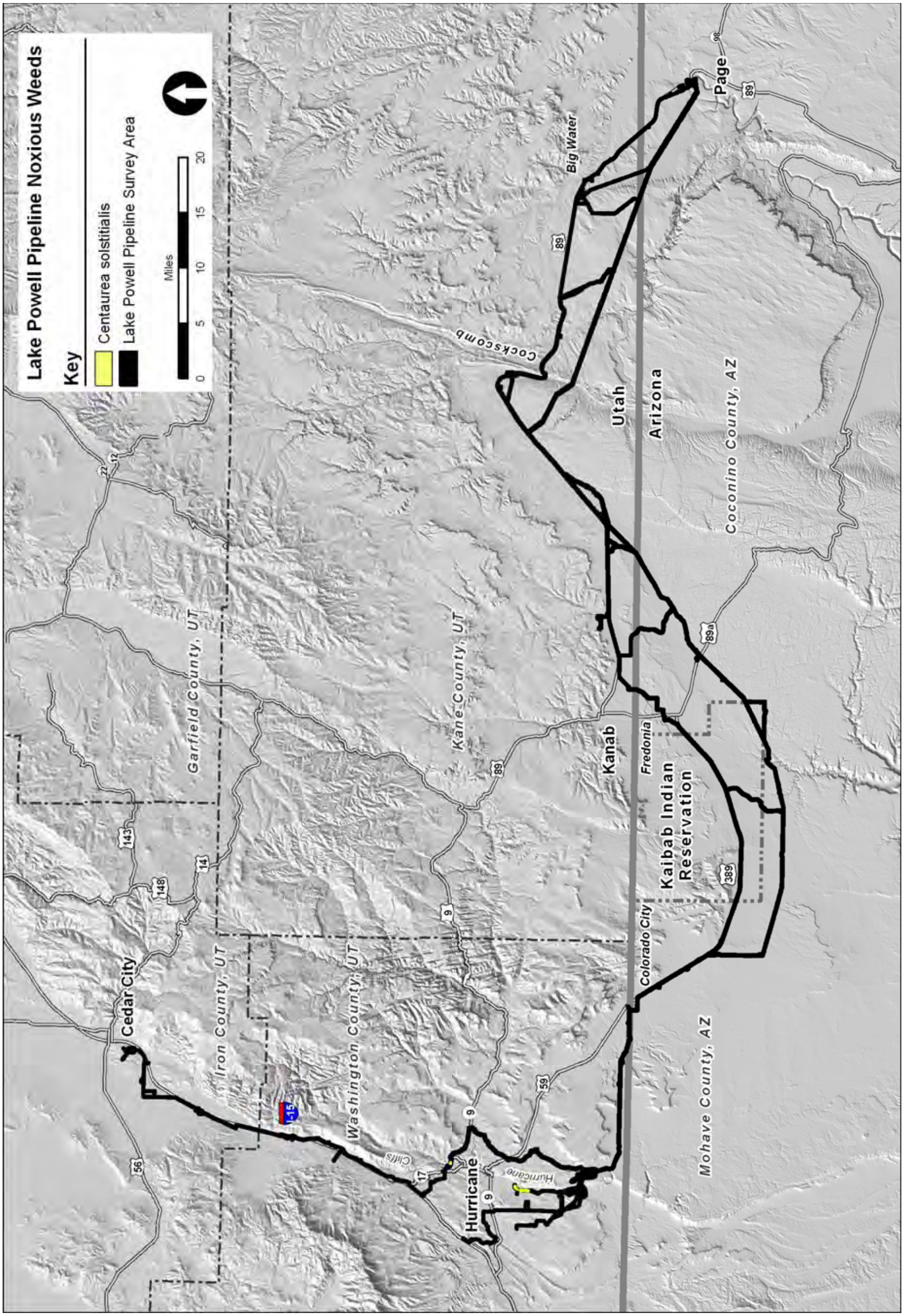
5.5.7.2 Survey Results

The survey encountered *Centaurea solstitialis* rarely (Map 5-41). *Centaurea solstitialis* was identified in only two reaches (Map 5-42to Map 5-44). In the Airport Road Reach it occurred northeast of the Hurricane Cliffs, in the vicinity of the Hurricane Airport, and in the Cedar Valley Pipeline System Reach the species was identified at a single location east of La Verkin Creek. *Centaurea solstitialis* was not detected in any 50 meter belt transects; all encounters occurred while conducting special status species and noxious weed surveys.

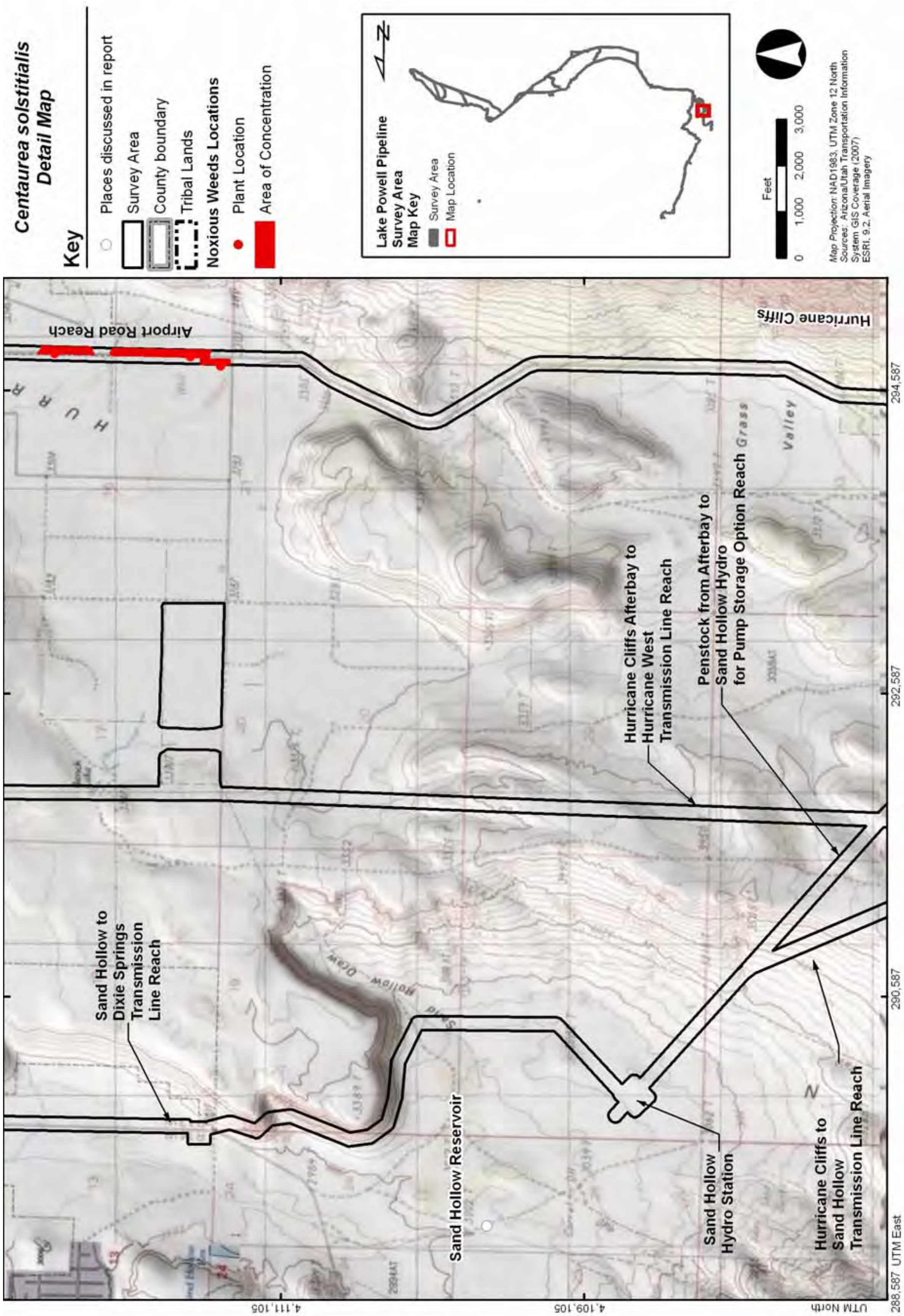
Centaurea solstitialis was only found in the Mohave Desert Ecological Region, where it occurred in the Mixed Desert Scrub ecological system. The species was also found in three anthropogenic lands: Agricultural Land, Developed Road, and Invasive Upland Vegetation. In Mixed Desert Scrub, it was encountered within a vegetative community co-dominated by *Erodium cicutarium*, *Gutierrezia sarothrae,* and *Krascheninnikovia lanata*. In anthropogenic lands, it also was found growing in areas dominated by invasive species, including *Bromus rubens*, *B. tectorum*, and *Salsola tragus*. The species was encountered in small quantities, as individuals or in small clusters, in a landscape modified by historic farming and recent subdivision of those farms into large residential lots and a private airport.

5.5.7.3 Discussion

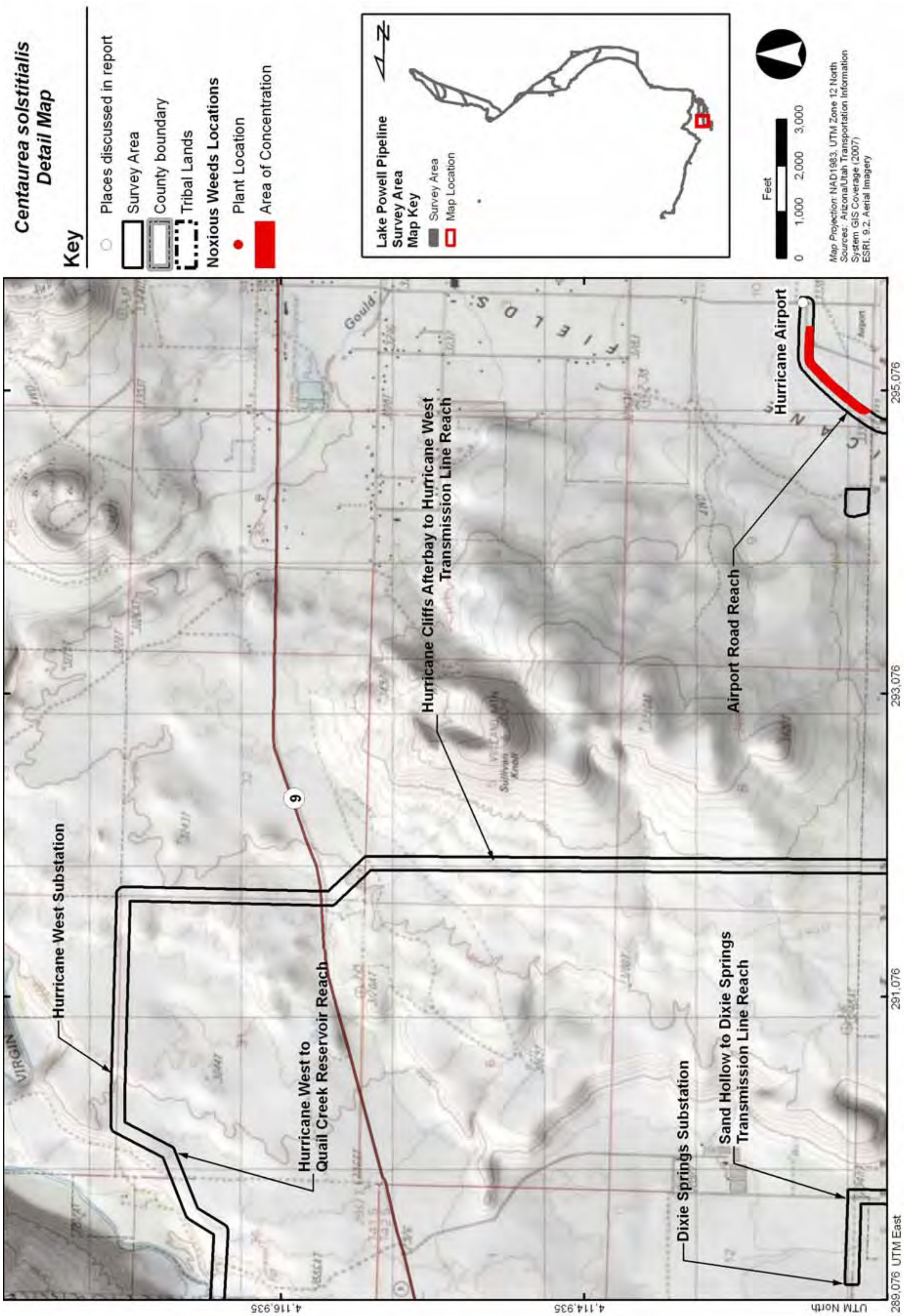
Centaurea solstitialis occurred rarely within the survey area; where it did occur, the species was found in small quantities, and in highly disturbed areas. However, given the severity of the management problems associated with *C. solstitialis*, as well as the highly competitive nature of the species, it is recommended that steps be taken to reduce the potential for spread within and adjacent to the survey area. Vehicle tires could be washed when departing work areas where the species occurs. Given the long-term viability of its seed, care could be taken to avoid the re-use of topsoil from areas with the potential to contain seed. Additionally, when encountered, it is recommended that individuals be chemically treated or otherwise removed.



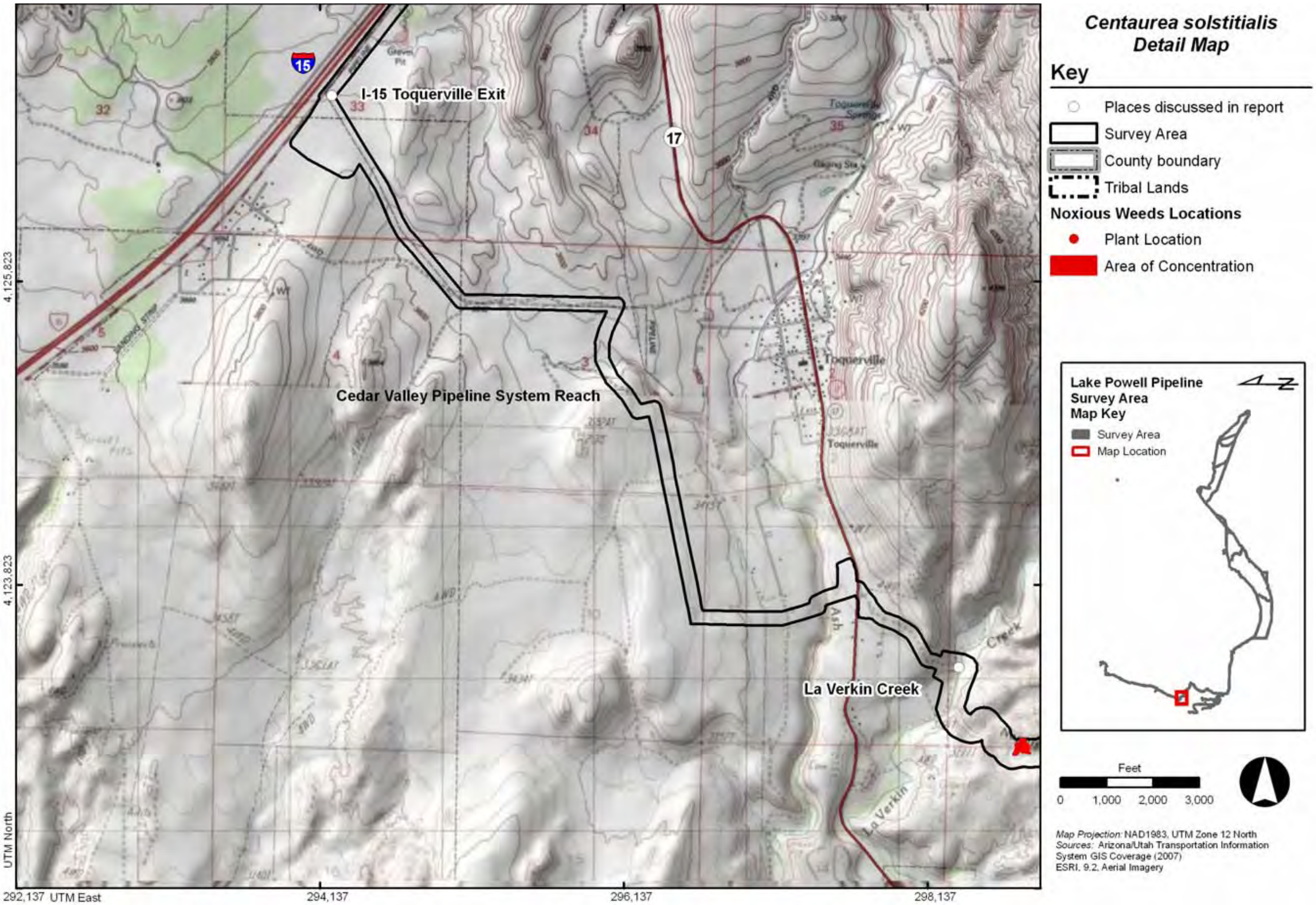
Map 5-41
***Centaurea solstitialis* Overview Map**



Map 5-42
***Centaurea solstitialis* Detail Map**



Map 5-43
***Centaurea solstitialis* Detail Map**



Map 5-44
***Centaurea solstitialis* Detail Map**

5.5.8 *Convolvulus arvensis* (Field bindweed)

5.5.8.1 Natural History

Figure 5-11
View of *Convolvulus arvensis* and its habitat within the survey area

Convolvulus arvensis is an herbaceous perennial vine in the Convolvulaceae (Morningglory family: (Figure 5-11). *Convolvulus arvensis* produces stems that twine around other plants and trail along the ground. Leaves are alternate, dark green, and shaped like arrowheads, oblong, or nearly round, 0.80 to 1.60 inch (2 to 4 centimeters) long, and rounded at the tips. The base of the leaf has pointed lobes that are flared outward. Stems are produced along horizontal roots that creep within the top 24 inches (60 centimeters) of the soil, but roots can grow to up to 10 feet (3 meters) deep, depending upon soil moisture availability. From April through October, *C. arvensis* produces white or pinkish flowers that are funnel-shaped (Figure 5-12), 0.80 to 2.36 inches (2 to 6 centimeters) long, pleated, and spiraled while in the bud. *Convolvulus arvensis* reproduces both vegetatively and by seed. Fruits occur as rounded capsules approximately 0.30 inch (8 millimeters) in diameter. Each capsule produces a few seeds which are dark gray-brown. Seed set is highly variable and dependent upon environmental conditions. Seeds fall near the parent plant but can be dispersed through agricultural activities, water, or by animals. Seeds can germinate very quickly after pollination occurs but can also remain dormant in the seed bank for up to 50 years (DiTomaso & Healy 2007).

Figure 5-12
Close up view of *Convovulus arvensis* in the survey area

Convolvulus arvensis is native to Europe and Asia. The arrival of *C. arvensis* in the United States most likely occurred as a contaminant in farm and garden seeds, though some plants were intentionally planted ornamentally as ground cover or in hanging baskets (Zoughar 2004). The current North American distribution extends from the agricultural regions in Canada southward throughout the United States and into northern Mexico (Zouhar 2004). In the western United States, the species is extensively distributed in cultivated fields and waste places. In Utah, *C. arvensis* is found along roadsides, railroads, and fields from 3,050 to 9,185 feet in elevation (Welsh et al.2008). In Arizona, *C. arvensis* invades dunes, scrublands, grasslands, riparian and montane conifer forests from 100 to 8,500 feet (The Sonoran Institute 2008).

Convolvulus arvensis is considered to be highly noxious in agricultural fields throughout the world. The species is remarkably adaptable to a range of environmental conditions (The Sonoran Institute 2008). Encroachment into wildlands follows disturbances such as road construction, ditch digging, mining, and mechanical fire suppression. *Convolvulus arvensis* easily invades agricultural areas where little competition, repeated disturbance, and high light intensity are ideal for growth (Zouhar 2004). The species can develop into dense, large patches which can reduce crop yields (DiTomaso & Healy 2007). *Convolvulus arvensis* is very difficult to eradicate due to a long, deep taproot which can penetrate the soil to a depth of 10 feet (3 meters) (Whitson et al. 1996).

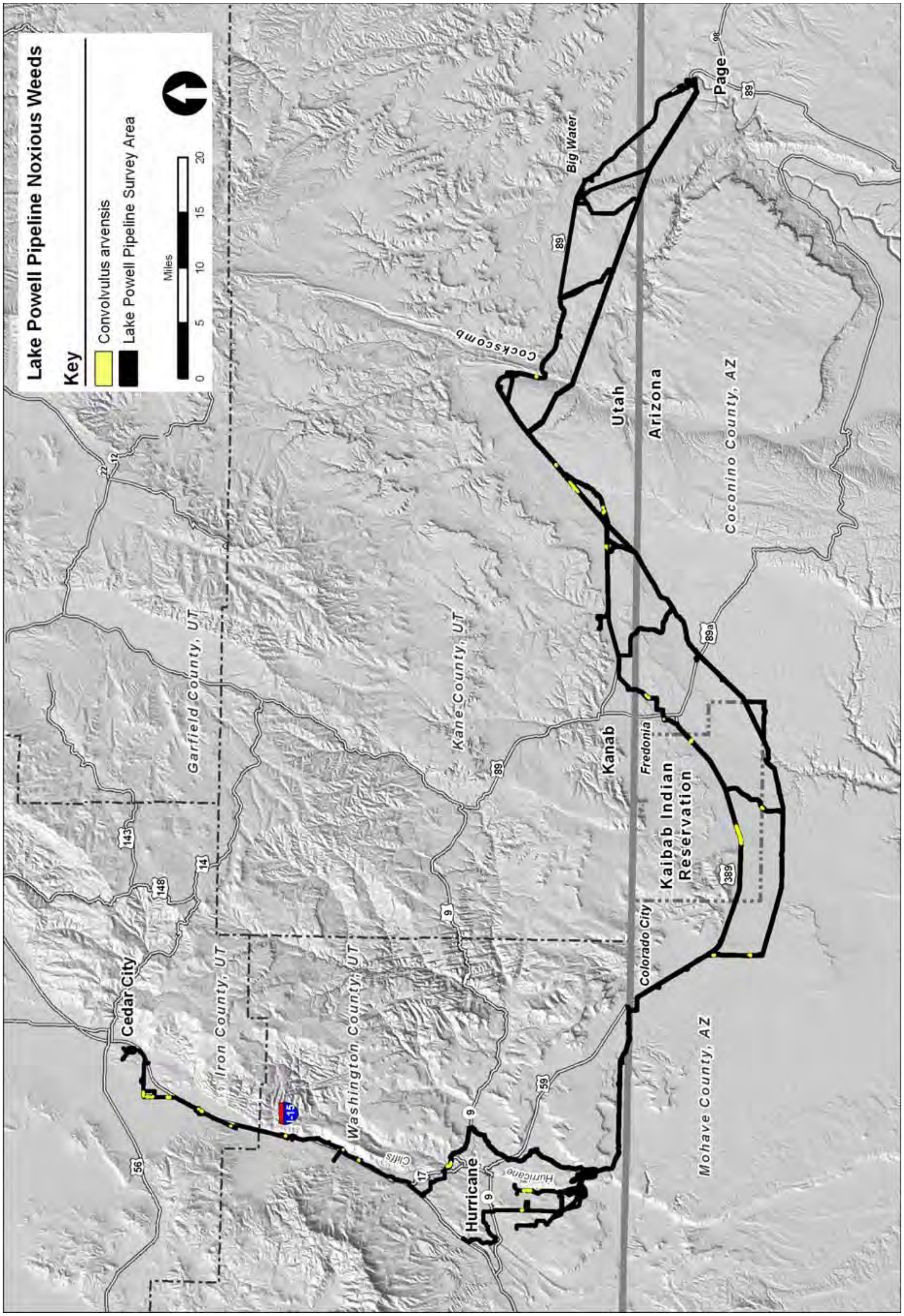
5.5.8.2 Survey Results

The survey encountered *Convolvulus arvensis* occasionally within the survey area, ranging from the area of the Cockscomb to the Bottoms, near Cedar City (Map 5-45). *Convolvulus arvensis* was identified in a total of seven reaches (Map 5-46to Map 5-63). In the Water Conveyance System Reach, individuals were encountered near the Cockscomb and at Telegraph Wash. In the Hydro System High Point Alignment Alternative Reach the species was detected southeast of Petrified Hollow Wash. *Convolvulus arvensis* was also identified in the Hydro System Existing Highway Alternative Reach, where it occurred at Seaman Wash; at a location south of the border of Kane County and Coconino County (south of Lost Spring Gap); just west of Kanab Creek; south of Cottonwood Wash; and in a large area between Twomile Wash and Pipe Springs National Monument. In the Mount Trumbull Road Reach the species was encountered at the Kaibab Indian Reservation south boundary. It was identified at two locations between Moonshine Ridge and Yellowstone Road at AZ Route 389 in the Hydro System South Alternative Reach. In the Airport Road Reach, *C. arvensis* was encountered along the road northwest of the Hurricane Cliffs (south of the Hurricane Airport). The species was identified northeast of Sand Hollow Reservoir in the Hurricane Cliffs Afterbay to Hurricane West Transmission Line Reach. In the Cedar Valley Pipeline System Reach the species occurred in the vicinity of La Verkin Creek, at three locations between Pintura and the border of Iron County and Washington County, at the I-15 Rest Area, and at sporadic locations between Kanarraville and the Bottoms. Individuals were mostly encountered while conducting special status species and noxious weed surveys; however, the species was also detected in two 50-meter belt transects (Transects #475 and 486).

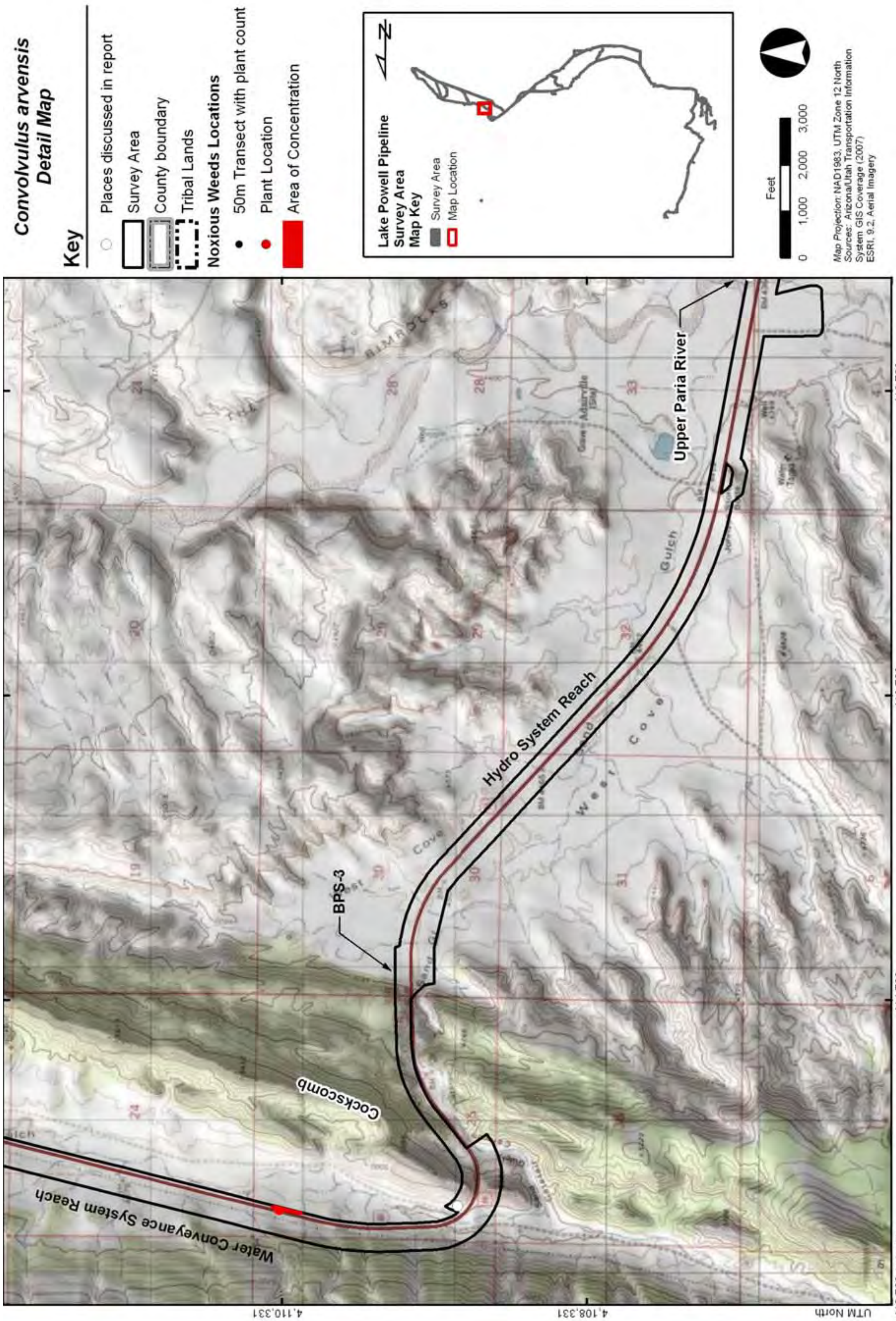
Convovulus arvensis was encountered in all three Ecological Regions, in a total of nine ecological systems, and in four anthropogenic lands. On the Colorado Plateau *C. arvensis* was identified in Active and Stabilized Dune, Big Sagebrush Shrubland, Gypsum Badland, Lower Montane Riparian Woodland and Shrubland, Mixed Desert Scrub, and Colorado Plateau Wash. In the Great Basin *C. arvensis* occurred in Big Sagebrush Shrubland and Pinyon-Juniper Woodland. In the Mohave Desert the species was identified in Lower Montane Riparian Woodland and Shrubland. Anthropogenic lands that supported *C. arvensis* included Agricultural Land, Developed Road, Invasive Upland Vegetation, and Ruderal Vegetation. It most commonly occurred in communities dominated by native shrubs, including *Artemisia* spp., *Atriplex* spp., *Gutierrezia sarothrae*, or *Sarcobatus vermiculatus*, or with non-native species such as *Agropyron cristatum*, *Erodium cicutarium*, or *Salsola tragus*. *Convolvulus arvensis* was commonly encountered within or adjacent to dry washes, perennial, or semi-perennial (frequently flooded) systems, where dominant species included *Populus fremontii*, *Tamarix* spp., or *Typha latifolia*. The species was mostly encountered in moderate sized patches to large populations.

5.5.8.3 Discussion

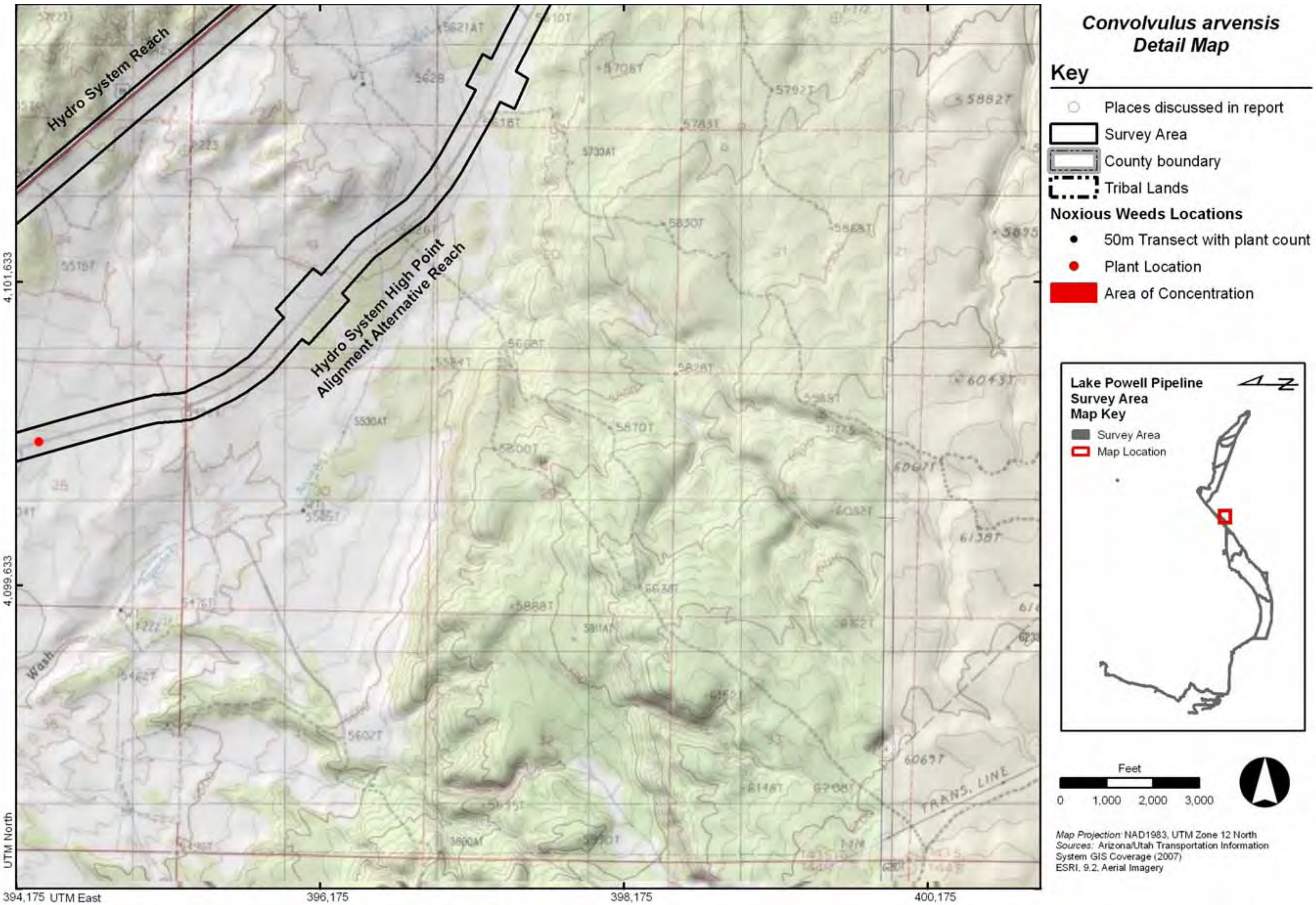
Convolvulus arvensis was encountered occasionally within the survey area and in a variety of ecological systems, but most commonly in disturbed areas including grazed lands, roadsides, and in agricultural lands. The species was frequently identified in areas receiving moisture, such as dry washes or perennial or semi-perennial systems, or irrigated fields. *Convolvulus arvensis* is highly competitive due to its ability to propagate by seed or vegetatively through rhizomes. Its deep taproots and the long viability of its seeds further give it a competitive advantage over native species and planted crops. The project would likely enhance the spread of *C. arvensis* within and adjacent to the survey area. In order to minimize this impact, vehicle tires could be washed when departing work areas where the species occurs. Additionally, where encountered, soil that likely contains active rhizomes could be disposed of rather than re-used on site.



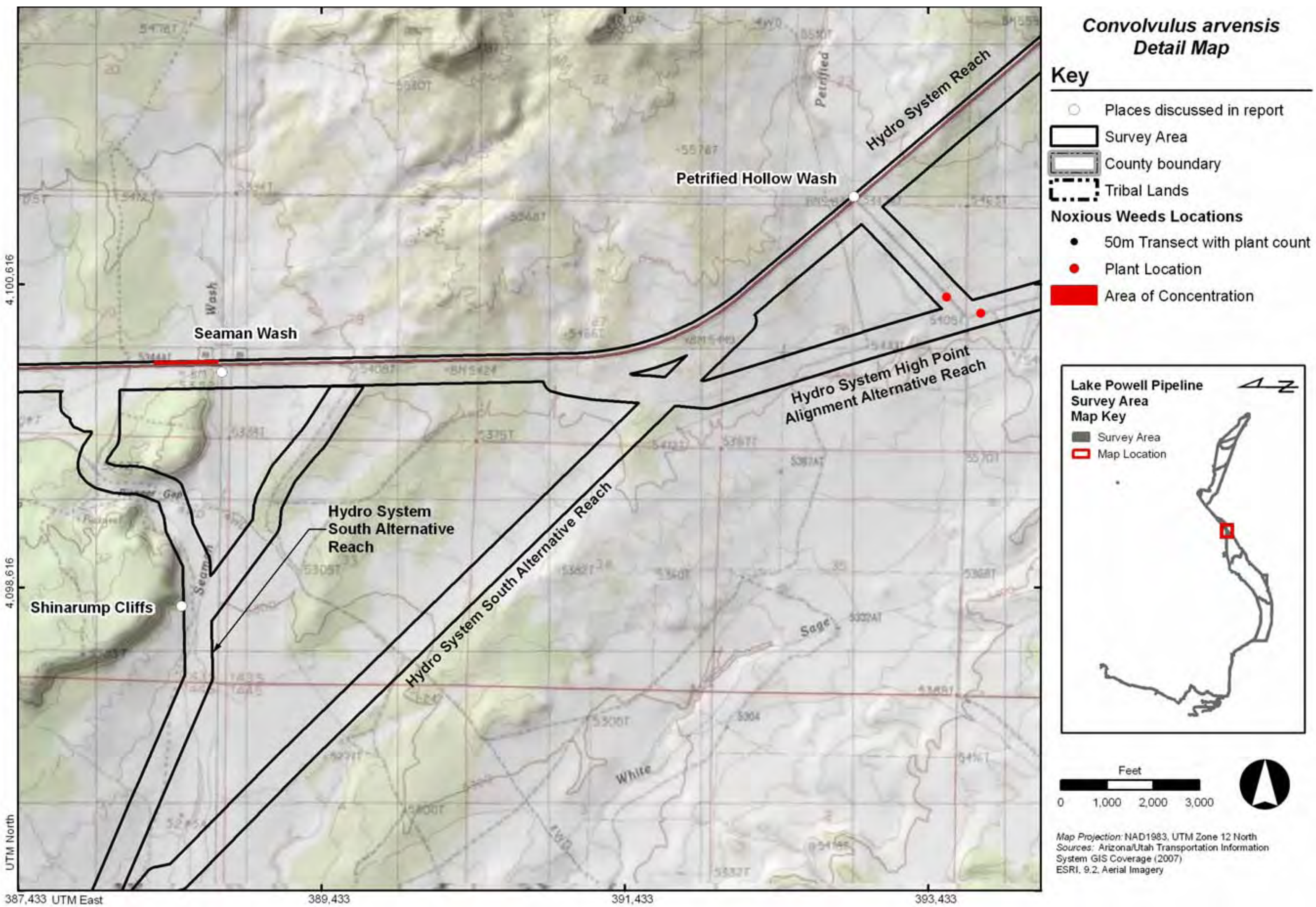
Map 5-45
***Convolvulus arvensis* Overview Map**



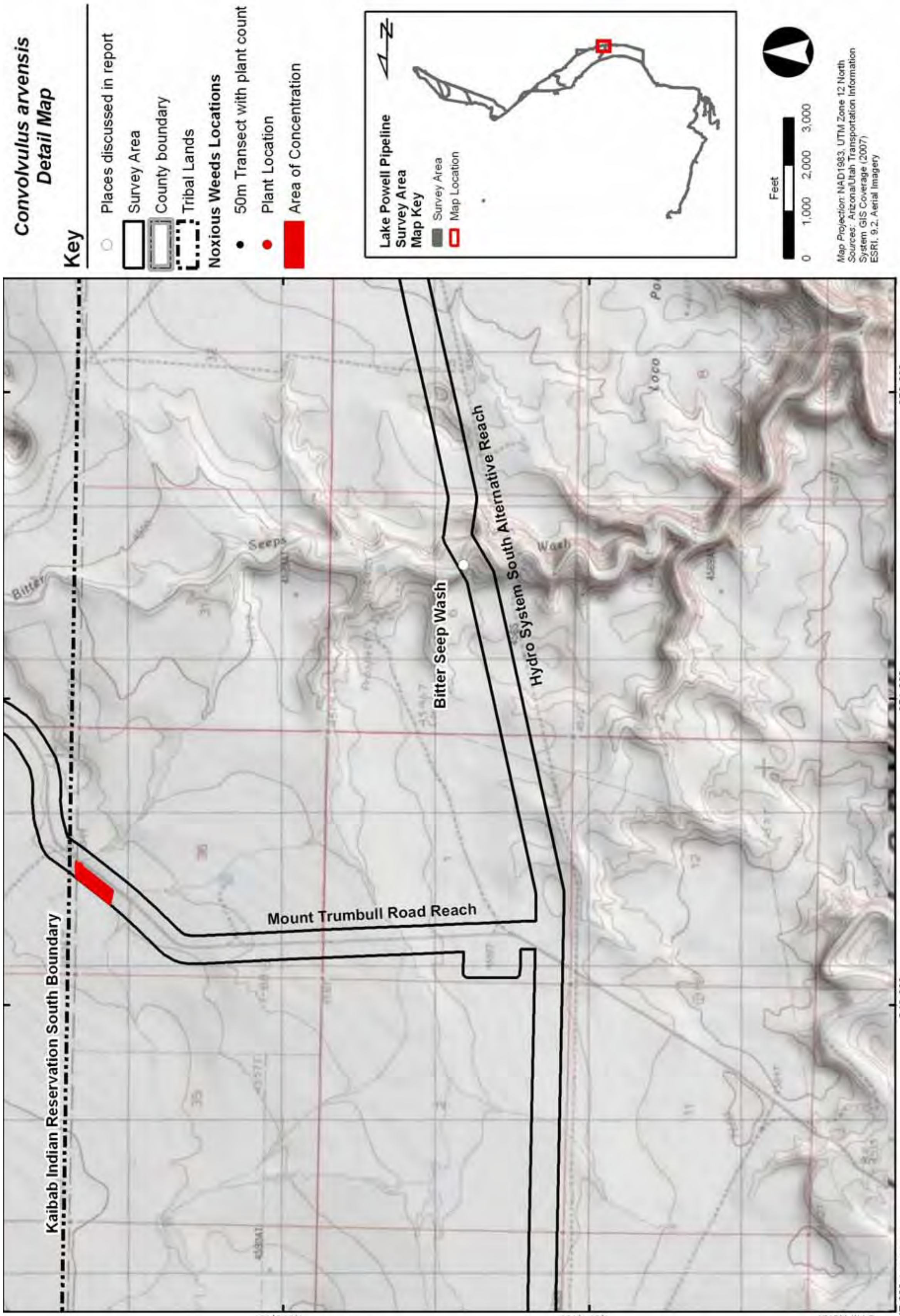
Map 5-46
***Convolvulus arvensis* Detail Map**



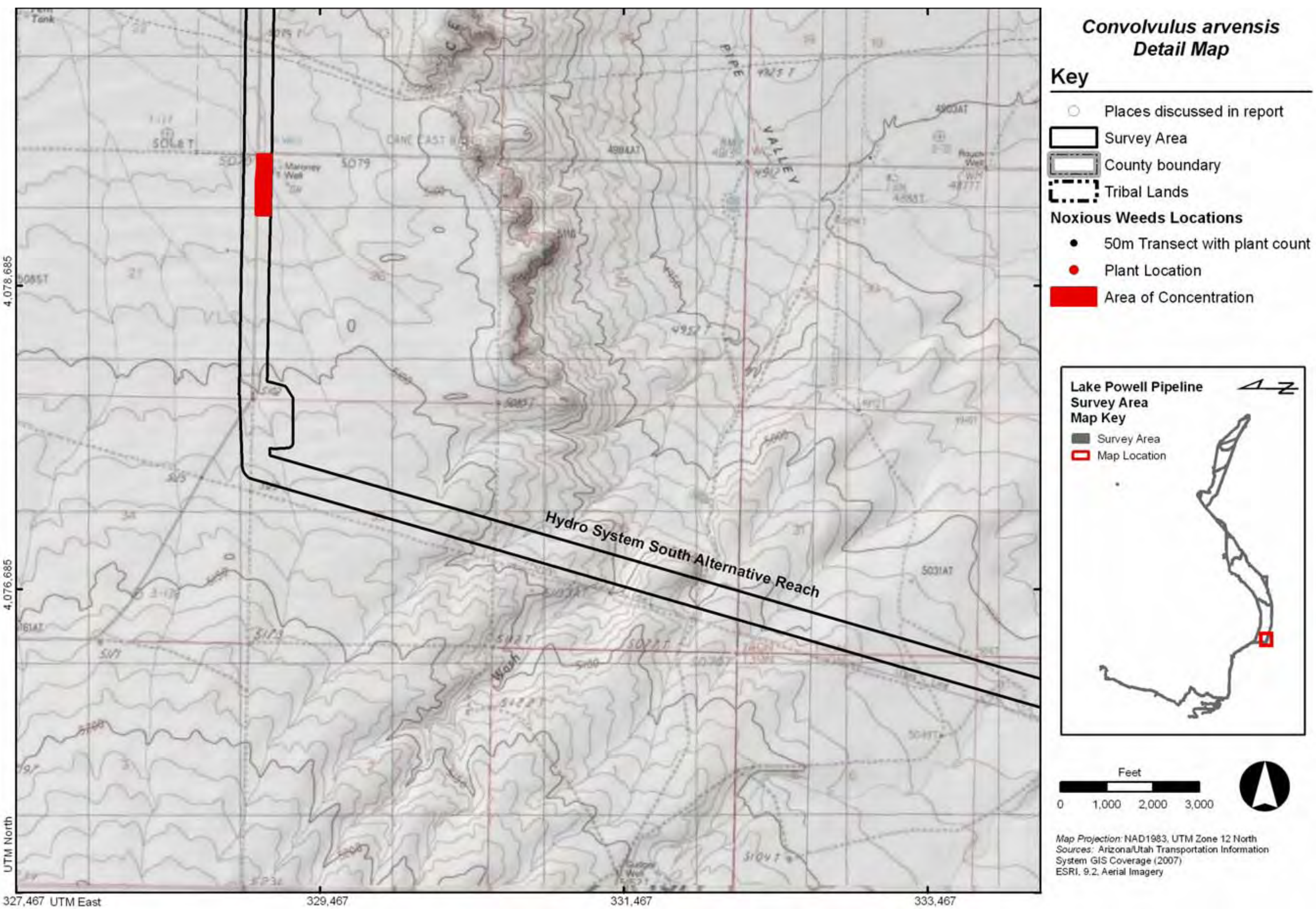
Map 5-47
***Convolvulus arvensis* Detail Map**



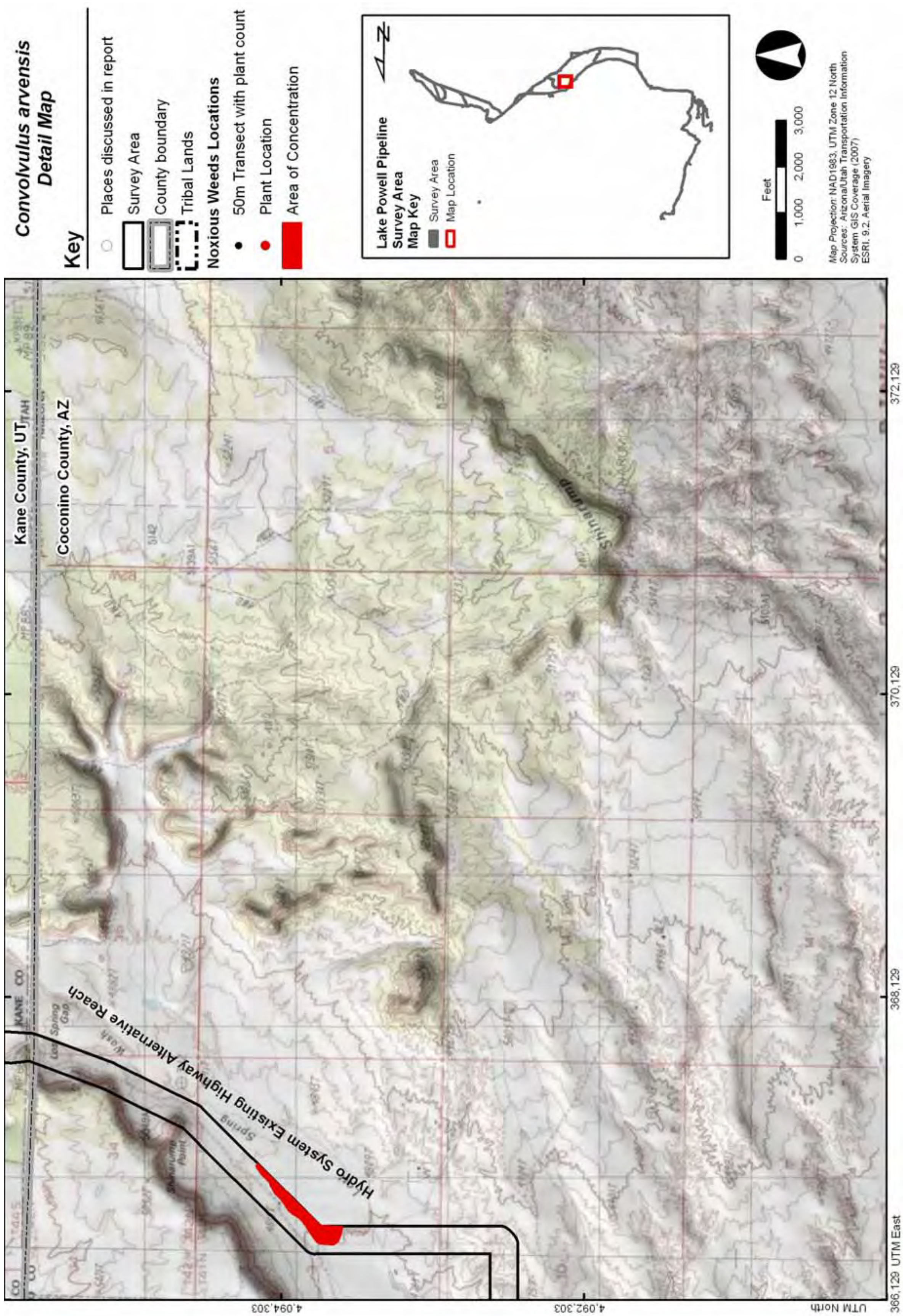
Map 5-48
***Convolvulus arvensis* Detail Map**



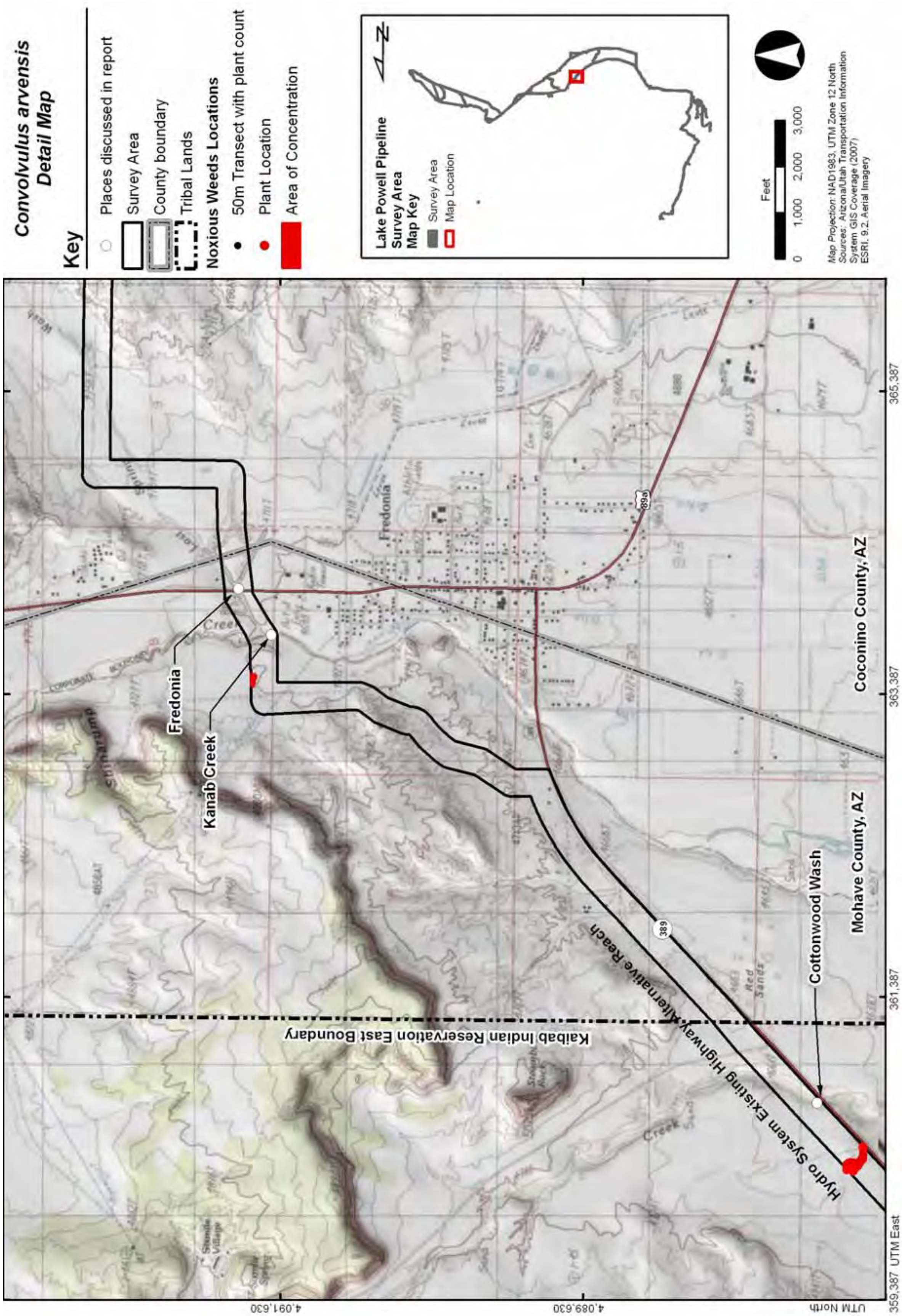
Map 5-49
***Convolvulus arvensis* Detail Map**



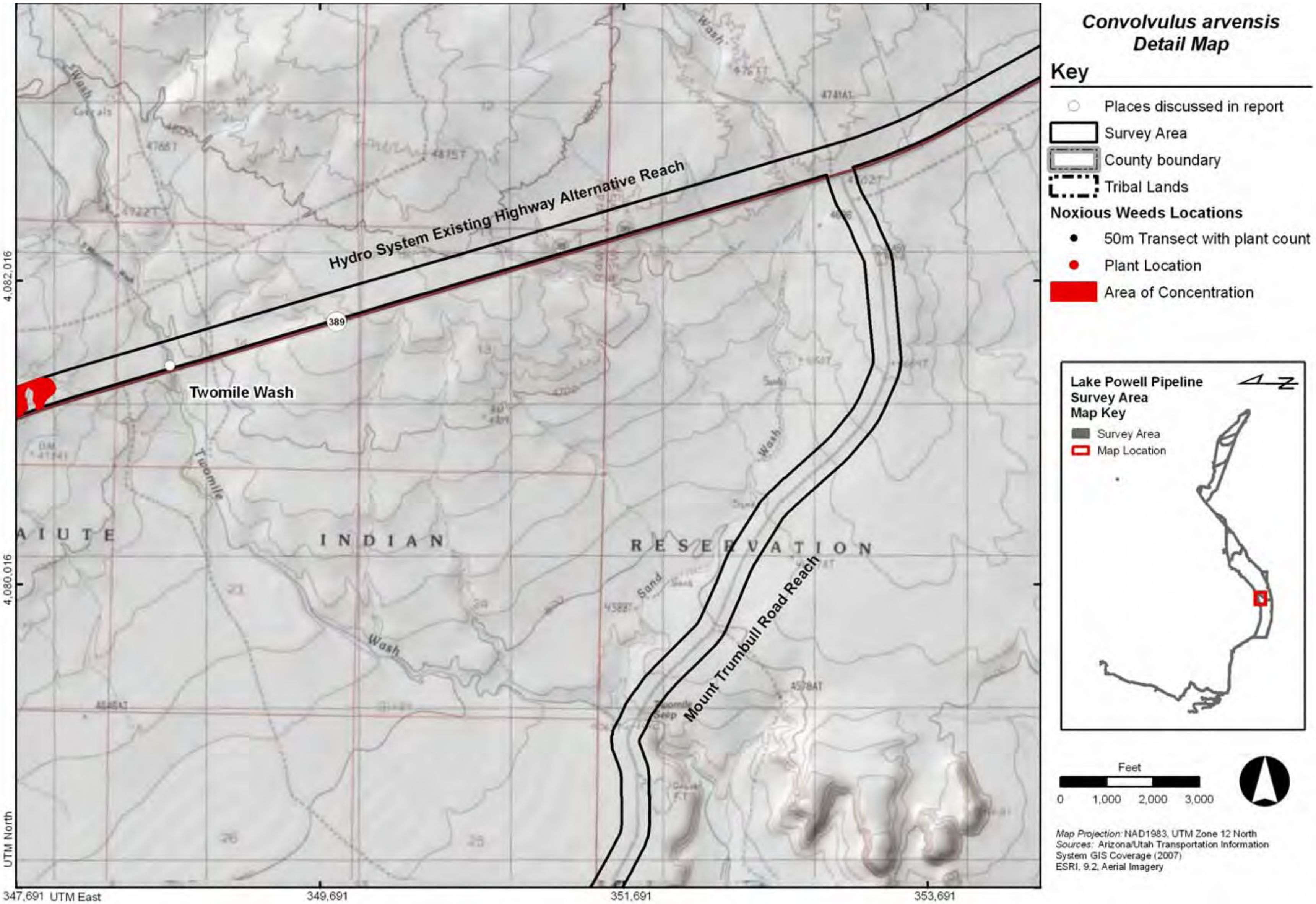
Map 5-50
***Convolvulus arvensis* Detail Map**



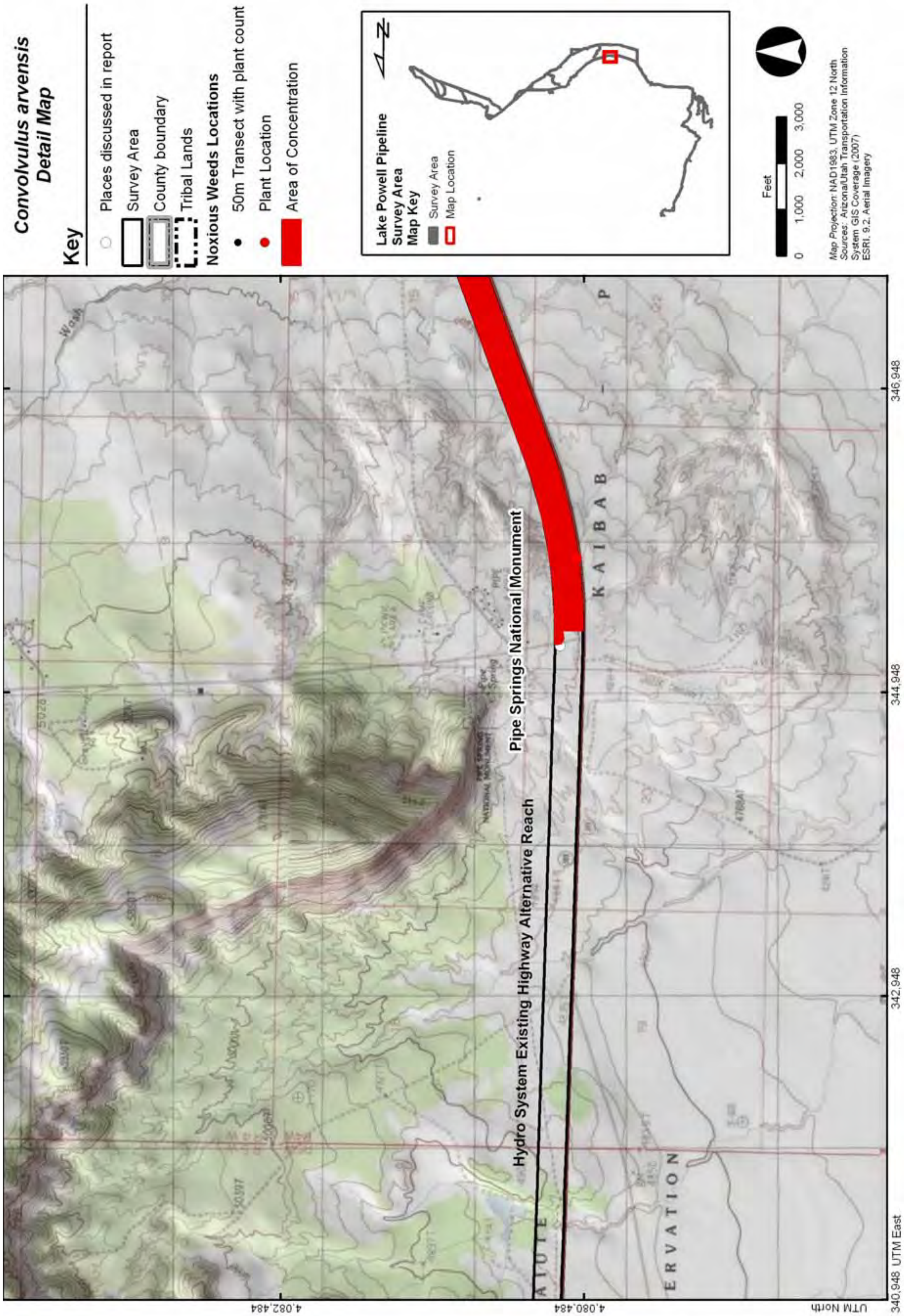
Map 5-51
***Convolvulus arvensis* Detail Map**



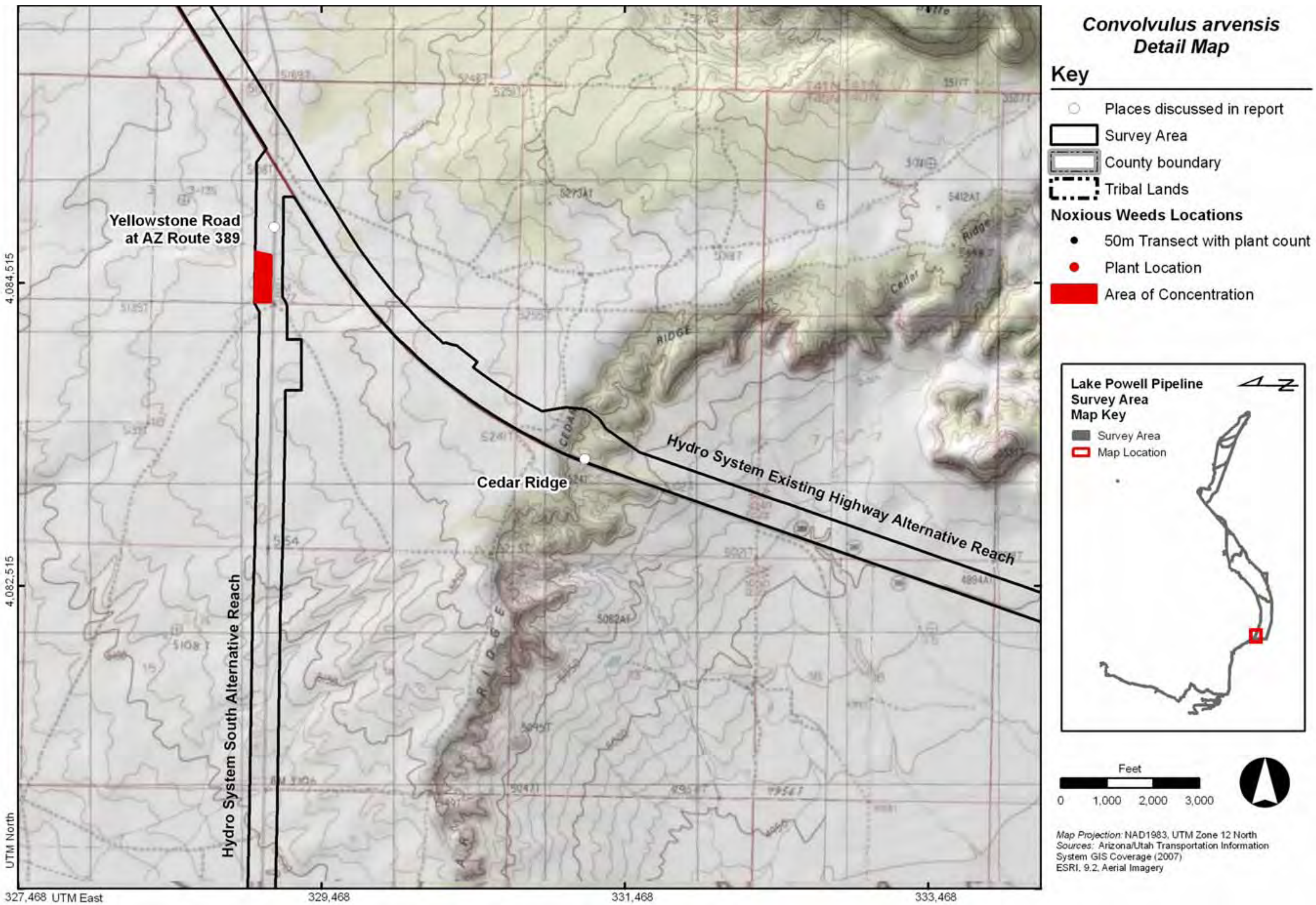
Map 5-52
***Convolvulus arvensis* Detail Map**



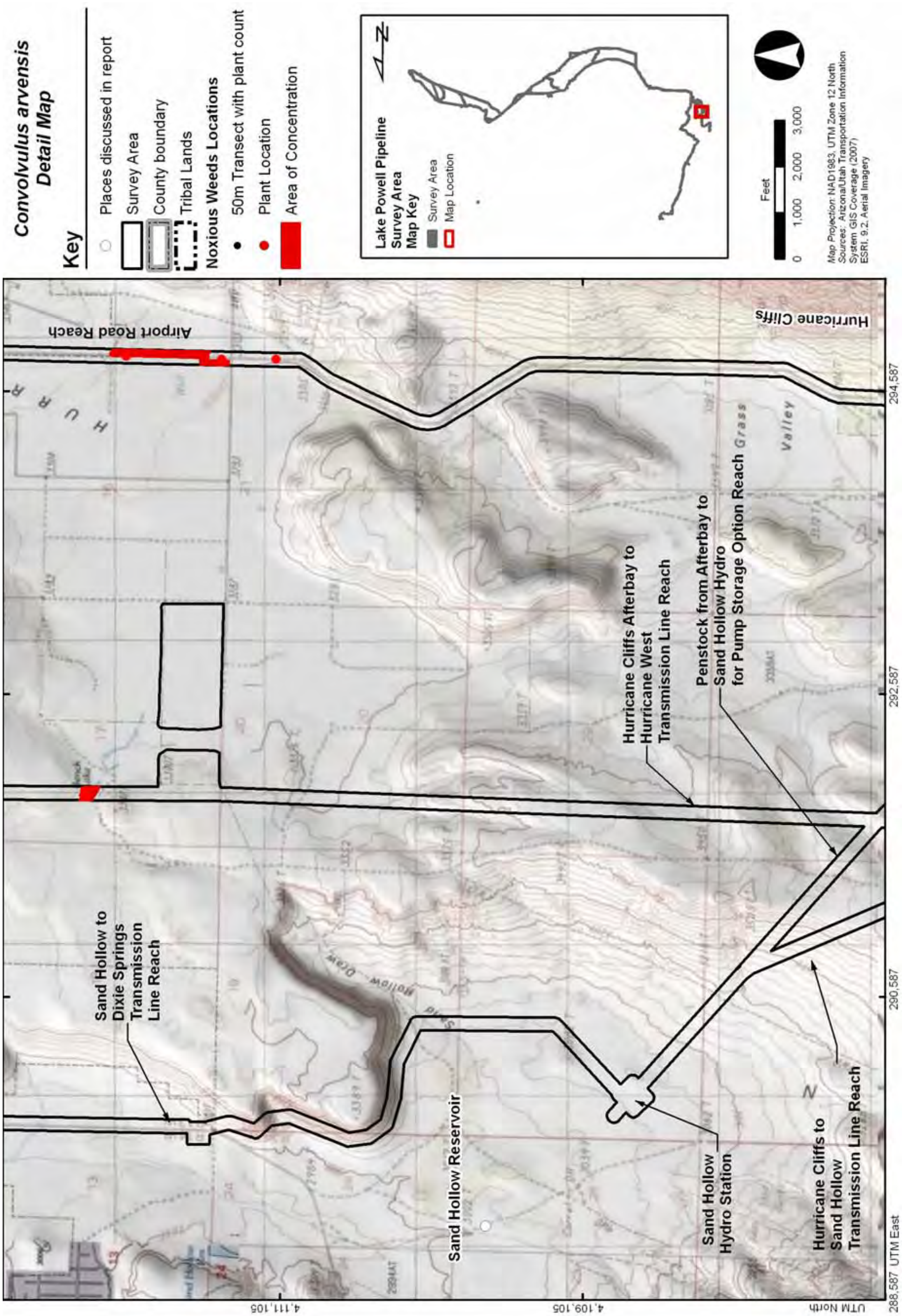
Map 5-53
***Convolvulus arvensis* Detail Map**



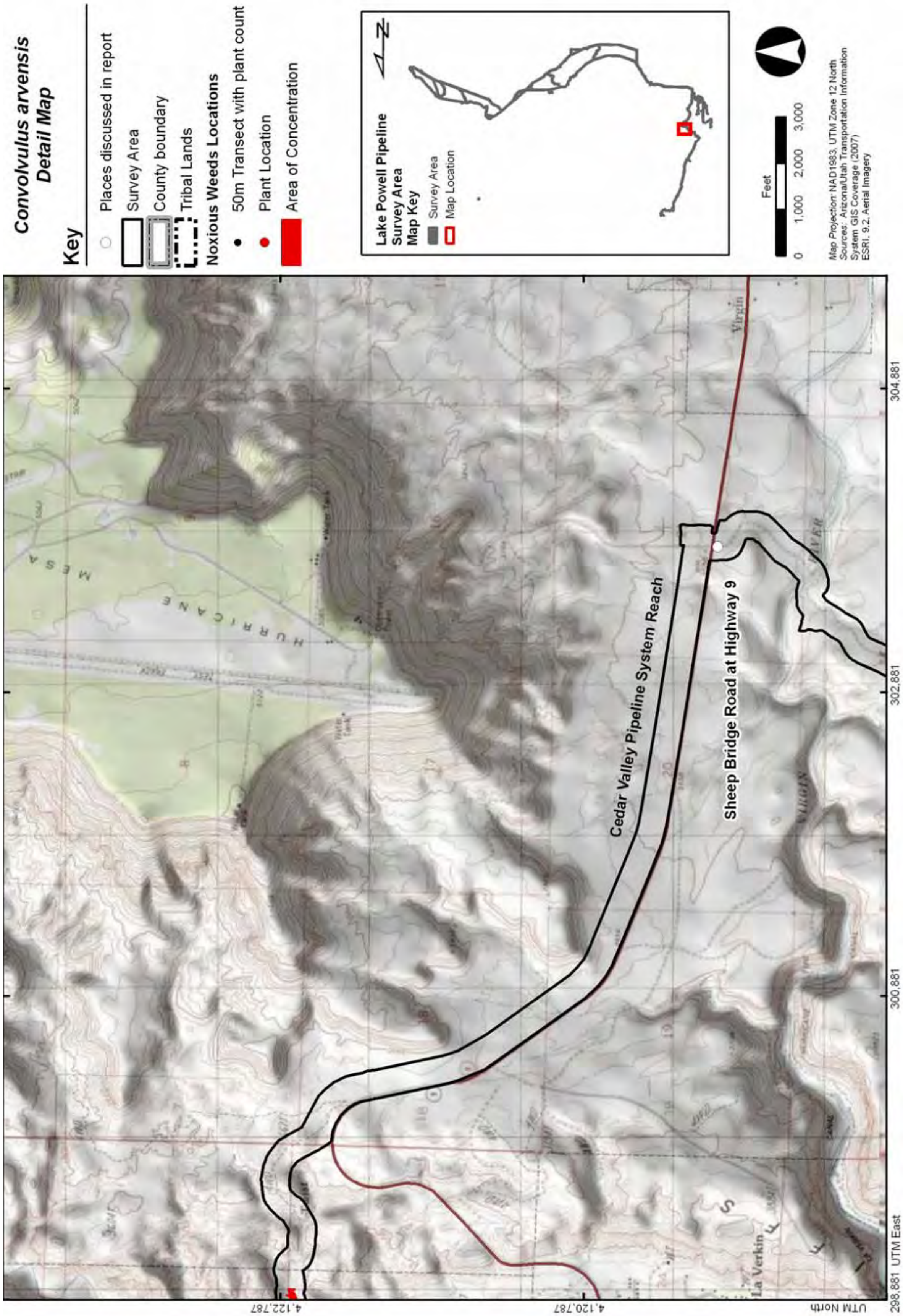
Map 5-54
***Convolvulus arvensis* Detail Map**



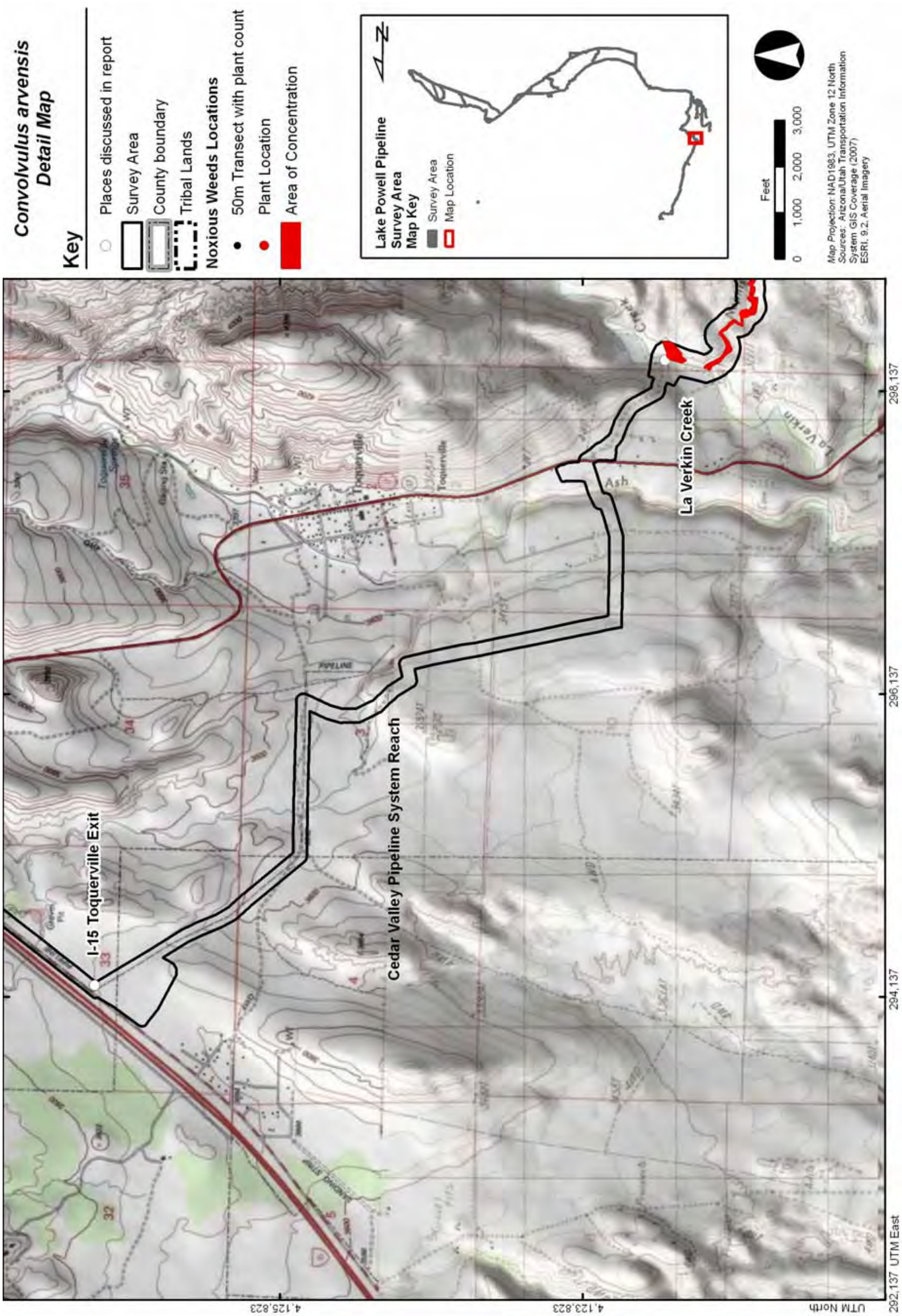
Map 5-55
Convolvulus arvensis **Detail Map**



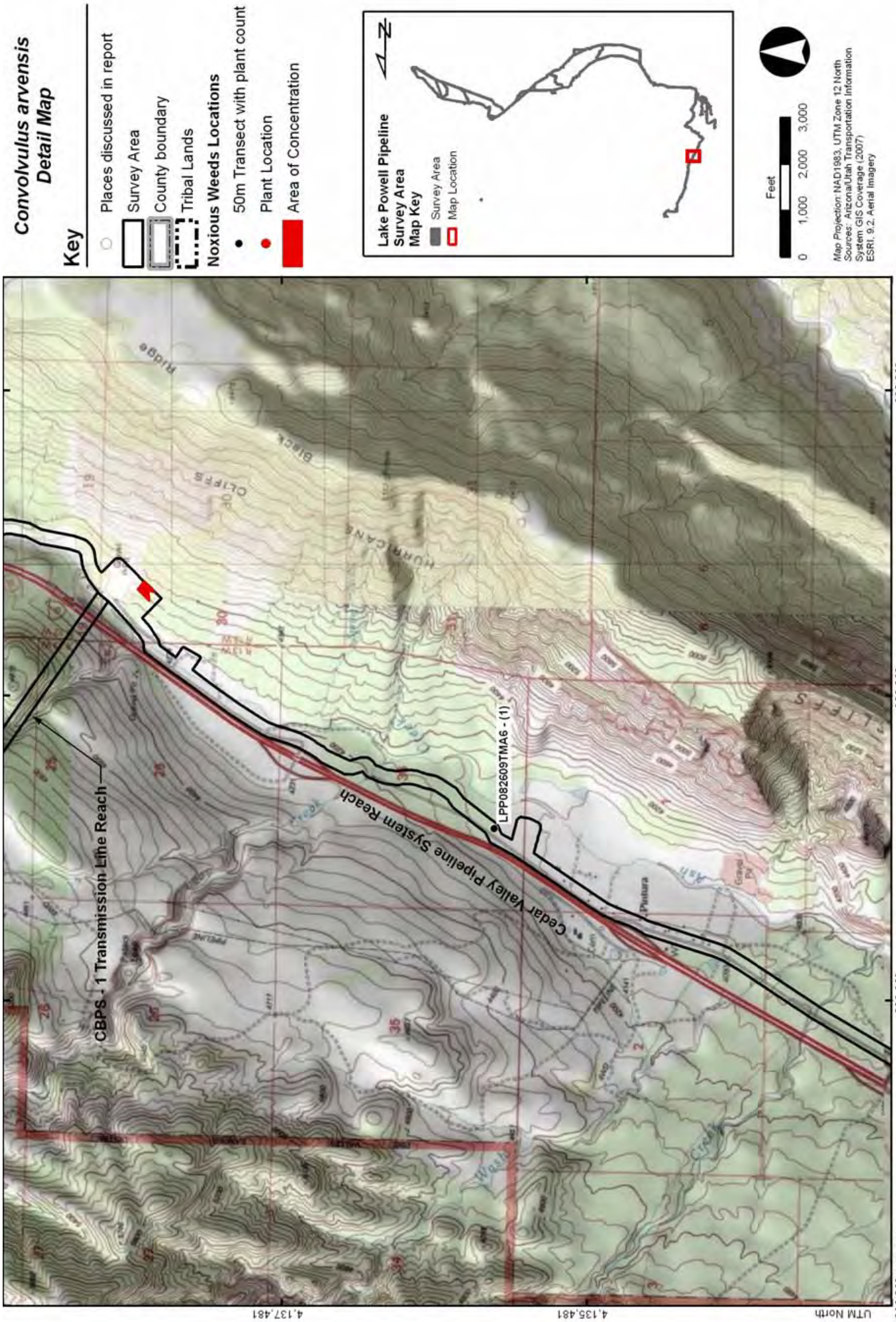
Map 5-56
***Convolvulus arvensis* Detail Map**



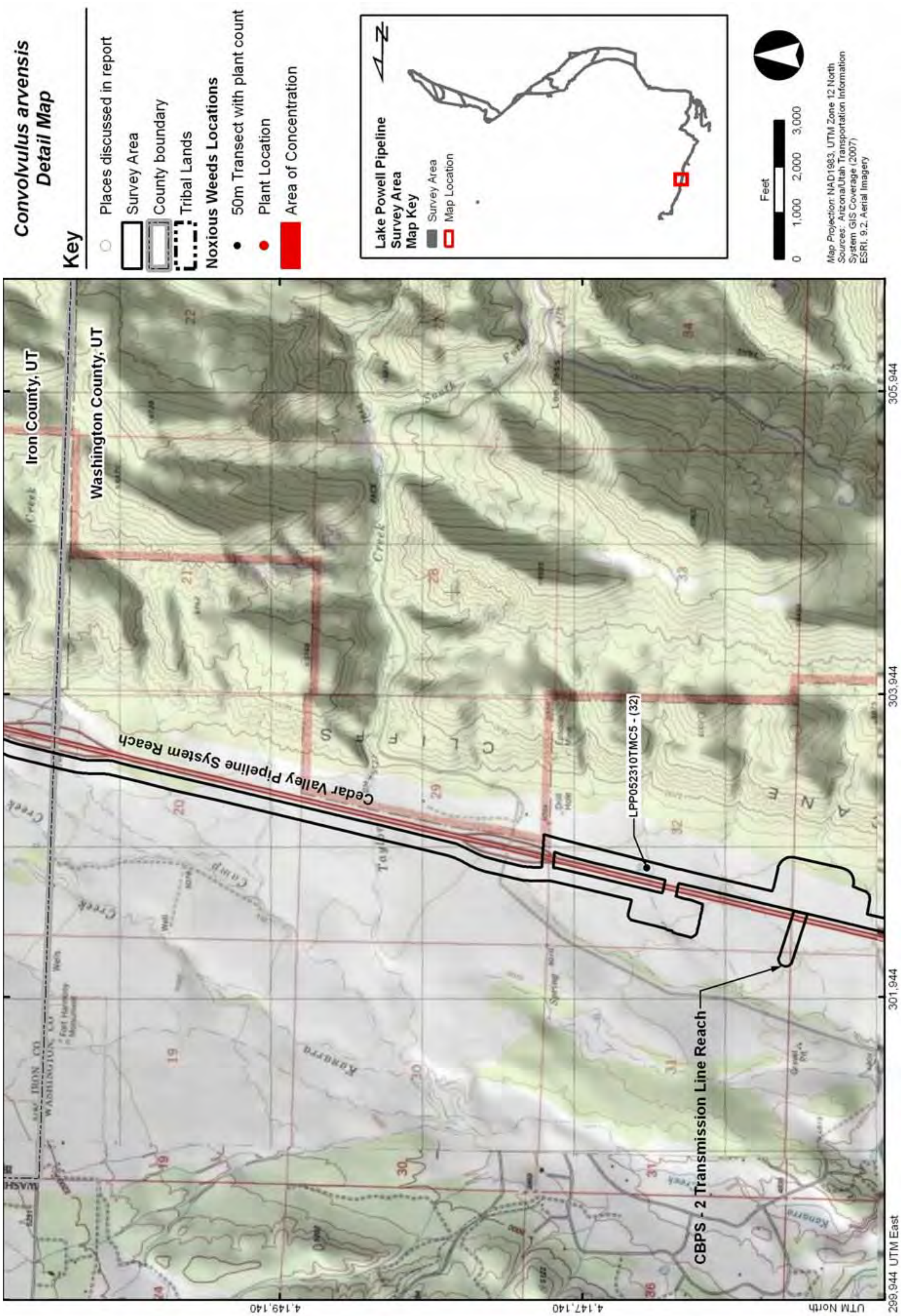
Map 5-57
***Convolvulus arvensis* Detail Map**



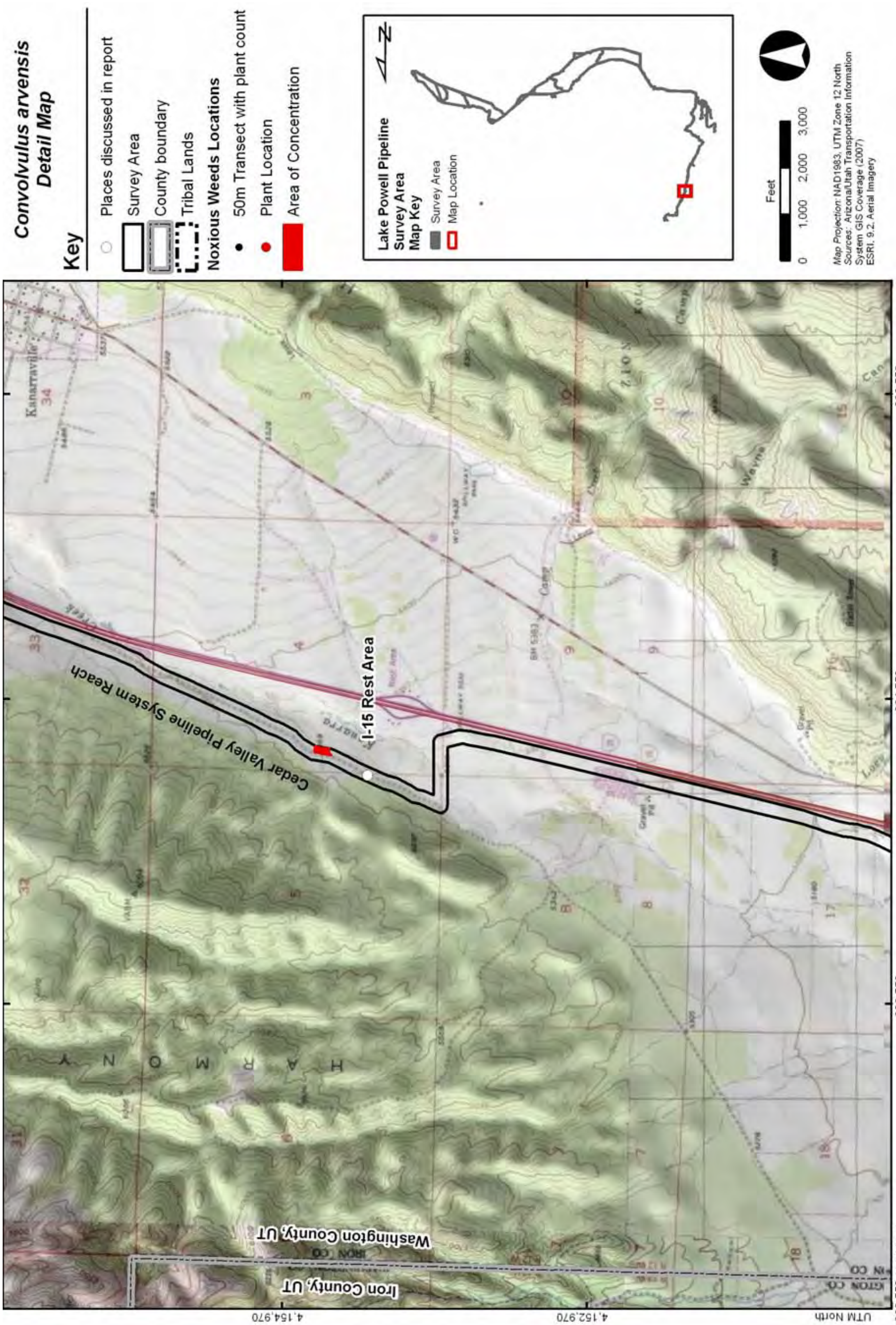
Map 5-58
***Convolvulus arvensis* Detail Map**



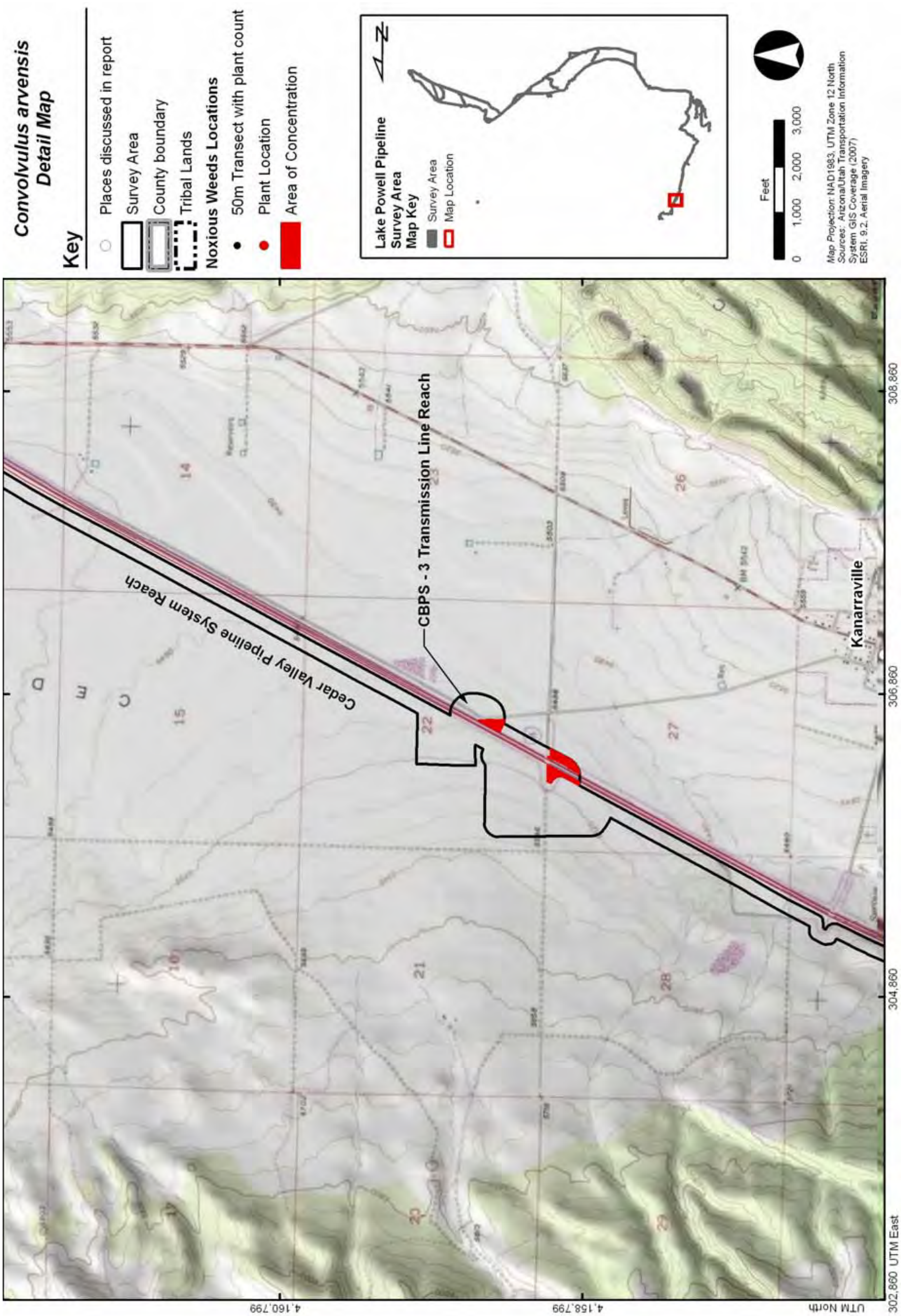
Map 5-59
***Convolvulus arvensis* Detail Map**



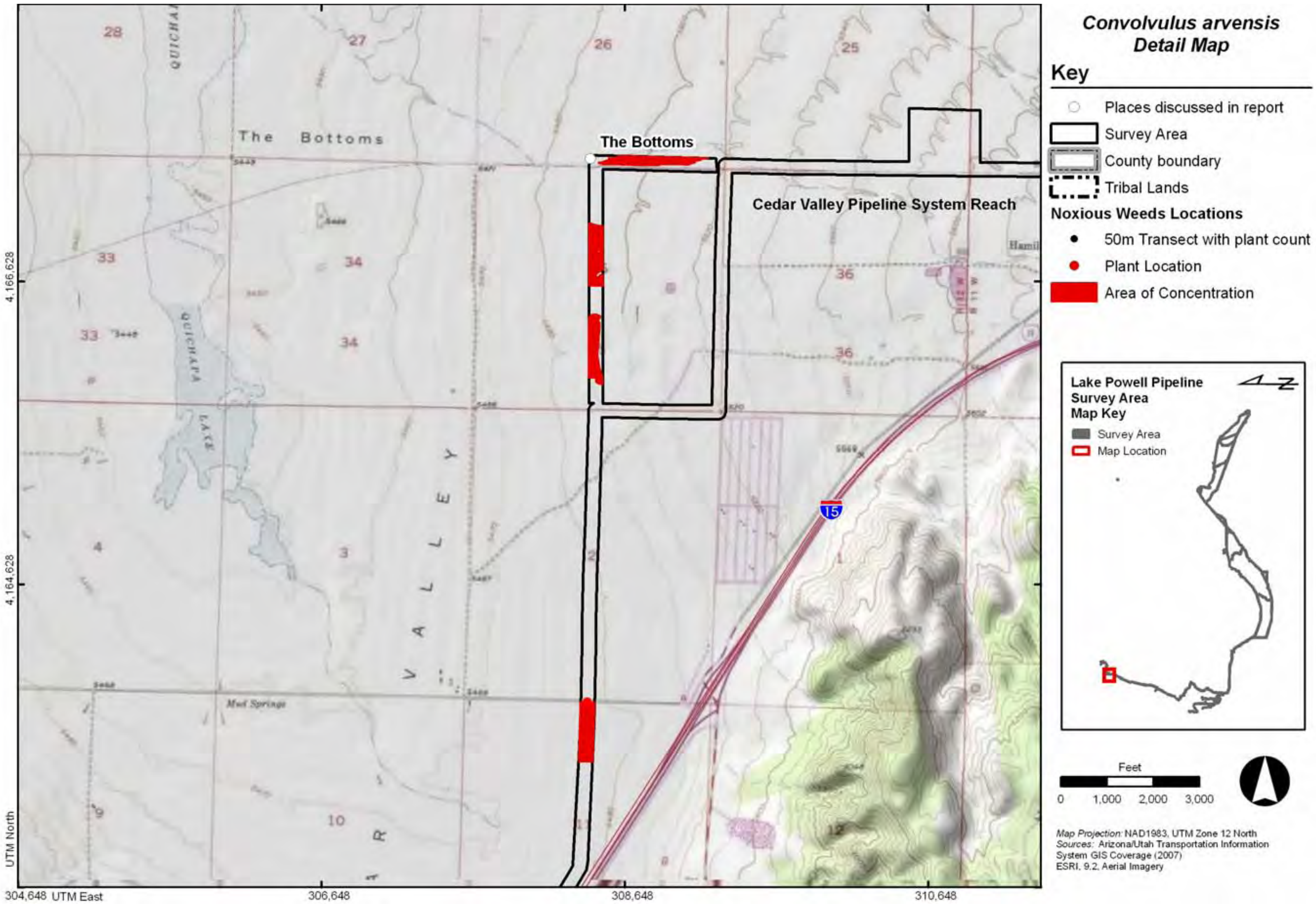
Map 5-60
***Convolvulus arvensis* Detail Map**



Map 5-61
***Convolvulus arvensis* Detail Map**



Map 5-62
***Convolvulus arvensis* Detail Map**



Map 5-63
***Convolvulus arvensis* Detail Map**

5.5.9 *Elaeagnus angustifolia* (Russian olive)

5.5.9.1 Natural History

Elaeagnus angustifolia is a deciduous tree in the Elaeagnaceae (Oleaster Family; Figure 5-13), which grows to 23 feet (7 meters) tall. Small branches are dark reddish brown and smooth, and twigs and branches are sometimes thorny and silvery gray. Leaves are 1.5 to 3.2 inches (4 to 8 centimeters) long, simple, alternately attached, and lanceoloate or elliptic in shape. The leaf margin is smooth, and upper surfaces are covered with silvery star-shaped hairs. From May to June, *E. angustifolia* produces umbel-like inflorescences containing fragrant bell-shaped yellow calyxes with 4 petal-less lobes. Fruits are drupelike, 0.40 to 0.80 inch (10 to 20 millimeters) long, and ovoid; they mature between September and November. Seeds are contained in fruits that remain on trees until animals, mainly birds, ingest the fruit and distribute the seeds. Seeds are dormant at maturity and germinate after a cool, moist stratification of 2 to 3 months (DiTomaso & Healy 2007).

Figure 5-13
View of *Elaeagnus angustifolia* within the survey area

Elaeagnus angustifolia may be confused with either *Ligustrum lucidum* or *Olea europaea*, two other olive species that can also escape cultivation on occasion. *Elaeagnus angustifolia* can be differentiated from *L. lucidum*, by its leathery glabrous leaves that are glossy on the top surface, and from *O. europaea*, which produces white, rather than yellow flowers.

Elaeagnus angustifolia is native to southwestern Europe and central and western Asia (Zouhar 2005). The species was introduced as an ornamental shade tree and now occurs throughout most of the United States, including in all western states. In Utah, the species typically grows in moist sites within native plant communities and has naturalized along drainages (Welsh et al. 1993). In Arizona, *E. angustifolia* invades grasslands, southwest interior riparian areas, and Great Basin and montane conifer woodlands from 5,500 to 7,000 feet (The Sonoran Institute 2008).

Elaeagnus angustifolia is a threat to riparian habitats throughout the southwest. The species grows rapidly and thrives in riparian areas where it has been documented out-competing native plants (The Sonoran Institute 2008). *Elaeagnus angustifolia* can withstand flooding, silting and drought, and is shade tolerant (The Sonoran Institute 2008). Individuals can become a serious weed problem when allowed to invade low-lying pastures, meadows, or waterways (Whitson et al. 1996). In many areas the species forms thickets and excludes most other species (Zouhar 2004). The seeds of *E. angustifolia* can germinate under a greater range of conditions than other native riparian tree species. Individuals can survive as seedlings under a cottonwood-willow canopy, and grow quickly when an opening in the canopy is created by the loss of a mature tree. At the same time, once established, cottonwood and willow seedlings are unable to survive under the canopy of *E. angustifolia,* and can therefore not compete.

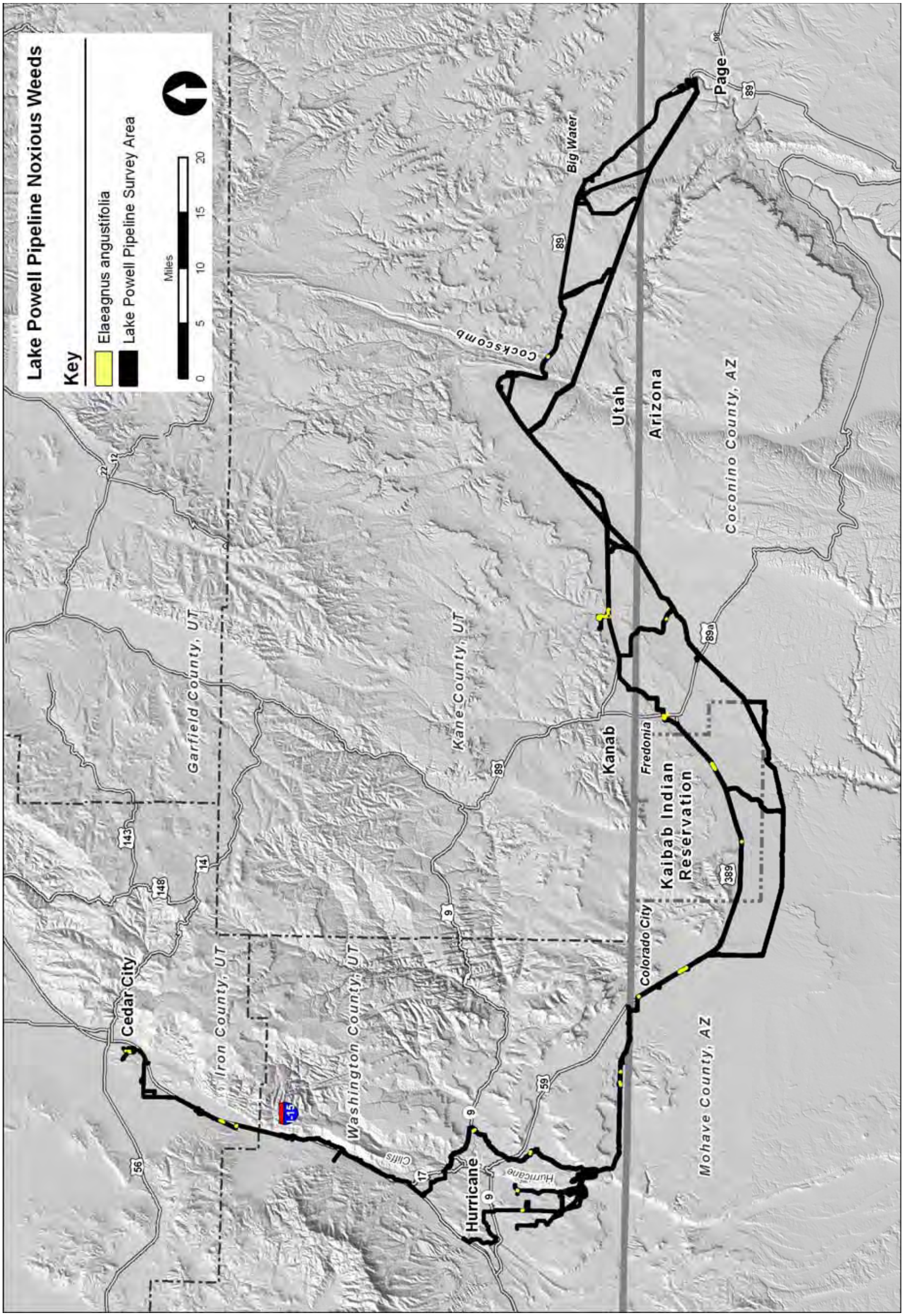
5.5.9.2 Survey Results

Elaeagnus angustifolia was encountered occasionally along the survey area, ranging from the vicinity of the Upper Paria River to Cedar City (Map 5-64). *Elaeagnus angustifolia* was identified in seven reaches (Map 5-65 to Map 5-80), including the Hydro System Reach, where it occurred at one location between the Upper Paria River and the Cockscomb; in an area north of Yellowstone Road at AZ Route 389; at Colorado City; and in the vicinity of Short Creek at Canaan Gap. In the Eightmile Gap Road Reach *E. angustifolia* was found at Johnson Wash, and in the Kane County Pipeline System Reach the species occurred in the vicinity of Johnson Canyon. In the Hydro System Existing Highway Alternative Reach the species was found south of Johnson Canyon; in Fredonia; at Kanab Creek; in an area midway between Cottonwood Wash and Twomile Wash; and at Pipe Springs National Monument. *Elaeagnus angustifolia* was also encountered south of the Hurricane Airport in the Airport Road Reach, and northeast of Sand Hollow Reservoir in the Hurricane Cliffs Afterbay to Hurricane West Transmission Line Reach. In the Cedar Valley Pipeline System Reach the species was identified north of Gould Wash; at Sheep Bridge Road at Highway 9; in the vicinity of the I-15 Rest Area; and in Cedar City. The species was also found in the eastern and southern portions of the Henrieville Substation. *Elaeagnus angustifolia* was not detected in any 50-meter belt transects; all encounters occurred while conducting special status species and noxious weed surveys.

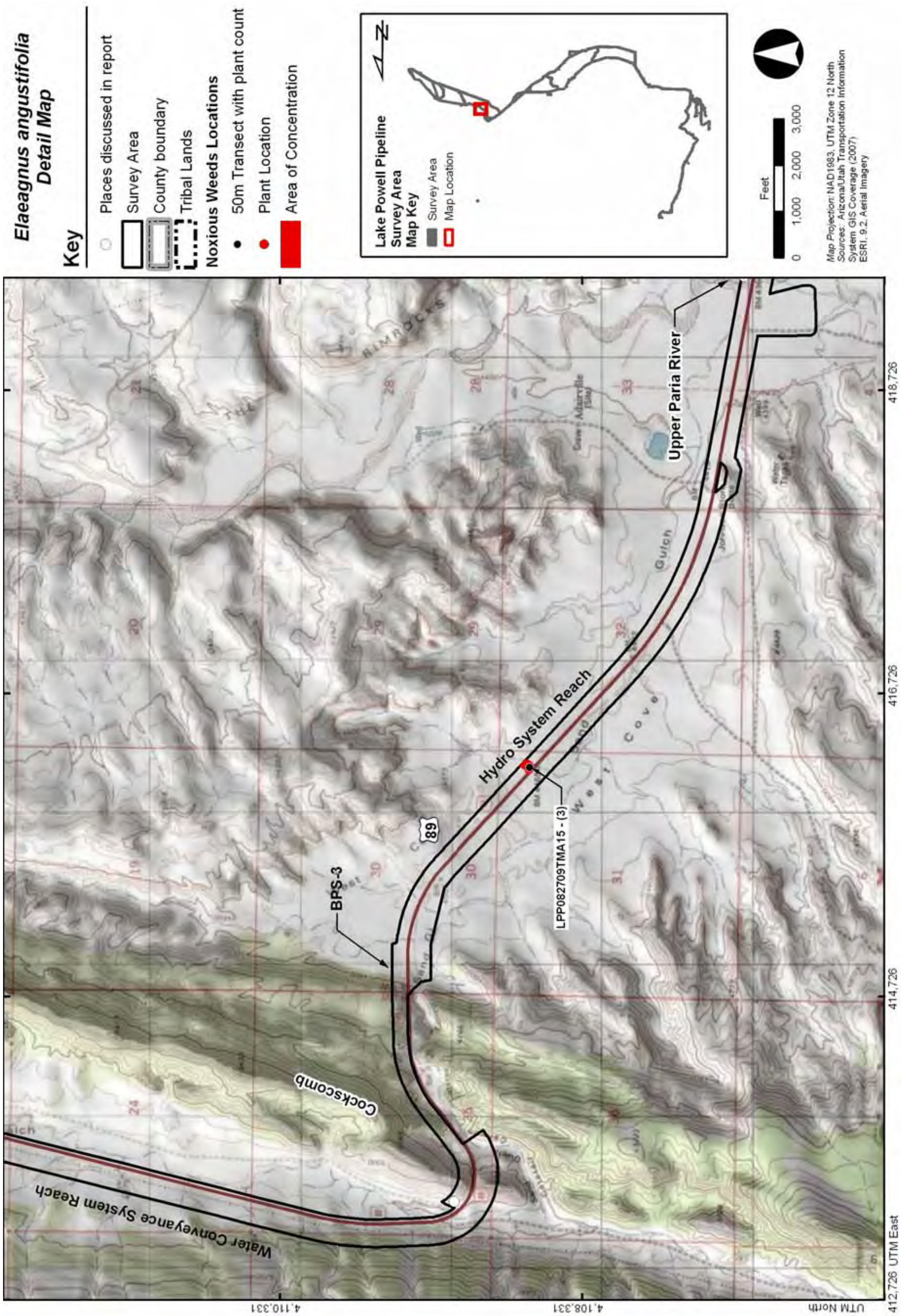
Elaeagnus angustifolia was identified in all three Ecological Regions, in nine ecological systems, and four anthropogenic lands. On the Colorado Plateau, *E. angustifolia* was found in Big Sagebrush Shrubland, Greasewood Flat, Lower Montane Riparian Woodland and Shrubland, Mixed Desert Scrub, and Colorado Plateau Wash. In the Great Basin the species was encountered in Lower Montane Riparian Woodland and Shrubland, Mixed Desert Scrub, and Shrub-Steppe. In the Mohave Desert, *E. angustifolia* was found in Lower Montane Riparian Woodland and Shrubland. Anthropogenic lands supporting *E. angustifolia* included Agricultural Land, Developed Land, Invasive Upland Vegetation, and Ruderal Vegetation. Most commonly, *E. angustifolia* was encountered in Colorado Plateau Lower Montane Riparian Woodland and Shrubland, and generally within or adjacent to dry washes. The species was often encountered as individuals or in small clusters; however, in many instances, *E. angustifolia* was co-dominant in riparian communities with *Populus fremontii* and/or *Tamarix* spp.

5.5.9.3 Discussion

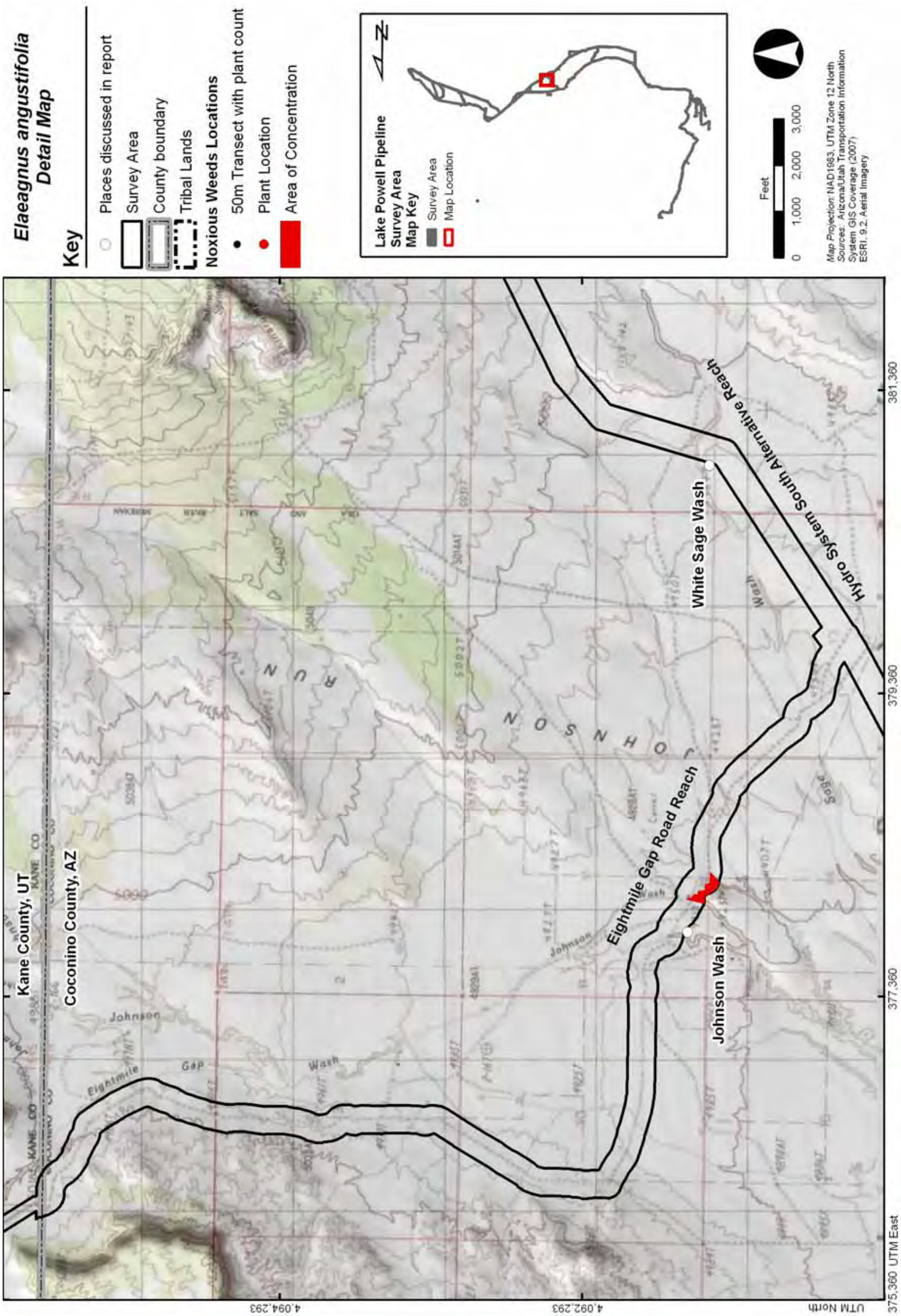
Elaeagnus angustifolia occurred occasionally within the survey area, although most frequently in localized patches within riparian or dry-riparian systems. As the species prefers moist habitats, and seeds require moist stratification for 2 to 3 months in order to germinate, it is not likely that the project will foster the spread of the species into many habitats found within the survey area. However, where work is planned to occur within riparian Ecological Systems, the disturbance associated with the project will undoubtedly give the species an opportunity to establish. Within these areas, if mature native riparian tree species exist, such as *Populus fremontii* and/or *Salix* spp., protection of these trees should be accomplished wherever possible. Where this is not possible, it is recommended to densely re-plant these areas with native riparian tree species. Additionally, these sites could be re-visited periodically following completion of construction, in order to remove or chemically treat any *E. angustifolia* individuals that have emerged.



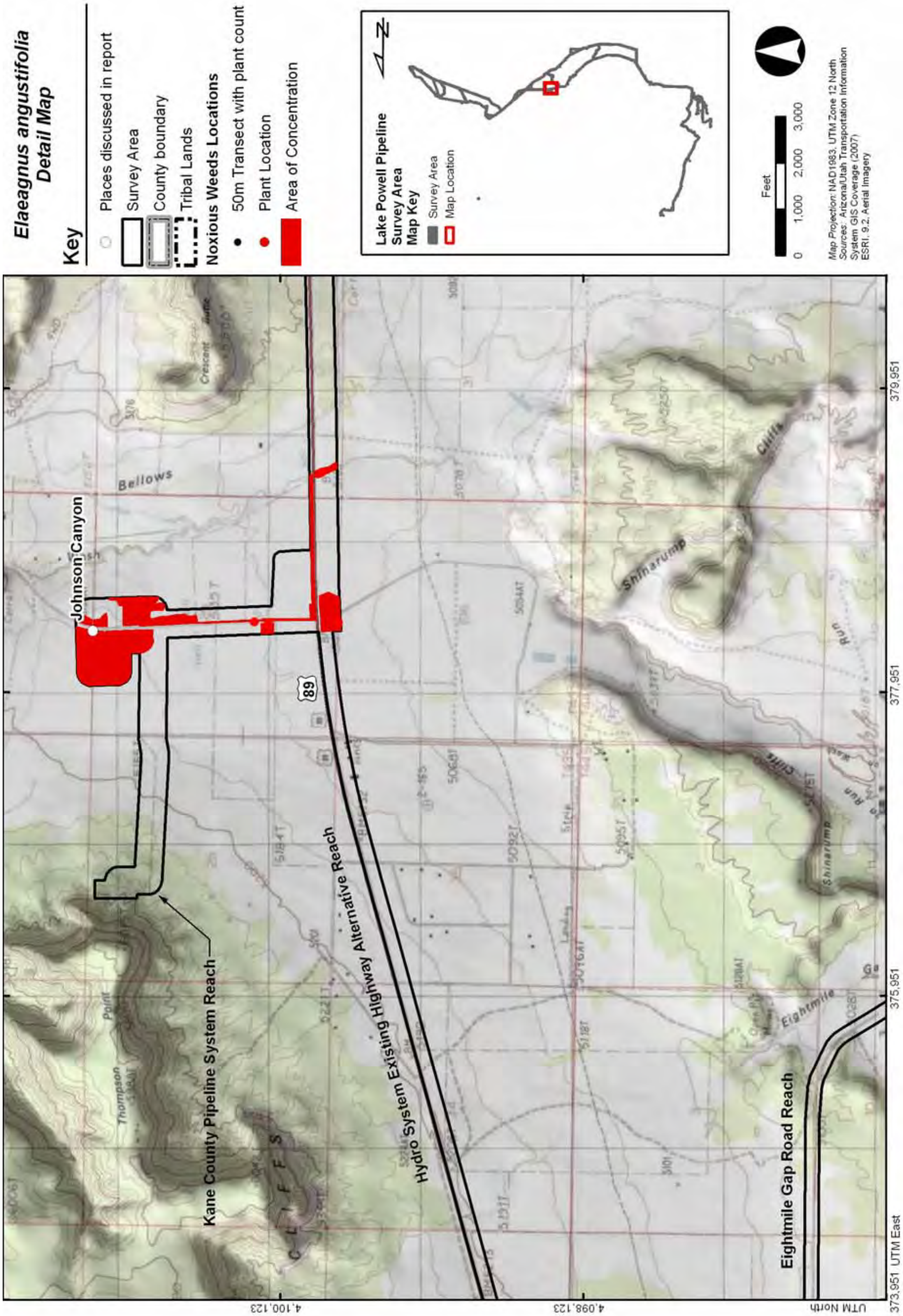
Map 5-64
***Elaeagnus angustifolia* Overview Map**



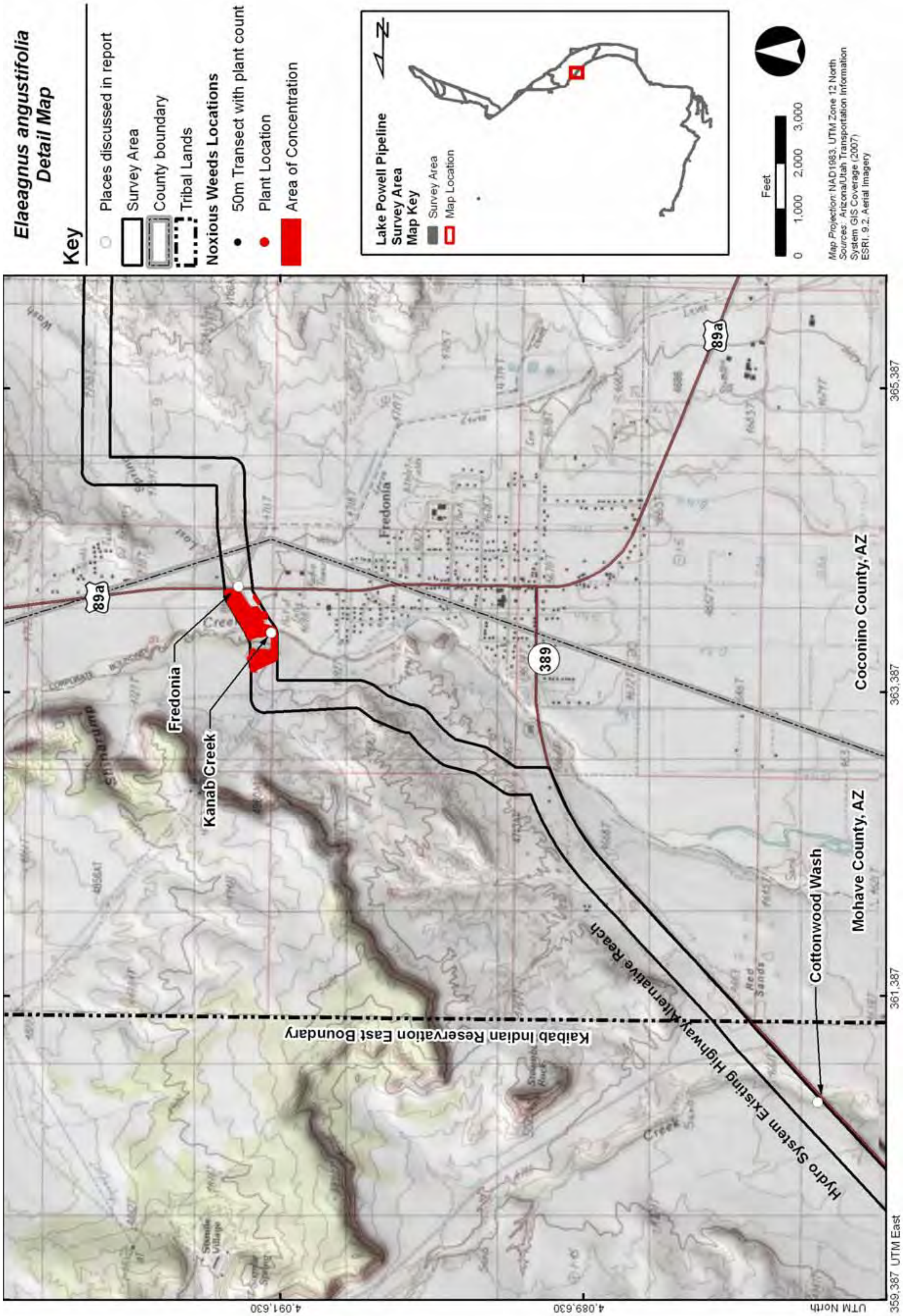
Map 5-65
***Elaeagnus angustifolia* Detail Map**



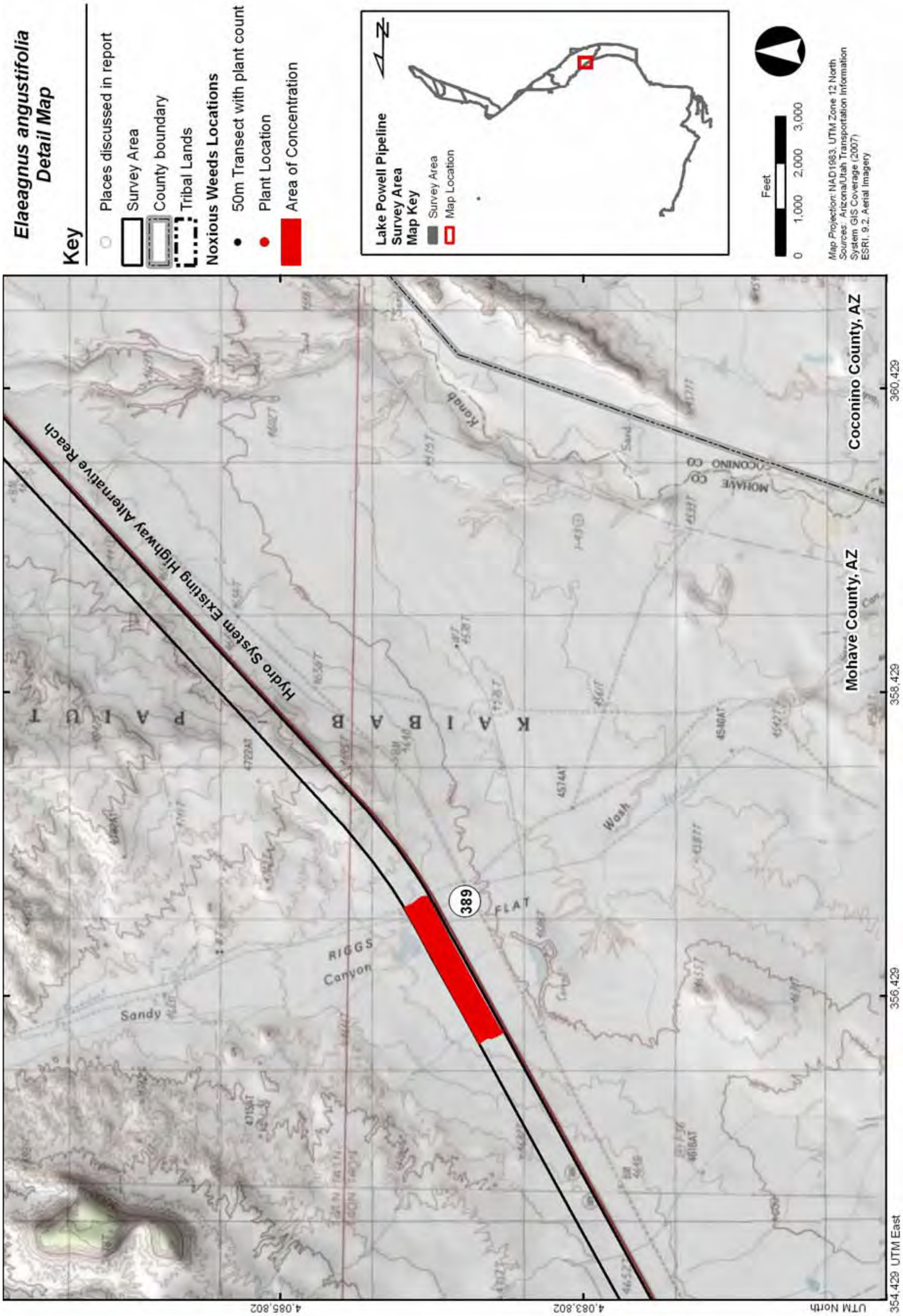
Map 5-66
***Elaeagnus angustifolia* Detail Map**



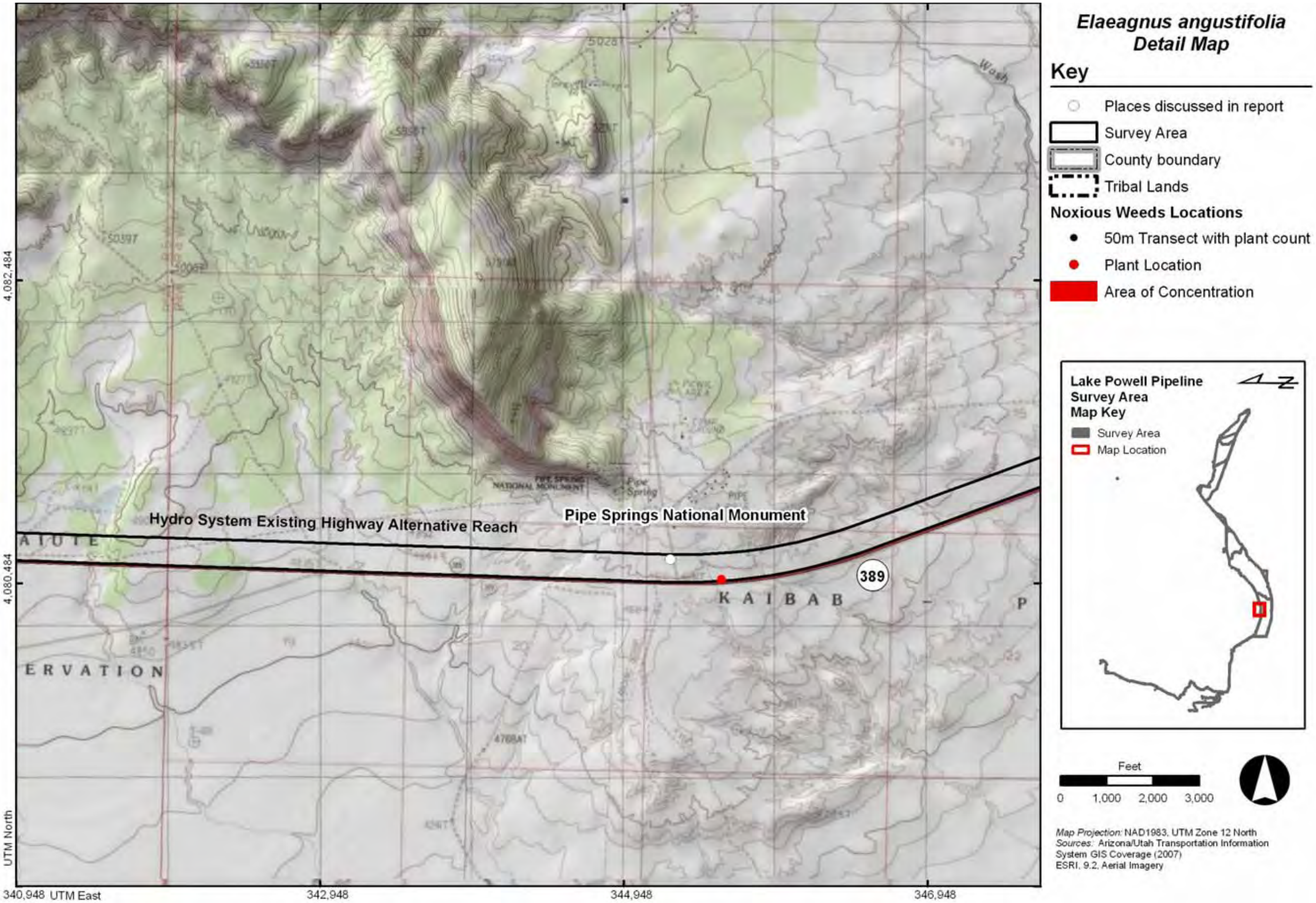
Map 5-67
***Elaeagnus angustifolia* Detail Map**



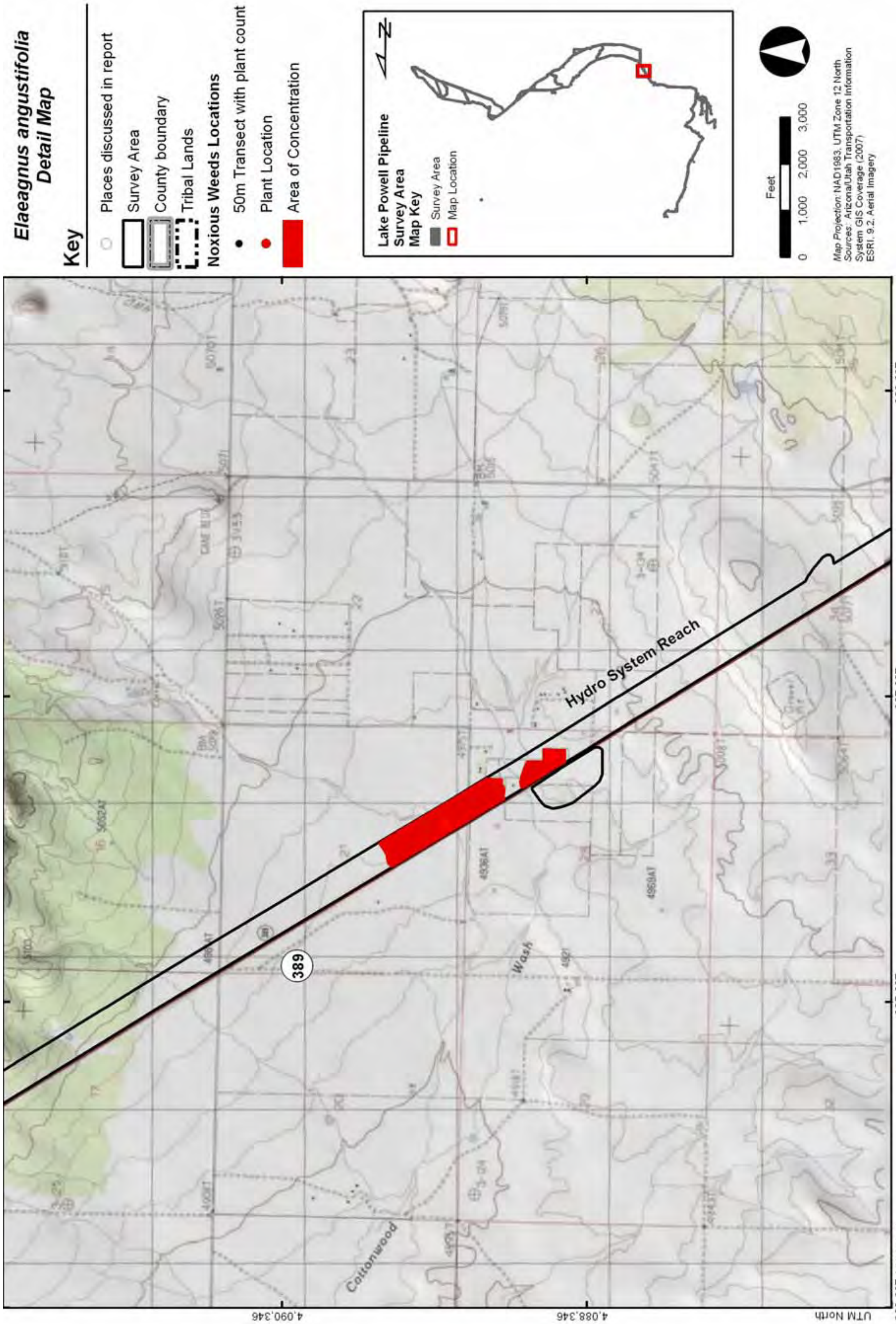
Map 5-68
***Elaeagnus angustifolia* Detail Map**



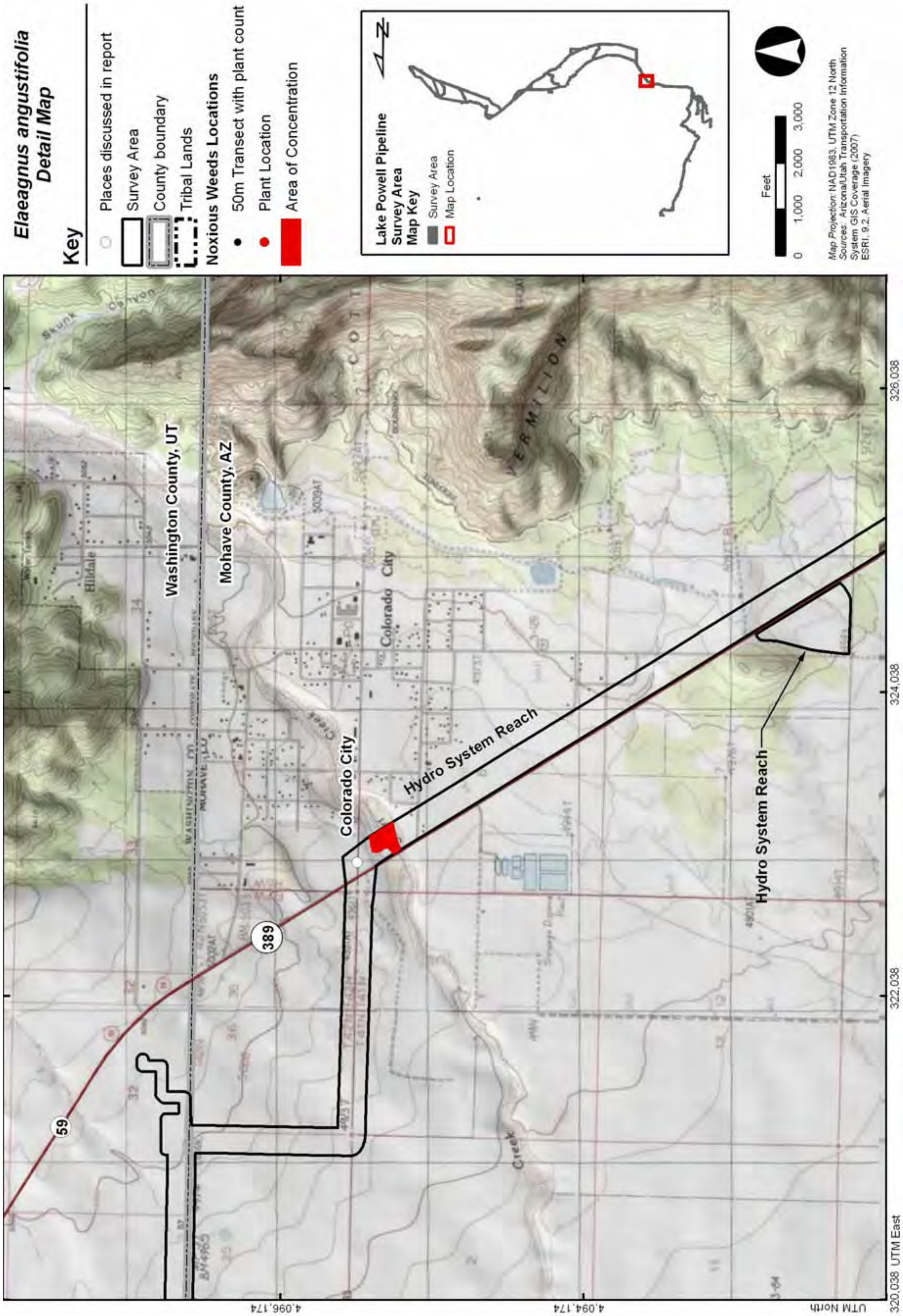
Map 5-69
***Elaeagnus angustifolia* Detail Map**



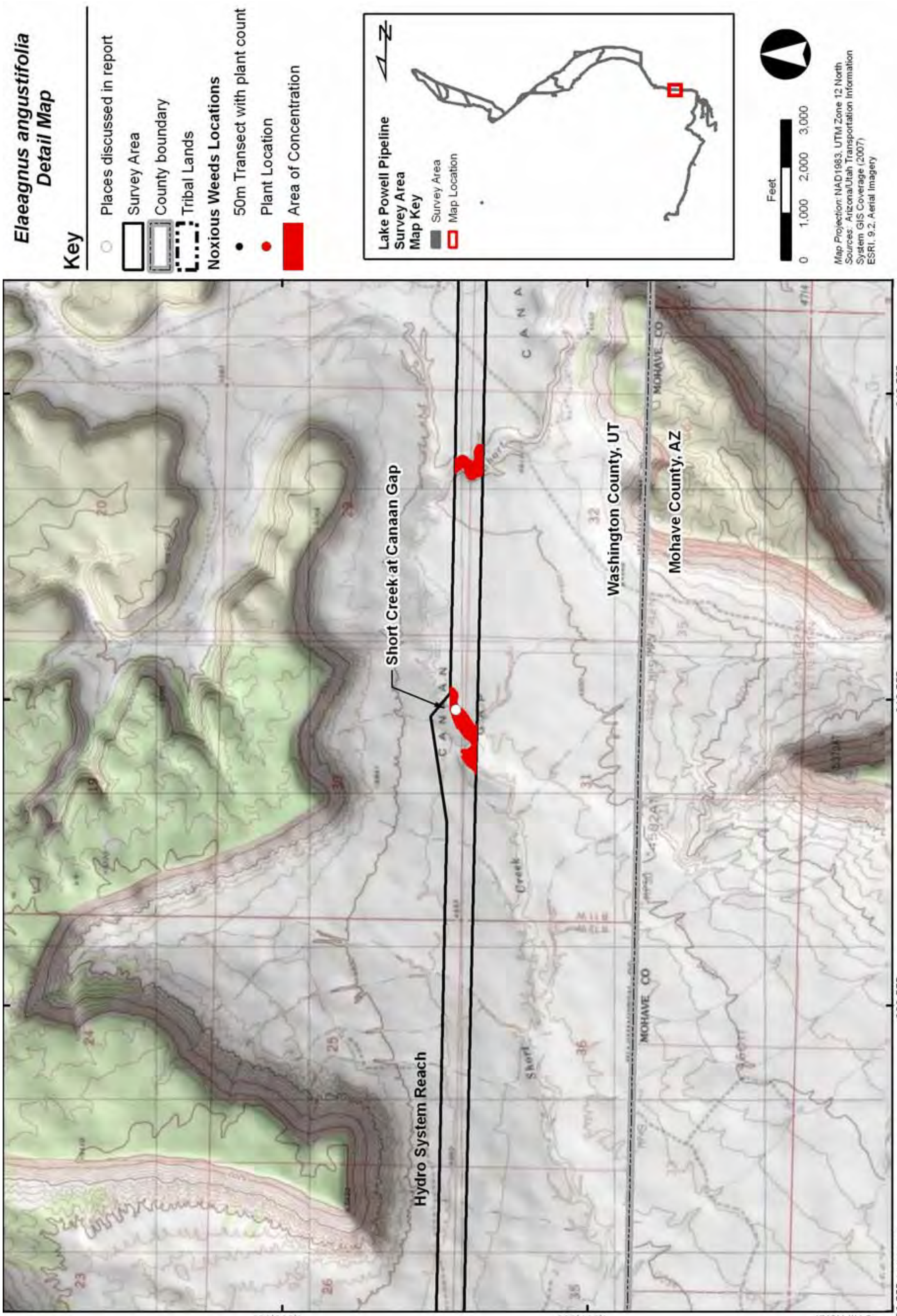
Map 5-70
***Elaeagnus angustifolia* Detail Map**



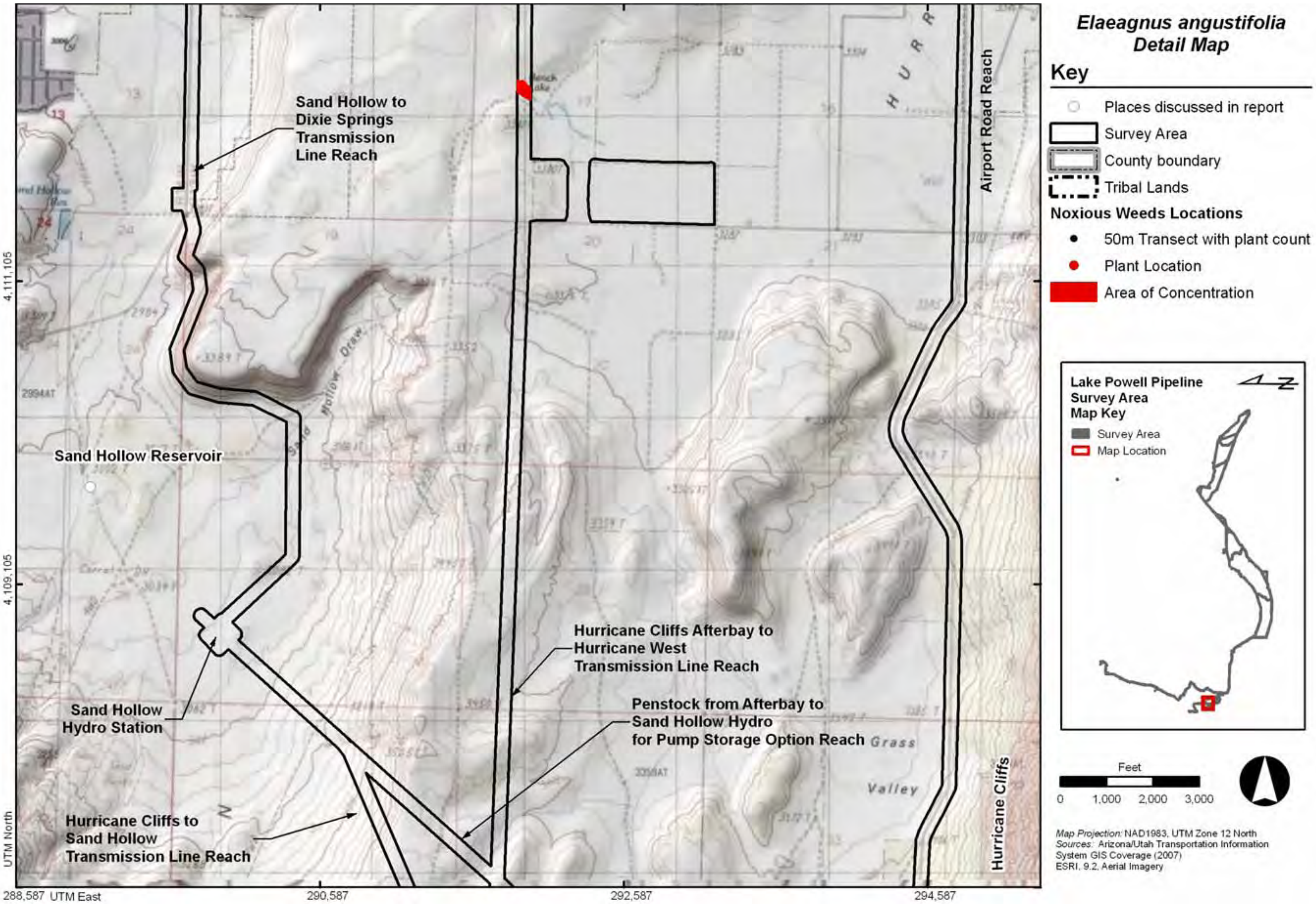
Map 5-71
***Elaeagnus angustifolia* Detail Map**



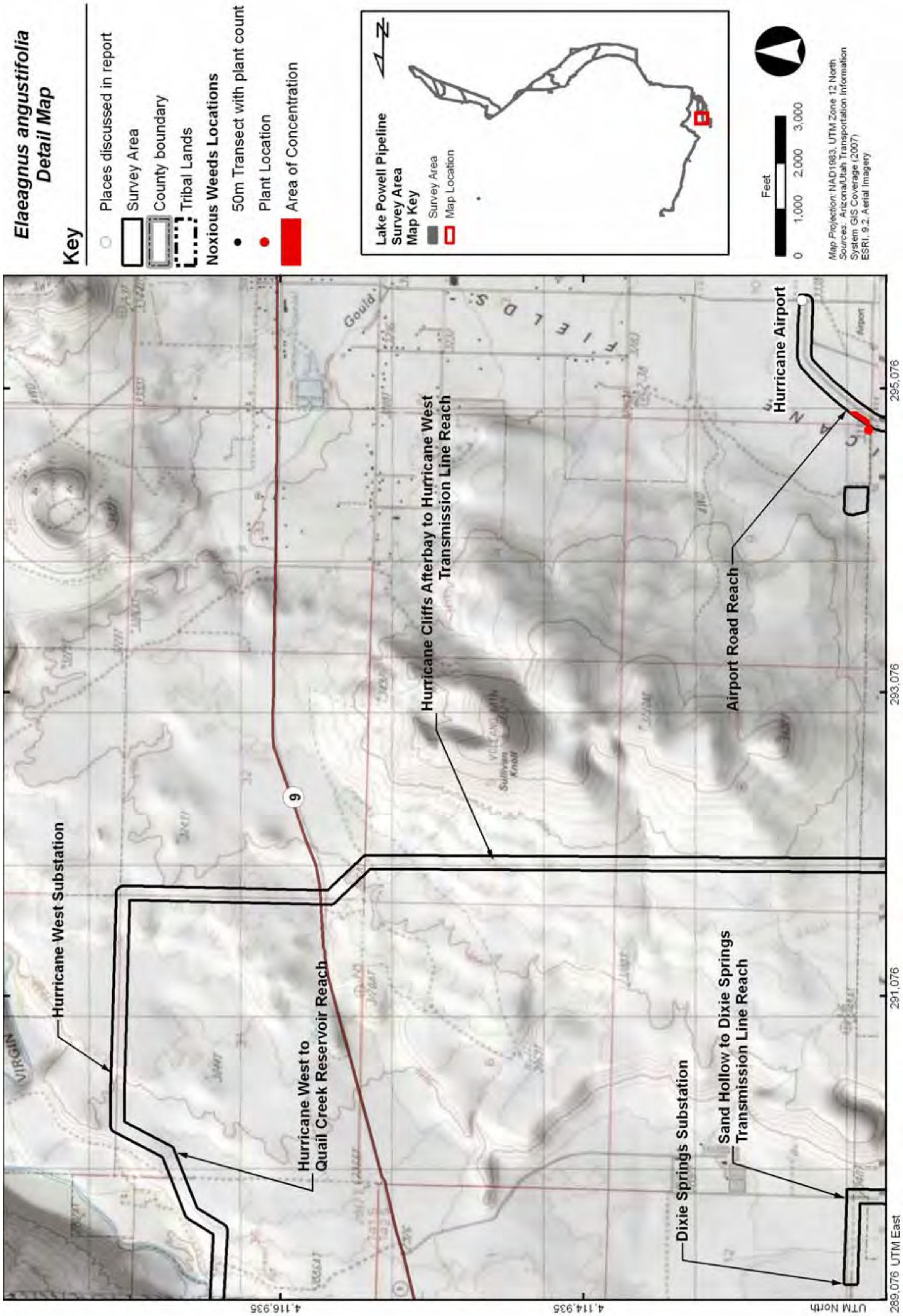
Map 5-72
***Elaeagnus angustifolia* Detail Map**



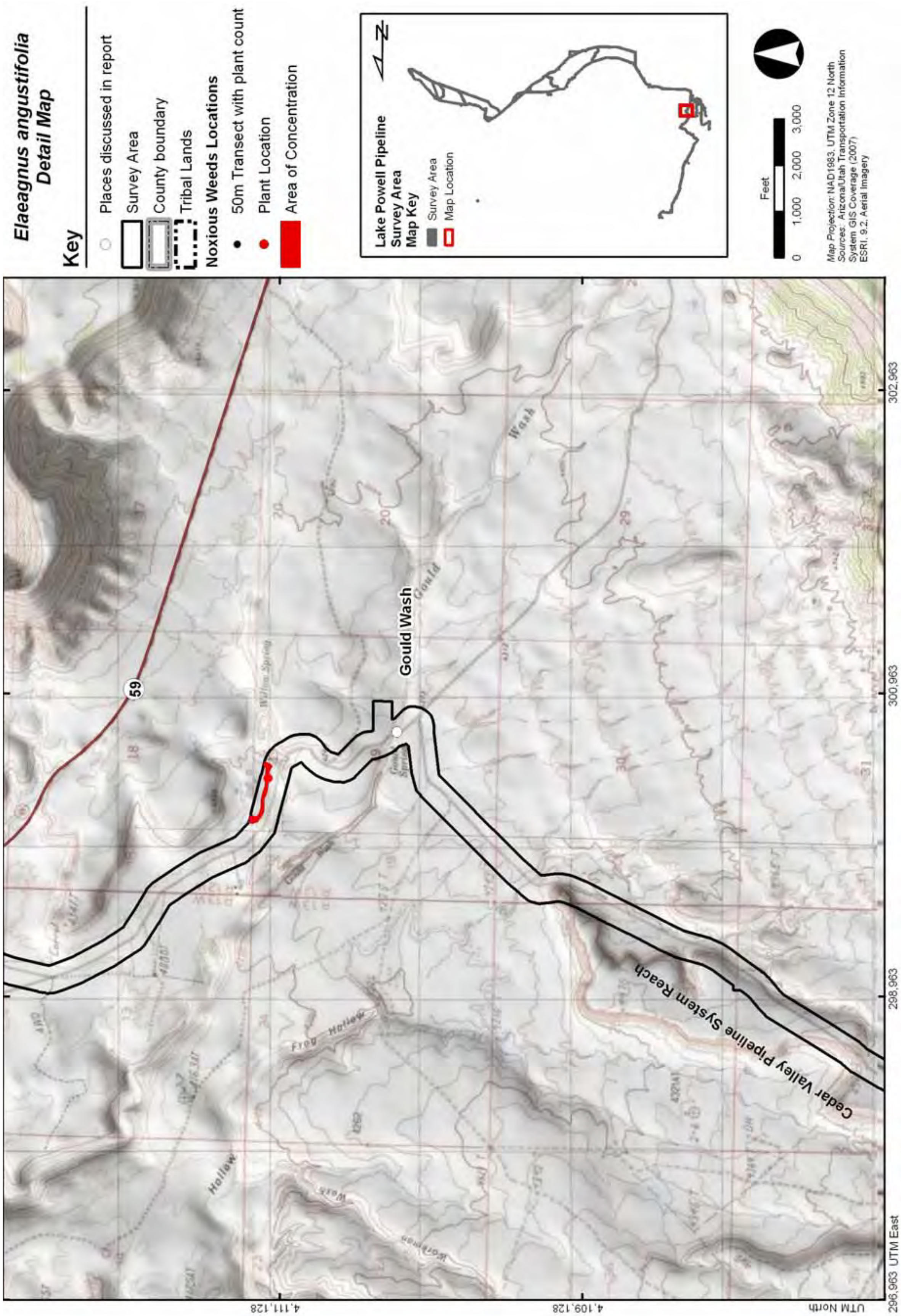
Map 5-73
***Elaeagnus angustifolia* Detail Map**



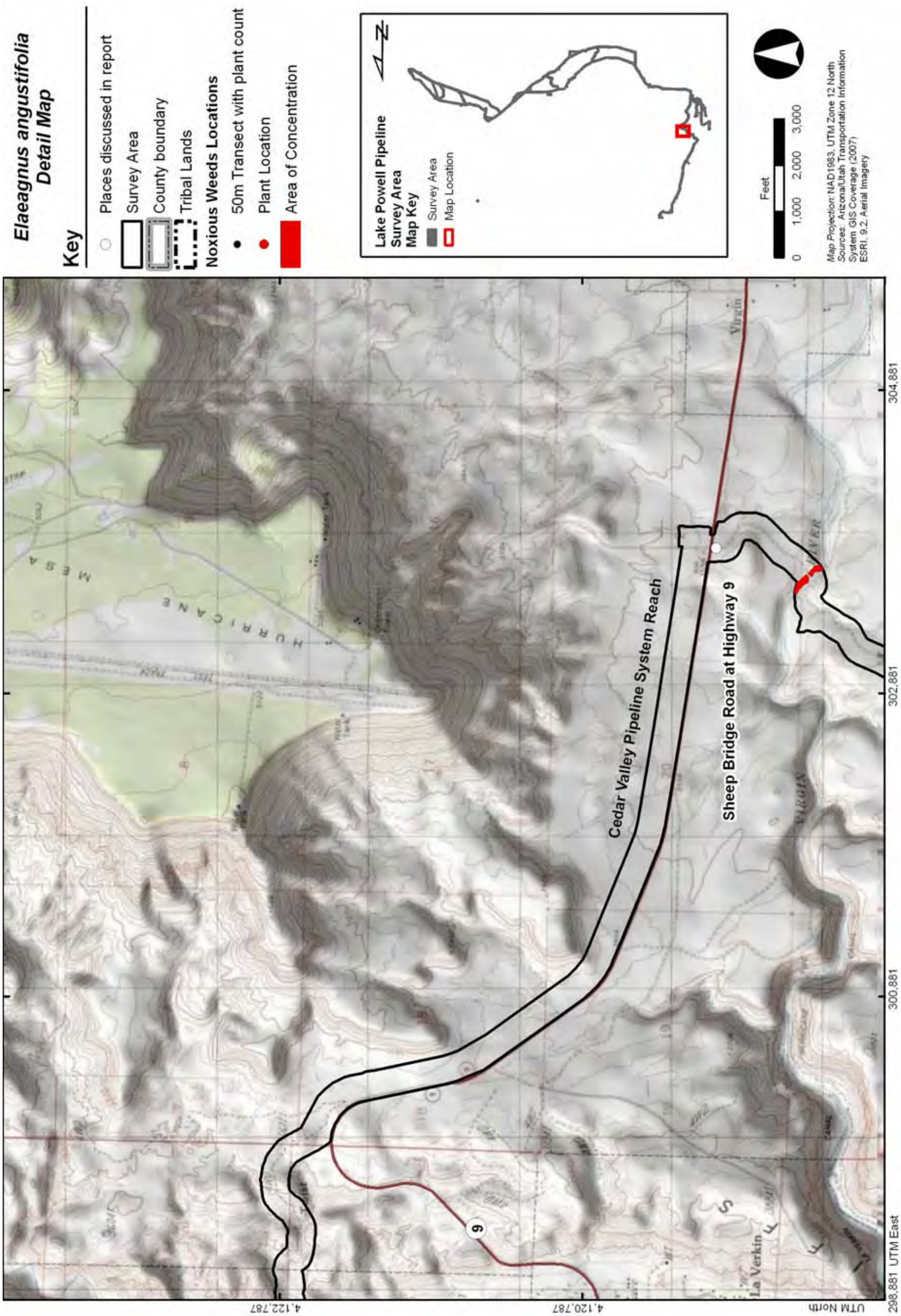
Map 5-74
***Elaeagnus angustifolia* Detail Map**



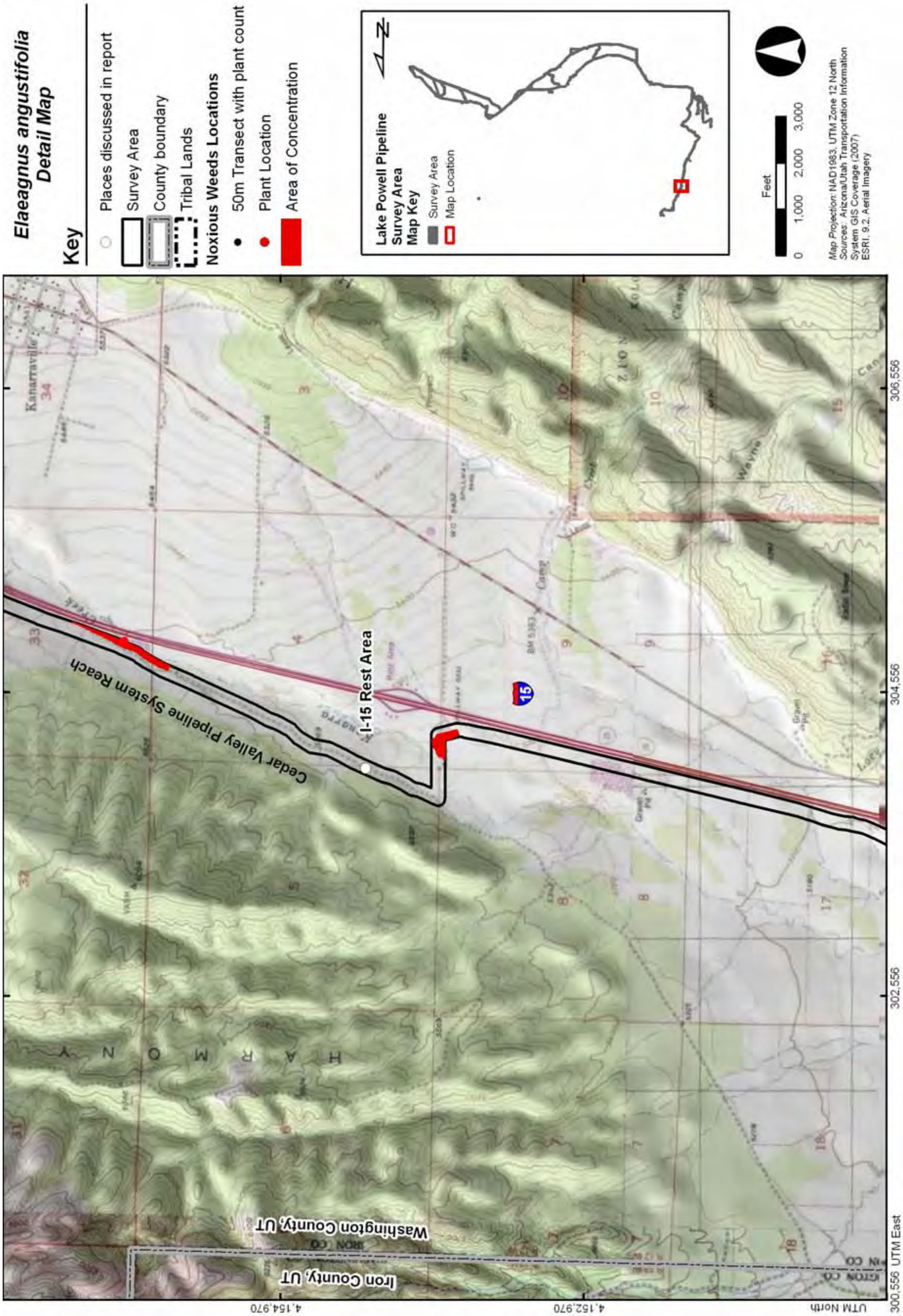
Map 5-75
***Elaeagnus angustifolia* Detail Map**



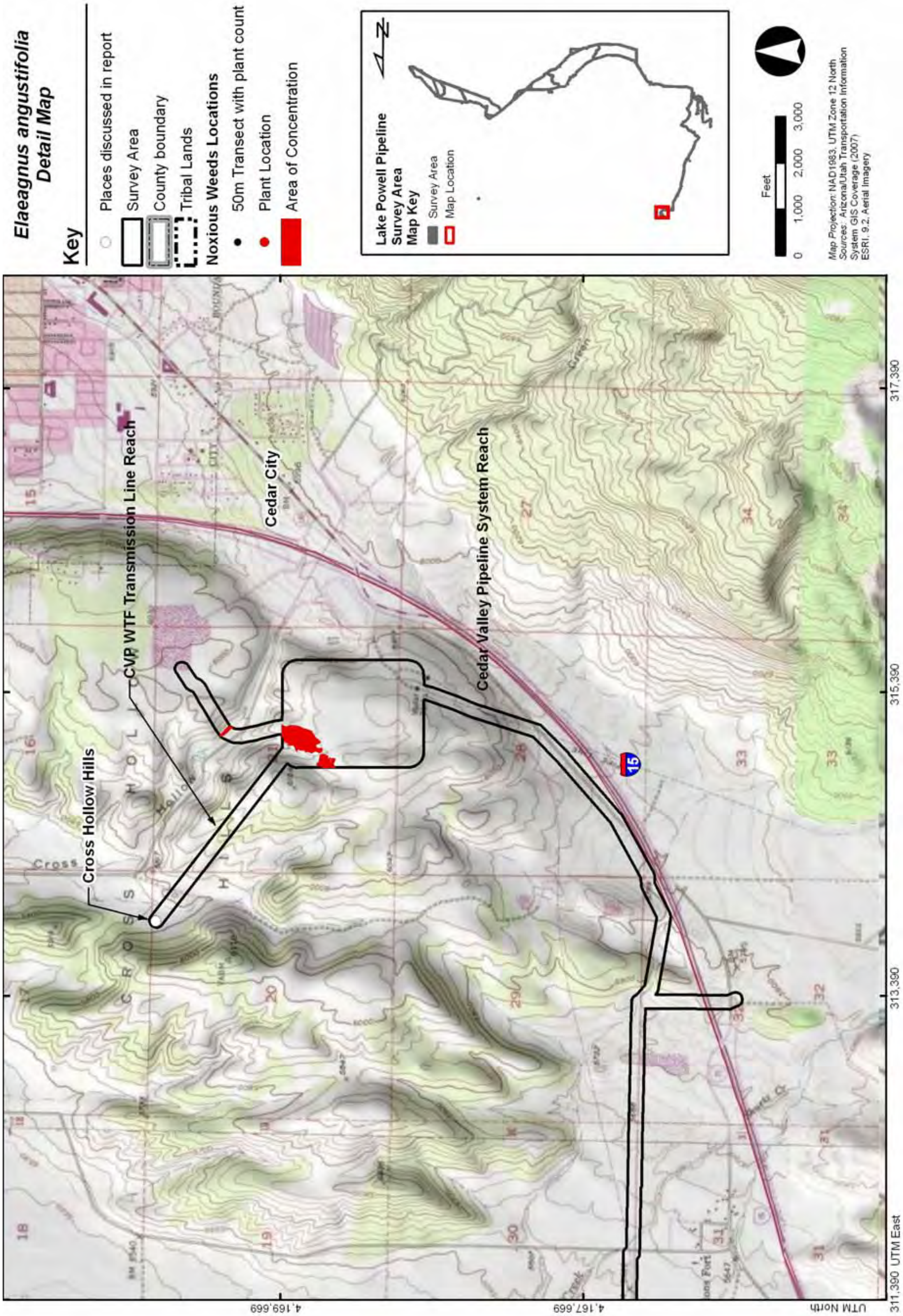
Map 5-76
***Elaeagnus angustifolia* Detail Map**



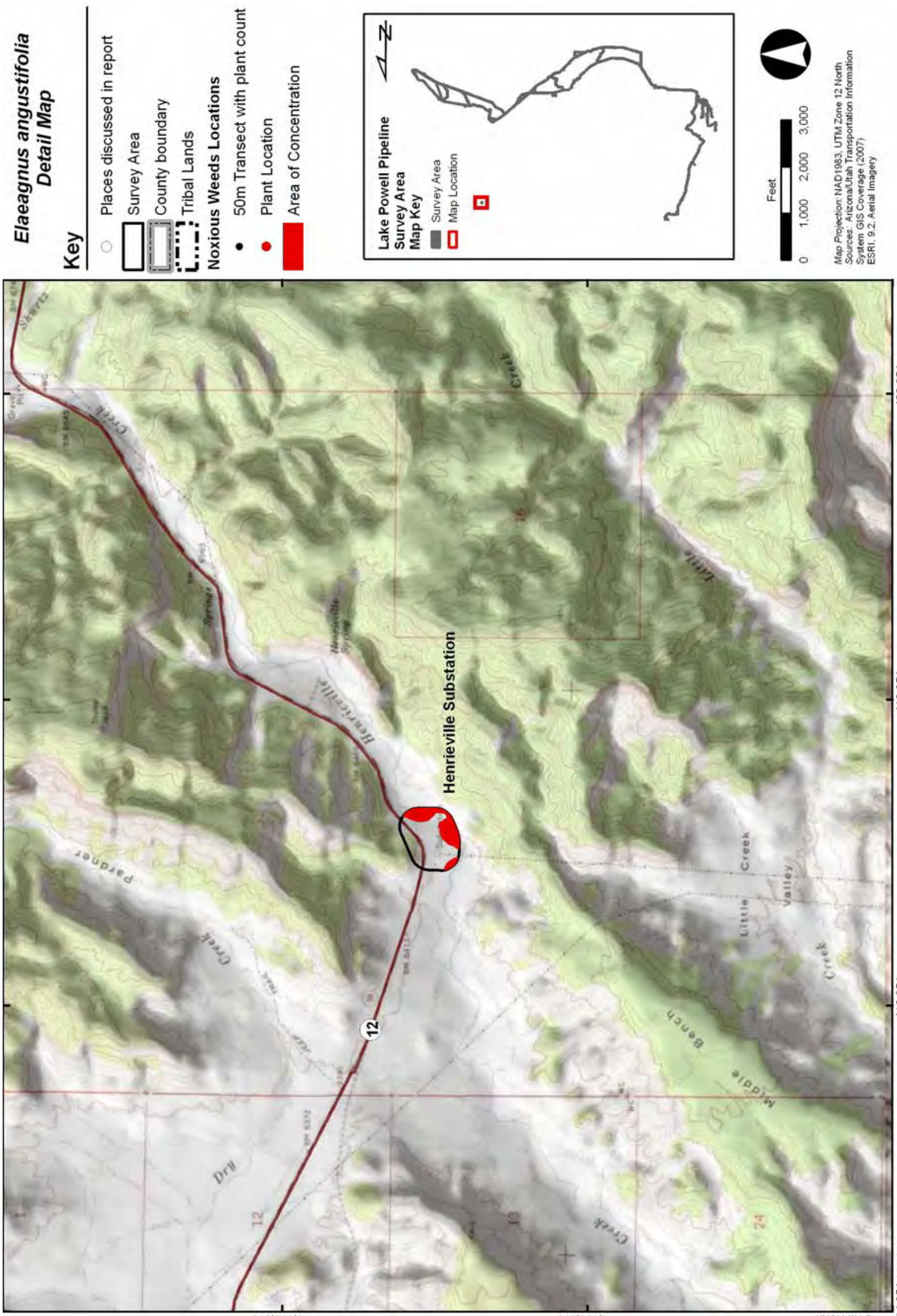
Map 5-77
***Elaeagnus angustifolia* Detail Map**



Map 5-78
***Elaeagnus angustifolia* Detail Map**



Map 5-79
***Elaeagnus angustifolia* Detail Map**



Map 5-80
***Elaeagnus angustifolia* Detail Map**

5.5.10 *Erodium cicutarium* (Stork's bill)

5.5.10.1 Natural History

Erodium cicutarium is an annual herb in the Geraniaceae (Geranium family) that grows to 1 foot (30 cm) tall. Spreading to prostrate stems arise from basal rosettes (Figure 5-14). Rosette leaves are 1 to 4 inches (3 to 10 centimeters) long and pinnate-compound, with 9 to 13 ovate leaflets that have deeply lobed or dissected margins. Stems and leaf stalks are reddish in color. Individuals exist as rosettes until late winter or spring, when flowering stems develop. From March to May, *E. cicutarium* produces pink to reddish lavender, 5-petaled flowers, which occur in umbels. Each flower cluster contains 2 to 10 individuals. Immature fruits consist of 5 fused ovary sections and 5 long styles, which combine to resemble a stork's head and beak. The beak is 0.80 to 2.0 inches (2 to 5 centimeters) long, and coils upon maturity. When conditions are dry, the styles tighten, which loosen when conditions become humid, driving the seeds into the soil. Upon maturity, the carpels explode, separating from the parent plant and dispersing seeds short distances away. Seeds can be dispersed further by soil and water movement, and by clinging to humans and animals, vehicle tires, and agricultural equipment (DiTomaso & Healy 2007).

Erodium cicutarium resembles other *Erodium* species, including *E. botrys* and *E. moschatum*, and can be distinguished from these by beak length. In contrast to the 0.80 to 2.0 inch (2 to 5 centimeters) long beak found on *E. cicutarium, E. botrys* produces a beak 2.0 to 4.72 inches (5 to 12 centimeters) long, and that of *E. brachycarpum* is 2.0 to 3.15 inches (5 to 8 centimeters) long. While the beak of *E. moschatum* is comparable in size to *E. cicutarium*, the species can be distinguished by the presence of hairs on the petal bases; while *E. cicutarium* is hairy on the margins, *E. moschatum* has glabrous petal bases (DiTomaso & Healy 2007).

Erodium cicutarium is a native of Eurasia, although pollen analysis studies have shown that the species has been established in California since before the arrival of Spanish missionaries in 1769 (DiTomaso & Healy 2007). Today, it is widely distributed across North America, from Canada south to Baja California, Mexico, and is found in all states except for Florida and Louisiana (Howard 1992). In Utah, the species occurs in open sites from 2,690 to 8,120 feet in elevation (Welsh et al. 2008). In Arizona, the species invades dunes, scrublands, desertlands, grasslands, riparian areas, and woodlands in Arizona and is abundant on plains, mesas, and slopes below 5,000 feet in elevation between February and March, and 5,000 to 7,500 feet in elevation from April to October (The Sonoran Institute 2008).

Figure 5-14
Close up view of *Erodium cicutarium* within the survey area

Erodium cicutarium can invade natural Ecological Systems following disturbance. *Erodium cicutarium* is a pioneer on disturbed sites and can be difficult to eradicate since seeds can remain viable for many years, forming extensive seed banks. The species can be a fire hazard as stems aid in spreading ground fire while dead plants contribute to fuel loads (Howard 1992). The specially-adapted fruits allow seeds to be driven into the soil, protecting them from fire, and giving the species a competitive advantage over many native herbaceous species.

5.5.10.2 Survey Results

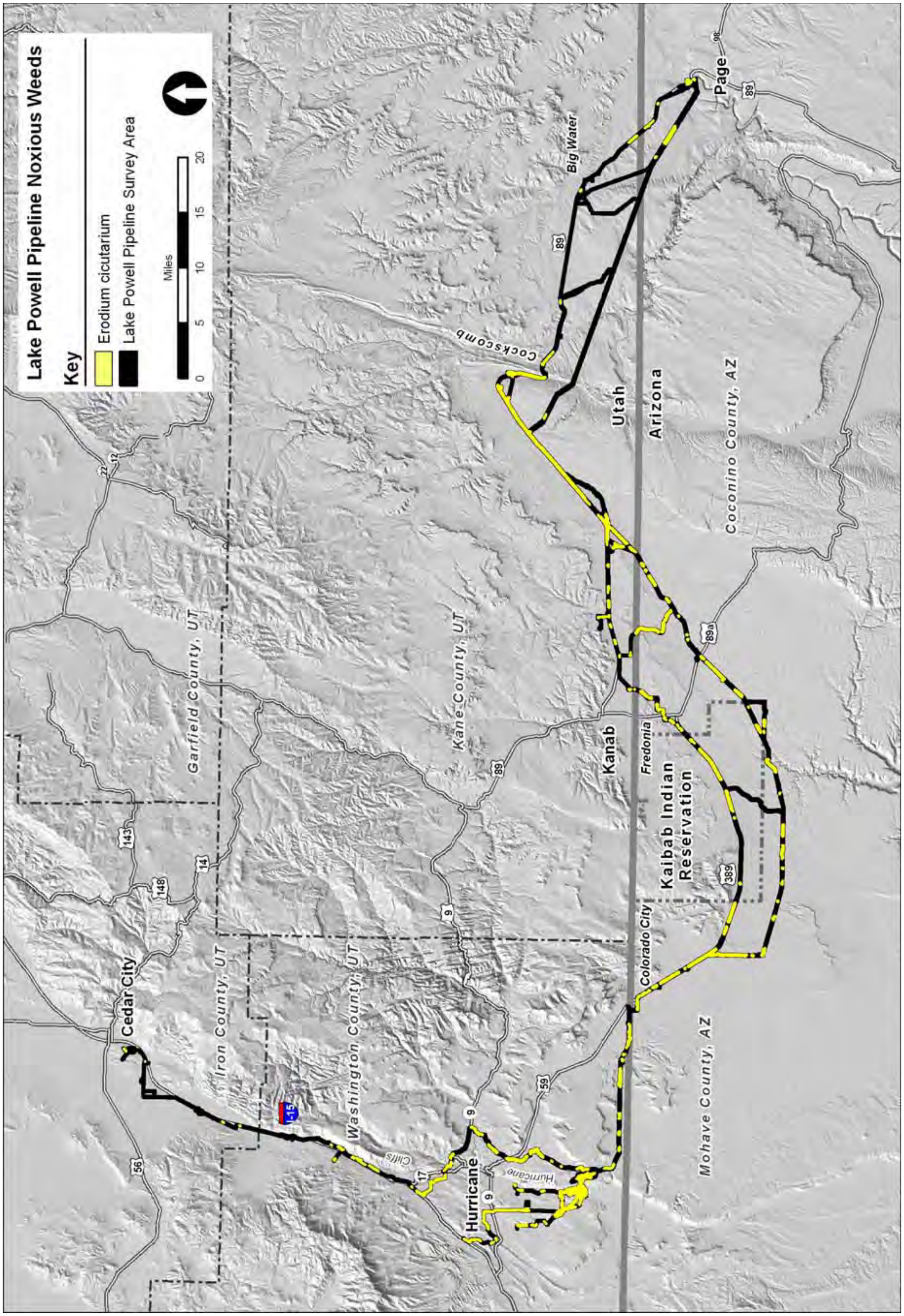
Erodium cicutarium was one of the most abundant noxious weeds encountered during the survey (Map 5-81). In general, the frequency of occurrences was highest from between the area of the Cockscomb and in the vicinity of Ash Creek Reservoir, while the species was encountered less frequently in the easternmost and northernmost extents of the survey area, from the Cockscomb east to Colorado River at Glen Canyon Dam, and from Ash Creek Reservoir north to Cedar City. *Erodium cicutarium* was identified in a total of 24 reaches within the survey area. At the Colorado River at Glen Canyon Dam it occurred at the Glen Canyon Substation. It was identified southeast of Upper Blue Pool Wash in the Glen Canyon to Buckskin Transmission Line Reach, and in the BPS-2 Transmission Line Alternative Reach. In the Water Conveyance System Reach, *E. cicutarium* was encountered around Greenhaven, west of Big Water, and throughout much of the area between the Paria Townsite Road Junction and Telegraph Wash. In the Hydro System Reach *E. cicutarium* was identified west of Cottonwood Canyon Road; in much of the area between Upper Paria River and the Cockscomb; and from Yellowstone Road at AZ Route 389 to Honeymoon Trail. The species was encountered at the Paria Substation, west of Fivemile Valley in the Buckskin to Paria Transmission Line Reach, and at the Buckskin Substation. In the Glen Canyon to Buckskin Transmission Line North Reach *E. cicutarium* was identified southeast of 5 Mile Mountain Road at US 89, and in the Hydro System High Point Alignment Alternative Reach it was located south of Petrified Hollow Wash. The species occurred in the Hydro System South Alternative Reach around Shinarump Cliffs, in much of the area between Petrified Hollow Wash and the Kaibab Indian Reservation East Boundary, and in sporadic locations between the Southeast Corner of Kaibab Indian Reservation and Yellowstone Road at AZ Route 389. In the Hydro System Existing Highway Alternative Reach, individuals were encountered at several locations between Petrified Hollow Wash and Yellowstone Road at AZ Route 389. In the Kane County Pipeline System Reach, *Erodium cicutarium* was identified in the area from Johnson Canyon to US 89. The species also occurred in the Eightmile Gap Road Reach, in much of the area around Johnson Wash extending north to the border of Kane County and Coconino County, and south of 8-Mile Gap Road at US 89. *Erodium cicutarium* was also found in the Forebay and throughout much of the Afterbay Reach. In the Airport Road Reach it was found occasionally between the Hurricane Cliffs and the Hurricane Airport. The species was encountered throughout much of the Penstock from Afterbay to Sand Hollow Hydro for Pump Storage Option Reach, the Hurricane Cliffs to Sand Hollow Transmission Line Reach, the Hurricane Cliffs Afterbay to Hurricane West Transmission Line Reach, and the Hurricane West to Quail Creek Reservoir Reach. Individuals were also found at several locations around Sand Hollow Reservoir, in the Sand Hollow to Dixie Springs Transmission Line Reach. In the Cedar Valley Pipeline System Reach *E. cituarium* was found commonly between the Divide and just south of Ash Creek Reservoir, in two locations around the I-15 Rest Area, and in the vicinity of Cedar City. The species was also identified in the northwestern portion of the CBPS-1 Transmission Line Reach. *Erodium cicutarium* was encountered while conducting surveys for special status species and noxious weeds, and was detected in a total of 84 transects.

Erodium cicutarium was encountered in all three Ecological Regions, in a total of 27 ecological systems, and in five anthropogenic lands. On the Colorado Plateau, *E. cicutarium* was identified in Active and Stabilized Dune, Big Sagebrush Shrubland, Blackbrush-Mormon-tea Shrubland, Grassland, Greasewood Flat, Gypsum Badland, Lower Montane Riparian Woodland and Shrubland, Mixed Bedrock Canyon and Tableland, Mixed Desert Scrub, Mixed Low Sagebrush Shrubland, Pinyon-Juniper Woodland, Shrub-Steppe, Volcanic Rock and Cinder Land,

and Colorado Plateau Wash. In the Great Basin *E. cicutarium* was encountered in Big Sagebrush Shrubland, Mixed Desert Scrub, Pinyon-Juniper Woodland, and Semi-Desert Grassland. In the Mohave Desert *E. cicutarium* was found in Active and Stabilized Dune, Blackbrush-Mormon-tea Shrubland, Creosote-White Bursage Desert Scrub, Grassland, Lower Montane Riparian Woodland and Shrubland, Mixed Desert Scrub, Shrub-Steppe, Volcanic Rock and Cinder Land, and Mohave Desert Wash. Anthropogenic lands which supported *E. cicutarium* included Agricultural Land, Developed Road, Developed Land, Invasive Upland Vegetation, and Ruderal Vegetation. *Erodium cicutarium* was found in a broad range of community types and was identified as a dominant species in many communities; however, in the majority of habitats it was not a prominent feature on the landscape. It occurred in habitats dominated by native shrubs including *Artemisia* spp., *Atriplex canescens, Ephedra* spp., *Gutterizia sarothrae*, or by *Juniperus osteosperma* and *Pinus edulis*. *Erodium cicutarium* was generally encountered in large quantities, where the species was considered common or abundant, and individuals were often encountered in conjunction with other invasive species, particularly *Bromus rubens* and *B. tectorum*.

5.5.10.3 Discussion

Erodium cicutarium was highly abundant throughout much of the survey area and occurred in a broad range of ecological systems. The species is well-adapted to disturbance, and readily invades newly-disturbed habitats. Furthermore, the special adaptations of the fruit allow it to be transported long distances by human activities. The disturbance associated with the project will undoubtedly foster the spread of the species within and adjacent to the survey area. It is therefore recommended that vehicle tires be washed when departing work areas where the species has been identified, and care should be taken to check clothing for seed-bearing fruit.



Map 5-81
Erodium cicutarium **Overview Map**

5.5.11 *Halogeton glomeratus* (Halogeton)

Figure 5-15
Close up view of *Halogeton glomeratus* within the survey area

5.5.11.1 Natural History

Halogeton glomeratus is a member of the Chenopodiaceae (Goosefoot family) and is a summer annual of varying height, growing from a few inches to over 18 inches (46 centimeters) tall. Stems branch from the base, first spreading then growing vertically (Figure 5-15). Leaves are alternate, dull green to bluish green, 0.16 to 0.90 inch (4 to 22 millimeters) long and 0.04 to 0.08 inch (1 to 2 millimeters) wide, fleshy, cylindrical, and terminate with a stiff bristle 0.04 to 0.08 inch (1 to 2 millimeters) long. *Halogeton glomeratus* produces a taproot that can penetrate up to 20 inches (50 centimeters) deep, and lateral roots that spread up to 20 inches (50 centimeters) (DiTomaso & Healy 2007). Plants are blue-green in the spring and in late summer turn red or yellow. From July to September, green inconspicuous flowers with minute cottony hairs are borne in leaf axils. *Halogeton glomeratus* produces two seed types, one that germinates immediately and one that delays germination for 10 or more years (USUE 2009). Individual plants produce great quantities of seed which are dispersed by water, wind, animals, and people. When plants are mature they break off and tumble in the wind, further dispersing seeds along their path (DiTomaso & Healy 2007).

When immature, *Halogeton glomeratus* may resemble *Salsola* spp. or *Kochia scoparia*; however, immature *Salsola* spp. have linear leaves rather than cylindrical leaves. *Halogeton glomeratus* can also be differentiated from *K. scoparia,* which has pubescent leaves that lack the terminal bristles found on *H. glomeratus*.

Halogeton glomeratus was introduced from southeastern Russia and northwestern China and is currently found in the Rocky Mountain and Great Basin regions in the United States (Pavek 1992). The species was introduced to Nevada in the early 1930s and quickly spread into western Utah (Welsh et al. 1993). In Utah the species occurs in disturbed areas in *Bromus tectorum*, *Salsola tragus*, mixed desert shrub, salt desert shrub, and pinyon-juniper communities from 4,002 to 6,512 feet in elevation (Welsh et al. 2008). R.K. Gierisch and Gary A. Reese collected the first Arizona specimens in 1978 at Antelope Springs and on the Paria Canyon floodplain, respectively. *Halogeton glomeratus* is common in disturbed sites in salt-desert shrubland and surrounding big sagebrush (*Artemisia tridentata*) steppe types, and in transition zones from shadscale (*Atriplex confertifolia*) to big sagebrush (Pavek 1992).

Halogeton glomeratus is poorly competitive with perennial vegetation that is established. However, when native species are reduced or removed from the landscape by human disturbance, fire, and overgrazing, *H. glomeratus* readily invades habitats (Figure 5-16). Spread of the species is particularly enhanced by fire disturbance, which encourages seed germination and the development of dense stands of individuals. *Halogeton glomeratus* is well adapted to arid and semiarid sites with saline or alkaline soils. Individual plants take up salts, which increases the salinity of the topsoil when dead plants decompose, further favoring the establishment of the species. *Halogeton*

Figure 5-16
View of *Halogeton glomeratus* and its habitat within the survey area

glomeratus accumulates oxalates which poison livestock, causing staggering, muscular spasms, and coma. When ingested in large quantities, *H glomeratus* can be fatally toxic (DiTomaso & Healy 2007).

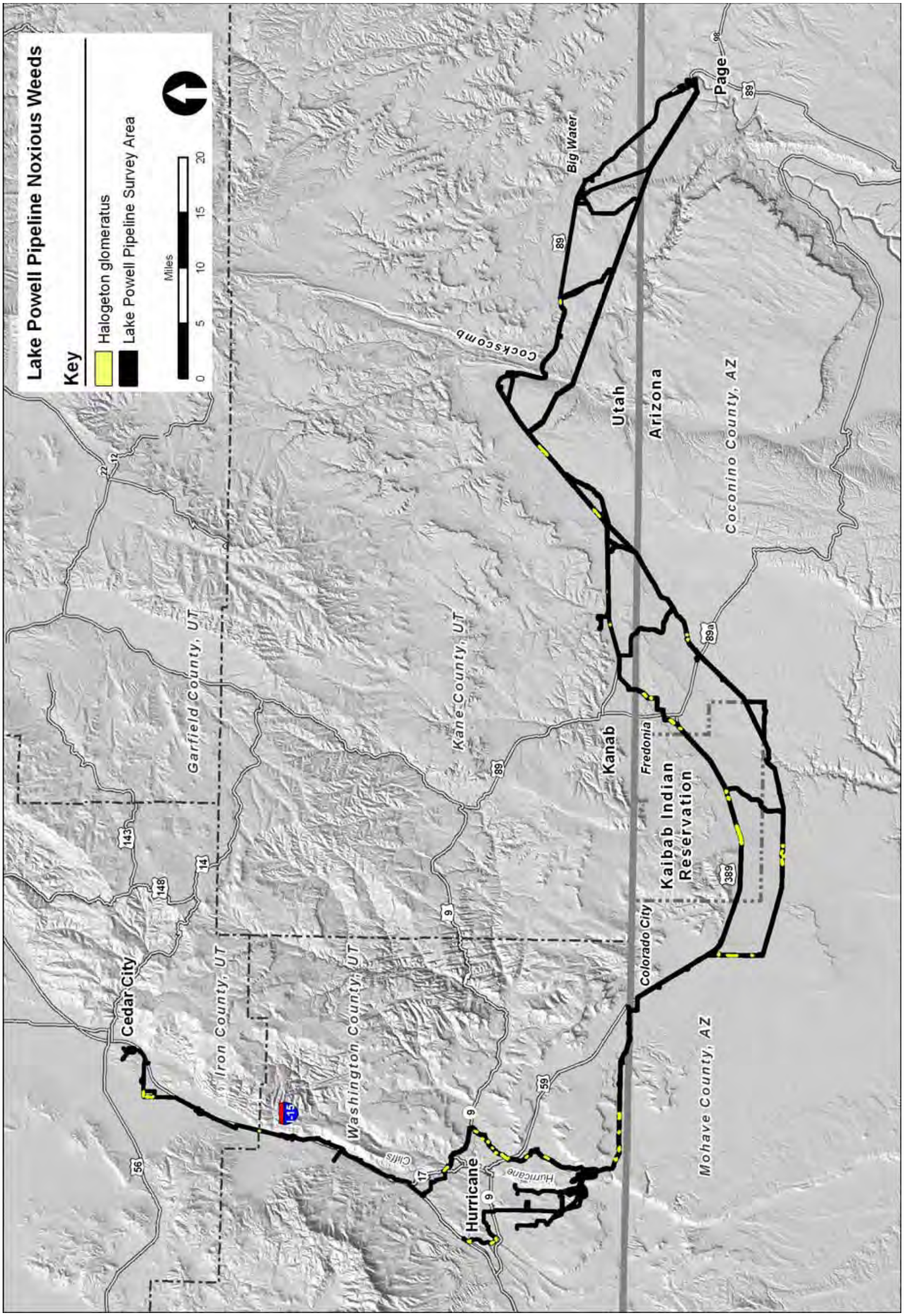
5.5.11.2 Survey Results

The distribution of *Halogeton glomeratus* was sporadic within the survey area (Map 5-82). *Halogeton glomeratus* occurred as far east as the vicinity of Cottonwood Canyon Road and as far north as the Bottoms. The species was found in six reaches (Map 5-83 to Map 5-105). In the Hydro System Reach *H. glomeratus* was identified at a location west of Cottonwood Canyon Road, in the vicinity of Petrified Hollow Wash, and at several locations east of Honeymoon Trail. In the Water Conveyance System Reach it was encountered in the vicinity of Buckskin Gulch. In the Hydro System Existing Highway Alternative Reach the species was found at two locations near the turn-off to Johnson Canyon, at a location south of the border of Kane and Coconino Counties (south of Lost Spring Gap), between Kanab Creek and Cottonwood Wash, east of Twomile Wash, and in the vicinity of Pipe Springs National Monument. *Halogeton glomeratus* was encountered sporadically along the Hydro System South Alternative Reach and in the Hurricane West to Quail Creek Reservoir Reach. In the Cedar Valley Pipeline System Reach individuals were encountered occasionally between the Divide and the vicinity of La Verkin Creek, at a location near the Iron and Washington County border (south of the I-15 Rest Area), and in the vicinity of the Bottoms. *Halogeton glomeratus* was mostly encountered while conducting surveys for special status species and noxious weeds; however, individuals were also detected in three 50-meter belt transects (Transect # 211, 285, and 286).

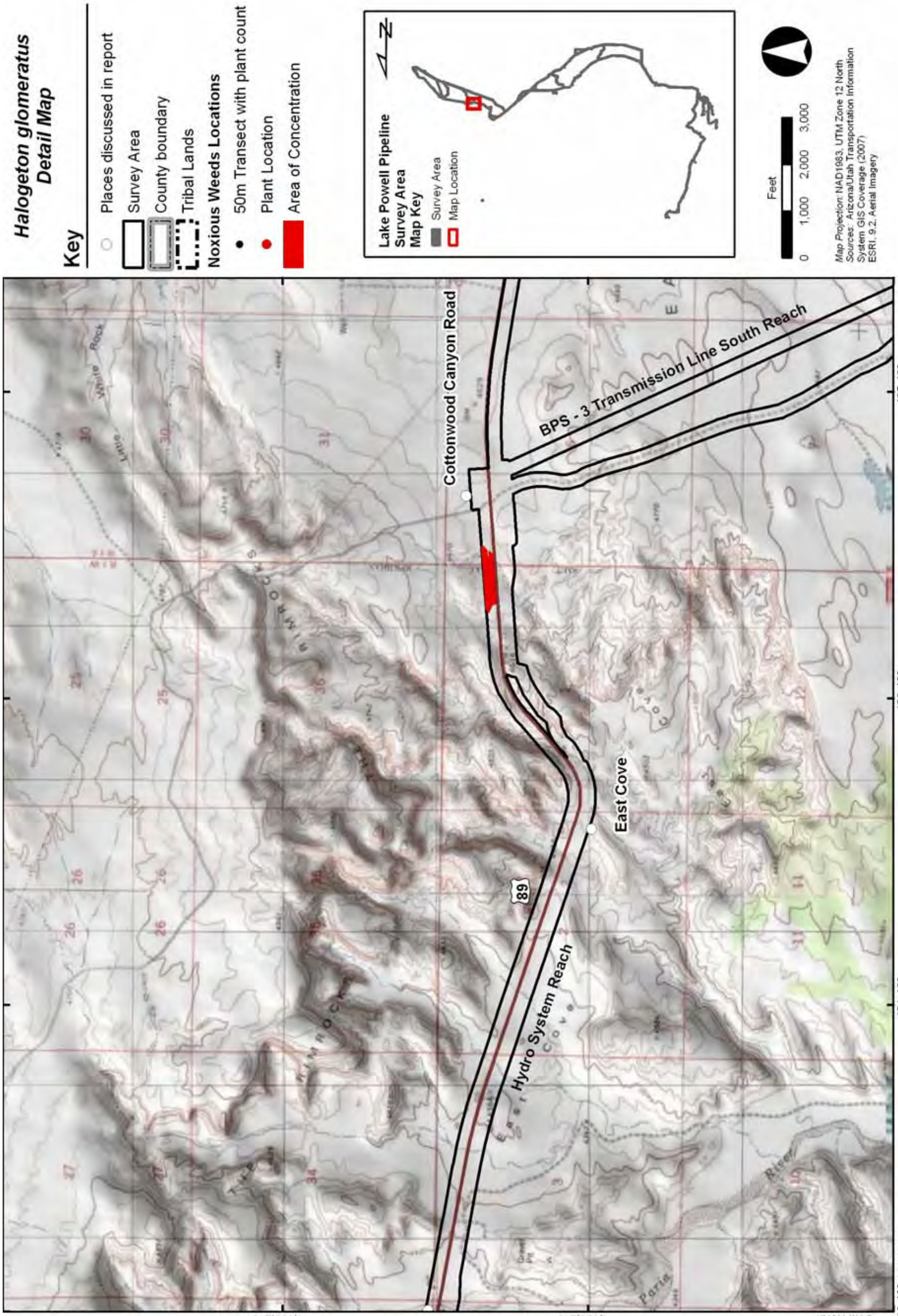
Halogeton glomeratus was encountered in all three Ecological Regions, in 12 ecological systems, and in three anthropogenic lands. On the Colorado Plateau *H. glomeratus* was identified in Big Sagebrush Shrubland, Blackbrush-Mormon-tea Shrubland, Greasewood Flat, Gypsum Badland, Lower Montane Riparian Woodland and Shrubland, Mixed Desert Scrub, Shrub-Steppe, and Colorado Plateau Wash. In the Great Basin *H. glomeratus* was encountered in Big Sagebrush Shrubland and Mixed Desert Scrub. In the Mohave Desert *H. glomeratus* was found in Blackbrush-Mormon-tea Shrubland and Creosote-White Bursage Desert Scrub. Anthropogenic lands supporting *H. glomeratus* included Agricultural Land, Invasive Upland Vegetation, and Ruderal Vegetation. *Halogeton glomeratus* was most commonly encountered in Colorado Plateau Mixed Desert Scrub. Most commonly, *H. glomeratus* was found in vegetative communities dominated or co-dominated by *Atriplex canescens*, but individuals were also frequently found inhabiting communities dominated by non-native species, particularly *Salsola tragus*. The species was mostly encountered in small quantities; however, on occasion, large populations were found.

5.5.11.3 Discussion

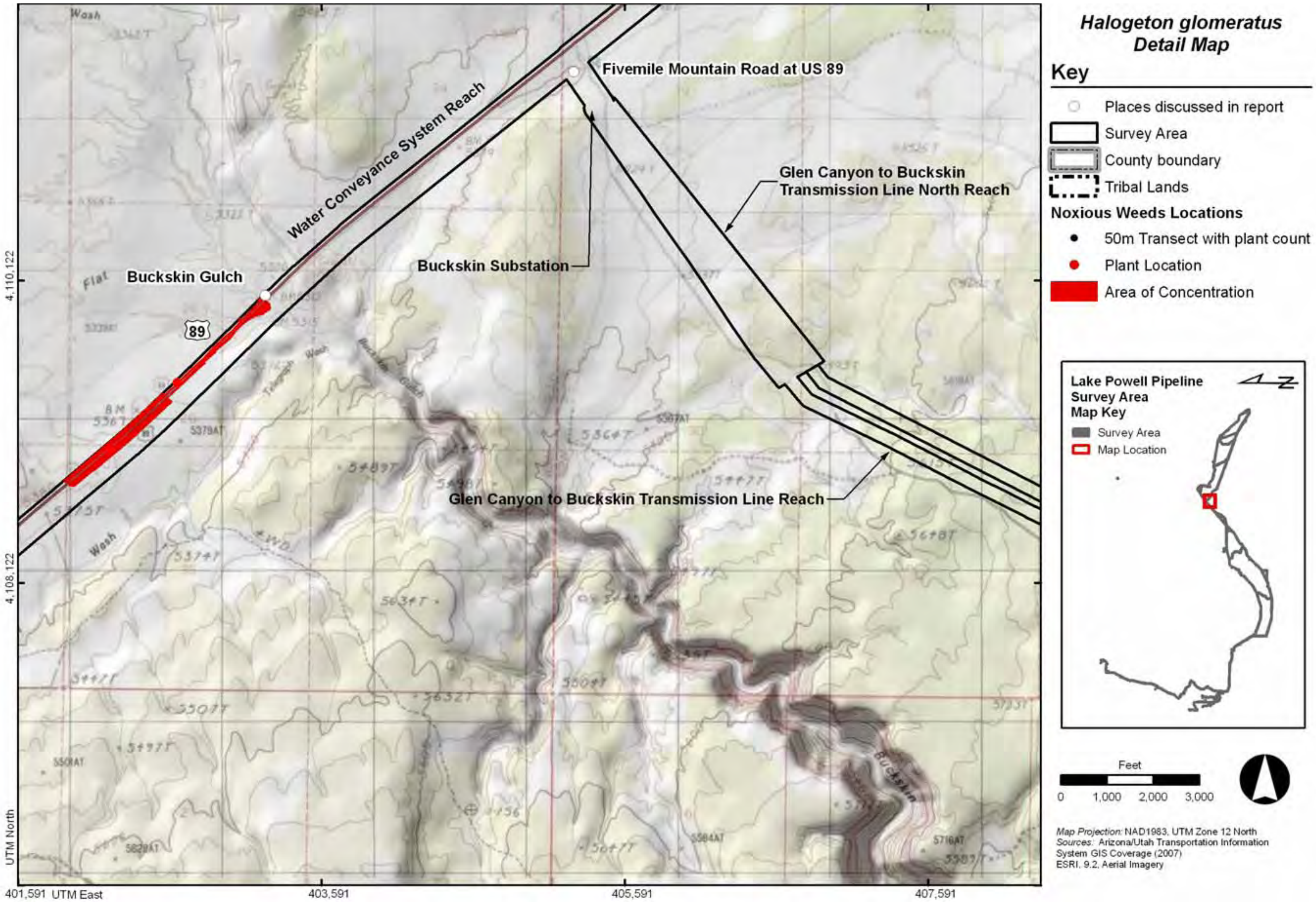
Halogeton glomeratus was encountered sporadically throughout the survey area and in a variety of ecological systems. *Halogeton glomeratus* is well-adapted to alkaline soils, and its ability to increase the salinity of soils through the uptake of salts gives it a competitive advantage over native species, particularly in disturbed habitats. Furthermore, its ability to produce extremely large quantities of seed, coupled with its ability to disperse its seed over long distances by rolling across the landscape, provides *H. glomeratus* much opportunity to establish itself in new habitats. Due to the disturbance likely to be created by the project, the project will undoubtedly enhance the ability of *H. glomeratus* to spread within and adjacent to the survey area. Plant skeletons that are found within work areas, which may contain viable seed, could be removed from the site and destroyed. Additionally, it is recommended that vehicle tires be washed when departing work areas where the species has been identified.



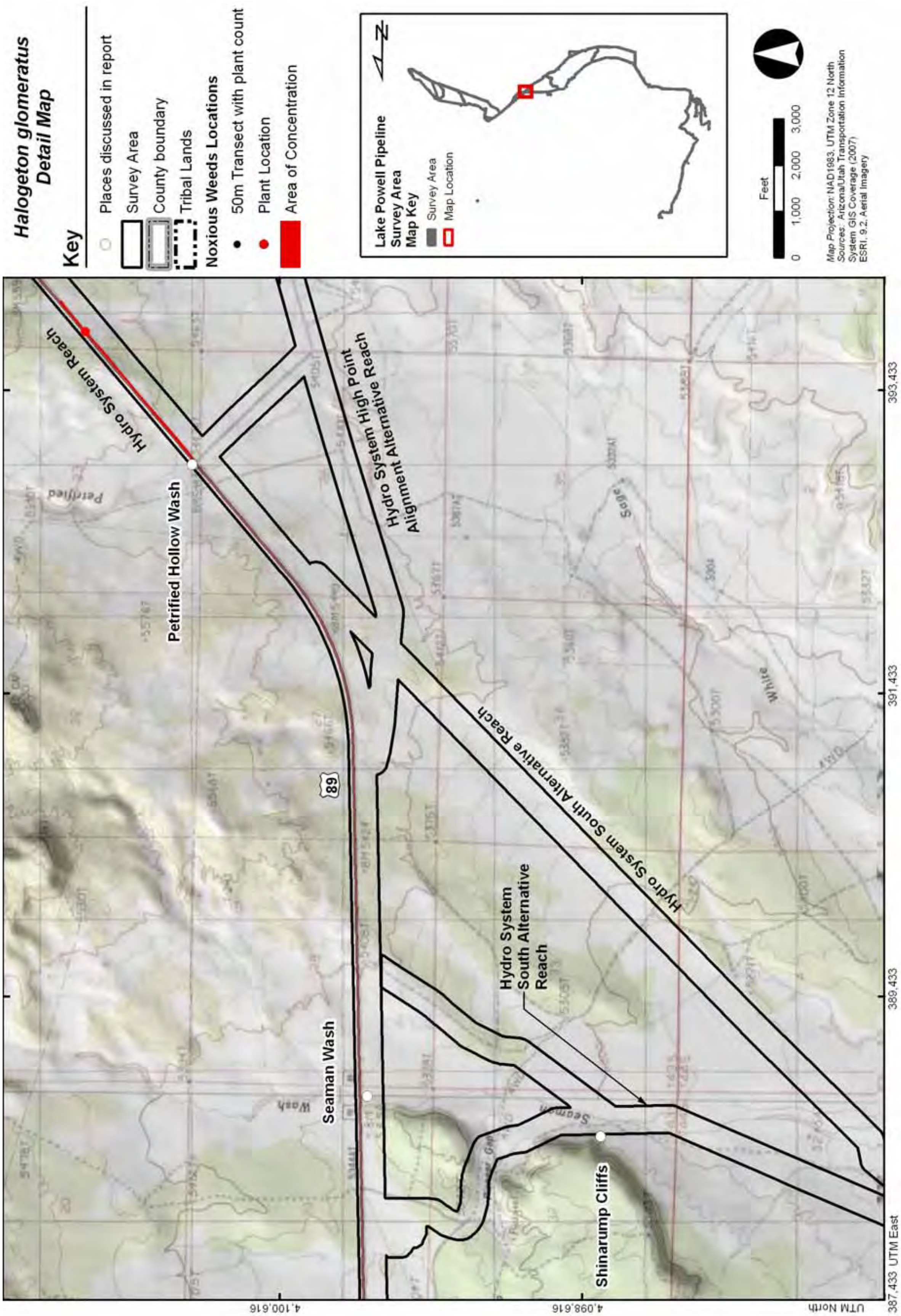
Map 5-82
***Halogeton glomeratus* Overview Map**



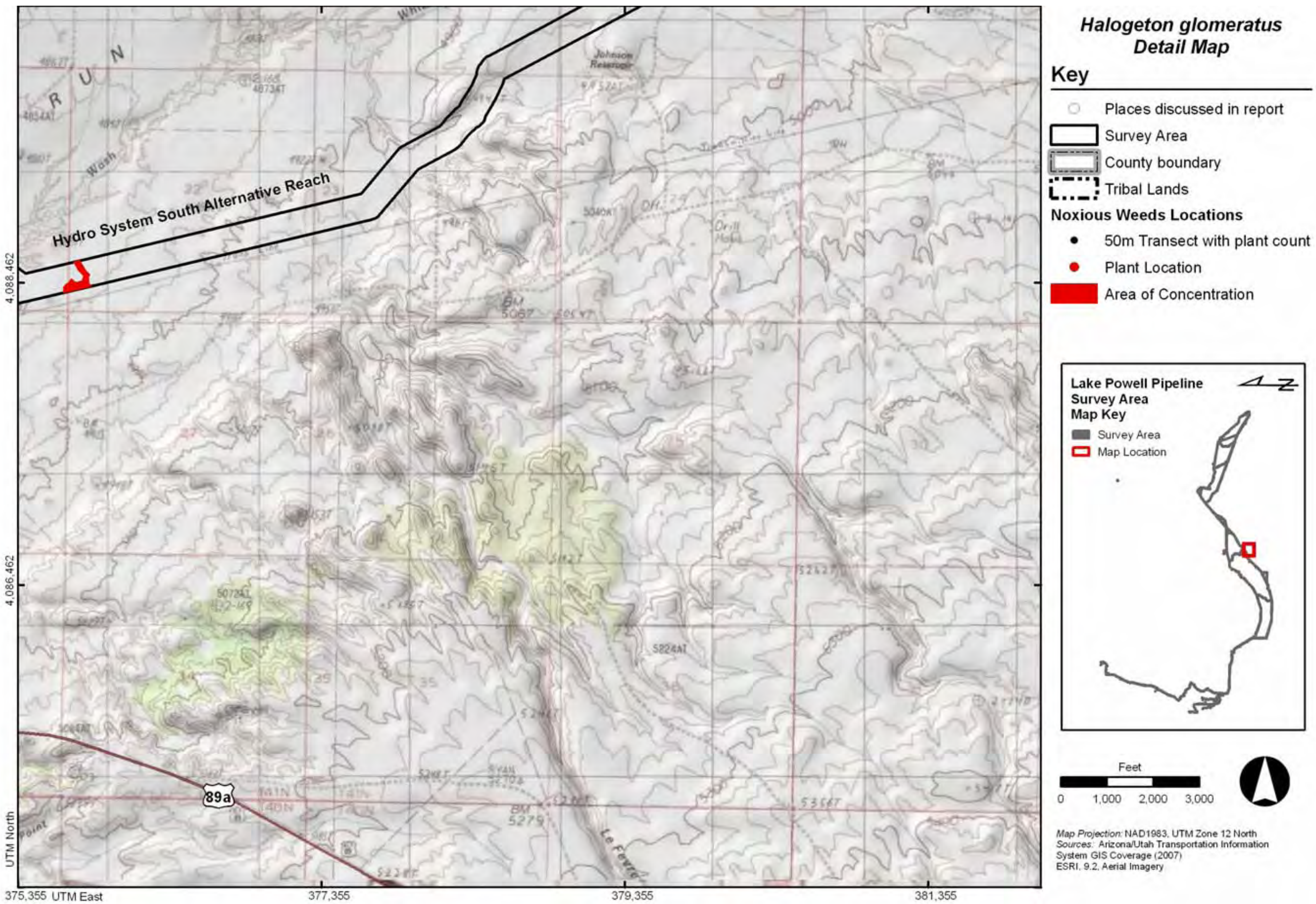
Map 5-83
***Halogeton glomeratus* Detail Map**



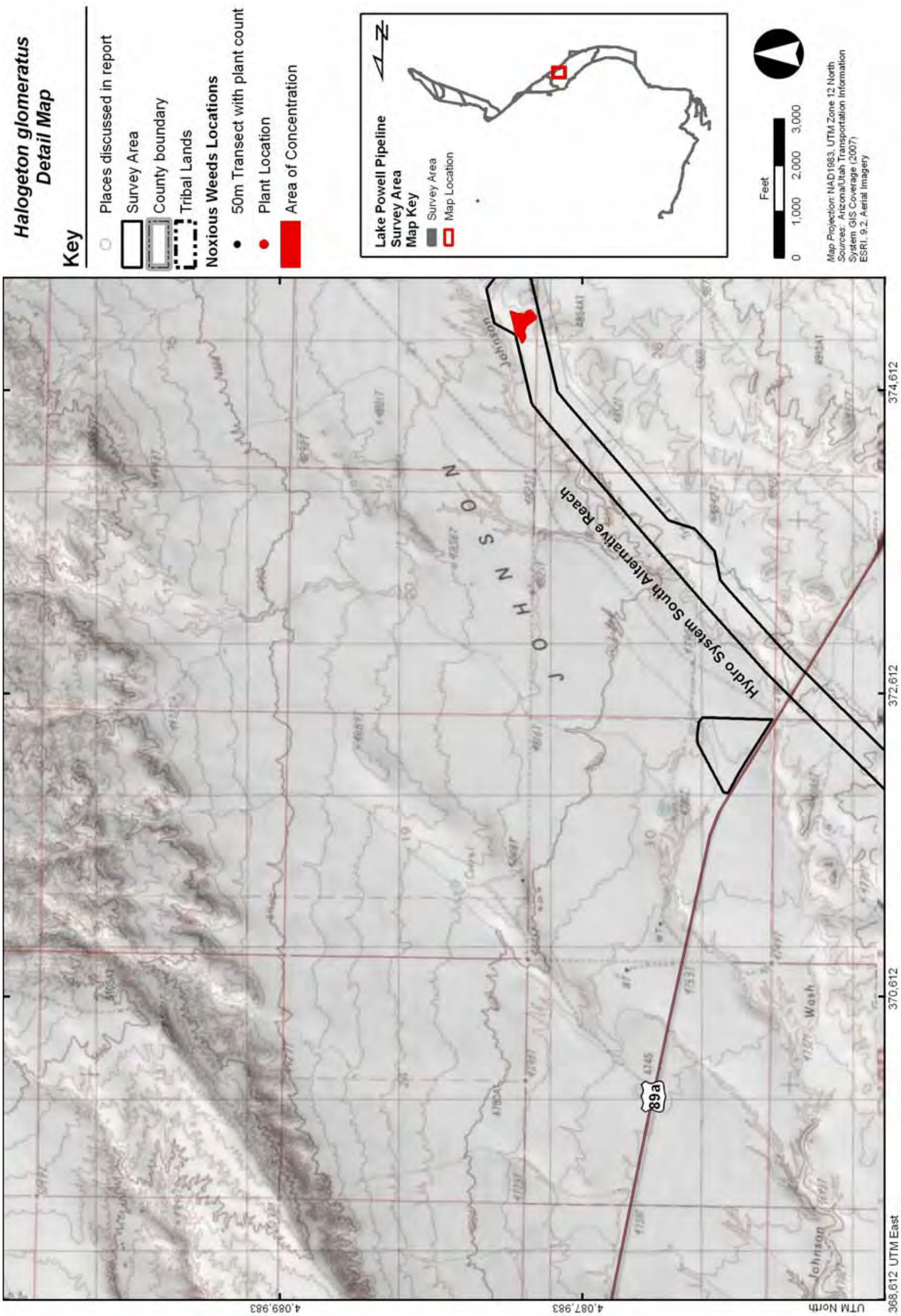
Map 5-84
Halogeton glomeratus **Detail Map**



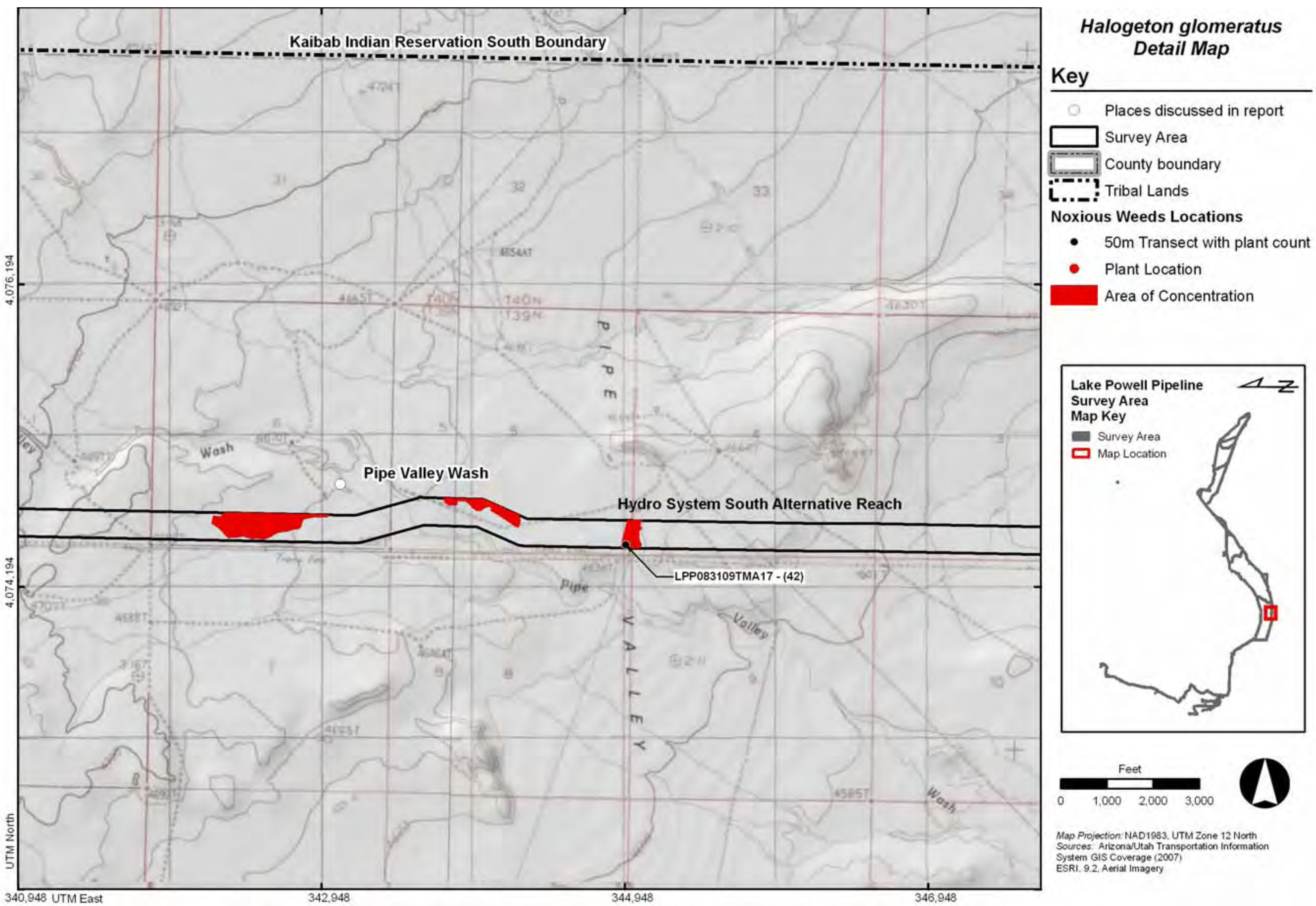
Map 5-85
***Halogeton glomeratus* Detail Map**



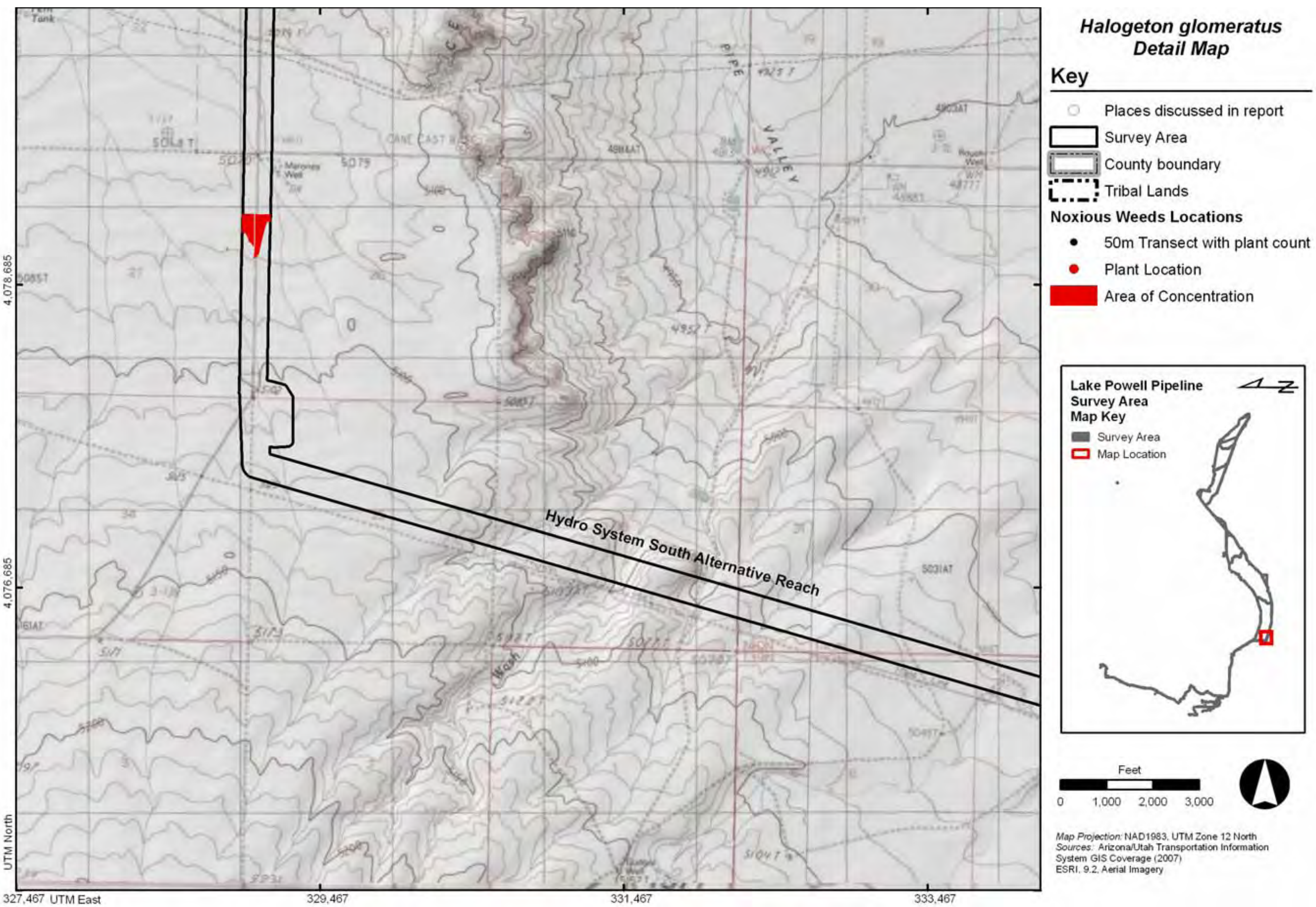
Map 5-86
***Halogeton glomeratus* Detail Map**



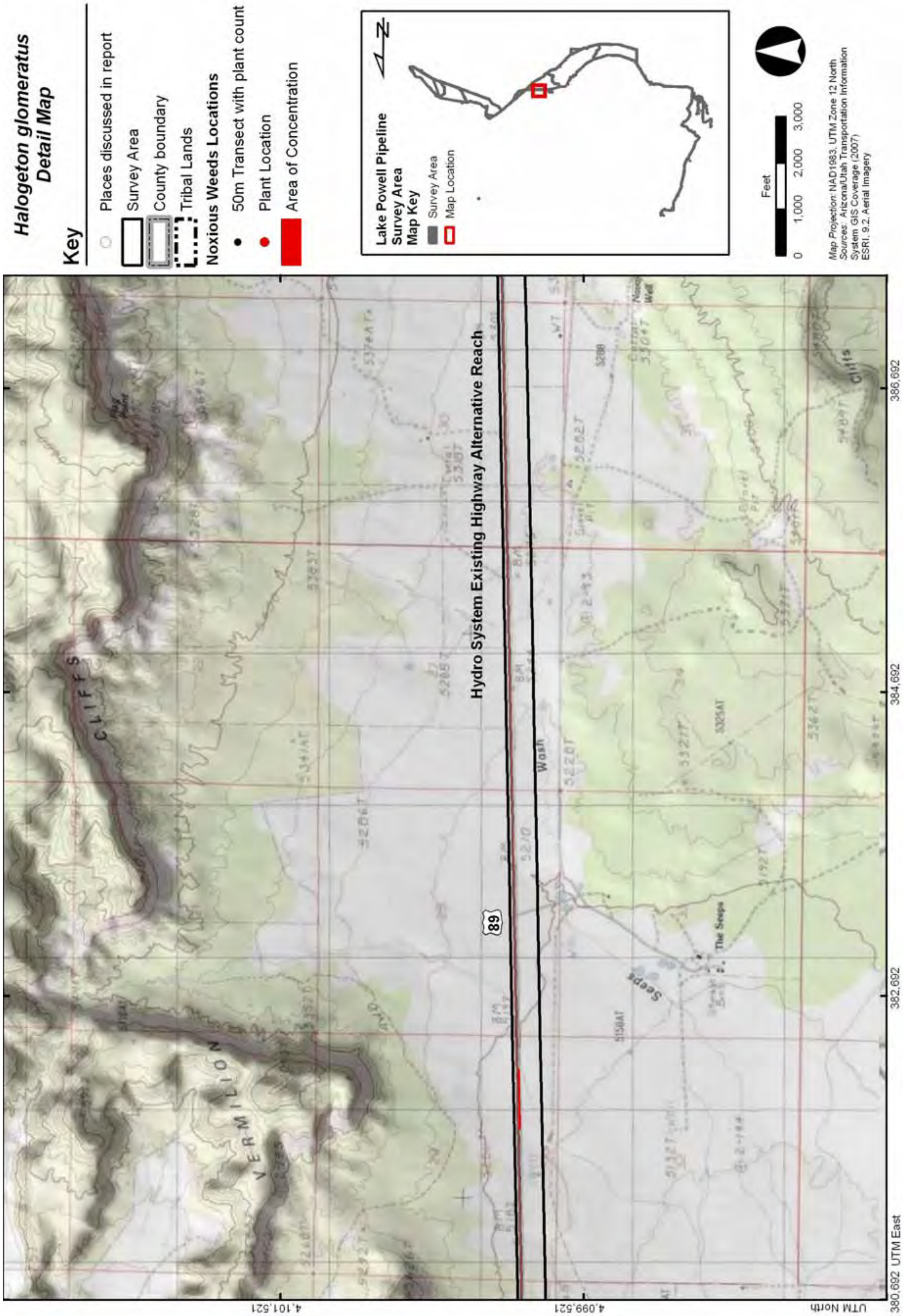
Map 5-87
***Halogeton glomeratus* Detail Map**



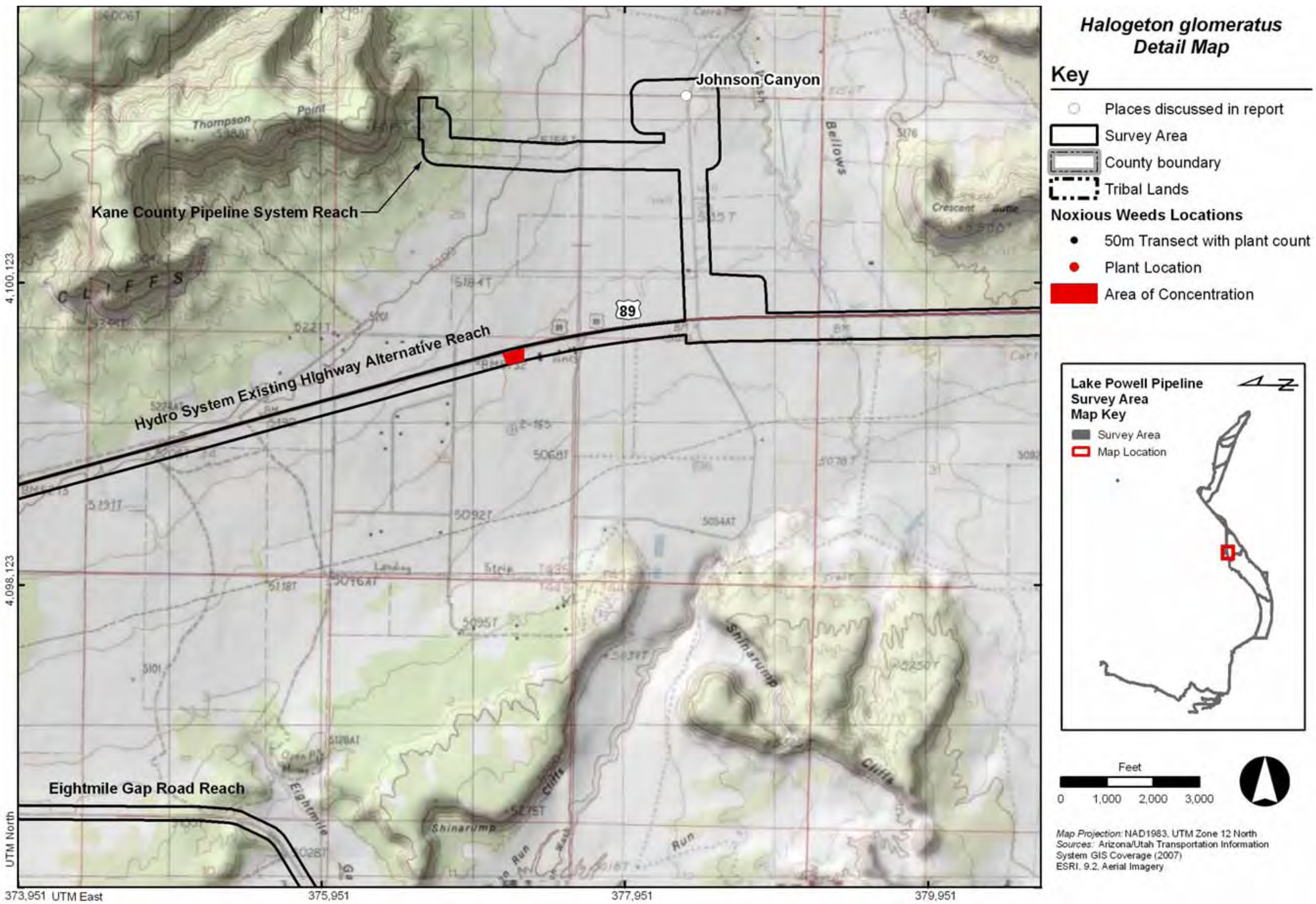
Map 5-88
***Halogeton glomeratus* Detail Map**



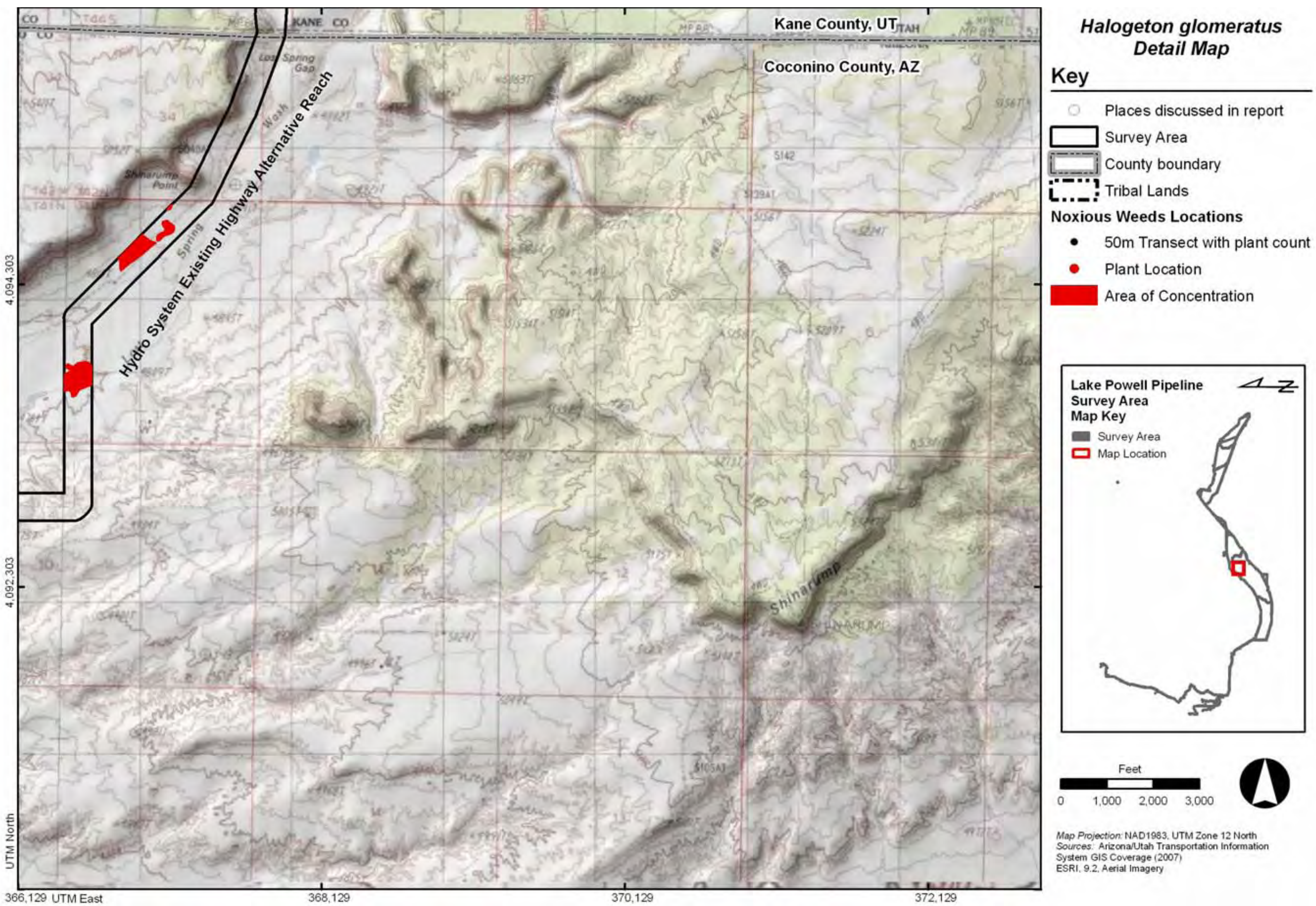
Map 5-89
***Halogeton glomeratus* Detail Map**



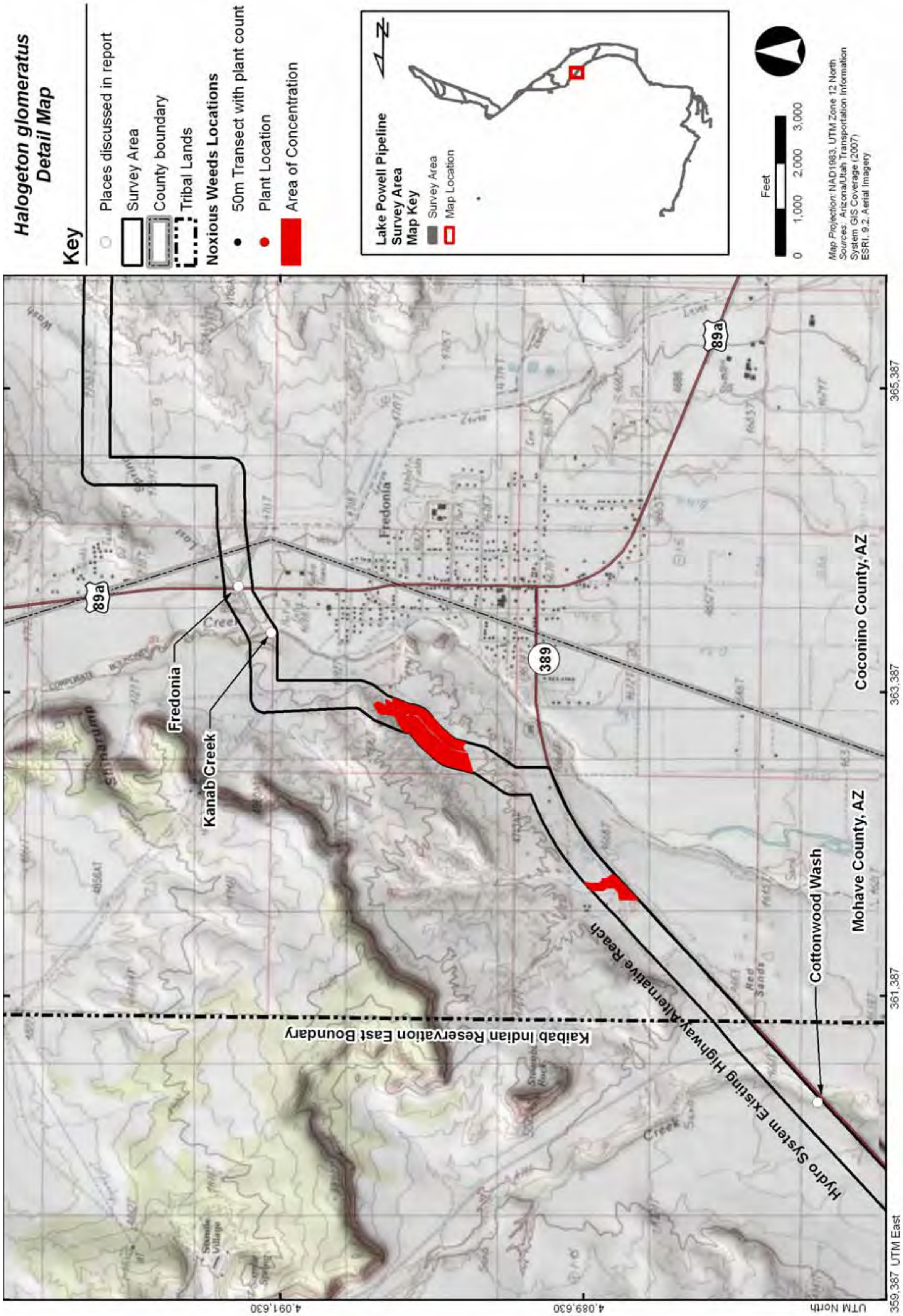
Map 5-90
***Halogeton glomeratus* Detail Map**



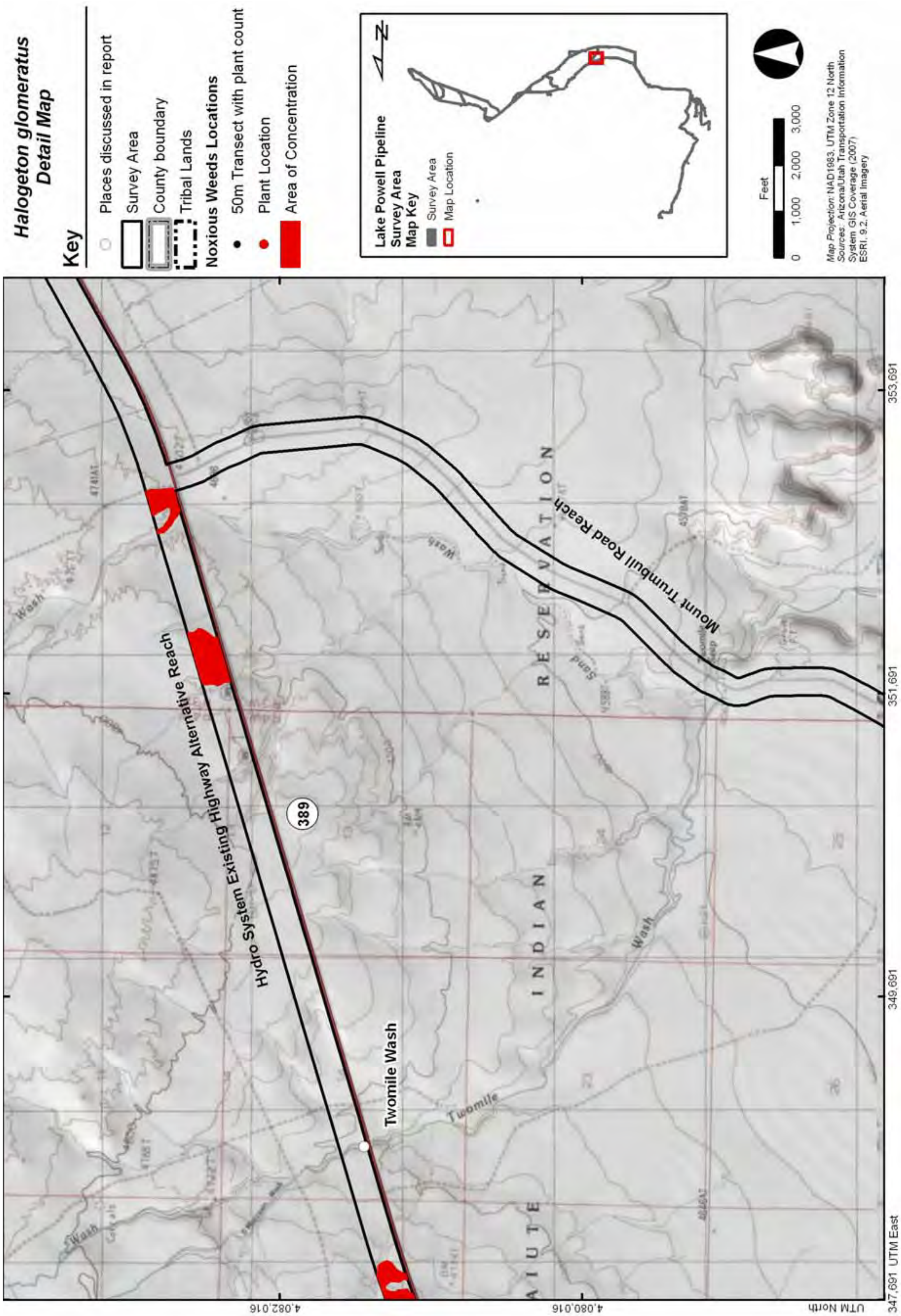
Map 5-91
***Halogeton glomeratus* Detail Map**



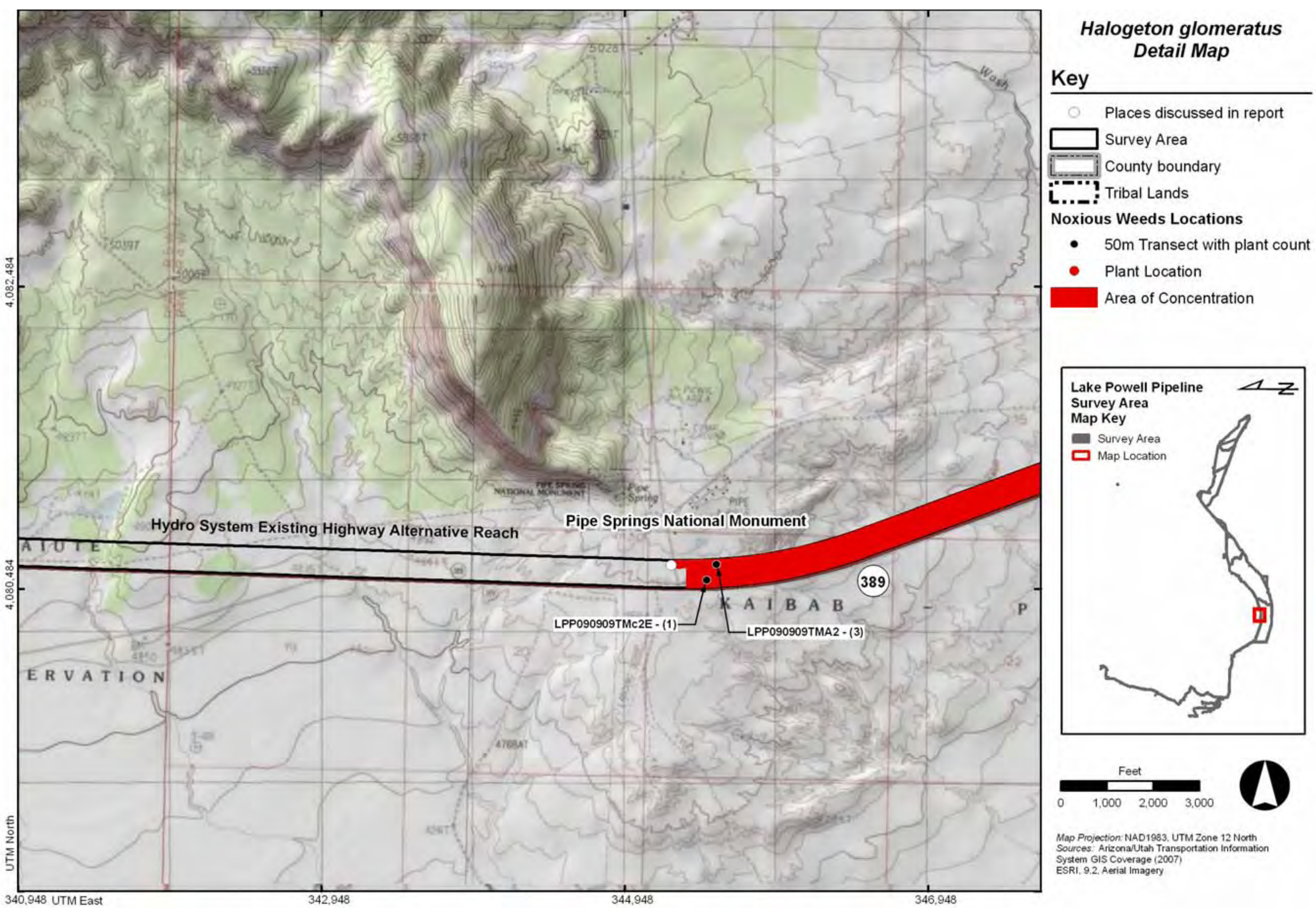
Map 5-92
***Halogeton glomeratus* Detail Map**



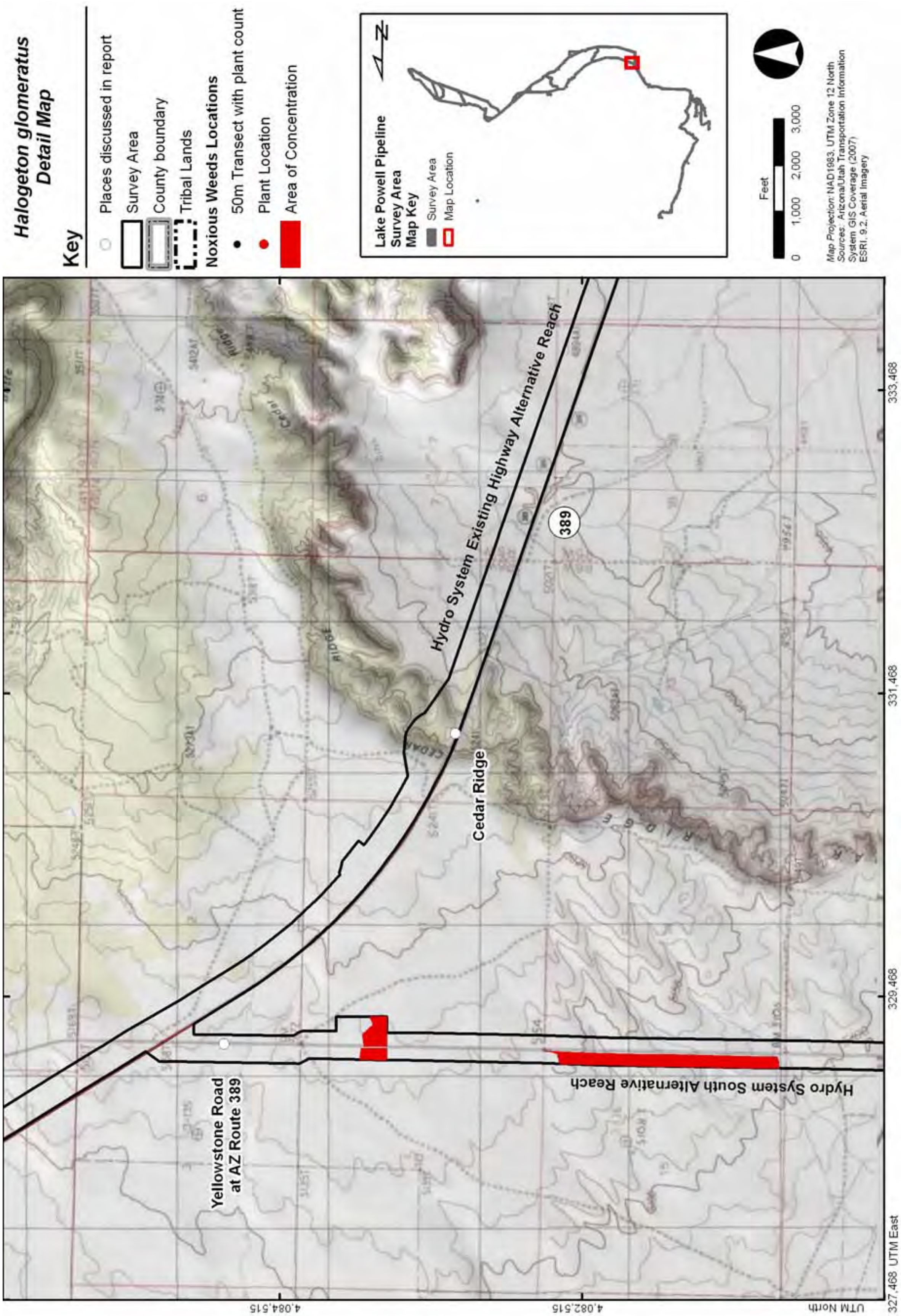
Map 5-93
***Halogeton glomeratus* Detail Map**



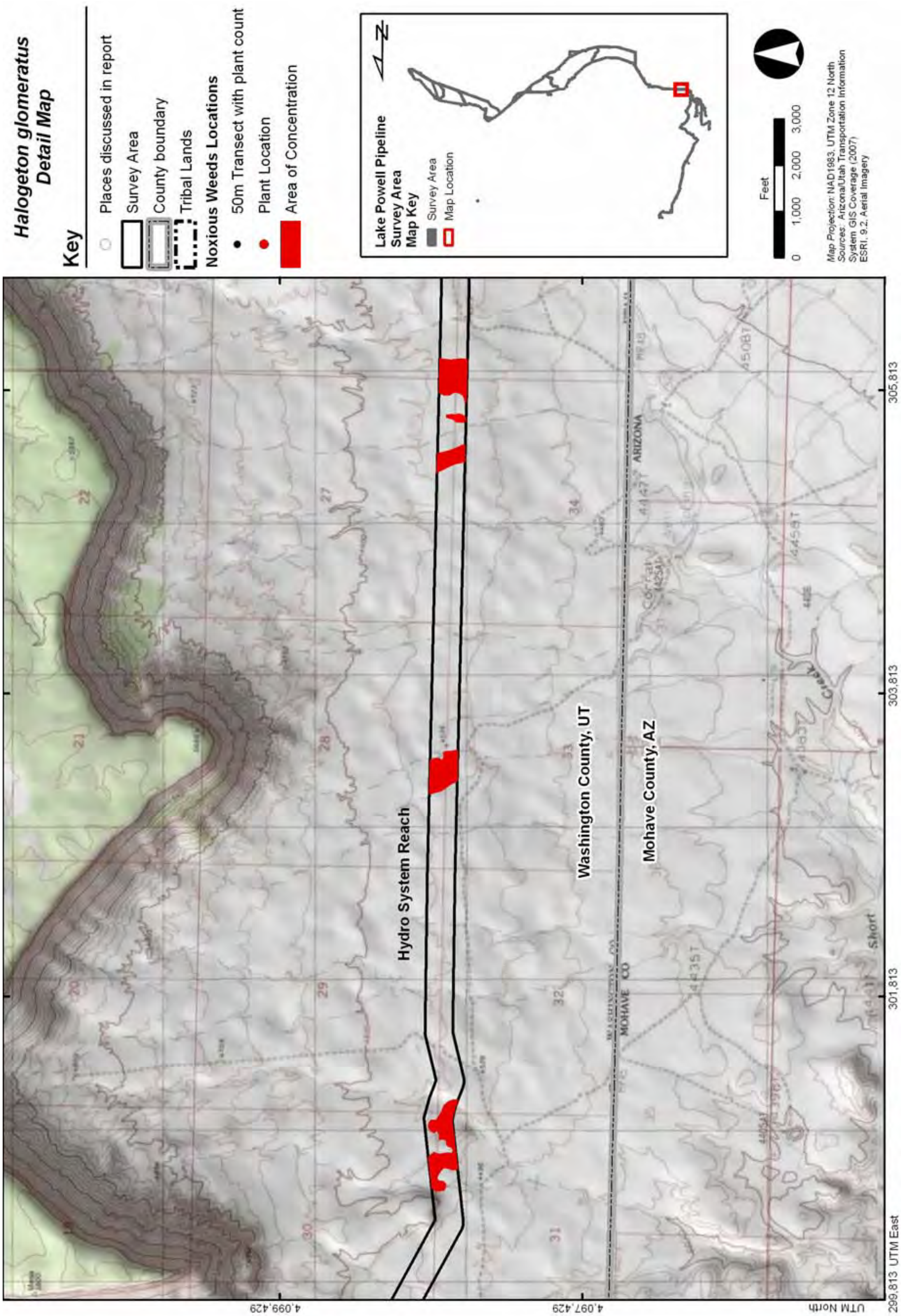
Map 5-94
***Halogeton glomeratus* Detail Map**



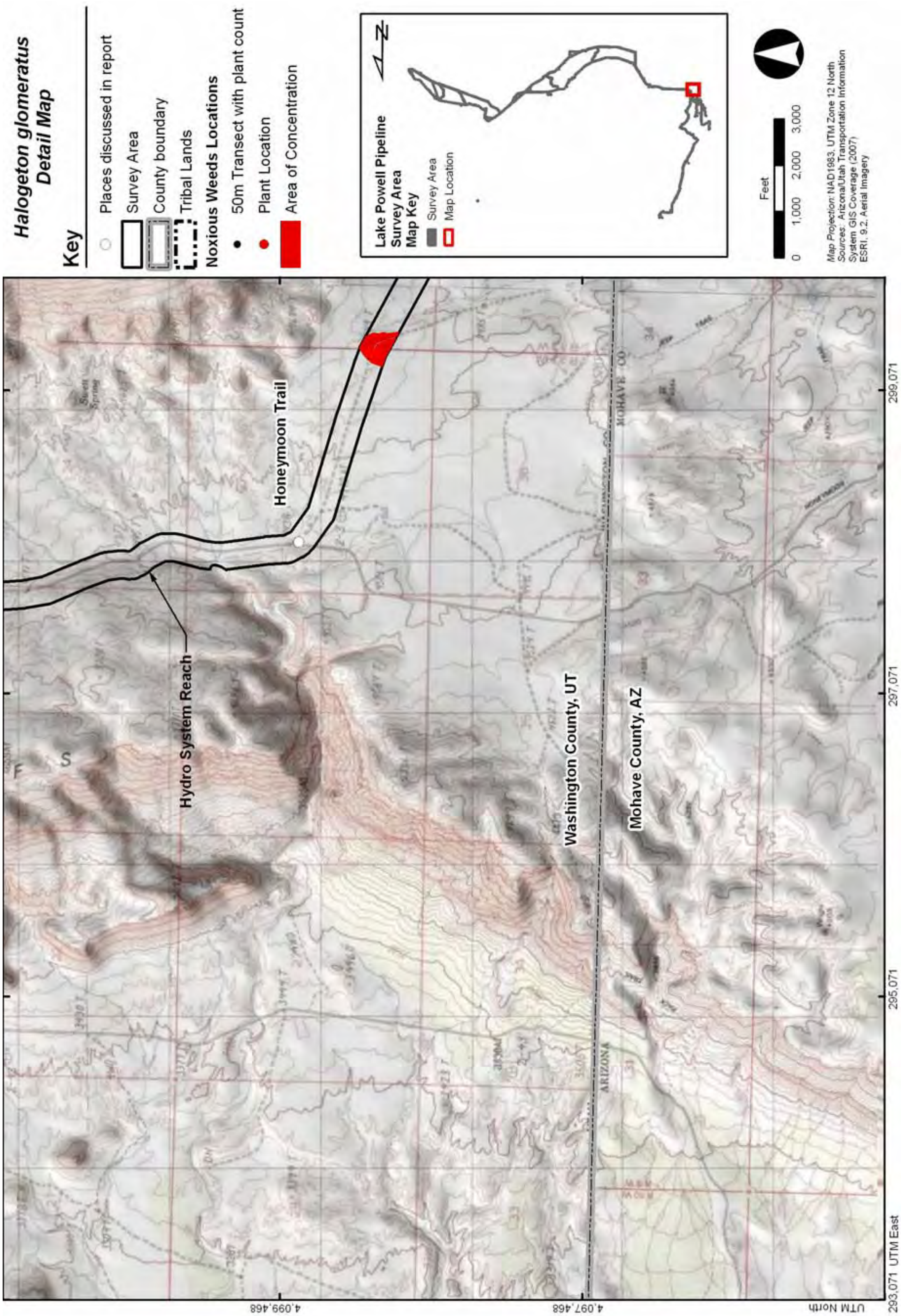
Map 5-95
***Halogeton glomeratus* Detail Map**



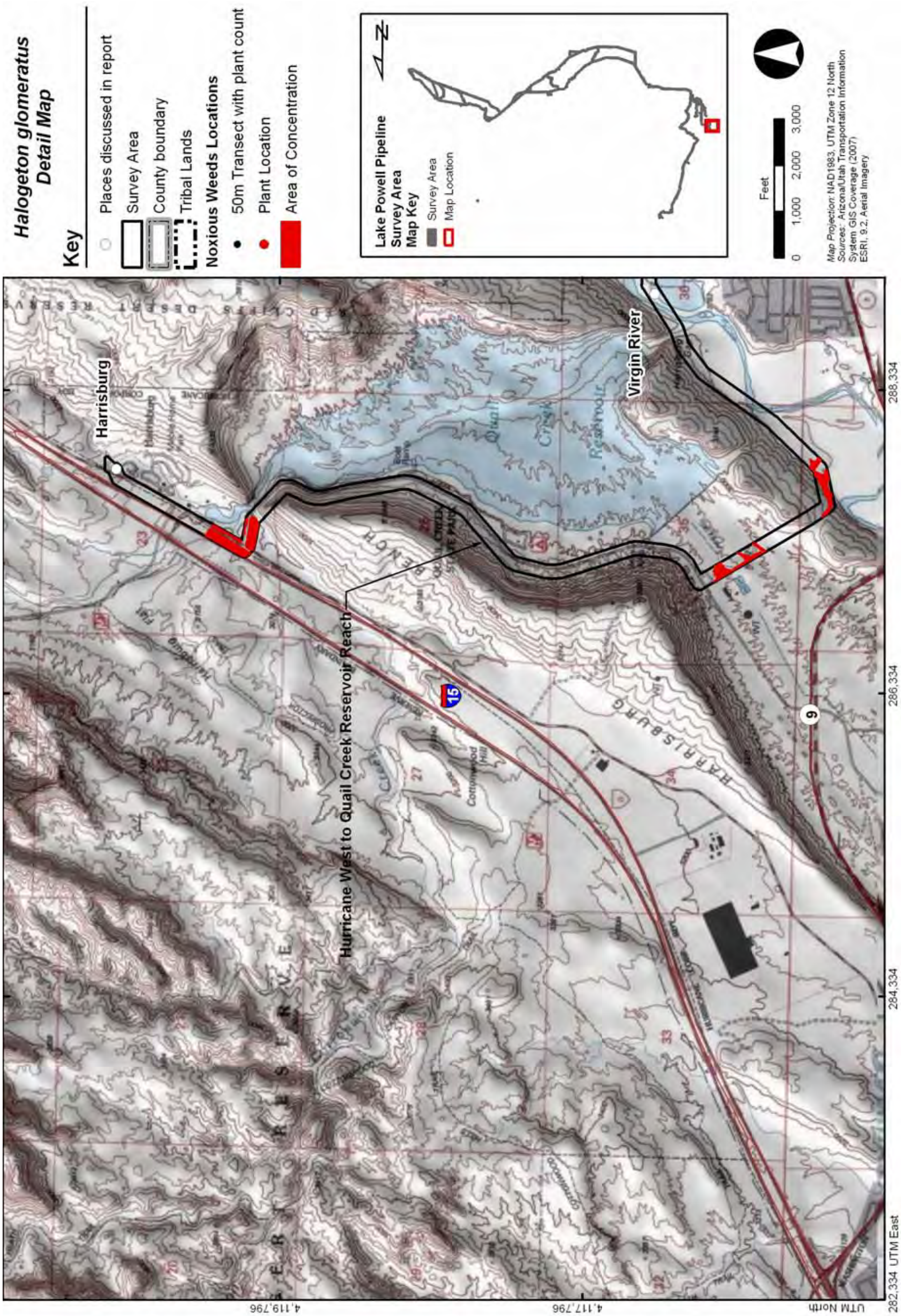
Map 5-96
***Halogeton glomeratus* Detail Map**



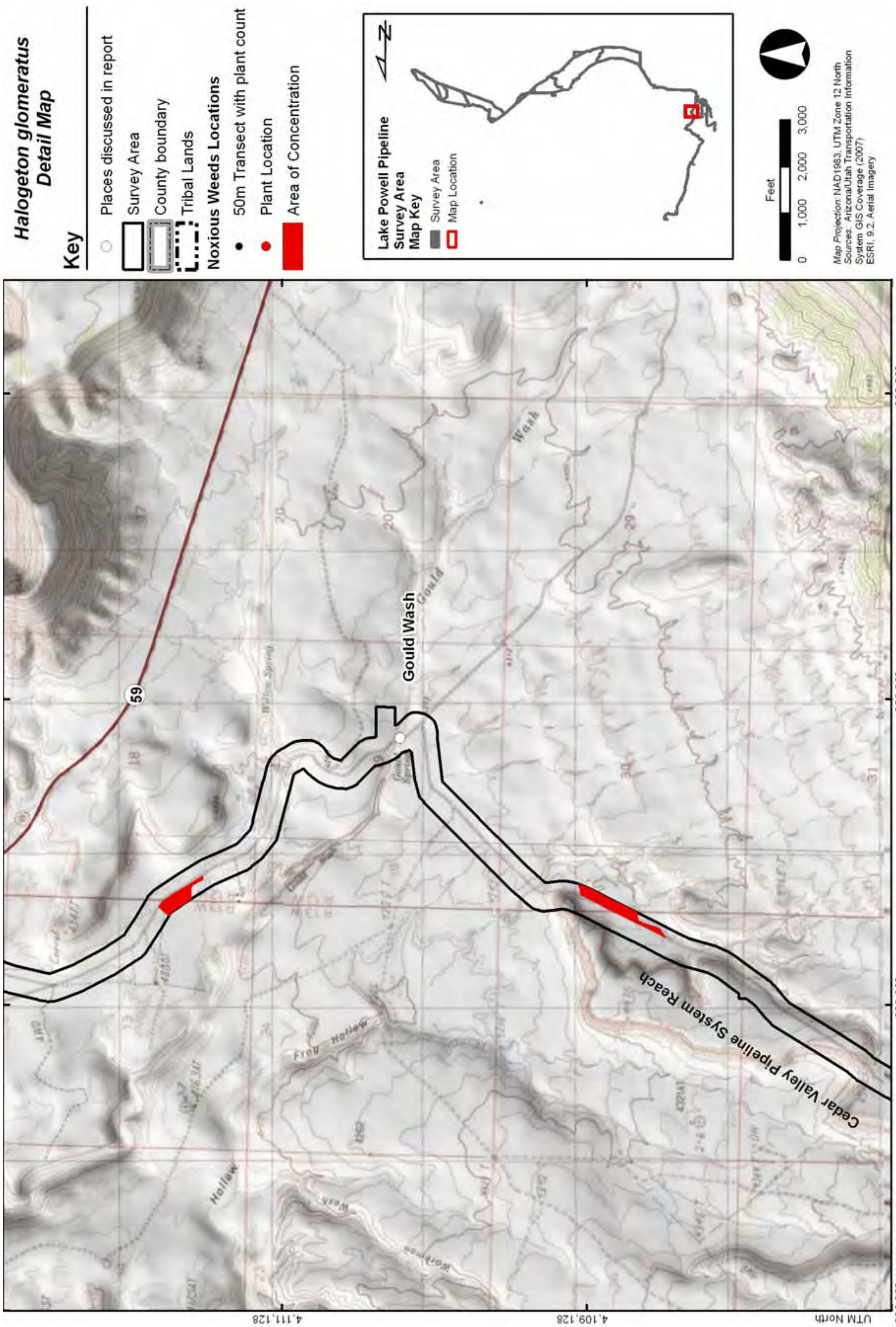
Map 5-97
***Halogeton glomeratus* Detail Map**



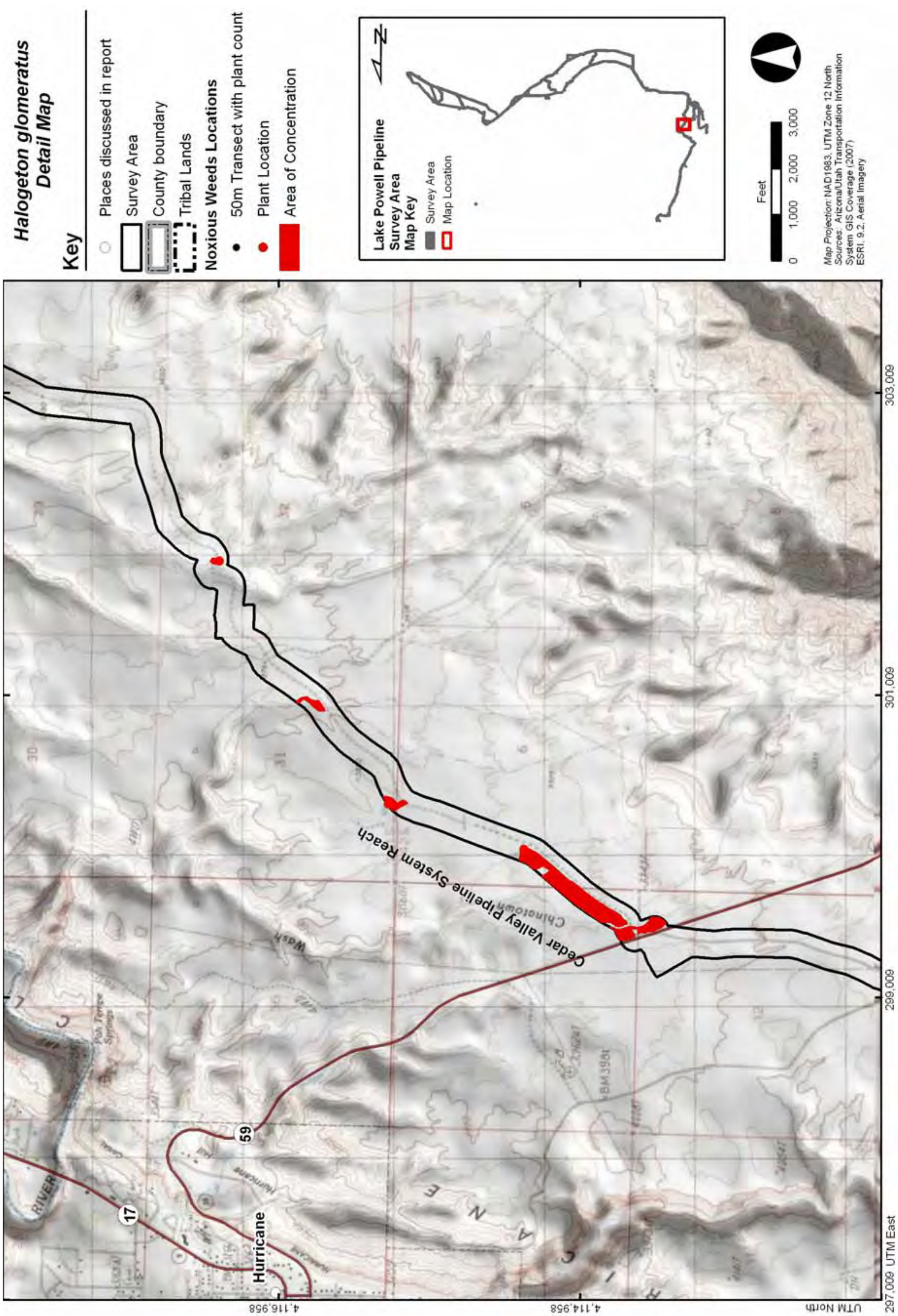
Map 5-98
***Halogeton glomeratus* Detail Map**



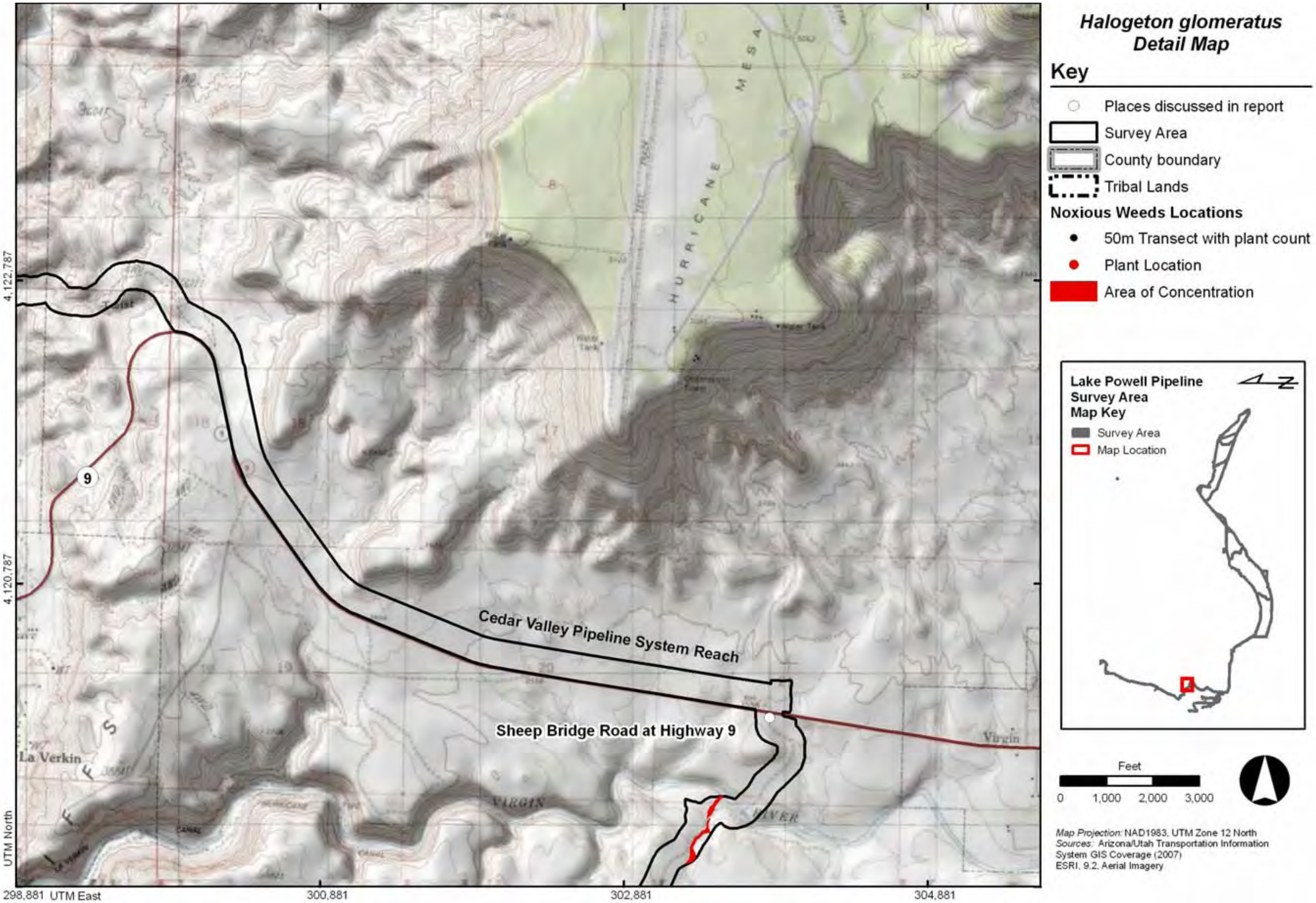
Map 5-99
***Halogeton glomeratus* Detail Map**



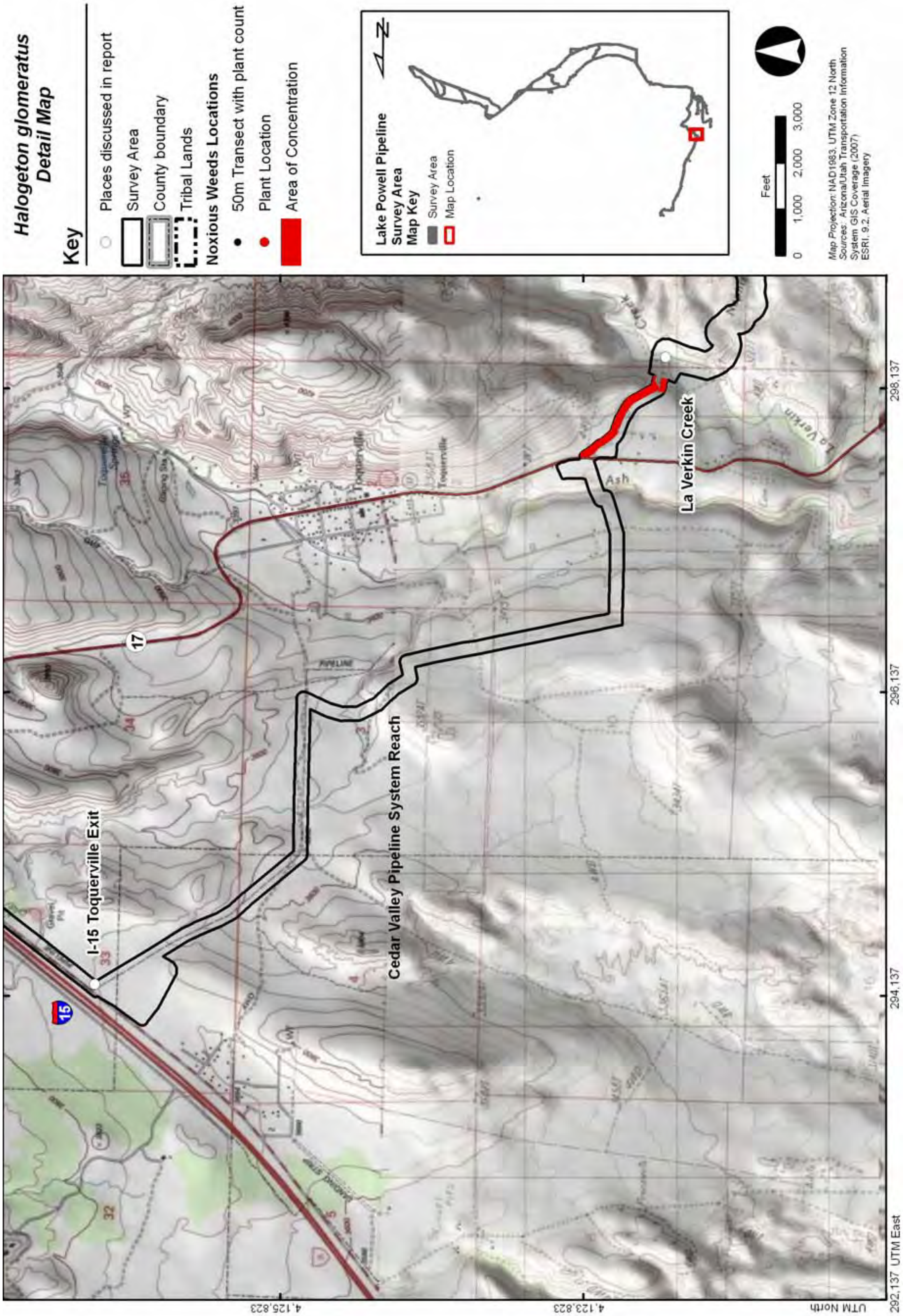
Map 5-100
***Halogeton glomeratus* Detail Map**



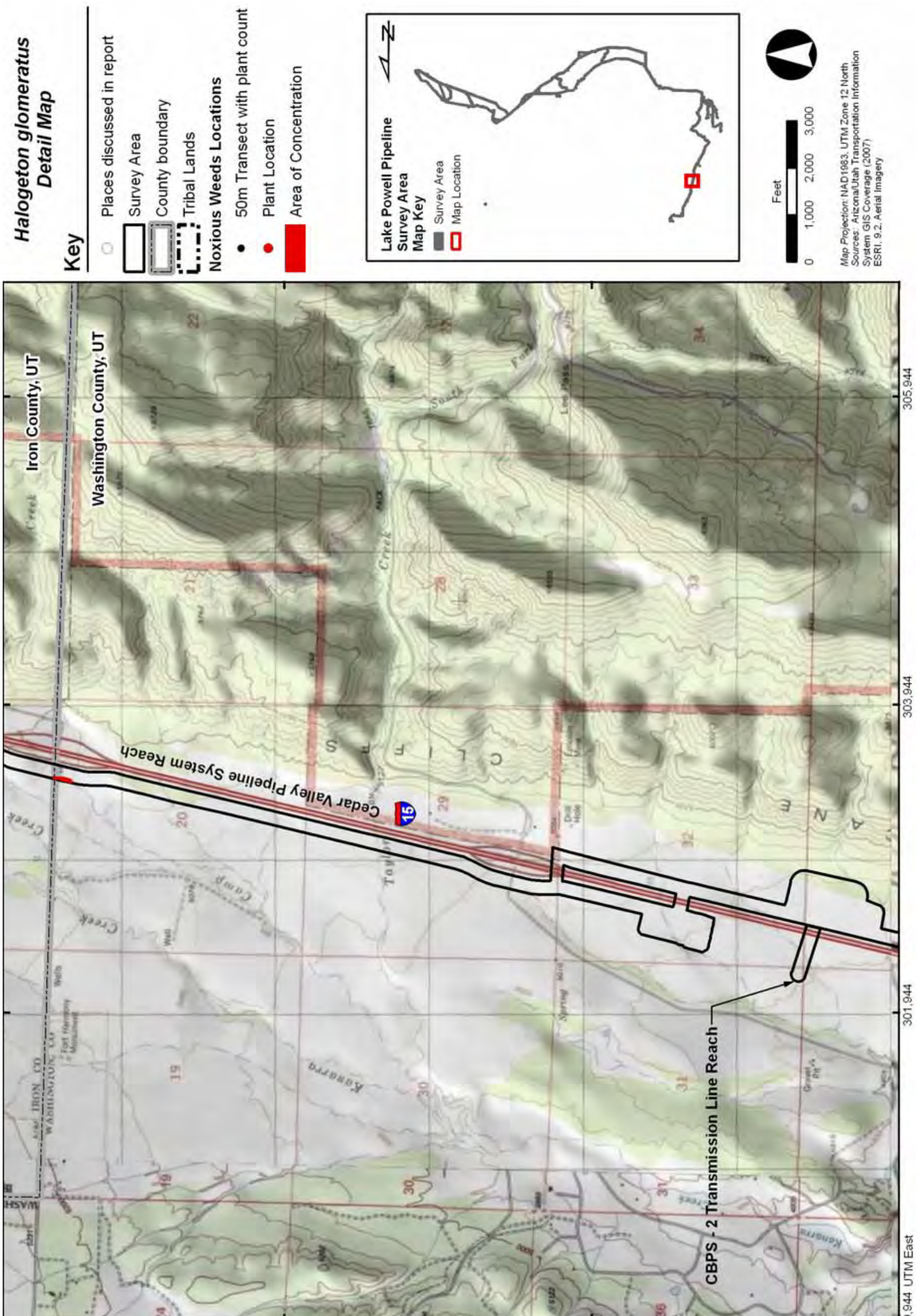
Map 5-101
***Halogeton glomeratus* Detail Map**



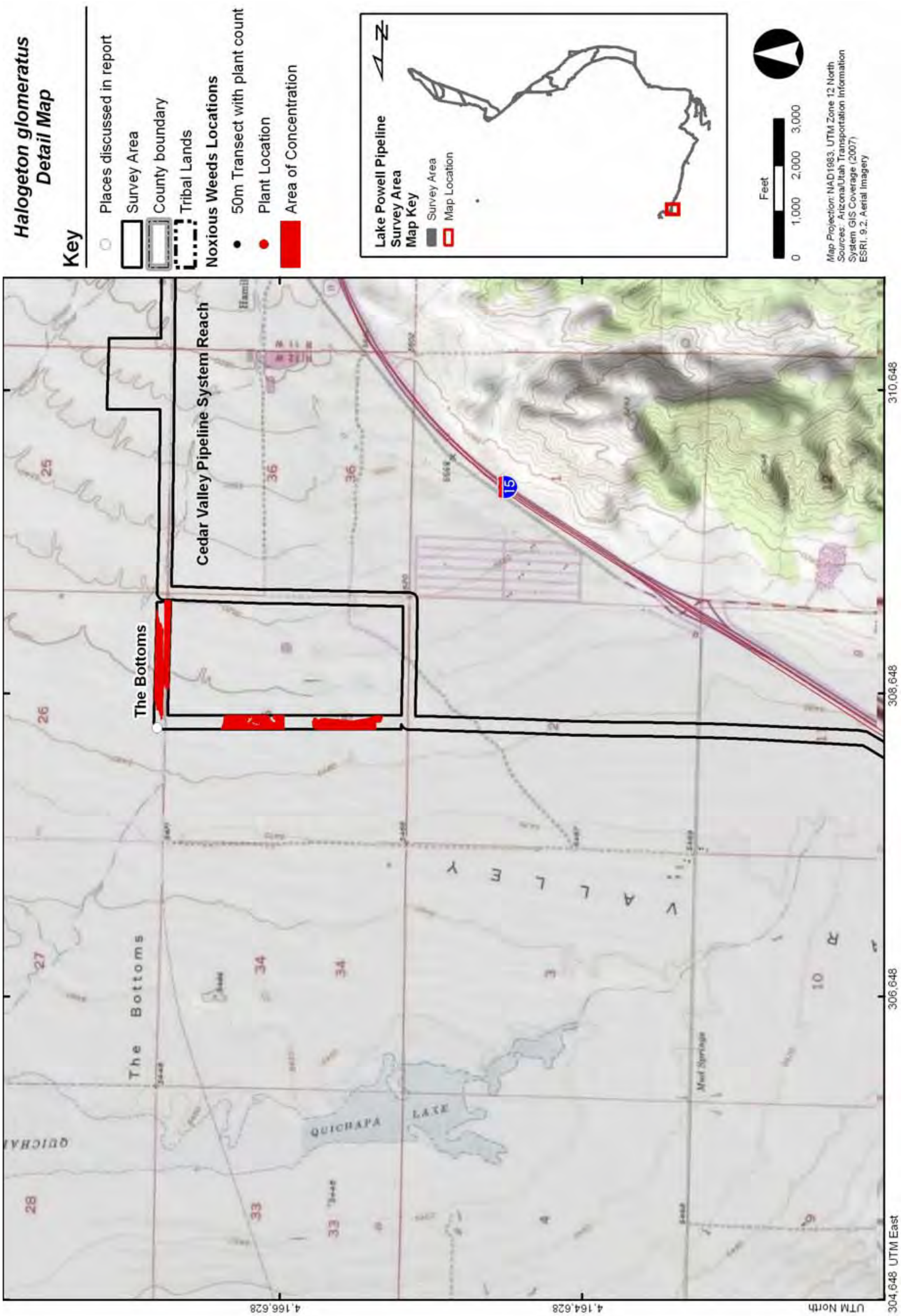
Map 5-102
***Halogeton glomeratus* Detail Map**



Map 5-103
***Halogeton glomeratus* Detail Map**



Map 5-104
***Halogeton glomeratus* Detail Map**



Map 5-105
***Halogeton glomeratus* Detail Map**

5.5.12 Onopordum acanthium (Scotch thistle)

Figure 5-17
View of *Onopordum acanthium* and its habitat within the survey area

5.5.12.1 Natural History

Onopordum acanthium is a member of the Asteraceae (Sunflower family) that grows up to 12 feet (3.7 meters) in height. *O. acanthium* is a biennial which produces herbaceous stems and foliage from a caulescent taproot. The stems emerge from basal rosettes, and appear to have spiny wings along their lengths. The leaves of the rosettes can grow very large, reaching 2 feet (60 centimeters) in length, and 1 foot (30 centimeters) in width. Upper leaves are coarsely lobed, winged, and occur alternately along the stems. Foliage is spiny and appears to be gray in color due to a covering of fine dense hair. In the second year of its growth cycle *O. acanthium* produces numerous flowers within multiple involucres 1 to 2.5 inches (30 to 65 millimeters) in diameter (Figure 5-17). Bracts are spine-tipped. Flowers are violet to reddish in color (Whitson et al. 2009). *O. acanthium* produces achenes that are 0.16 to 0.20 inch (4 to 5 millimeters) long, with pink to reddish pappus bristles 0.28 to 0.35 inch (7 to 9 millimeters) long. Seeds fall near the parent, but are dispersed short distances by animals and wind, and can be distributed further away by water or people. A single plant can produce up to 40,000 seeds which can remain viable for up to 20 years (DiTomaso & Healy 2007).

Onopordum spp., including *O. acanthium*, can be distinguished from other genera of thistles by the lack of bristles, and the presence of deep pits on the flower head receptacles.

Onopordum acanthium is native to eastern Asia and Europe, but is now naturalized throughout much of North America. In Utah individuals have been documented at elevations from 4,000 to 7,000 feet (1,220 to 2,135 meters) within Beaver, Cache, Millard, Salt Lake, Summit, Tooele, Uintah, Utah, Wasatch, Washington, and Weber counties (Welsh et. al. 2008). *Onopordum acanthium* frequently inhabits waste areas and roadsides, but its spread into native plant communities has also been documented, including riparian areas and sagebrush, where it successfully competes with indigenous species.

Onopordum acanthium is well adapted to areas disturbed by livestock, including trail sites, and may cause management concerns as it is very aggressive, sometimes forming dense stands which are impenetrable to livestock (Whitson et al. 2009).

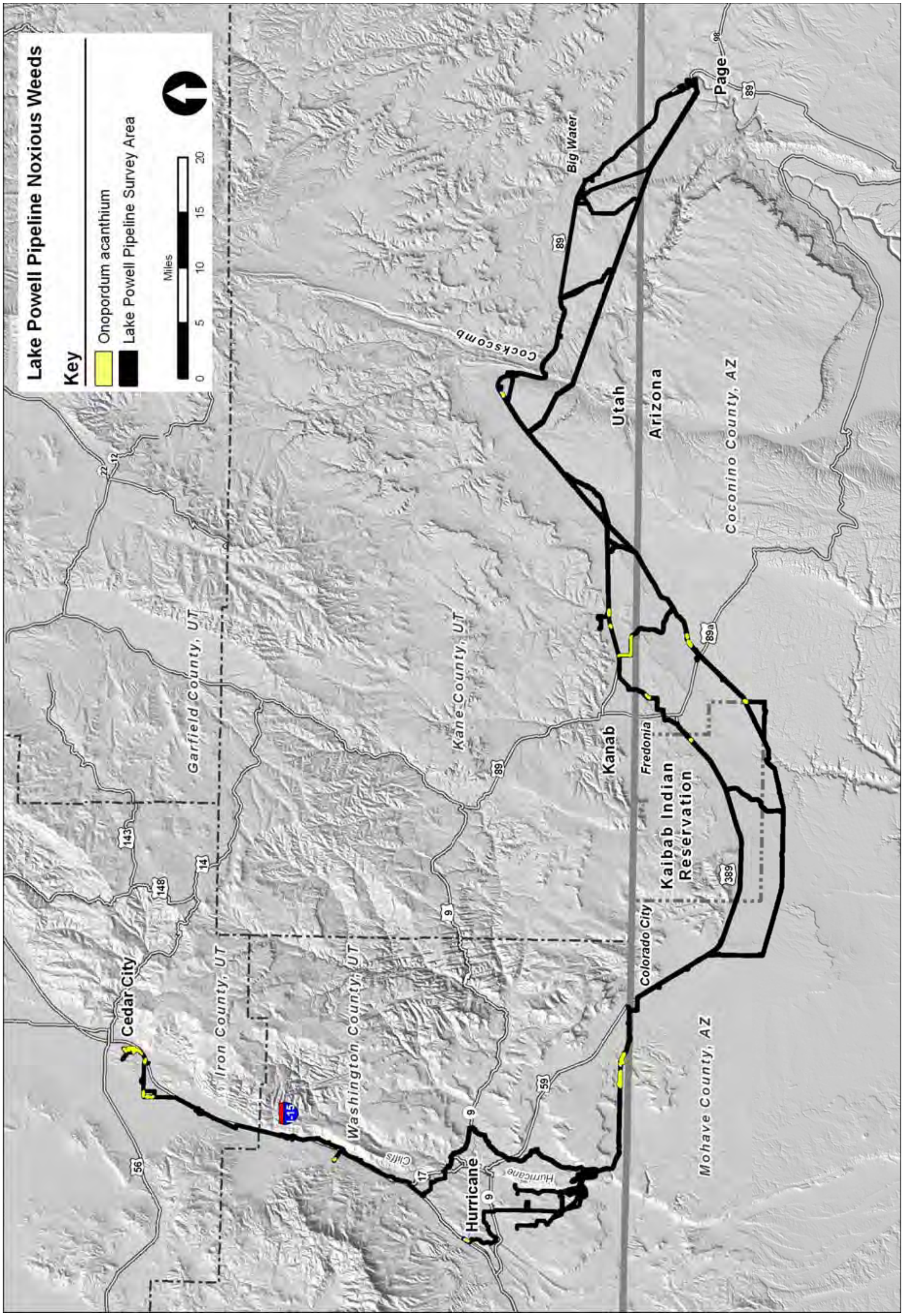
5.5.12.2 Survey Results

Onopordum acanthium was encountered occasionally within the survey area, between the vicinity of Johnson Canyon and Cedar City (Map 5-106). *Onopordum acanthium* was encountered in eight reaches of the survey area (Map 5-107to Map 5-121). In the Water Conveyance System Reach the species was found near the Paria Townsite Road Junction, and in the Hydro System South Alternative Reach it was encountered infrequently between White Sage Wash and the Southeast Corner of the Kaibab Indian Reservation. The species was also identified in the Eightmile Gap Road Reach, from the area north of the border of Kane and Coconino Counties to Eightmile Gap Road at US 89. In the Hydro System Existing Highway Alternative Reach it was encountered infrequently between the turn-off to Johnson Canyon and Cottonwood Wash. In the Hydro System Reach the species was encountered north of the border between Washington County and Mohave County (east of Short Creek at Canaan Gap) and in the vicinity of Short Creek at Canaan Gap. *Onopordum acanthium* was found near Harrisburg in the Hurricane West to Quail Creek Reservoir Reach, and in the northwestern portion of the CBPS-1 Transmission Line Reach. In the Cedar Valley Pipeline System Reach, individuals were encountered in the vicinity of the Bottoms and at several locations near Cedar City. *Onopordum acanthium* was not detected in any 50-meter belt transects; all encounters occurred while conducting special status species and noxious weed surveys.

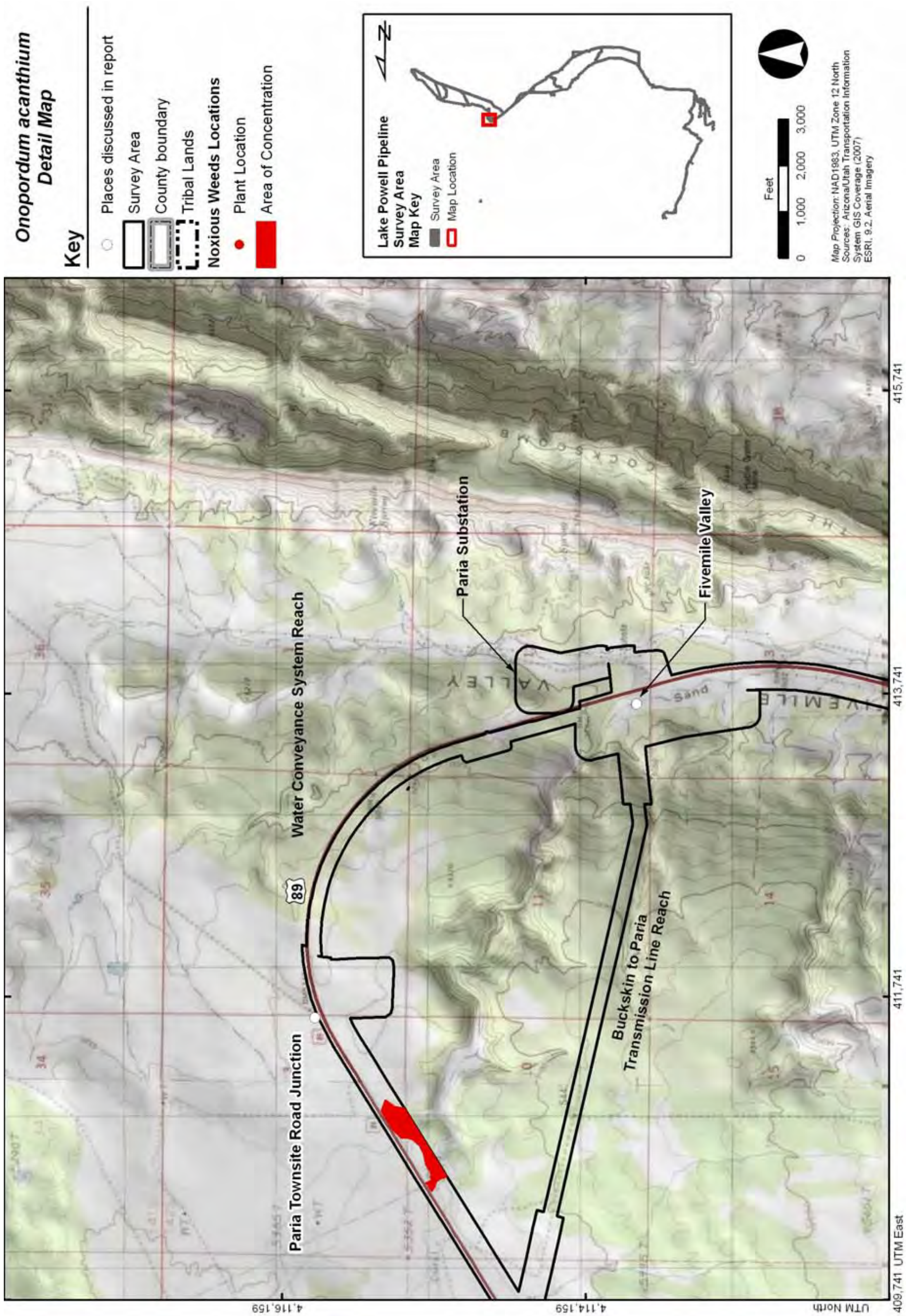
Onopordum acanthium was found in the Colorado Plateau and Great Basin Ecological Regions, in 11 ecological systems, and in two anthropogenic lands. On the Colorado Plateau, *O. acanthium* was identified in Big Sagebrush Shrubland, Lower Montane Riparian Woodland and Shrubland, Mixed Desert Scrub, Pinyon-Juniper Woodland, Shrub-Steppe, and Colorado Plateau Wash. In the Great Basin, *O. acanthium* was identified in Big Sagebrush Shrubland, Mixed Desert Scrub, and Pinyon-Juniper Woodland. Anthropogenic lands which supported individuals included Developed Road and Invasive Upland Vegetation. Most commonly, *O. acanthium* was encountered in the Great Basin Pinyon-Juniper Woodland ecological system, where vegetation was co-dominated by *Juniperus osteosperma, Pinus edulis*, and *Artemisia tridentata* ssp. *vaseyana*, but it also was commonly encountered in habitats dominated or co-dominated by other invasive species, particularly *Bromus rubens* and *Salsola tragus*. Encounters with *O. acanthium* were mostly as individuals or small clusters; the species was never considered a dominant member of a vegetative community.

5.5.12.3 Discussion

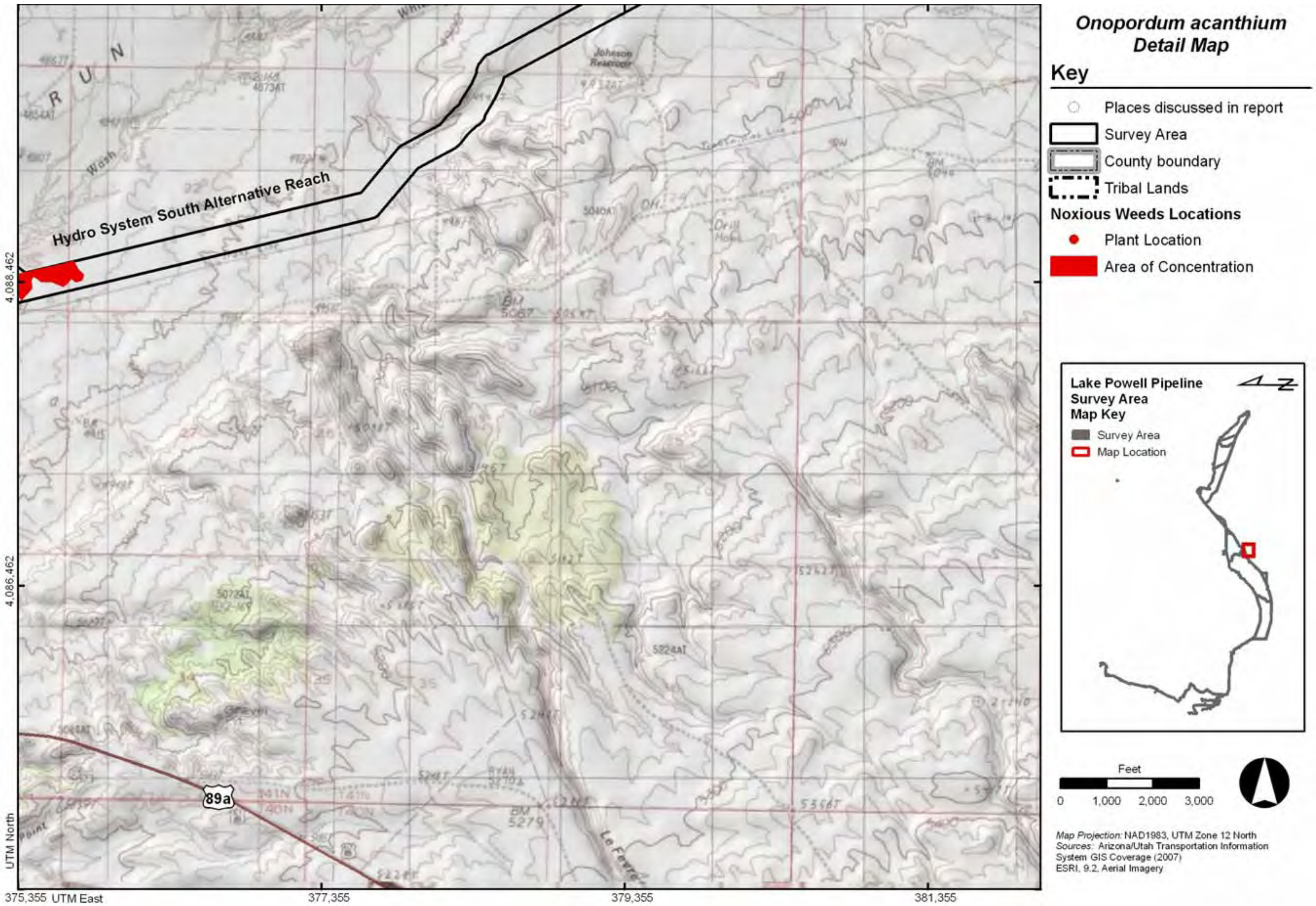
Onopordum acanthium only occurred occasionally within the survey area, and generally in small quantities. However, given the potential for the species to spread into newly disturbed areas, the large quantity of seed produced by individuals, and the ability of the seed to be dispersed by human activity, it is recommended that vehicle tires be washed when departing infested areas. Additionally, topsoil from infested areas could be disposed of, rather than re-used on-site.



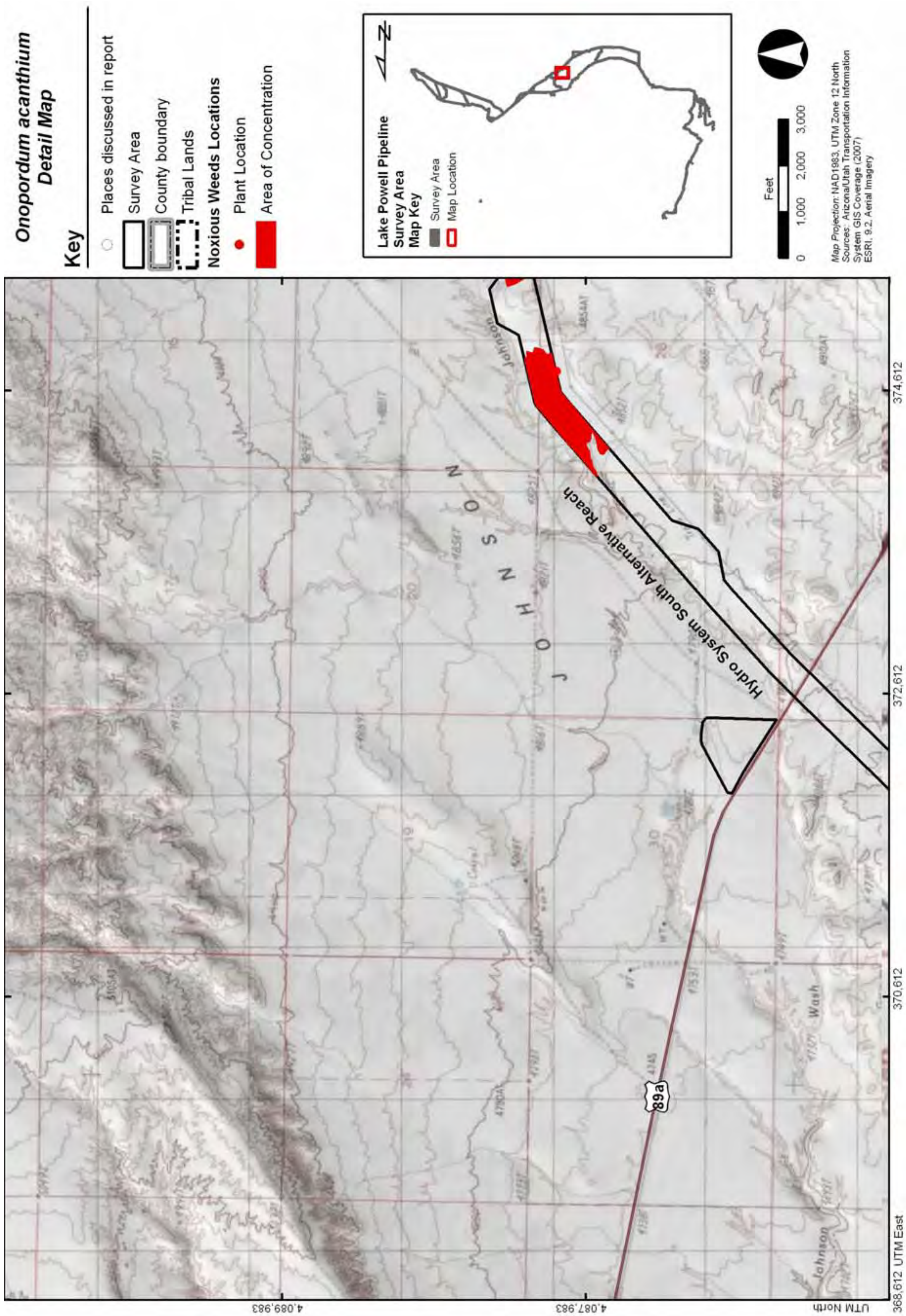
Map 5-106
Onopordum acanthium **Overview Map**



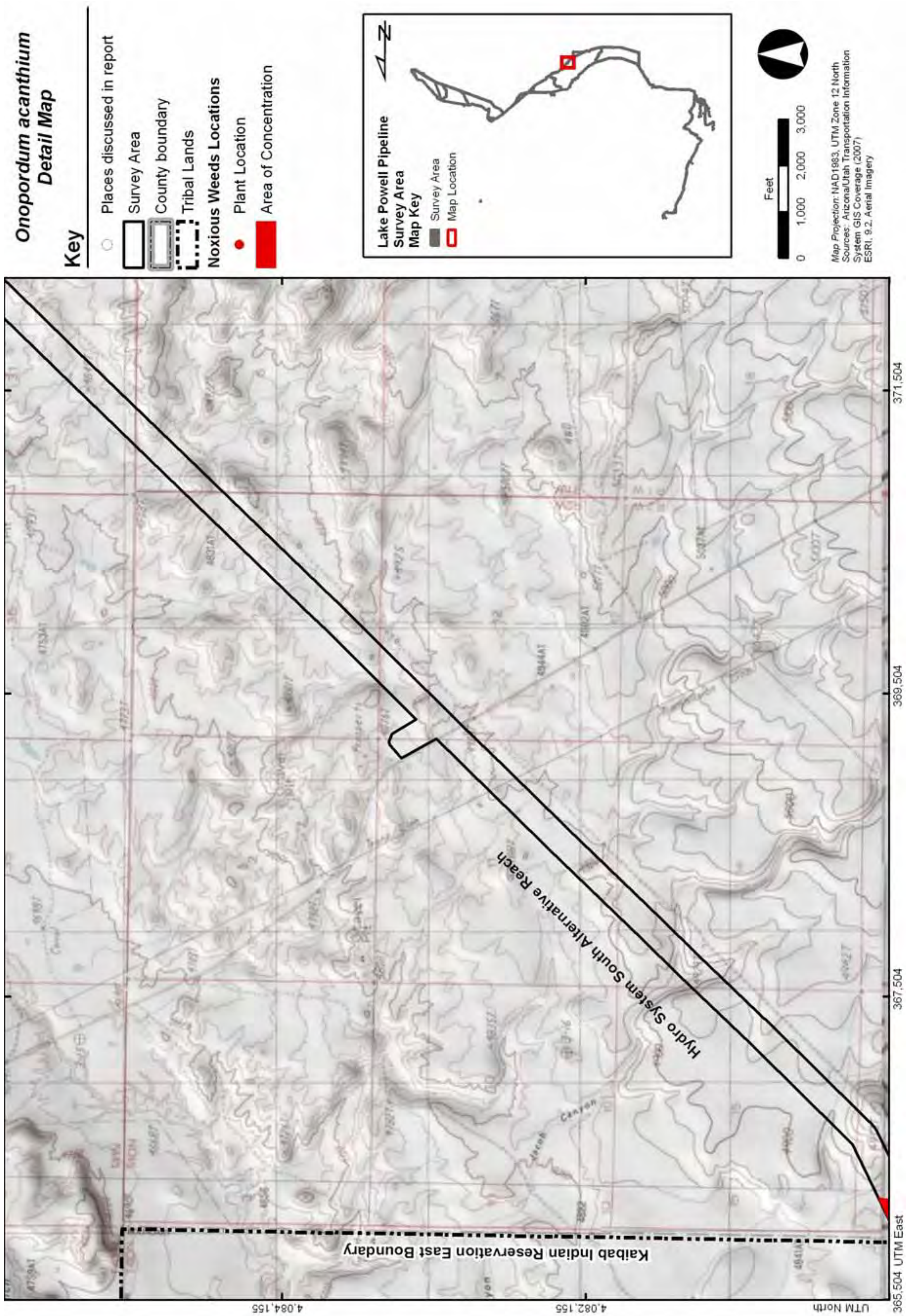
Map 5-107
***Onopordum acanthium* Detail Map**



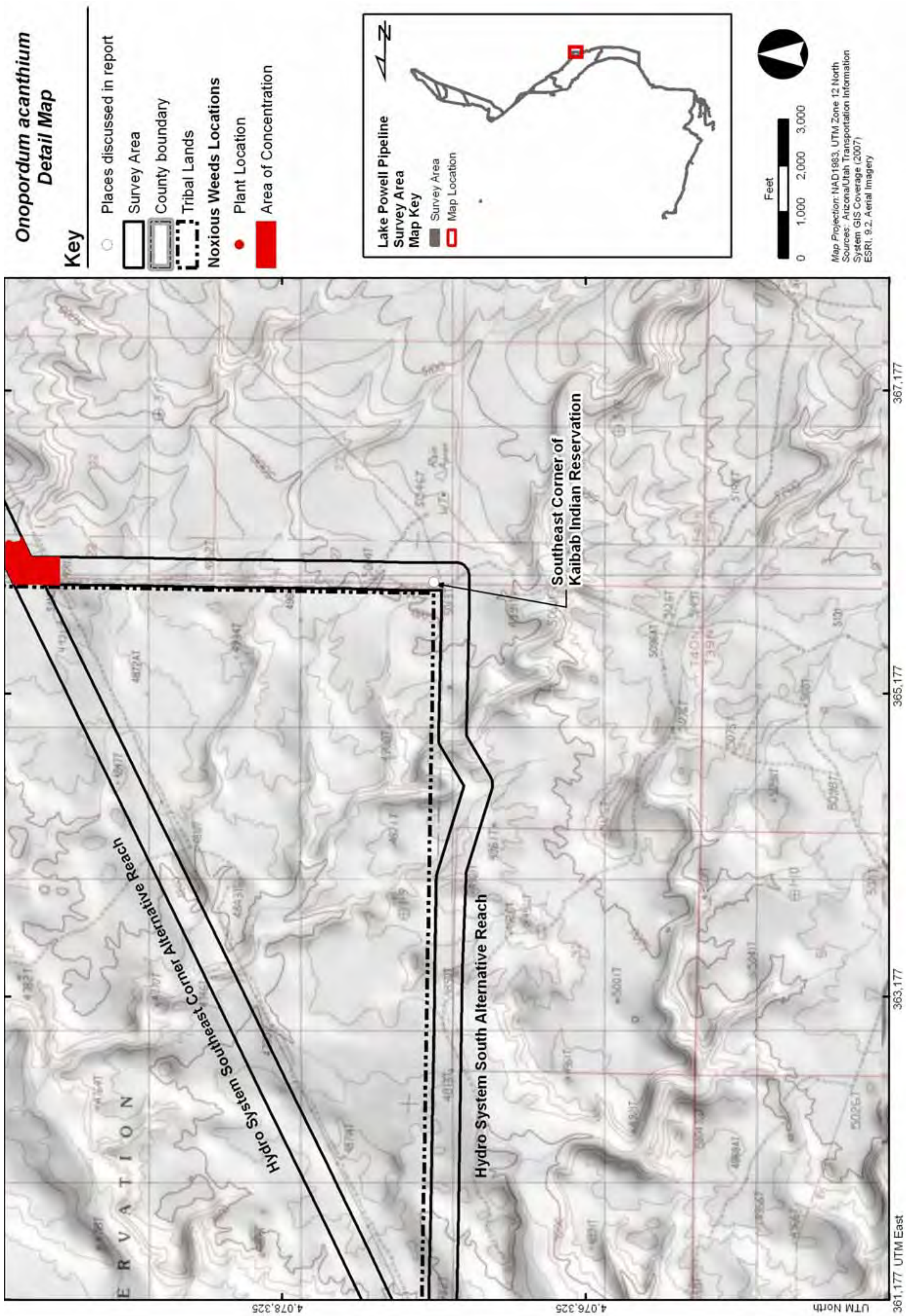
Map 5-108
***Onopordum acanthium* Detail Map**



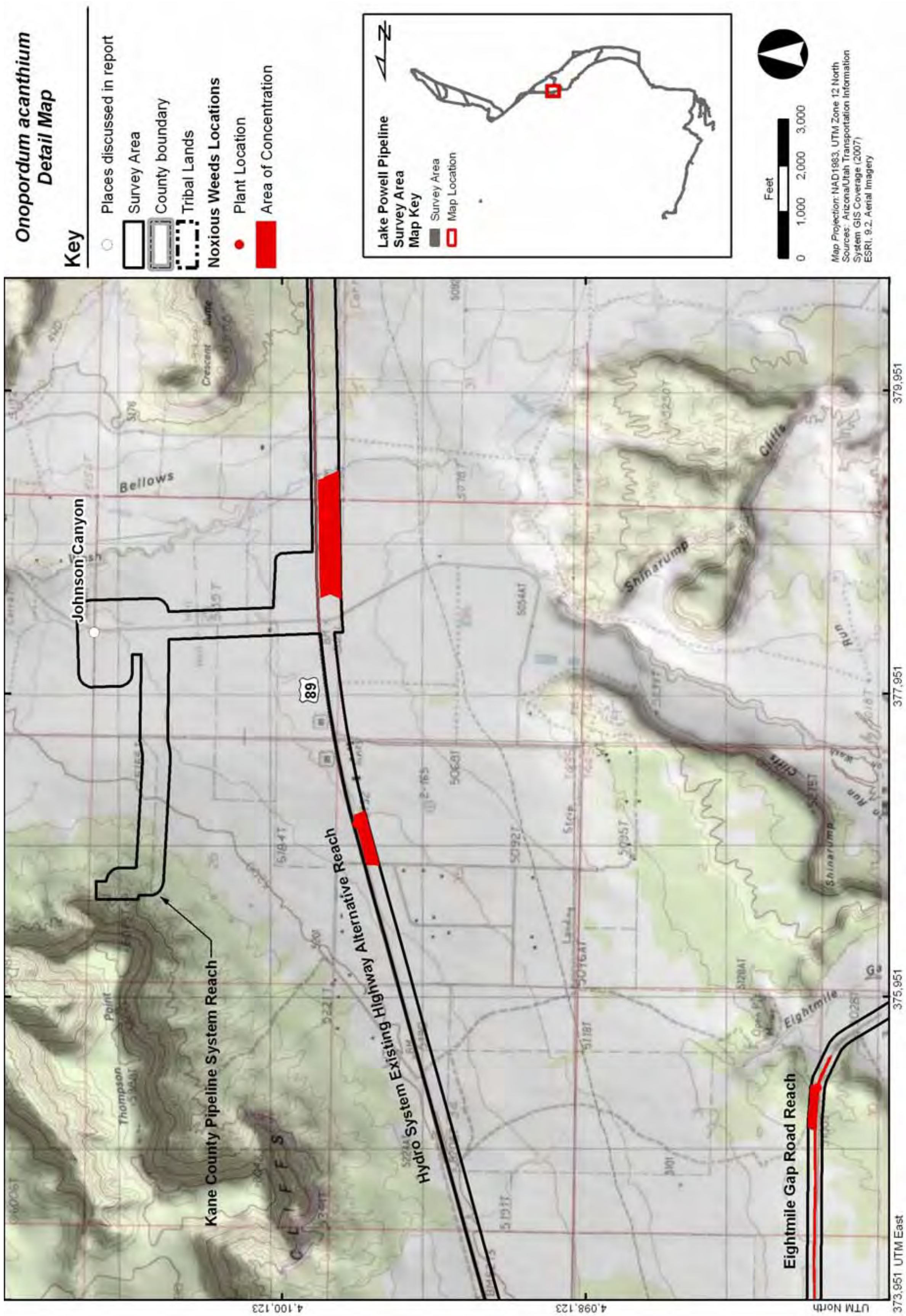
Map 5-109
***Onopordum acanthium* Detail Map**



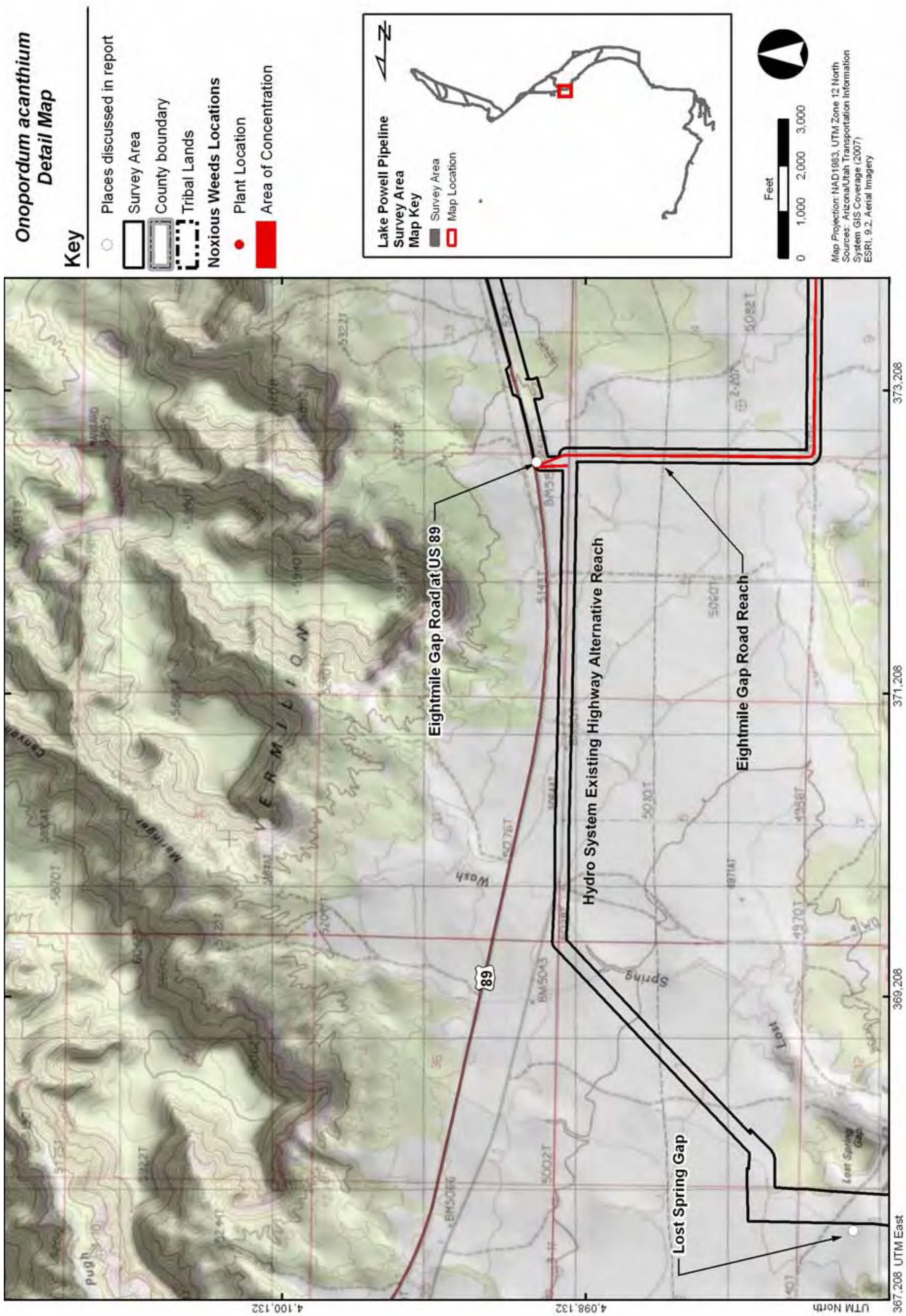
Map 5-110
***Onopordum acanthium* Detail Map**



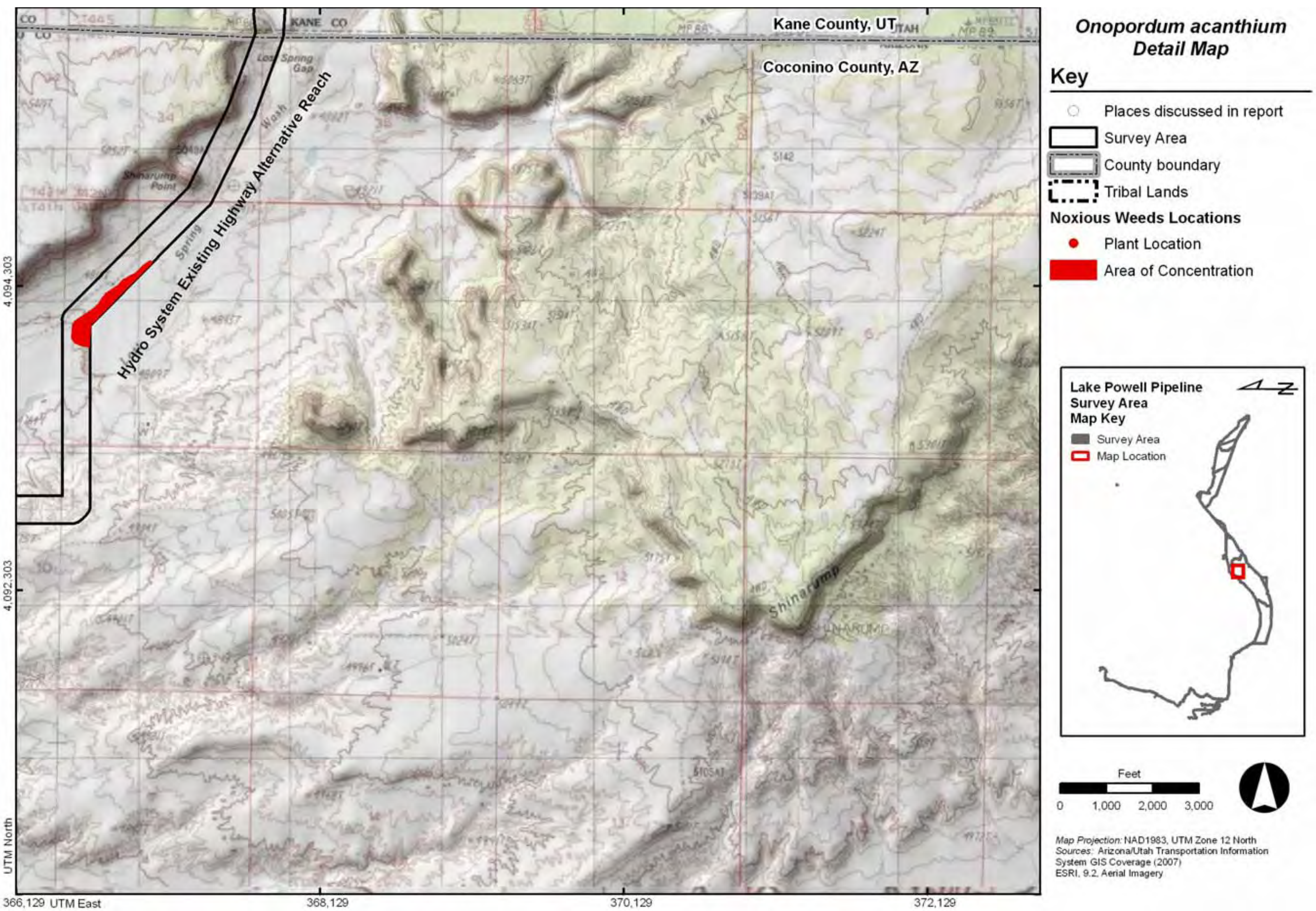
Map 5-111
***Onopordum acanthium* Detail Map**



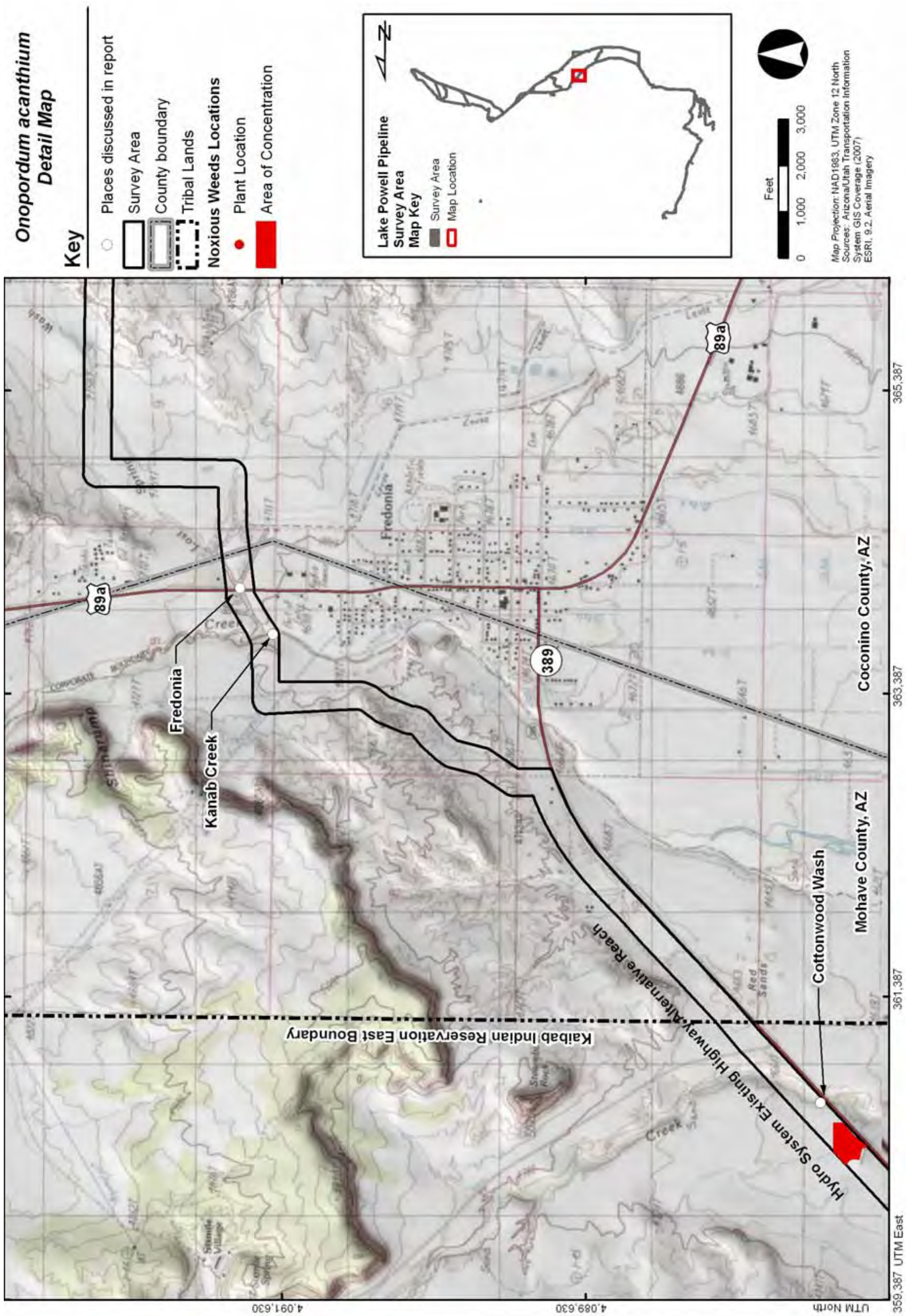
Map 5-112
***Onopordum acanthium* Detail Map**



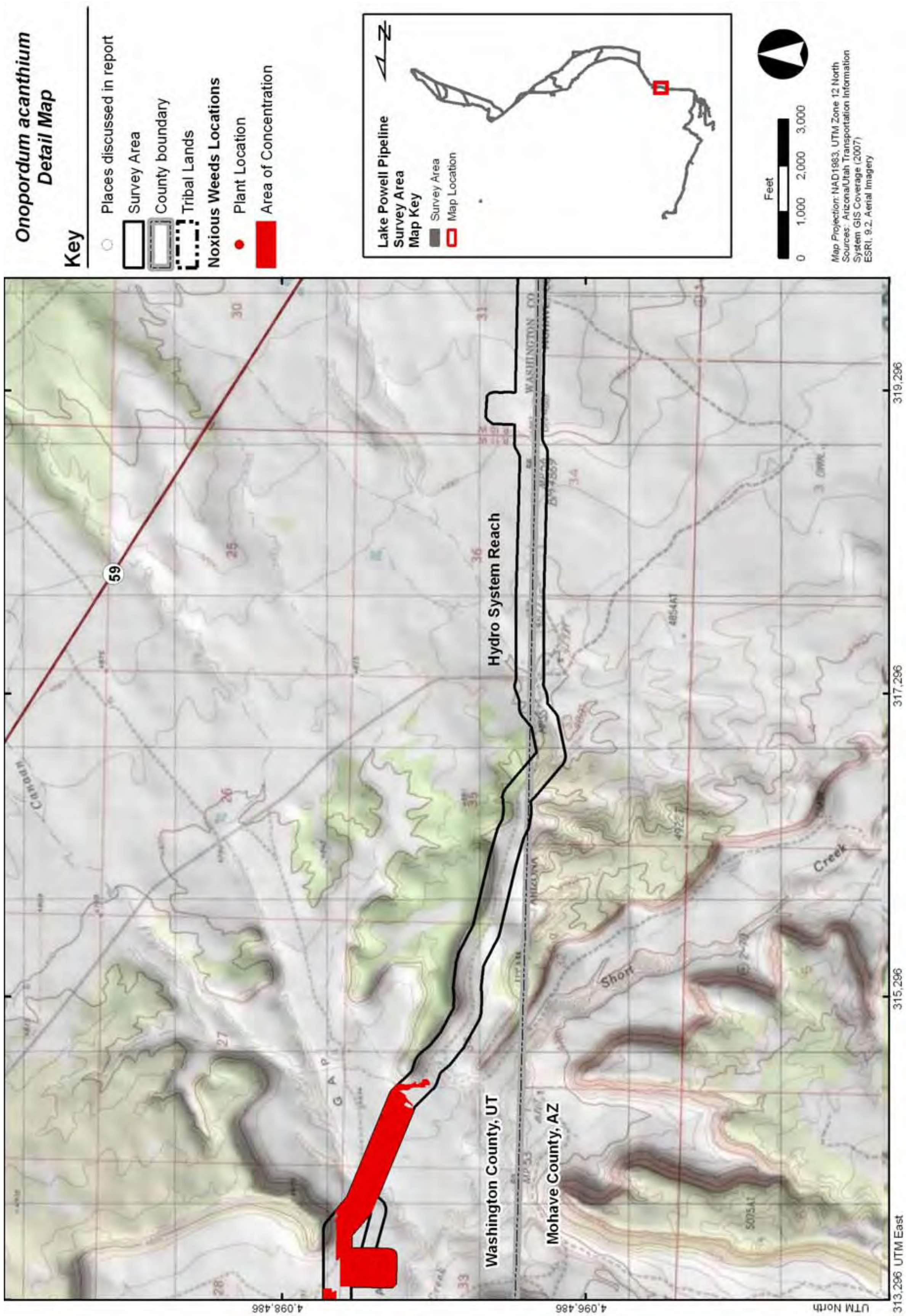
Map 5-113
***Onopordum acanthium* Detail Map**



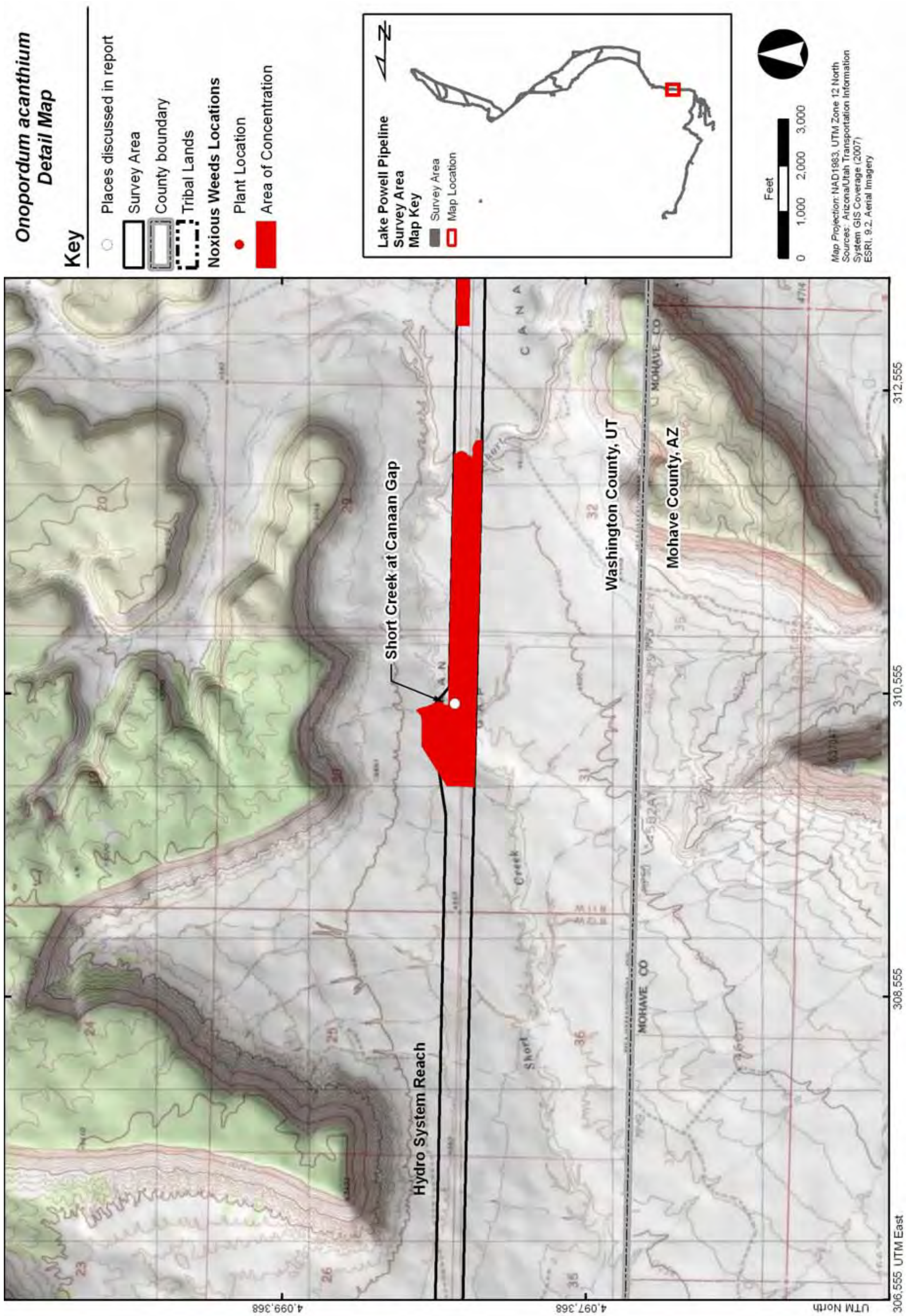
Map 5-114
***Onopordum acanthium* Detail Map**



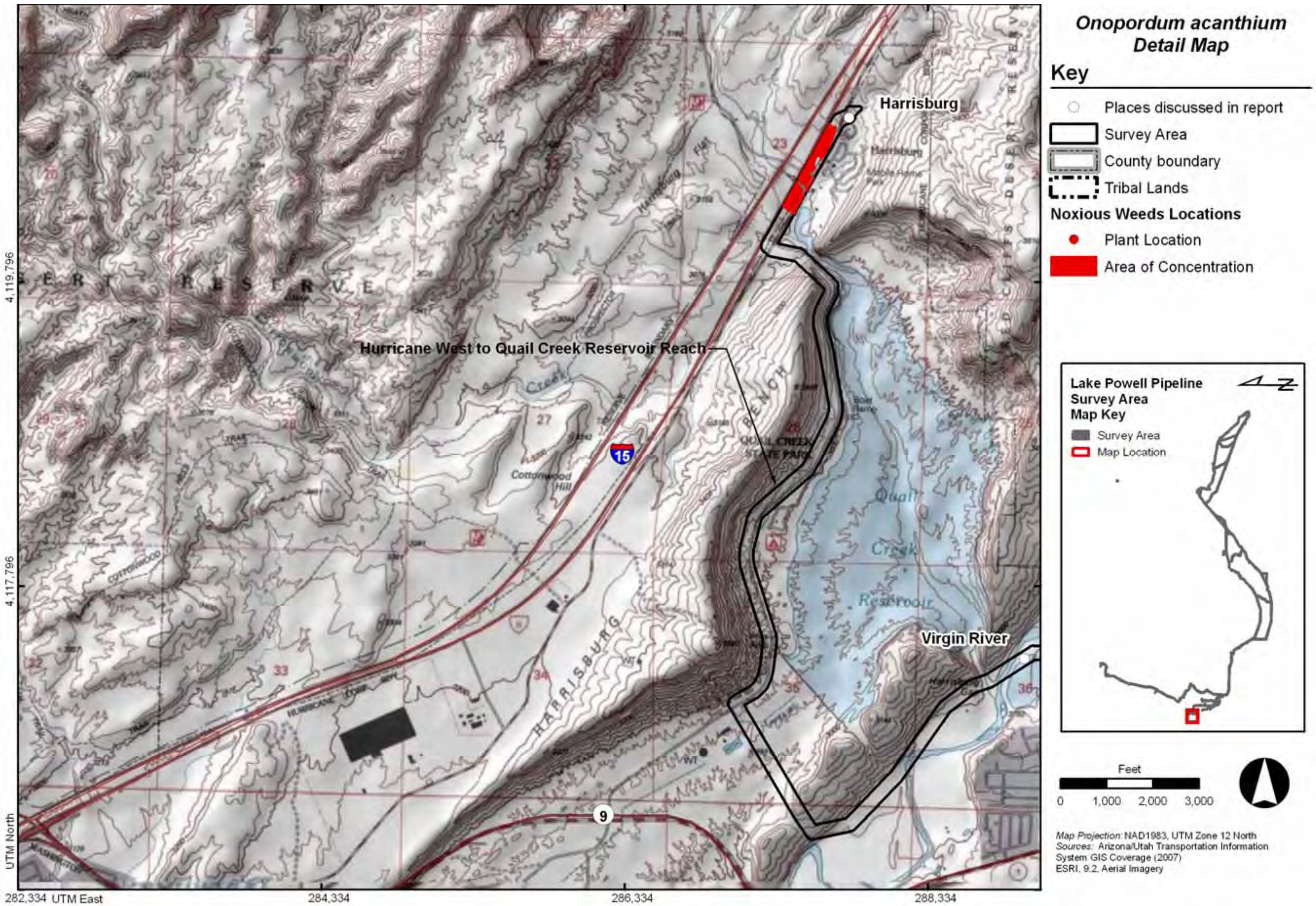
Map 5-115
***Onopordum acanthium* Detail Map**



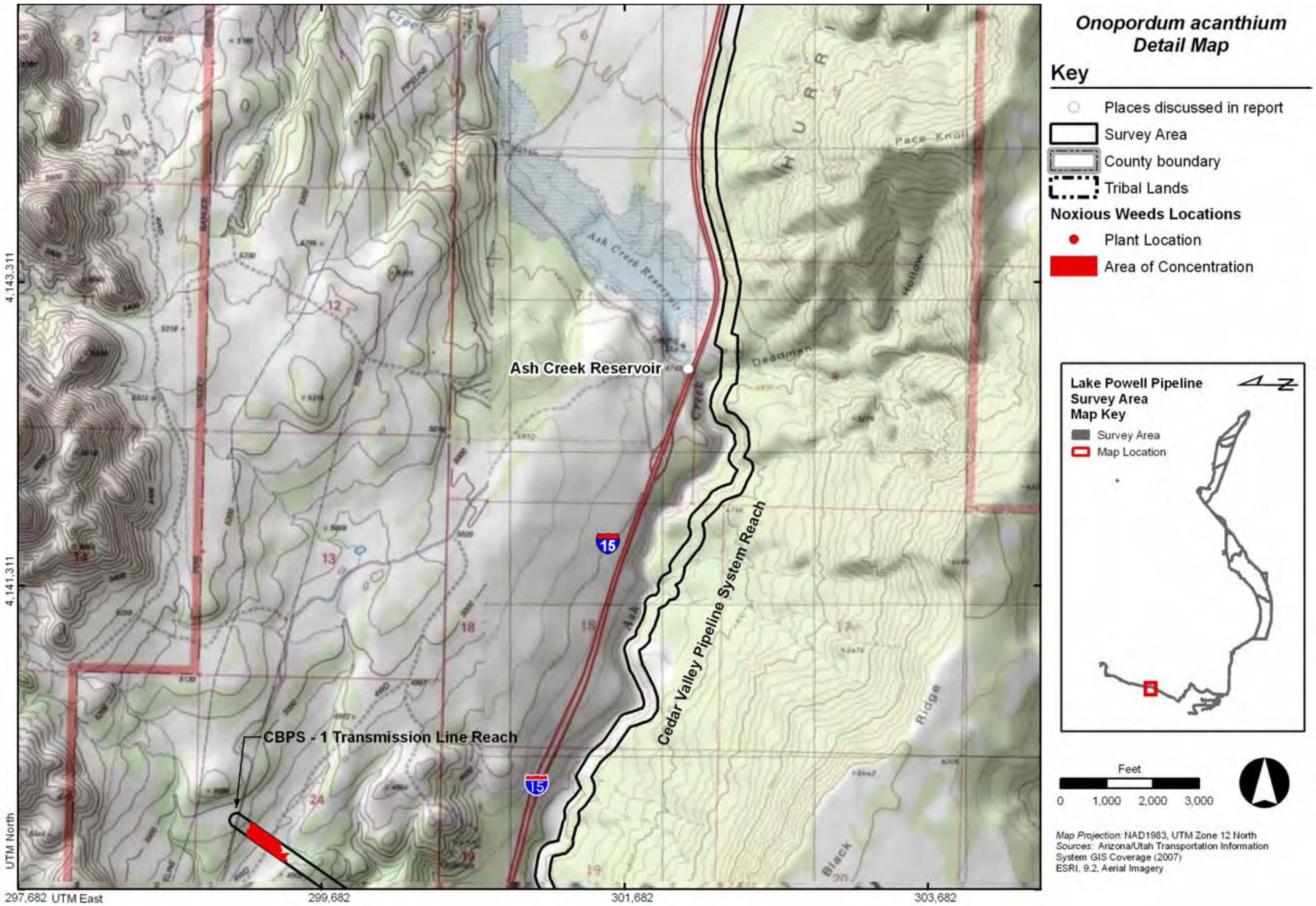
Map 5-116
***Onopordum acanthium* Detail Map**



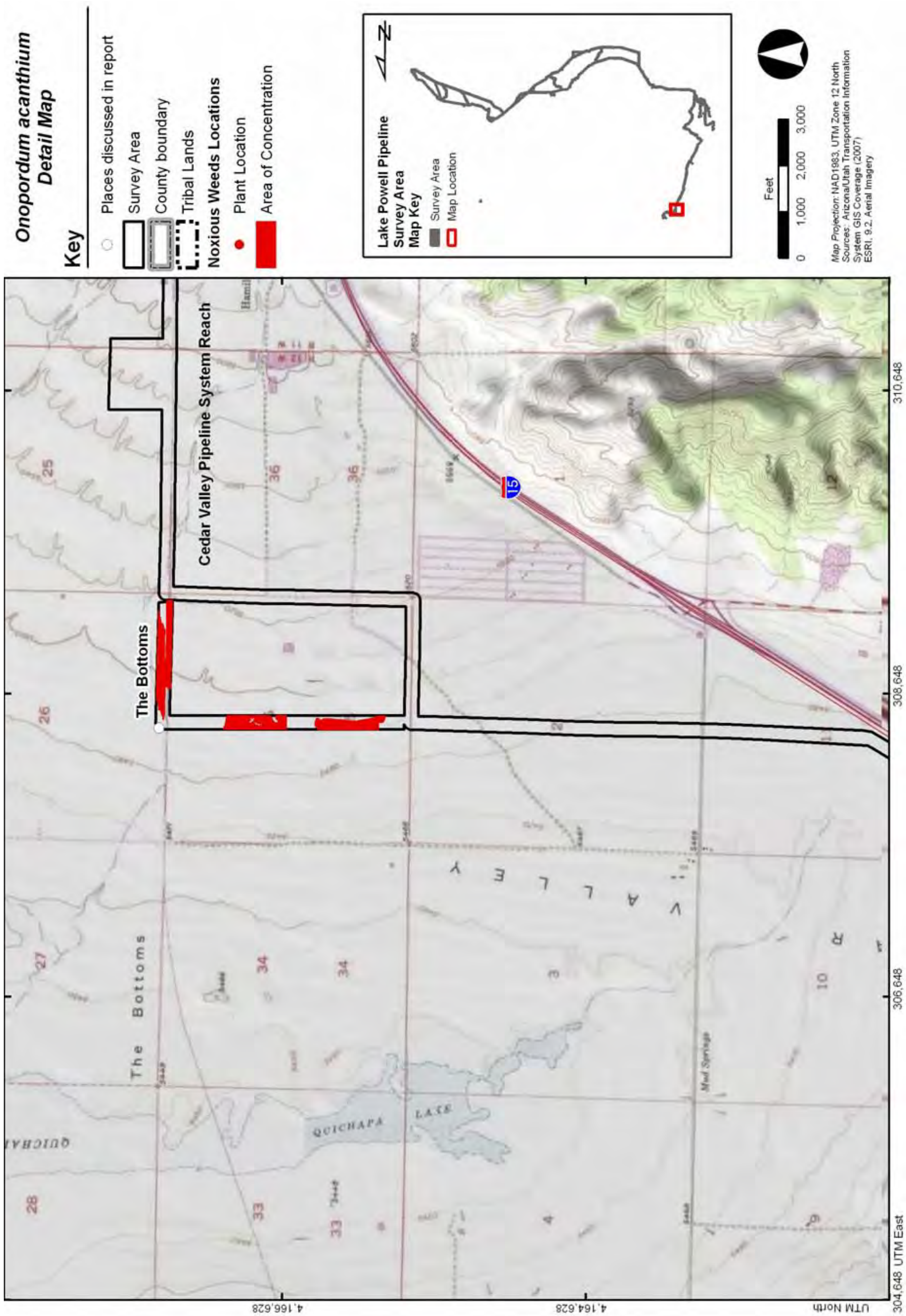
Map 5-117
***Onopordum acanthium* Detail Map**



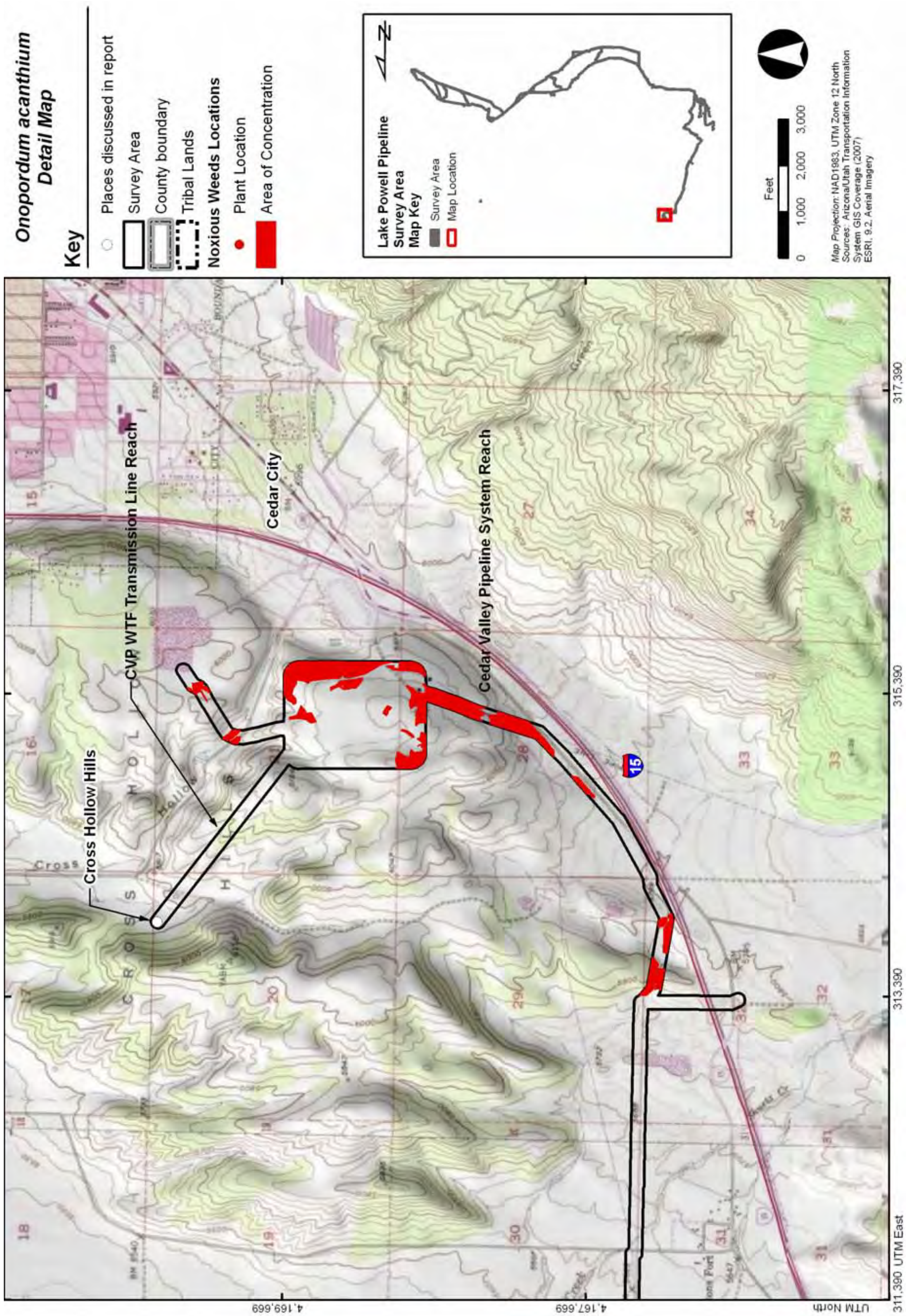
Map 5-118
Onopordum acanthium Detail Map



Map 5-119
***Onopordum acanthium* Detail Map**



Map 5-120
***Onopordum acanthium* Detail Map**



Map 5-121
***Onopordum acanthium* Detail Map**

5.5.13 *Portulaca oleracea* (Common purslane)

Figure 5-18
Close up view of *Portulaca oleracea* within the survey area

5.5.13.1 Natural History

Portulaca oleracea is a succulent annual in the Portulacaceae (Purslane family), with prostrate and spreading stems up to 3 feet (1 meter) long and reddish in color (Figure 5-18). Leaves are alternate or opposite, glabrous and succulent, and obovate or spatula shaped, between 0.20 and 1.18 inch (5 and 30 millimeters) long. Roots are generally spread near the soil surface. From May to September, *P. oleracea* produces yellow flowers either singly or in clusters of 2 to 5, at the tips of stems. In Arizona, flowering occurs from April to June and from August to November (Parker 2003). Flowers are 5-petaled and 0.12 to 0.20 inch (3 to 5 millimeters) long. Fruits occur as round to ovoid capsules, 0.16 to 0.30 inch (4 to 8 millimeters) long and 0.12 to 0.30 inch (3 to 8 millimeters) wide, and contain circular-ovate flattened seeds 0.02 to 0.04 inch (0.5 to 1 millimeter) in diameter. Seeds generally fall near the parent, but can be dispersed by water and soil movement, by transport on animals, or through human activities. Seeds are also dispersed as a contaminant of feed and seed.

Portulaca oleracea may be confused with *Trianthema portulacastrum*, although this other species is encountered less frequently. The taxa may be distinguished by their flowers; in contrast to the yellow flowers that occur at the stem tips of *P. oleracea*, those of *T. portulacastrum* are purplish-pink in color, and are borne in the leaf axils.

Introduced from Europe, *Portulaca oleracea* is now widely distributed across North America (Welsh et al. 1993). In Utah, *P. oleracea* is widespread in disturbed sites in indigenous plant communities from 2,725 to 8,005 feet in elevation (Welsh et al. 2008). In Arizona, the species is common on overgrazed eroded areas, mountain slopes, and meadows from 100 to 8,500 feet in elevation (Parker 2003).

Figure 5-19
View of *Portulaca oleracea* and its habitat within the survey area

Portulaca oleracea is an important plant worldwide, as it is eaten in salads or cooked as a vegetable, used medicinally, and used as fodder for livestock (DiTomaso & Healy 2007). However, *P. oleracea* can be invasive in overgrazed areas (Figure 5-19), in meadows, and on mountain slopes, and can be a pest in agricultural fields, particularly in lettuce, carrots, and sugar beet fields (Parker 2003). The species is especially difficult to control as plants produce seeds throughout the growing season and are able to root again after cultivation (Whitson et al. 1996).

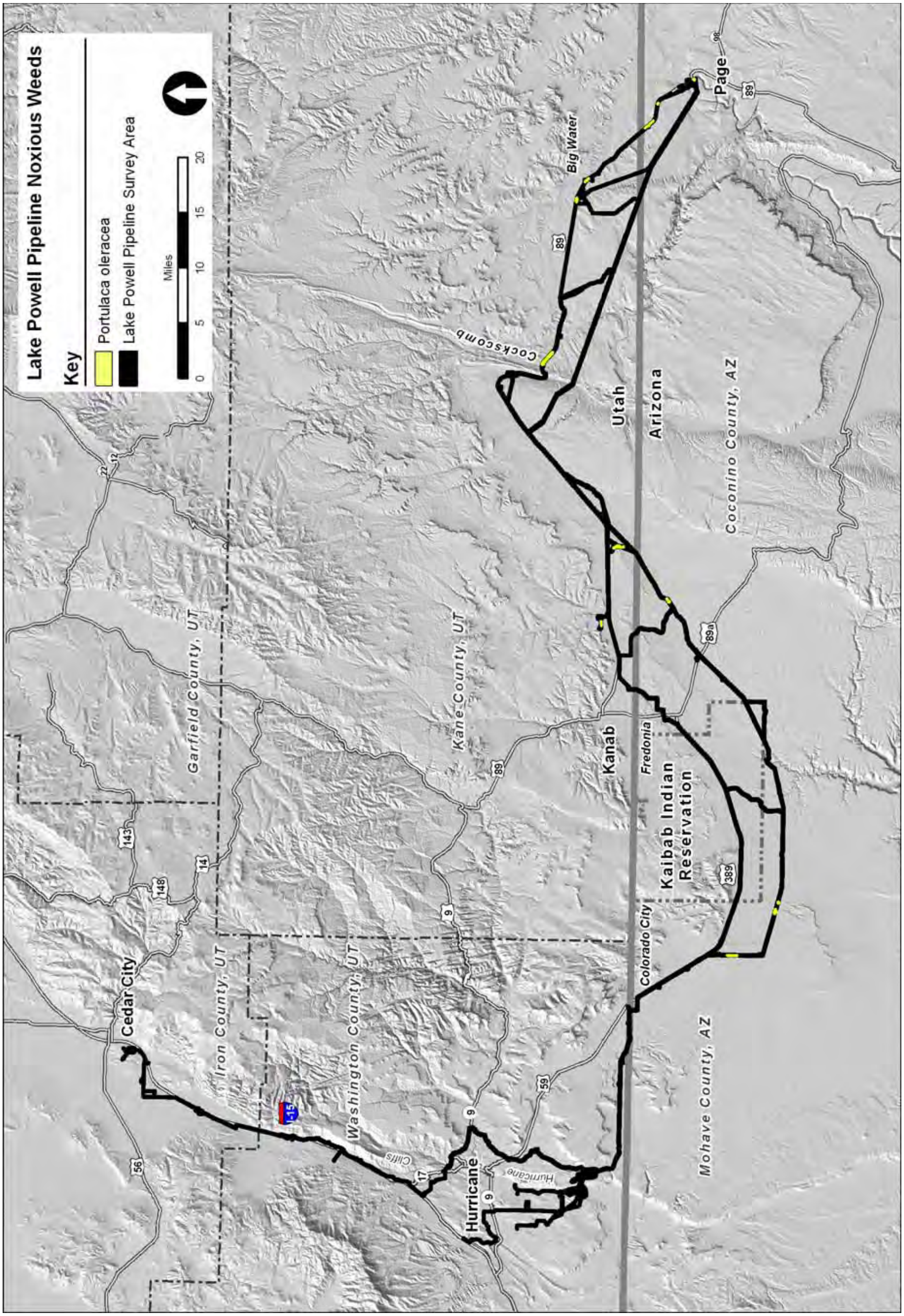
5.5.13.2 Survey Results

The survey identified *Portulaca oleracea* infrequently, in only a handful of locations within the survey area (Map 5-122). *Portulaca oleracea* was encountered primarily in the eastern and central portions of the survey area, and found within five reaches (Map 5-123to Map 5-133). *Portulaca oleracea* was identified at the Glen Canyon Substation. In the Water Conveyance System Reach it was found in the vicinity of Greenhaven, near Big Water, and north of Jacob's Tank Road at US 89. In the Hydro System Reach, individuals were encountered in a number of locations between Upper Paria River and Cockscomb, and in the Kane County Pipeline System Reach the species was found west of Johnson Canyon. In the Hydro System South Alternative Reach, it was encountered near Shinarump Cliffs, at White Sage Wash, in the vicinity of Moonshine Ridge, and in an area south of Yellowstone Road at AZ Route 389. *Portulaca oleracea* was not detected in any 50 meter belt transects; all encounters occurred while conducting special status species and noxious weed surveys.

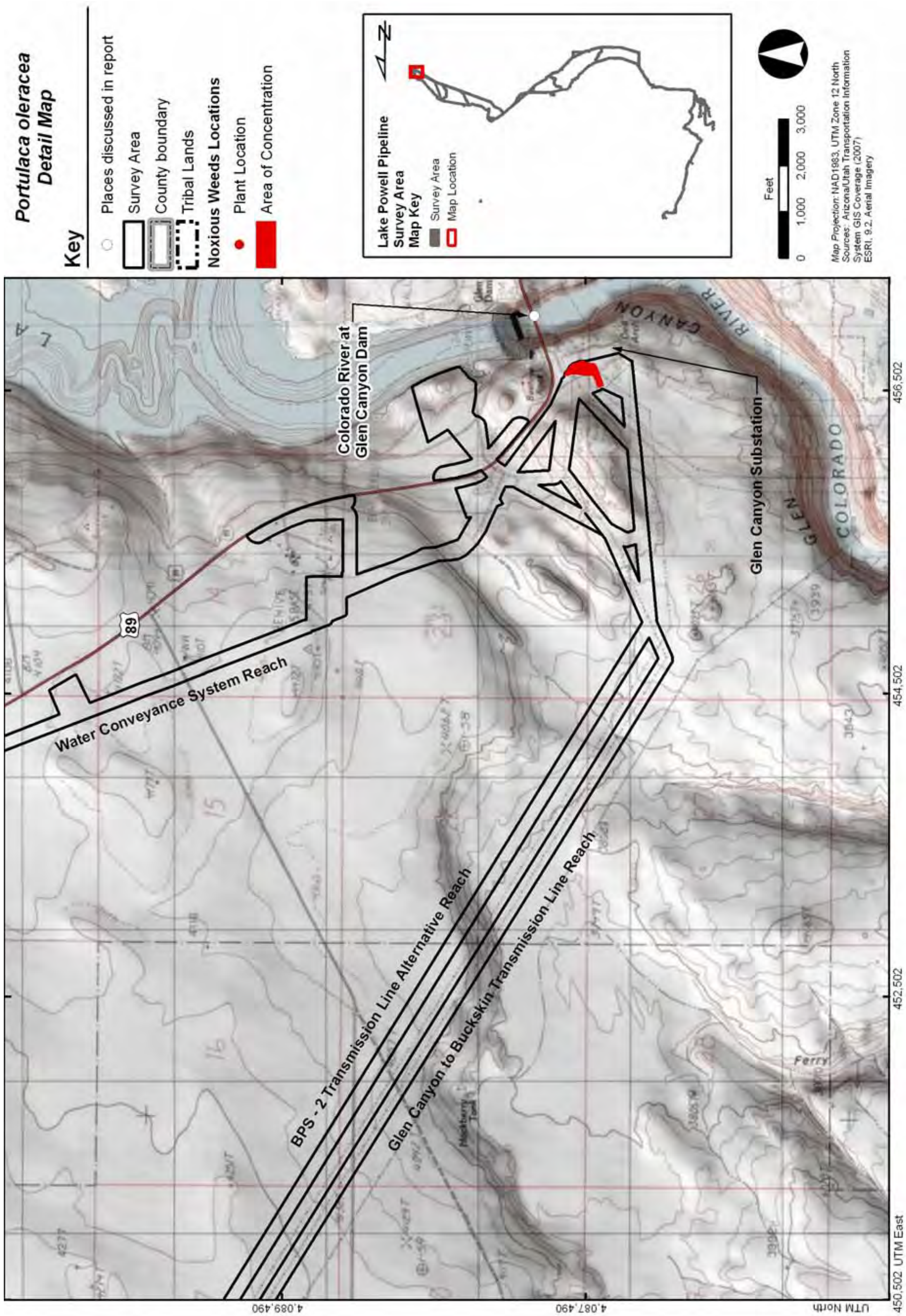
Portulaca oleracea was identified in the Colorado Plateau Ecological Region, in eight reaches, and in four anthropogenic lands. On the Colorado Plateau, *P. oleracea* occurred in Big Sagebrush Shrubland, Blackbrush-Mormon-tea Shrubland, Greasewood Flat, Lower Montane Riparian Woodland and Shrubland, Mixed Desert Scrub, Pinyon Juniper Woodland, Shrub-Steppe, and Colorado Plateau Wash. Anthropogenic lands which supported *P. oleracea* included Agricultural Land, Developed Land, Invasive Upland Vegetation, and Ruderal Vegetation. Most commonly, individuals were encountered in Colorado Plateau Mixed Desert Scrub, where the species occurred in vegetation communities dominated by *Artemisia* spp. and/or *Atriplex canescens.* In most cases, encounters occurred as small to large clusters of individuals. *P. oleracea* was not detected in any 50-meter belt transects; all encounters occurred while conducting special status species and noxious weed surveys.

5.5.13.3 Discussion

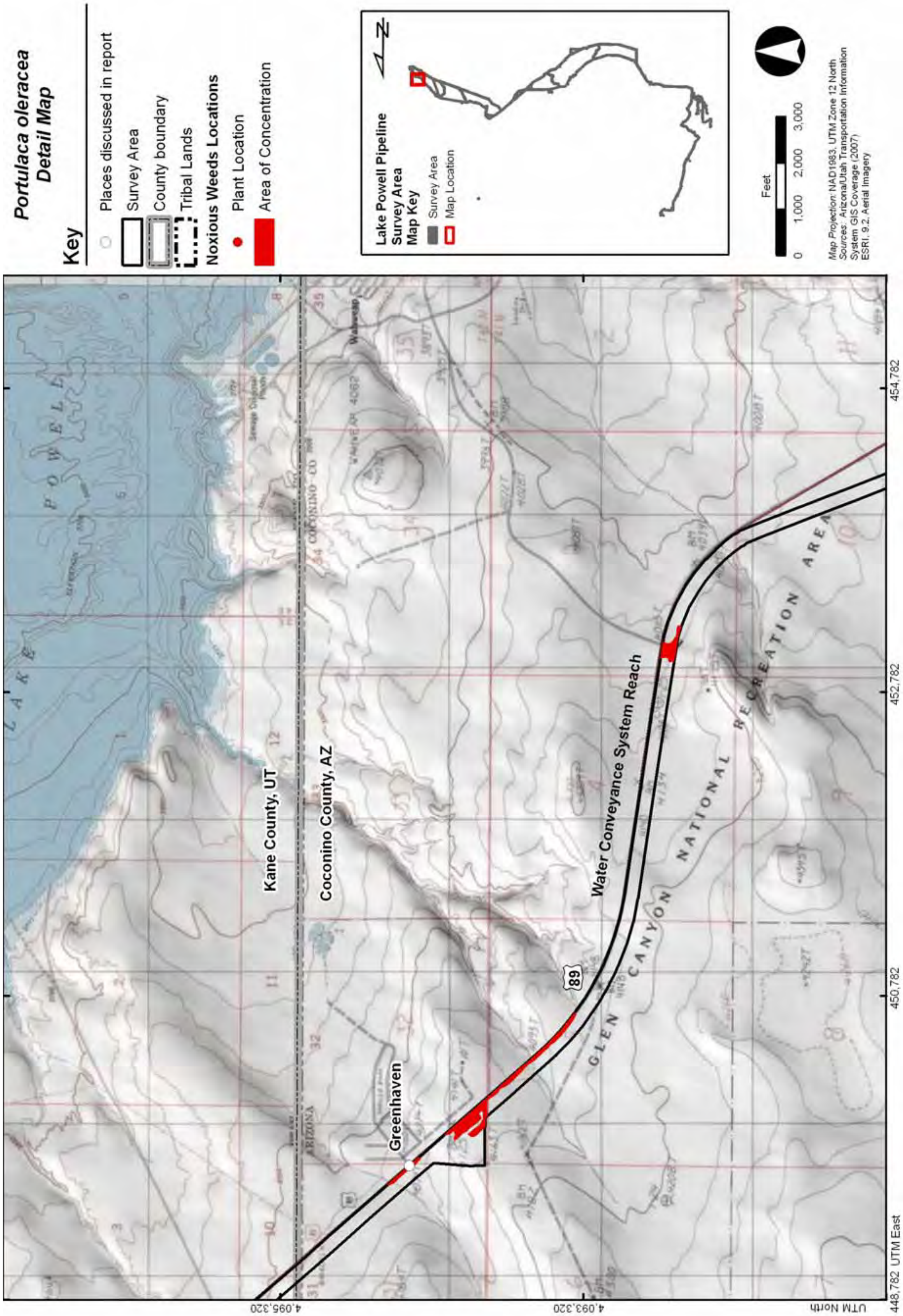
Portulaca oleracea only occurred on occasion within the survey area. However, given the potential for the species to spread into newly disturbed areas, as well as the difficulty to control the species once it becomes established, care should be taken to minimize seed dispersal. Therefore, vehicle tires could be washed when departing infested areas.



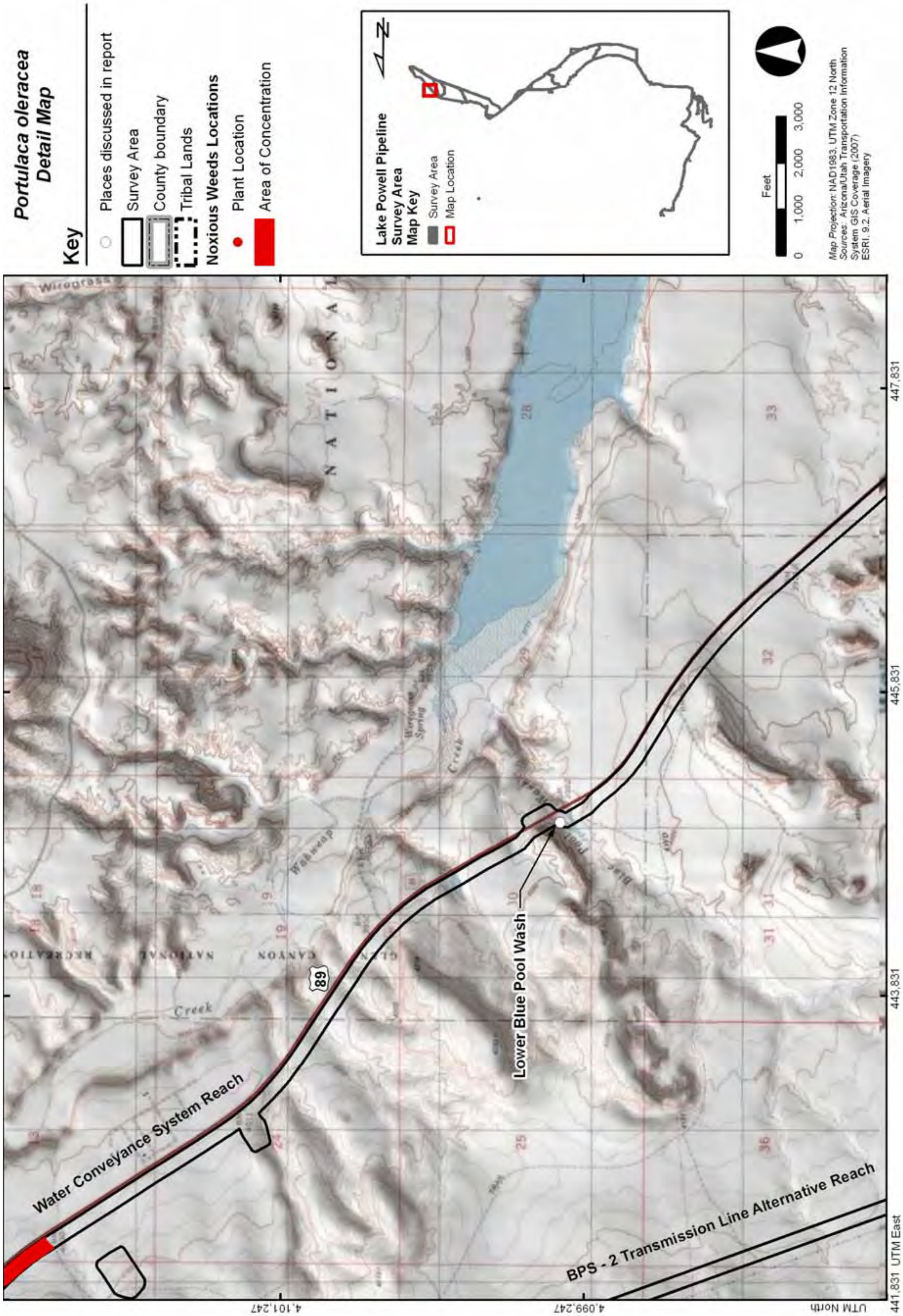
Map 5-122
***Portulaca oleracea* Overview Map**



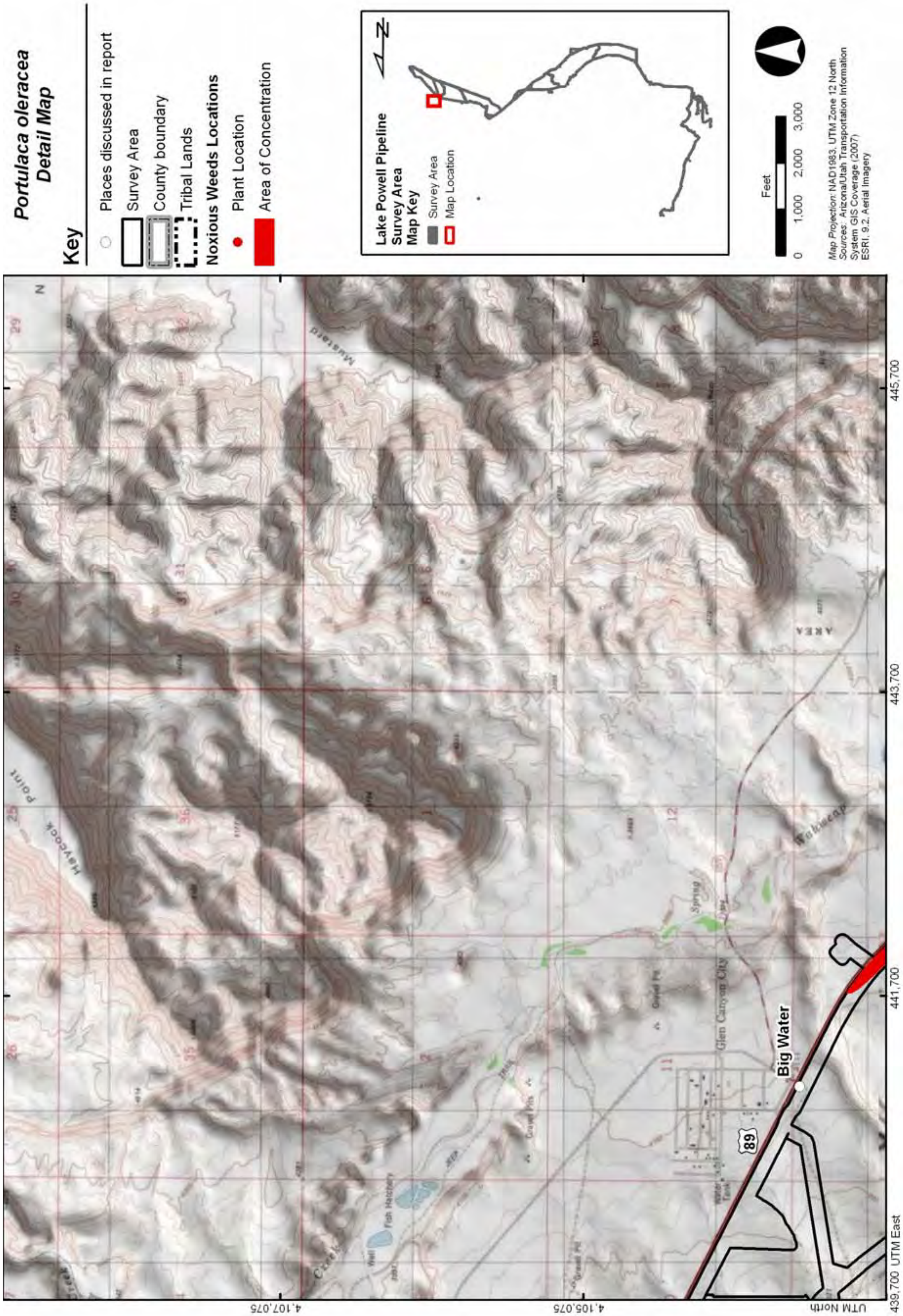
Map 5-123
***Portulaca oleracea* Detail Map**



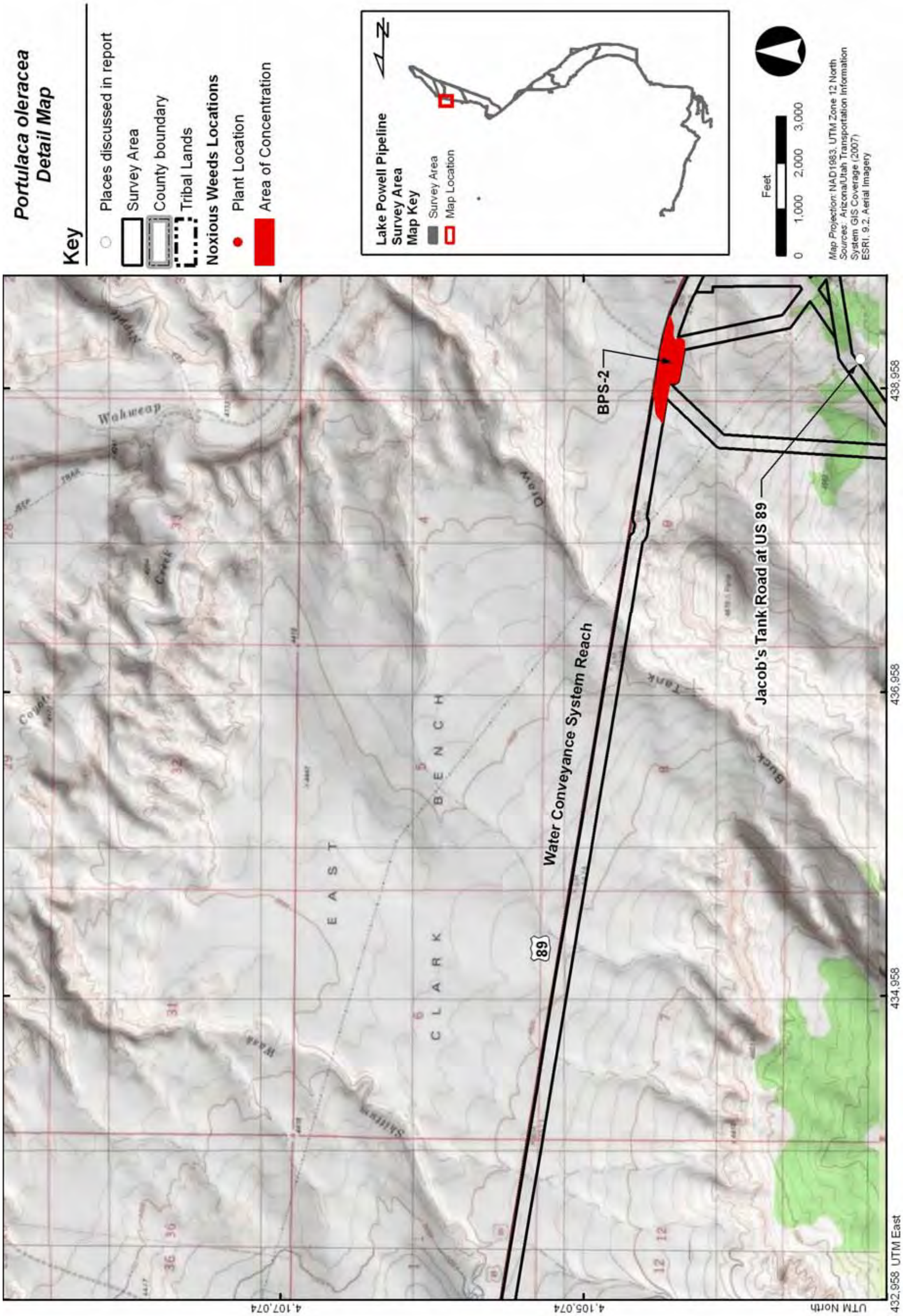
Map 5-124
***Portulaca oleracea* Detail Map**



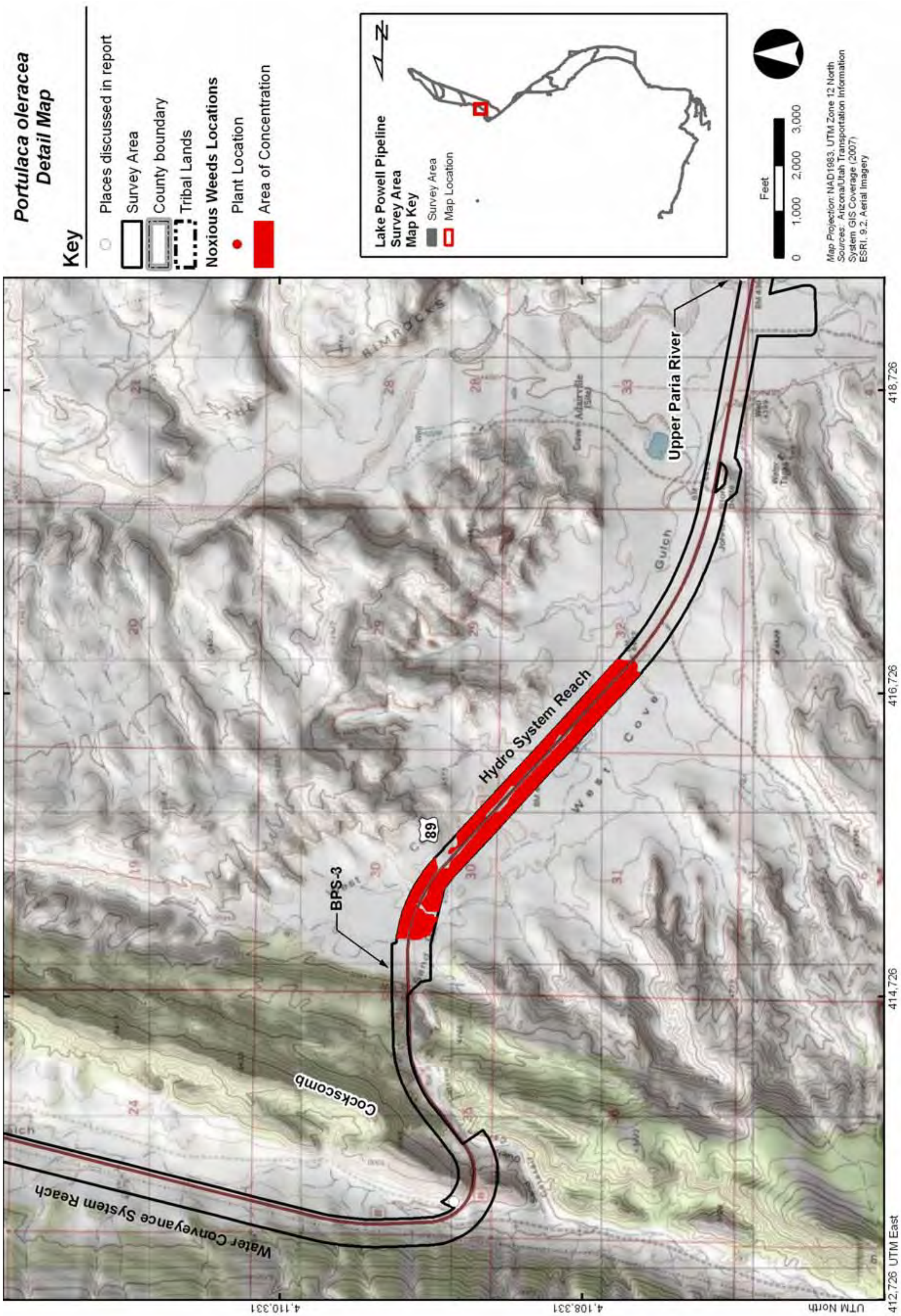
Map 5-125
***Portulaca oleracea* Detail Map**



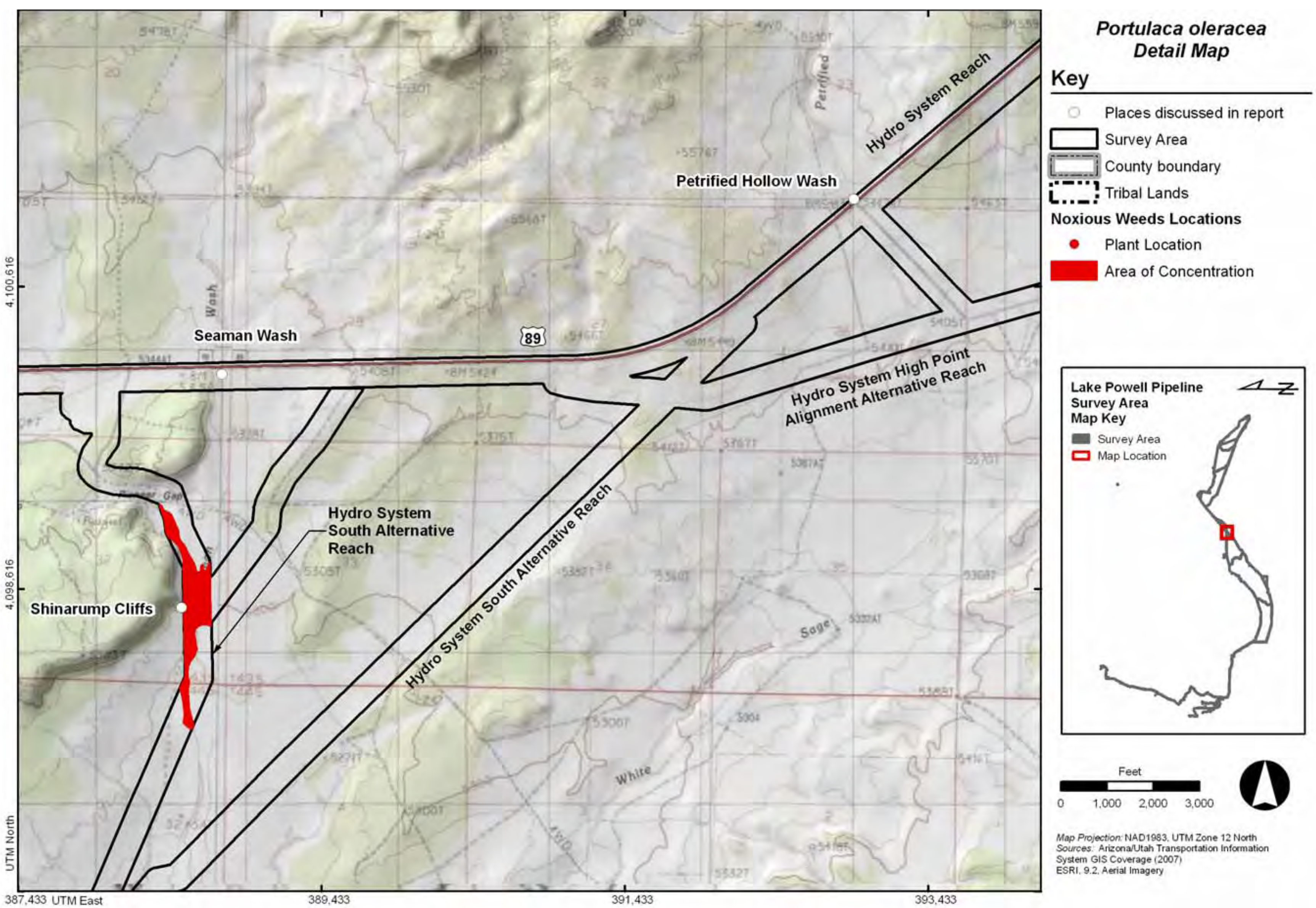
Map 5-126
***Portulaca oleracea* Detail Map**



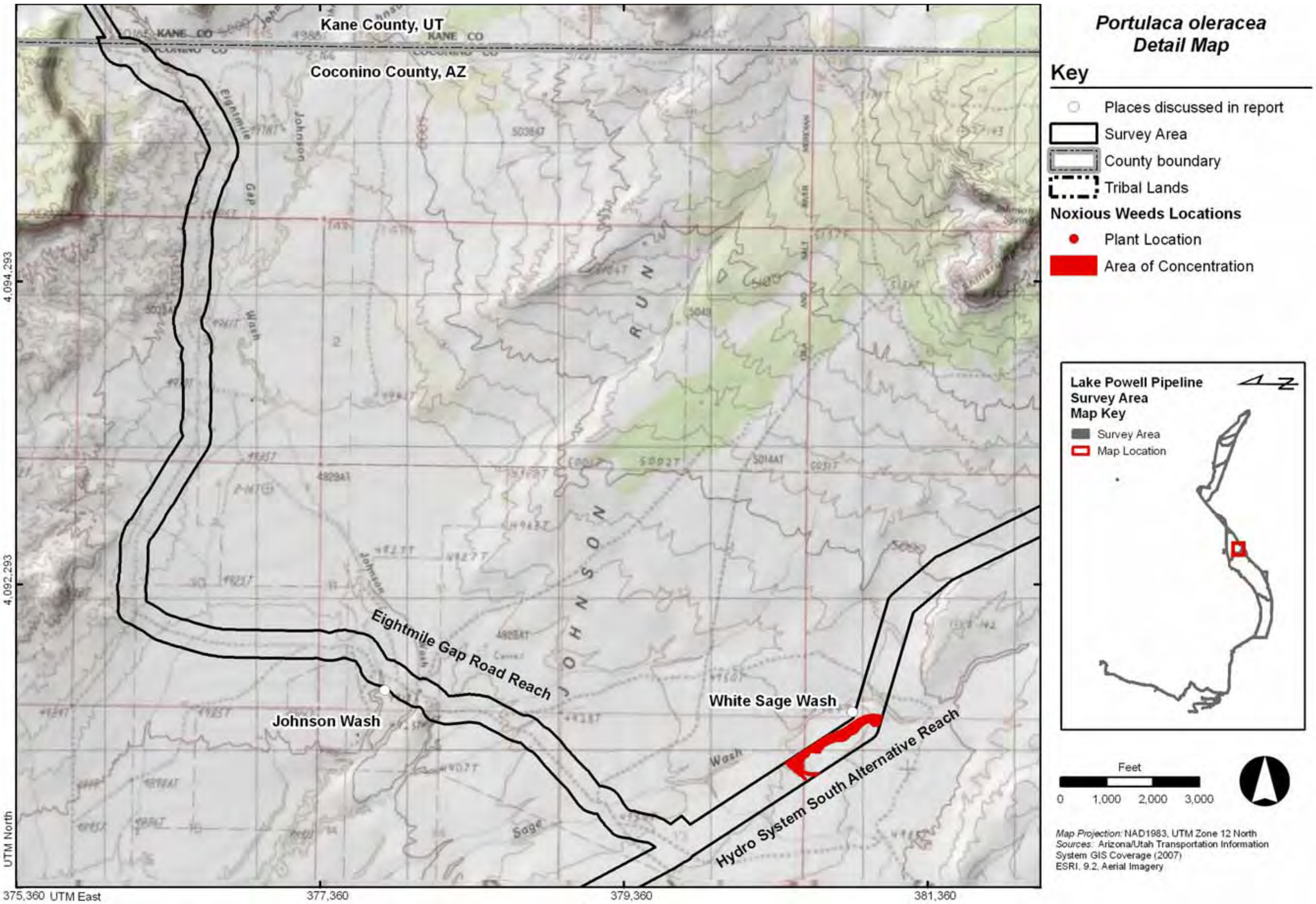
Map 5-127
***Portulaca oleracea* Detail Map**



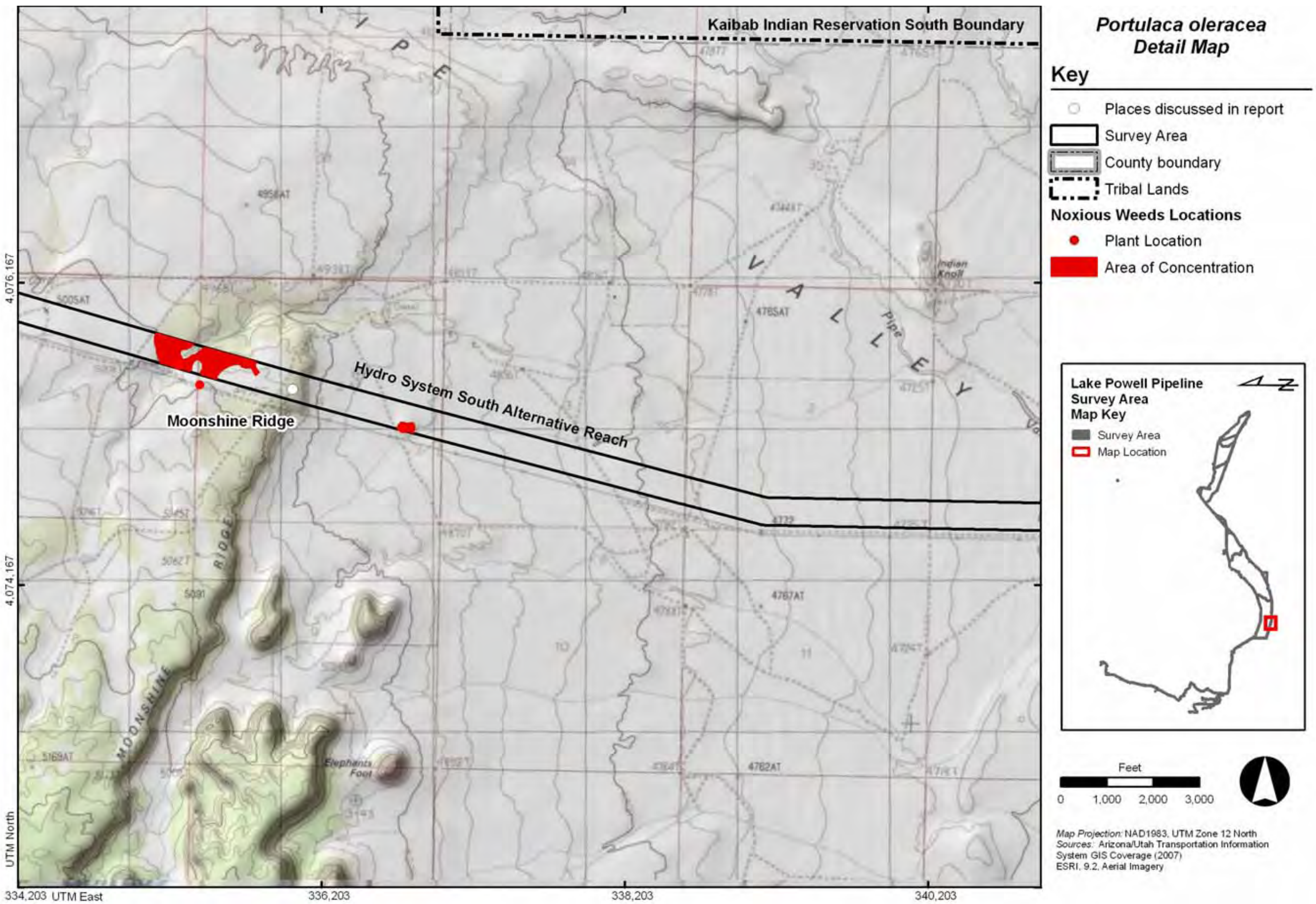
Map 5-128
***Portulaca oleracea* Detail Map**



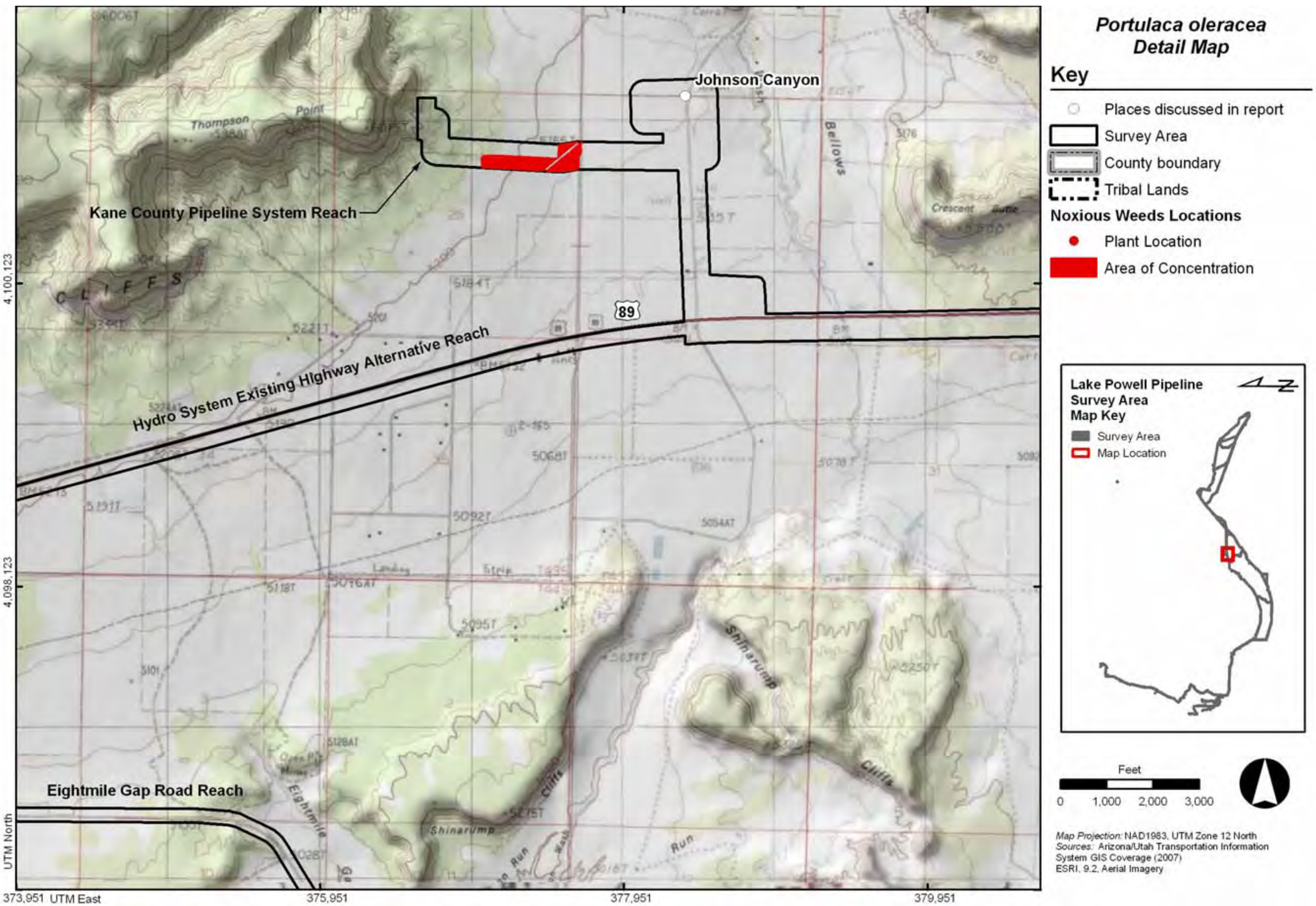
Map 5-129
***Portulaca oleracea* Detail Map**



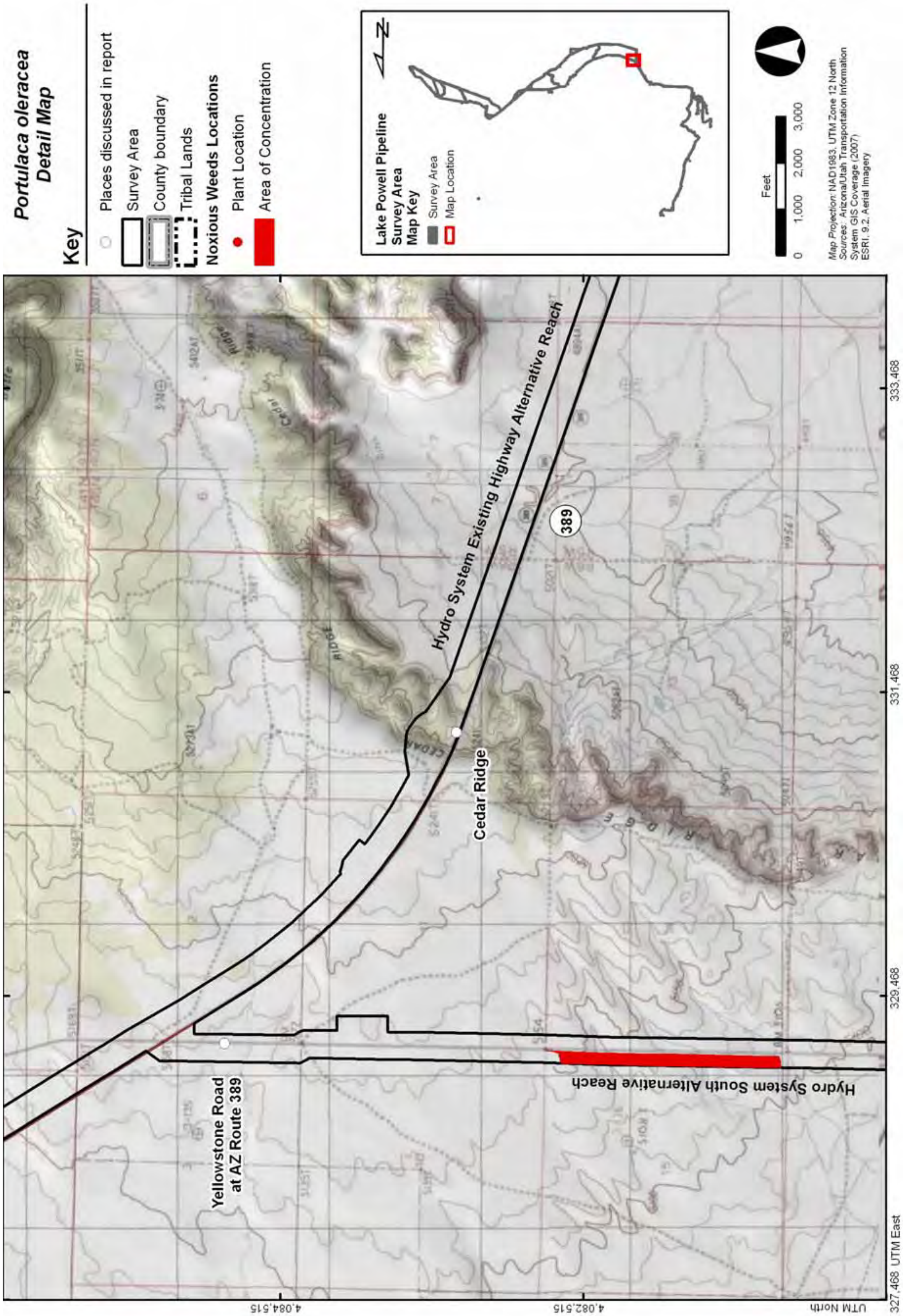
Map 5-130
***Portulaca oleracea* Detail Map**



Map 5-131
***Portulaca oleracea* Detail Map**



Map 5-132
***Portulaca oleracea* Detail Map**



Map 5-133
***Portulaca oleracea* Detail Map**

5.5.14 *Salsola tragus* (Russian thistle)

Figure 5-20
Close up view of *Salsola tragus* within the survey area

5.5.14.1 Natural History

Salsola tragus is an annual in the Chenopodiaceae (Goosefoot family), which grows to 3 feet (1 meter) tall and approximately as wide (Figure 5-20). Stems are green or striped with purple, rigid, and curve upward. Leaves are 0.30 to 2.0 inches (8 to 52 millimeters) long, 0.02 to 0.04 inch (0.5 to 1 millimeter) wide, and fleshy with a sharp tip. Foliage is blue-green in color. Leaves are alternate, occurring at first string-like, then later scale-like and spine-tipped. Flowers are green and occur in the axils of upper leaves (Welsh et al. 2008). From July through October, *S. tragus* produces green flowers in the axils of upper leaves with pinkish to deep red sepals. Sepal wings are 0.02 to 0.10 inch (0.5 to 2.5 millimeters) long and fan-shaped. Fruits are sphere-shaped, utricles, to 0.30 inch (8mm) in diameter, and contain a single gray to brown seed, compressed-round in shape, 0.06 to 0.08 inch (1.5 to 2 millimeters) in diameter. Upon maturity, individuals break off from the base and tumble in the wind, dispersing seeds along their path. An average sized plant can produce up to 2,000 seeds, while large individuals can produce up to 100,000. Seeds can remain viable for many years. (DiTomaso & Healy 2007).

Salsola tragus can be easily confused with other *Salsola* species, particularly *S. collina* and *S. paulsenii*, with which it can hybridize. They are difficult to differentiate; however, the perianths of mature *S. tragus* individuals generally do not have distinct wings, while those of *S. colina* and *S. paulsenii* do have wings (DiTomaso & Healy 2007).

Salsola tragus was introduced with flax seed from Russia into South Dakota in the late 1800s, and spread quickly throughout the United States (DiTomaso & Healy 2007). *Salsola tragus* is adapted to dry areas but also is common in disturbed wastelands, overgrazed rangelands, and irrigated croplands (Whitson et al. 2009). In Utah, the species is found in nearly all counties in disturbed habitats from 2,493 to 8,005 feet in elevation (Welsh et al. 2008). In southern Arizona, *S. tragus* is abundant in waste areas, river bottoms, and irrigated areas, and in northeastern Arizona it occurs commonly on pastures and overgrazed ranges, in chaparral and pinyon-juniper areas, from 150 to 7,000 feet in elevation (Parker 2003).

Salsola tragus grows vigorously in disturbed areas (Figure 5-21), and dead plants fill ravines, clog irrigation ditches, and can challenge vehicles on roadways (Welsh et al. 2008). *Salsola tragus* can also affect agriculture, as it serves as a host for sugarbeet leafhopper, which carries a virus that affects beets, and also is the source that causes blight in spinach, tomatoes, and beans (Parker 2003).

5.5.14.2 Survey Results

Salsola tragus was widespread throughout the survey area, ranging from the vicinity of Colorado River at Glen Canyon Dam to Cedar City (Map 5-134). *Salsola tragus* was found in a total of 24 reaches. The species was encountered sporadically in the Glen Canyon to Buckskin Transmission Line Reach, the BPS-2 Transmission Line Alternative Reach, and the Glen Canyon to Buckskin Transmission Line North Reach. In the Water Conveyance System Reach *S. tragus* was identified near the border of Kane County and Coconino County (northeast of Upper Blue Pool Wash), at several locations in the vicinity of Big Water and Cottonwood Canyon Road, between the Cockscomb and Fivemile Valley, and between Fivemile Valley and the vicinity of Telegraph Wash. It occurred in the eastern half of the Paria Substation. In the BPS-2 Transmission Line Reach, individuals were encountered in the vicinity of Jacob's Tank Road at US 89, and in the BPS-2 Transmisison Line South Reach, it was found sporadically. In the Hydro System Reach, individuals were identified on occasion from Cottonwood Canyon Road to the Cockscomb, and from the area north of Yellowstone Road at AZ Route 389 to the vicinity of the Honeymoon Trail. *Salsola tragus* was widespread throughout the Hydro System High Point Alignment Alternative Reach, and was encountered frequently in the Hydro System South Alternative Reach and Eightmile Gap Road Reach. In the Hydro System Existing Highway Alternative Reach, *S. tragus* was frequently encountered between Seaman Wash and Yellowstone Road at AZ Route 389. It was found at several locations in the Kane County Pipeline System Reach and Mount Trumbull Road Reach. The species was very common in the Forebay, and occasionally encountered in the Afterbay Reach. In the Airport Road Reach, *S. tragus* was common between the Hurricane Cliffs and the Hurricane Airport, and was also common throughout much of the Hurricane Cliffs to Sand Hollow Transmission Line Reach and Penstock from Afterbay to Sand Hollow Hydro for Pump Storage Option Reach. The species was encountered at one location northeast of Sand Hollow Reservoir in the Hurricane Cliffs Afterbay to Hurricane West Transmission Line Reach, and north of Sand Hollow Reservoir in the Sand Hollow to Dixie Springs Transmission Line Reach. *Salsola tragus* was also encountered at one location near Harrisburg in the Hurricane West to Quail Creek Reservoir Reach. In the Cedar Valley Pipeline System Reach the species was identified commonly between the Divide and La Verkin Creek, at two locations north of Pintura, in an area north of Kanarraville (adjacent to and in the CBPS-3 Transmission Line Reach), in the vicinity of the Bottoms, and frequently in the vicinity of Cedar City. *Salsola tragus* was encountered while conducting surveys for special status species and noxious weeds; however, the species was also detected in a total of 199 50-meter belt transects.

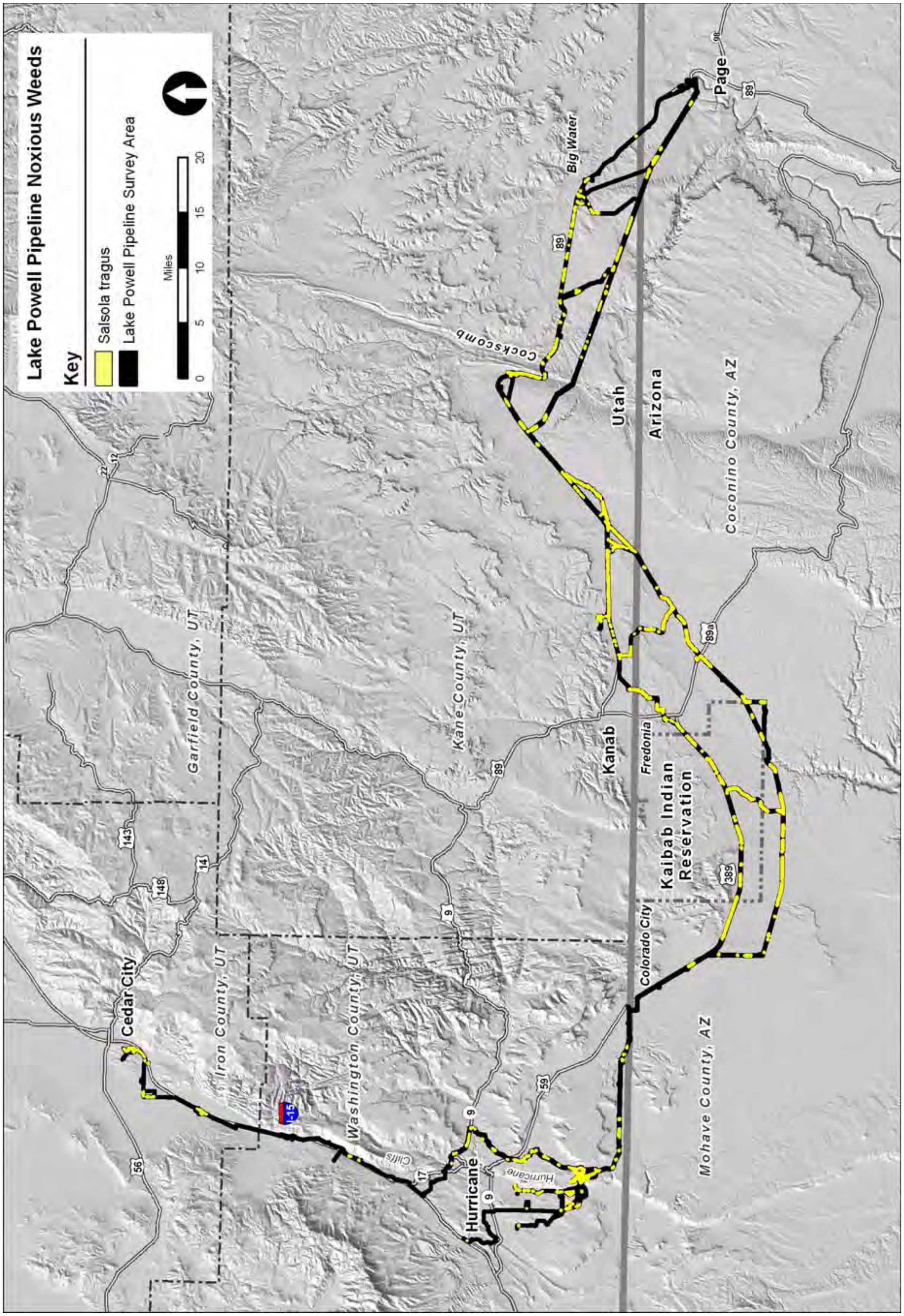
Figure 5-21
View of *Salsola tragus* and its habitat within the survey area

Salsola tragus was identified in all three Ecological Regions, in 26 ecological systems, and in six anthropogenic lands. On the Colorado Plateau, *S. tragus* was encountered in Active and Stabilized Dune, Big Sagebrush Shrubland, Blackbrush-Mormon-tea Shrubland, Grassland, Greasewood Flat, Gypsum Badland, Juniper Savanna, Lower Montane Riparian Woodland and Shrubland, Mixed Bedrock Canyon and Tableland, Mixed Desert Scrub, Mixed Low Sagebrush Shrubland, Pinyon-Juniper Woodland, Shrub-Steppe, Volcanic Rock and Cinder Land, and Colorado Plateau Wash. In the Great Basin, individuals were identified in Big Sagebrush Shrubland, Lower Montane Riparian Woodland and Shrubland, Mixed Desert Scrub, and Pinyon-Juniper Woodland. In the Mohave

Desert, *S. tragus* was encountered in Active and Stabilized Dune, Creosote-White Bursage Desert Scrub, Grassland, Lower Montane Riparian Woodland and Shrubland, Mixed Desert Scrub, Shrub-Steppe, and Volcanic Rock and Cinder Land. Anthropogenic lands supporting *S. tragus* included Agricultural Land, Developed Road, Developed Land, Invasive Upland Vegetation, Quarry, and Ruderal Vegetation. Most commonly, *S. tragus* was either a dominant or co-dominant member of the vegetative community in which it was found, or occurred in communities dominated by *Artemisia tridentata* ssp. *vaseyana.* The species was encountered singly, in small clusters, and in large populations.

5.5.14.3 Discussion

Salsola tragus was highly abundant with the survey area, and was found inhabiting a broad range of ecological systems. The species is highly competitive in habitats disturbed both by natural and artificial means. *Salsola tragus* is the first species to colonize denuded floodplains which have historically been subjected to repeated flash floods. On broad floodplains like Johnson Wash, wildfire followed by floods from thunderstorms leave heavy silt deposition which buries the native seed bank. Its ability to produce huge quantities of seed which can remain viable for many years, in addition to its ability to readily distribute seed across the landscape, provides the species great opportunity to establish in newly disturbed habitats. The project will undoubtedly enhance the ability of *S. tragus* to spread within and adjacent to the survey area. It is recommended that vehicle tires be washed when departing work areas where the species has been identified. Additionally, plant skeletons that are found within work areas, which may contain viable seed, could be removed from the site and destroyed.



Map 5-134
***Salsola tragus* Overview Map**

5.5.15 *Sorghum halepense* (Johnsongrass)

5.5.15.1 *Natural History*

Sorghum halepense is a perennial in the Poaceae (Grass family) that grows to 6.5 feet (2 meters) tall. Stems are erect and unbranched, and have solid internodes. Leaf blades are 0.20 to 0.80 inch (0.5 to 2 centimeters) wide, up to 24 inches (60 centimeters) long, bright green with conspicuous whitish veins, flat, with open, ribbed sheaths that can be pale green to reddish. Roots are fibrous, grow to a depth of 4 feet (1.2 meters). Rhizomes can grow to approximately 0.40 inch (1 centimeter) wide and 80 inches (2 meters) long, and produce new plants quickly. Rhizomes can live up to 1 year, and are able to produce new shoots from depths of up to 12 inches (30 centimeters). Inflorescences are open, pyramidal purplish or reddish black panicles that contain spikelets 0.16 to 0.28 inch (4 to to 7 mm) long and 0.06 to 0.08 inch (1.5 to 2 mm) wide. Lemma awns are absent or between 0.35 to 0.60 inch (9 to 15 mm) long. Seeds are reddish brown to black in color, elliptic to ovoid in shape, 0.06 to 0.08 inch (1.5 to 2 mm) wide and 0.16 to 0.28 inch (4-7 mm) long. Seeds are retained in the panicle or are shed near the parent plant, but can be dispersed by water, animals, human activities, and vehicles. Seeds are tightly enclosed in glumes, protecting them from decomposition. Seeds can remain dormant for up to at least 6 years, but can remain viable for nearly 15 years under ideal conditions (DiTomaso & Healy 2007).

Sorghum halepense resembles *S. bicolor*, although *S. bicolor* is an annual which produces larger leaves, 1.2 to 4 inches (3-10 cm) wide and up to 40 inches (100 cm) long, and in contrast to the open panicle of *S. halapense*, generally has a compact and dense panicle (DiTomaso & Healy 2007).

Sorghum halepense was introduced from the Mediterranean as a forage or hay crop (Whitson et al. 2009). It has spread throughout the southern half of the United States, and is a common weed throughout the world's warm temperate regions (Welsh et al. 2008). In Utah, *S. halepense* grows in ditchbanks and mostly mesic, waste places from 2,788 to 4,921 feet in elevation in many counties (Welsh et al. 2008). In Arizona, *S. halepense* grows throughout the state, in moist waste places, irrigation ditches, and cultivated fields from 100 to 6,000 feet in elevation (Figure 5-22); it flowers from April to November (Parker 2003).

Sorghum halepense is considered one of the most noxious weeds in the world, is difficult to eradicate (Welsh et al. 2008) and is toxic to livestock due to the formation of hydrocyanic acid when subjected to frost or moisture stress (Whitson et al. 2009). Additionally, *S. halepense* is a host for viruses that can cause diseases to sugar cane and corn (DiTomaso & Healy 2007).

Figure 5-22
Close up view of *Sorghum halapense* within the survey area

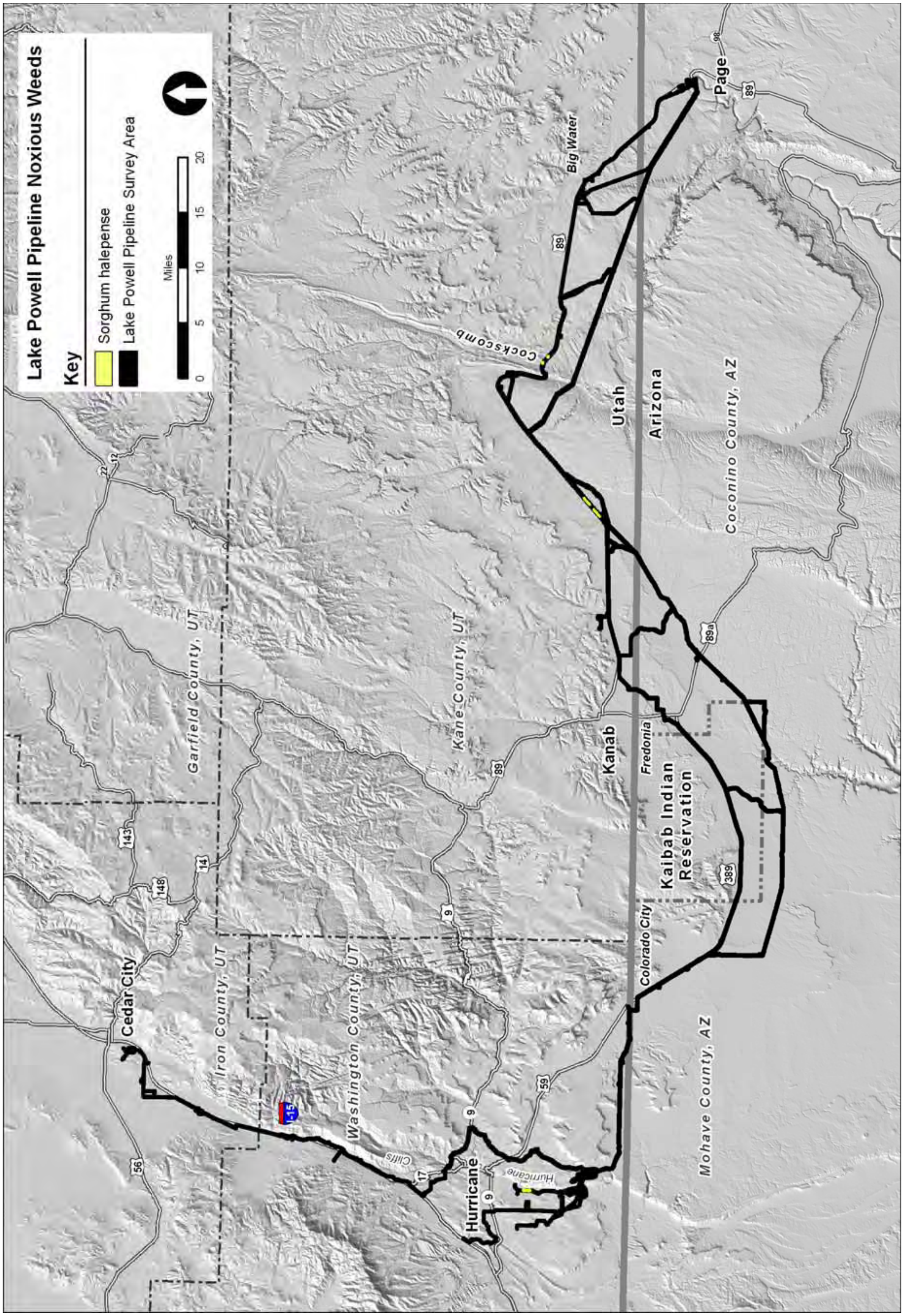
5.5.15.2 Survey Results

Sorghum halepense occurred rarely within the survey area (Map 5-135), and in only two reaches (Map 5-136 to Map 5-140). In the Hydro System Reach the species was identified at two locations between Upper Paria River and the Cockscomb, and in the vicinity of Petrified Hollow Wash. In the Airport Road Reach it was identified north and west of the Hurricane Cliffs (between the Hurricane Airport and Sky Ranch Airport Community). *Sorghum halepense* was mostly encountered while conducting special status species and noxious weed surveys; however, the species was also detected in three 50-meter belt transects (Transects # 65, 67, and 451).

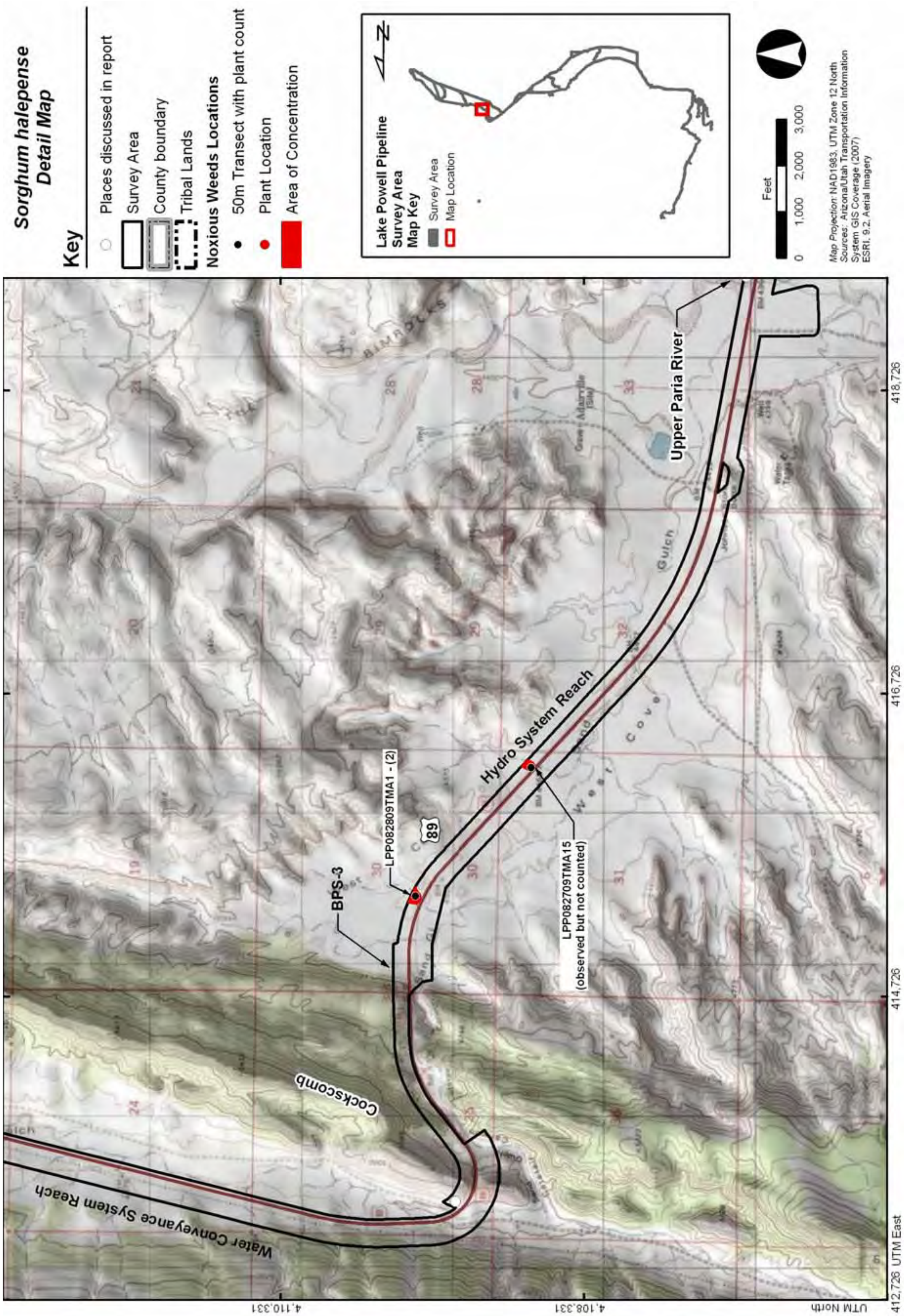
Sorghum halepense was encountered in the Colorado Plateau and Mohave Desert Ecological Regions, where it occurred in two ecological systems and two anthropogenic lands. On the Colorado Plateau the species was identified in Shrub-Steppe and Colorado Plateau Wash. In the Mohave Desert *S. halepense* was found in Agricultural Land and Ruderal Vegetation anthropogenic lands. Most commonly, it was encountered in disturbed lands, and individuals were identified in small numbers.

5.5.15.3 Discussion

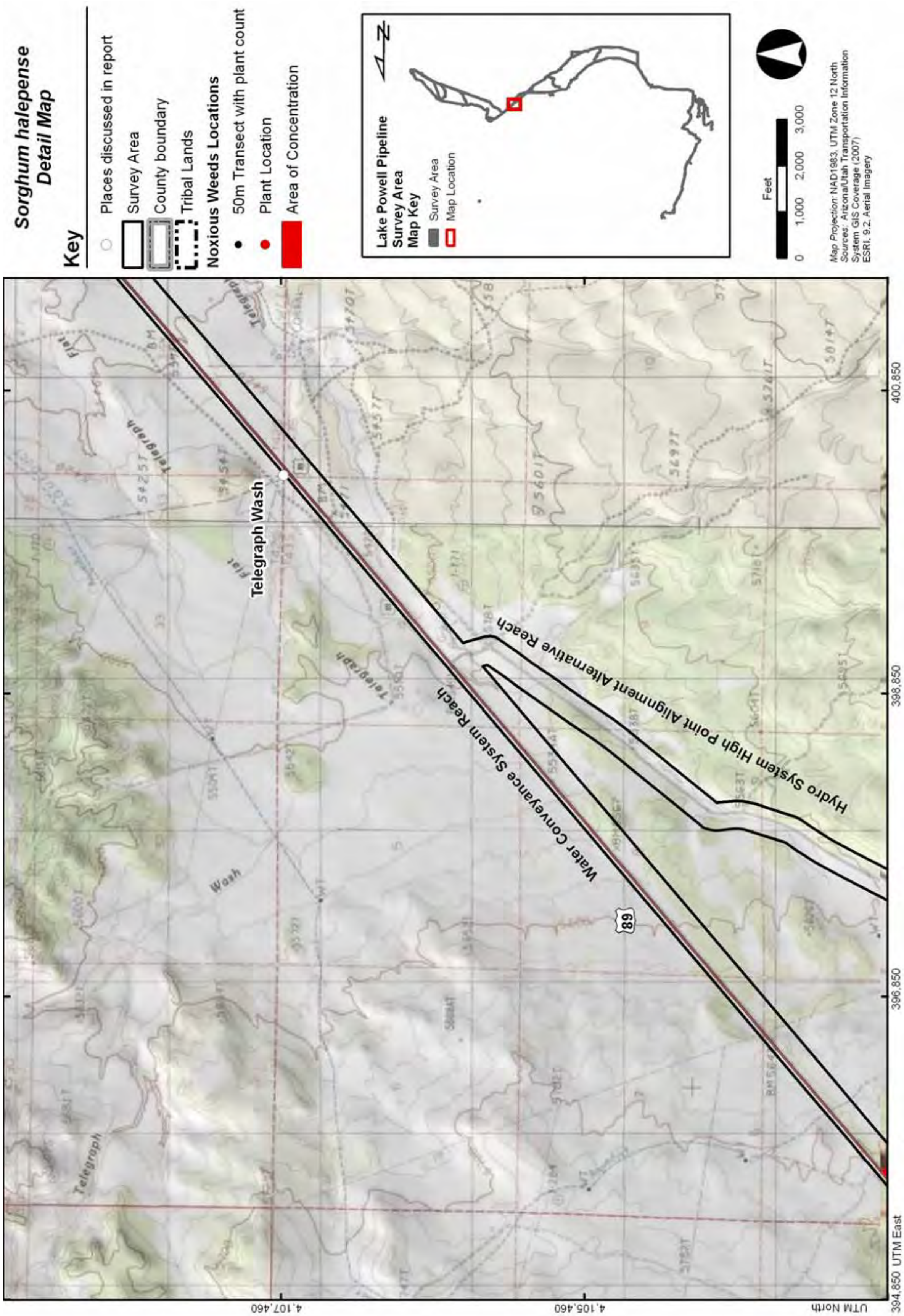
Sorghum halepense occurred very infrequently within the survey area; where it did occur, it was encountered in small, localized quantities. The species prefers moist habitats; therefore, the ability of the project to further the spread of the species is somewhat restricted. However, due to its ability to succeed in cultivated fields, the project has the potential to spread the species into agricultural fields adjacent to the survey area. Due to the severity of problems that the species can cause, particularly to agriculture, it is highly recommended that vehicle tires be washed when departing work areas where individuals have been identified. Furthermore, due to the ability of its long-term seed viability, it is recommended that topsoil from these localized areas not be re-used within the project. Additionally, any individuals or populations could be treated with an herbicide when encountered during project construction.



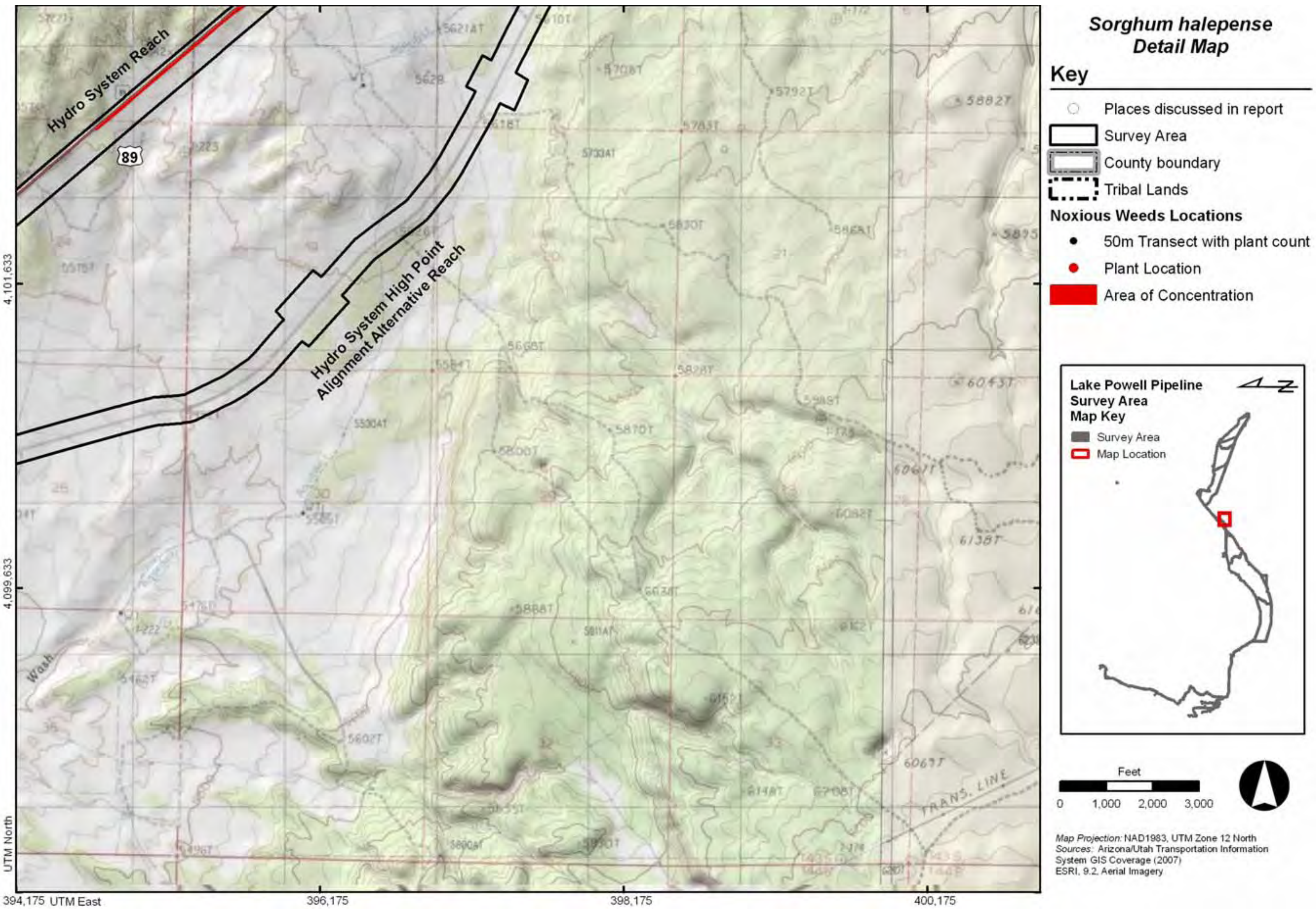
Map 5-135
***Sorghum halepense* Overview Map**



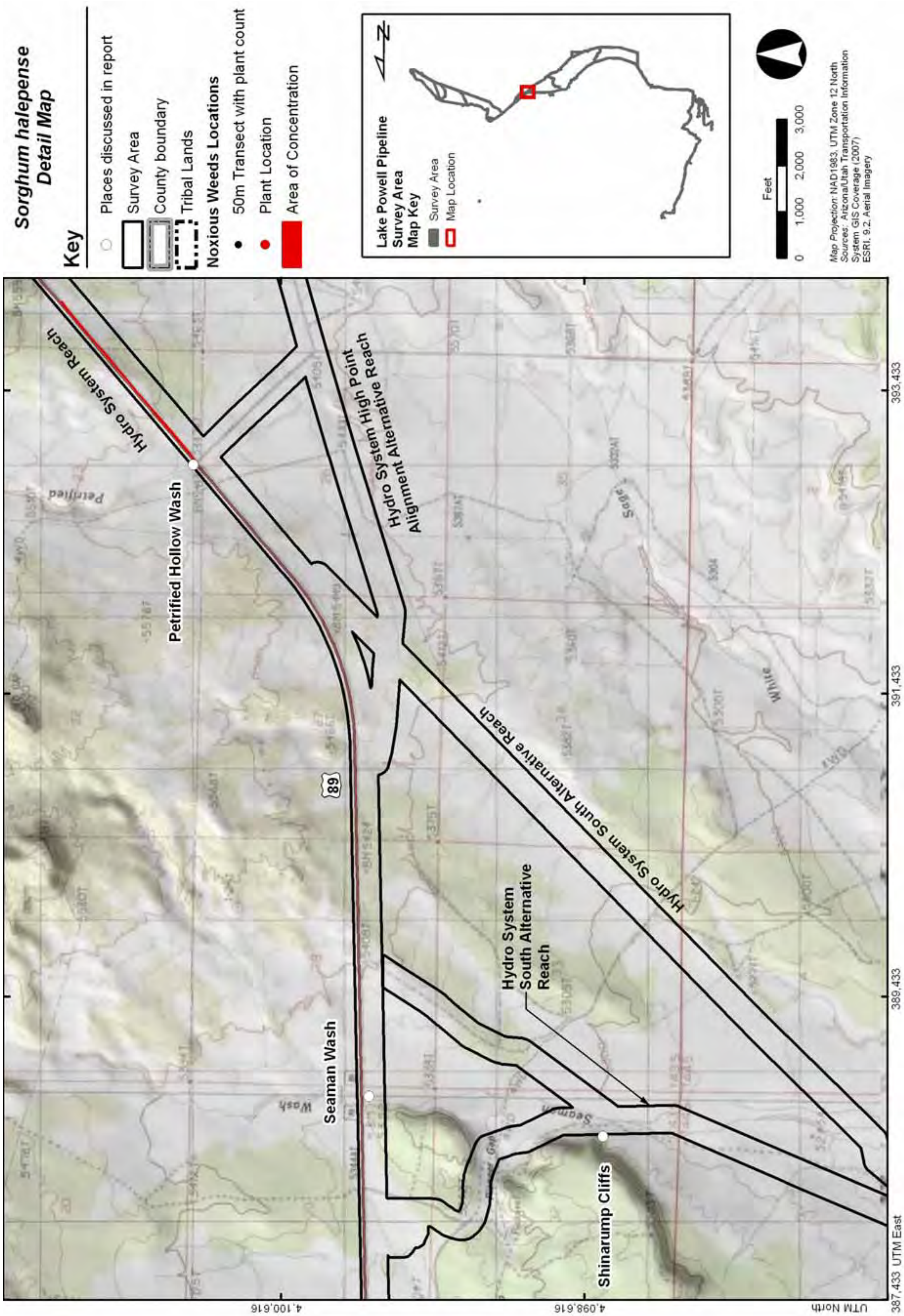
Map 5-136
***Sorghum halepense* Detail Map**



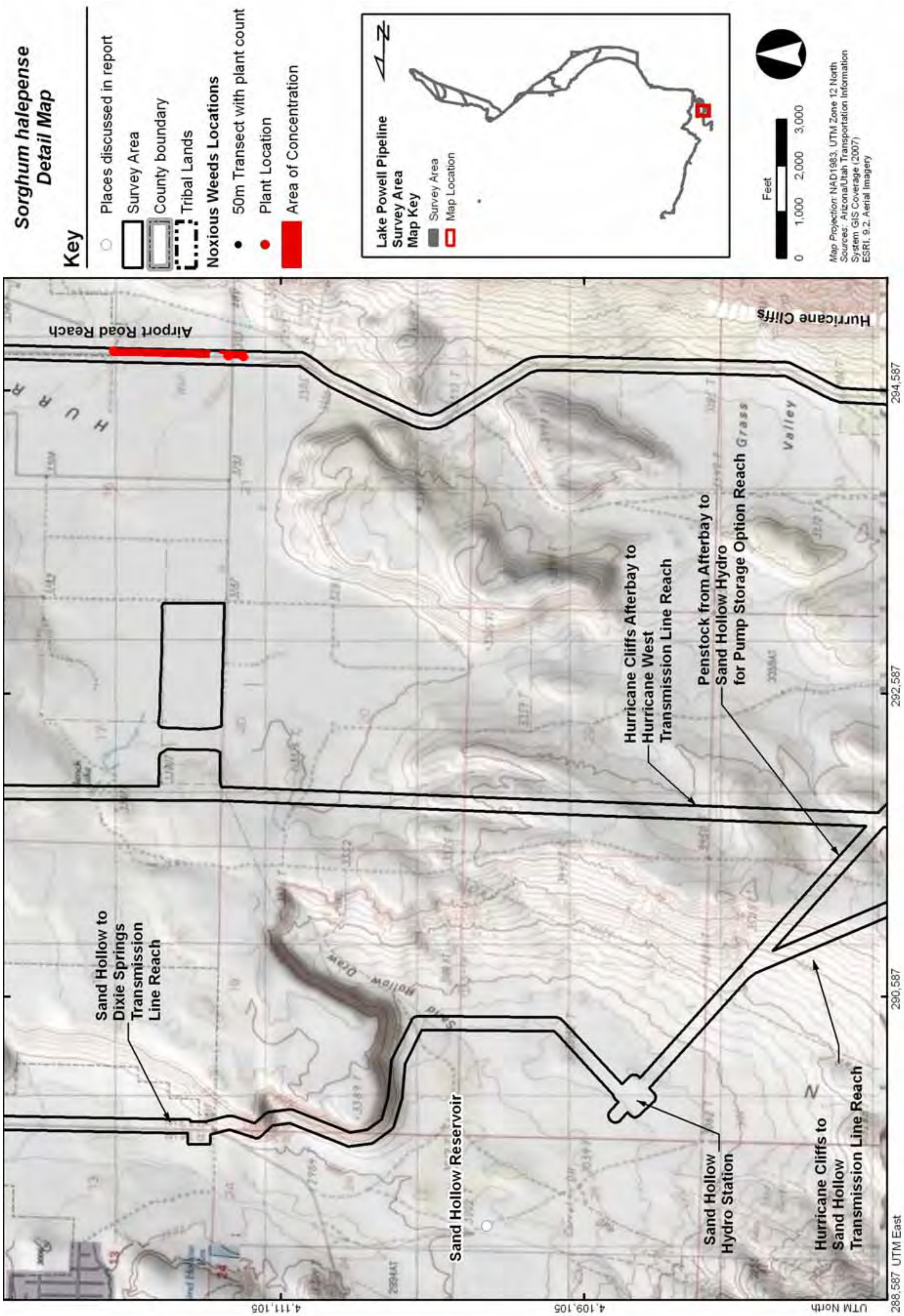
Map 5-137
***Sorghum halepense* Detail Map**



Map 5-138
***Sorghum halepense* Detail Map**



Map 5-139
***Sorghum halepense* Detail Map**



Map 5-140
***Sorghum halepense* Detail Map**

5.5.16 *Tamarix* spp. (Tamarisk)

5.5.16.1 Natural History

Figure 5-23
Close up view of *Tamarix* spp. within the survey area

Tamarix spp. is a deciduous or evergreen perennial shrub or small tree in the Tamaricaceae (Tamarisk family) which grows up to 26 feet (8 meters) tall. The bark is reddish-brown, and trunks are short, with erect to spreading branches, creating a dense canopy of drooping or arched twigs. Leaves are scale-like, alternate, and ovate, 0.06 to 0.14 inch (1.5-3.5 mm) long, and bluish-green in color. Flowers are produced April through August, but in some areas, flowering may occur throughout much of the year. Inflorescences are simple or compound racemes, which contain white or pink flowers with 5 sepals, stamens and petals (Figure 5-23. Fruits are small capsules, less than 0.20 inch (5 mm) long, which open along 3 valves to release many seeds, 0.004 to 0.008 inch (0.1-0.2 mm) long, each, with a tuft of hairs at the apex of the seed (DiTomaso & Healy 2007).

Tamarix species are difficult to differentiate, and in the southwest, individual species (*T. chinensis*, *ramossisima, parviflora*) hybridize, further increasing confusion over identification. *Tamarix chinensis* and *T. ramossisima* have become synonomous, and can be distinguished from *T. parviflora* by their flowers; the flowers of *T. chinensis* and *T. ramossisima* have 5 parts, while those of *T. parviflora* have 4 parts.

Figure 5-24
View of *Tamarix* spp. and its habitat within the survey area

Tamarix species are native to Eurasia, where *T. ramosissima and T. chinensis* have distinct distributions (Zouhar 2003). *Tamarix* spp. was introduced to the United States as an ornamentals and for use in wind breaks, but is now widespread and common throughout the country. *Tamarix* spp. has become naturalized along seeps, streams, canals, and reservoirs throughout much of the west (Whitson et al. 1996). In Arizona, *Tamarix* spp. occurs throughout the state, but primarily in watercourses, banks, and drainages within deserts and desert grasslands between 100 to 5,000 feet in elevation (Figure 5-24), but Tamarix spp. is also common at elevations as high as 6,000 in northern Arizona, around the area of Canyon de Chelly (Parker 2003). In Utah, *Tamarix* spp. is well established in much of the state's riparian habitat, and has been found along streams and at seeps from 2,790 to 5,610 feet in elevation in Emery, Kane, Salt Lake, Utah, Washington, and Wayne counties (Welsh et al. 1993).

Tamarix spp. is highly invasive in riparian systems in the southwest. *Tamarix* spp. communities are frequently associated with past disturbances and/or changes in historic disturbance regimes (Zouhar 2003). In riparian areas, *Tamarix* spp. out-competes native vegetation where salinity is high or water tables are depressed. For over 50 years in the Arizona Strip and Grand Canyon, it has been colonizing the eroded embankments of creeks and rivers after heavy flooding. Paradoxically, heavy flooding (and simulated flooding) will remove colonies of *Tamarix* spp. established during past disturbances, though they rapidly re-colonize by wind-dispersed seed and an extensive root system.

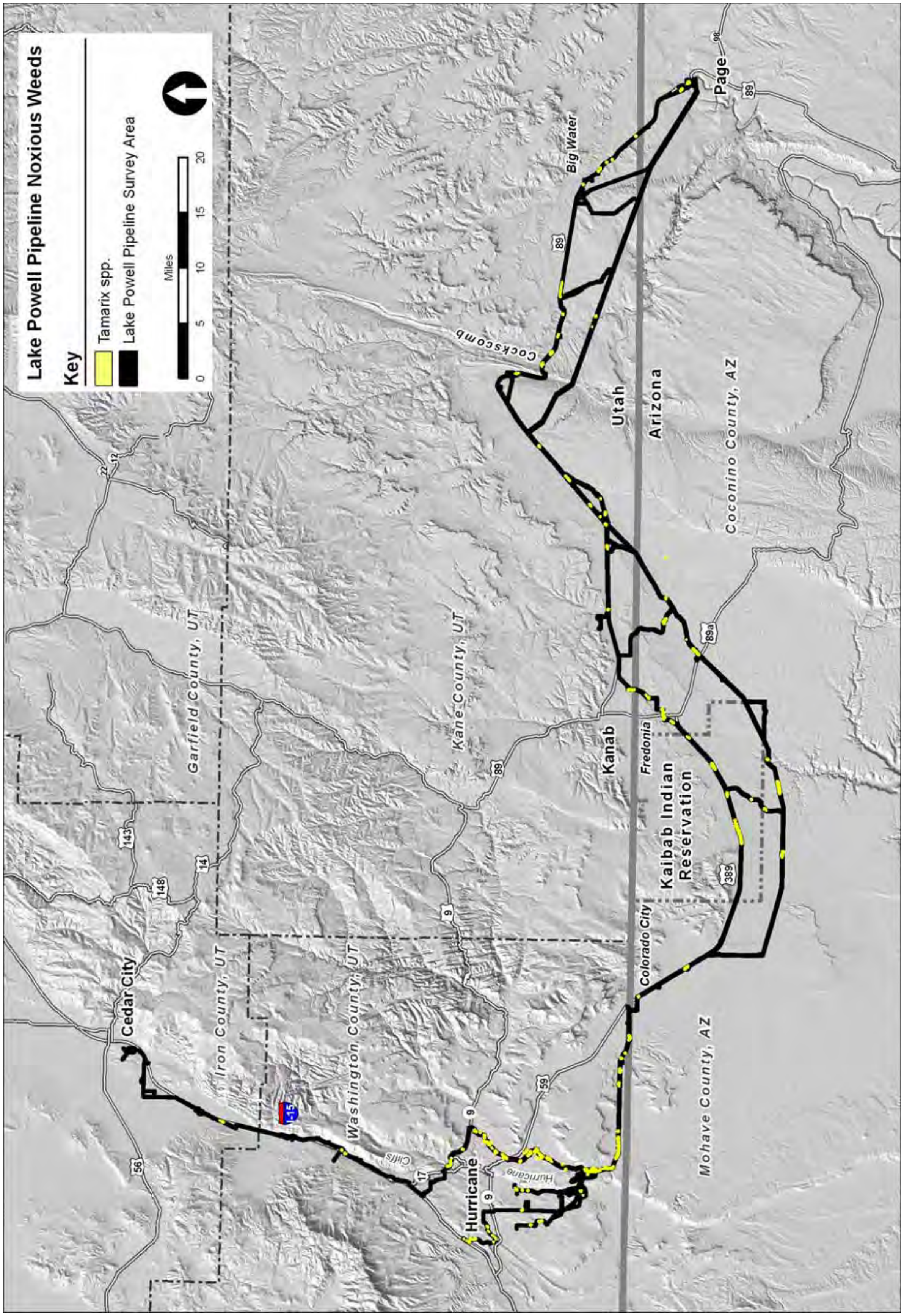
5.5.16.2 Survey Results

Tamarix spp. was abundant throughout much of the survey area, ranging from the Colorado River at Glen Canyon Dam to the vicinity of the I-15 Rest Area (Map 5-141). The species was encountered in a total of 14 reaches. In the Glen Canyon Substation, it occurred near the Colorado River at Glen Canyon Dam. *Tamarix* spp. was sporadic within the Water Conveyance System Reach, most notably occurring near Lower Blue Pool Wash, Big Water, Cottonwood Canyon Road, Buckskin Gulch, and in the vicinity of Telegraph Wash. In the Hydro System Reach, the species occurred at East Cove, at a handful of locations between Upper Paria River and Cockscomb, near Petrified Hollow Wash, sporadically from Yellowstone Road at AZ Route 389 to Short Creek at Canaan Gap, and at several locations near the Honeymoon Trail. It was encountered at a handful of locations within the Hydro System High Point Alignment Alternative Reach, and sporadically in the Hydro System South Alternative Reach, most notably at White Sage Wash, Kanab Creek Canyon, Bitter Seep Wash, and Pipe Valley Wash. *Tamarix* spp. also occurred sporadically within the Hydro System Existing Highway Alternative Reach, from Seaman Wash to Pipe Springs National Monument, and at two locations near the Kaibab Indian Reservation South Boundary in the Mount Trumbull Road Reach. The species was encountered in portions of the eastern half of the Forebay, in a few communities in the Afterbay Reach, and in the Airport Road Reach. *Tamarix* spp. was found in one location northeast of Sand Hollow Reservoir in the Hurricane Cliffs Afterbay to Hurricane Cliffs West Transmission Line Reach, in one location north of Sand Hollow Reservoir in the Sand Hollow to Dixie Springs Transmission Line Reach, and in a number of locations in the Hurricane West to Quail Creek Reservoir Reach, most of which occurred between the Virgin River and Harrisburg. In the Cedar Valley Pipeline System Reach, the species was encountered frequently from the area of Gould Wash to La Verkin Creek, in a few locations near Pintura, and near the I-15 Rest Area. The species was also found in the eastern and southern portions of the Henrieville Substation. *Tamarix* spp. was not detected on any 50-meter belt transects; all encounters occurred while conducting special status species and noxious weed surveys.

Tamarix spp. occurred in all three Ecological Regions, in 16 ecological systems, and five anthropogenic lands. On the Colorado Plateau, individuals were encountered in Active and Stabilized Dune, Big Sagebrush Shrubland, Blackbrush-Mormon-tea Shrubland, Greasewood Flat, Gypsum Badland, Lower Montane Riparian Woodland and Shrubland, Mixed Bedrock Canyon and Tableland, Mixed Desert Scrub, Mixed Low Sagebrush Shrubland , Pinyon-Juniper Woodland, Shrub-Steppe, and Colorado Plateau Wash. In the Great Basin, it was encountered in Lower Montane Riparian Woodland and Shrubland. In the Mohave Desert, it was identified in Blackbrush-Mormon-tea Shrubland, Lower Montane Riparian Woodland and Shrubland, and Mixed Desert Scrub. Anthropogenic lands which supported *Tamarix* spp. included Agricultural Land, Developed Road, Developed Land, Invasive Upland Vegetation, and Ruderal Vegetation. The species was most commonly found in Colorado Plateau Lower Montane Riparian Woodland and Shrubland, to a lesser extent in Mohave Desert Riparian Woodland and Shrubland, but was also encountered in upland habitats, including Mixed Desert Scrub and Pinyon-Juniper Woodland. Occurrences were often in or near drainages, where encounters were with individuals or small clusters of individuals. However, at many locations, *Tamarix* spp. grew very densely, and was commonly dominant or co-dominant within riparian vegetative communities.

5.5.16.3 Discussion

Tamarix spp. occurred frequently within the survey area, most commonly in riparian or dry-riparian systems, but also in upland ecological systems. The species thrives in disturbed areas and the project will likely create new habitats for the species to invade. Due to its aggressive nature and ability to displace native riparian vegetation, it is highly recommended that where mature native riparian tree species, such as *Populus fremontii* and/or *Salix* spp. exist, protection of these trees in place should be accomplished wherever possible. Where this is not possible, it is recommended to densely re-plant these areas with native riparian species. Additionally, these sites could be re-visited periodically following completion of construction in order to chemically treat any *Tamarix* spp. individuals that have emerged.



Map 5-141
***Tamarix* spp. Overview Map**

Figure 5-25
View of *Tribulus terrestris* and its habitat within the survey area

5.5.17 *Tribulus terrestris* (Puncturevine)

5.5.17.1 Natural History

Tribulus terrestris is a mat-forming annual in the Zygophyllaceae (Caltrop family; Figure 5-25). Stems are prostrate spreading to almost erect in dense vegetation reaching 0.5 to 5 feet (0.15 to 1.5 meter) long. Leaves are opposite, hairy and divided into four to eight pairs of leaflets (Figure 5-26). From March through October, yellow, five-petaled flowers, 0.20 to 0.60 inch (5-15 mm) diameter, are borne in the leaf axils. Fruits are woody burs, which are 5-lobed, 0.20 to 0.40 inch (5-10 mm) in diameter, gray to tan, hairy, and separate into 5 nutlets, each with 2 spines 0.16 to 0.28 inch (4-7 mm) long, and are covered in short prickles. Nutlets contain between 3-5 seeds, which remain on the senesced plants until they adhere to and are dispersed by animals, humans, or vehicle tires. Individuals produce hundreds of burs throughout the warm season (DiTomaso & Healy 2007).

The growth form, flower and fruit of *Tribulus terrestris* are unique enough that the species is not easily confused with any other.

Tribulus terrestris was introduced from southern Europe and is now widespread in the United States (Whitson et al. 1996). The species grows in gardens, along roads, and in waste places (The Sonoran Institute 2008). In Utah, *T. terrestris* is found from 2,788 to 7,005 feet in elevation (Welsh et al. 2008). In Arizona, *T. terrestris* occurs throughout the state at elevations less than 7,000 feet (Kearney and Peebles, 1969).

Tribulus terrestris may be injurious to livestock, and seeds can remain dormant in the soil for four to five years, making eradication difficult (Whitson et al. 1996). The species can develop into dense populations with stems up to 12 inches (30 cm) deep. Burs can injure people and animals, and even puncture tires. Additionally, *T. terrestris* contains saponin compounds that render it toxic to livestock, if ingested in large quantities (DiTomaso & Healy 2007).

Figure 5-26
Close up view of *Tribulus terrestris* within the survey area

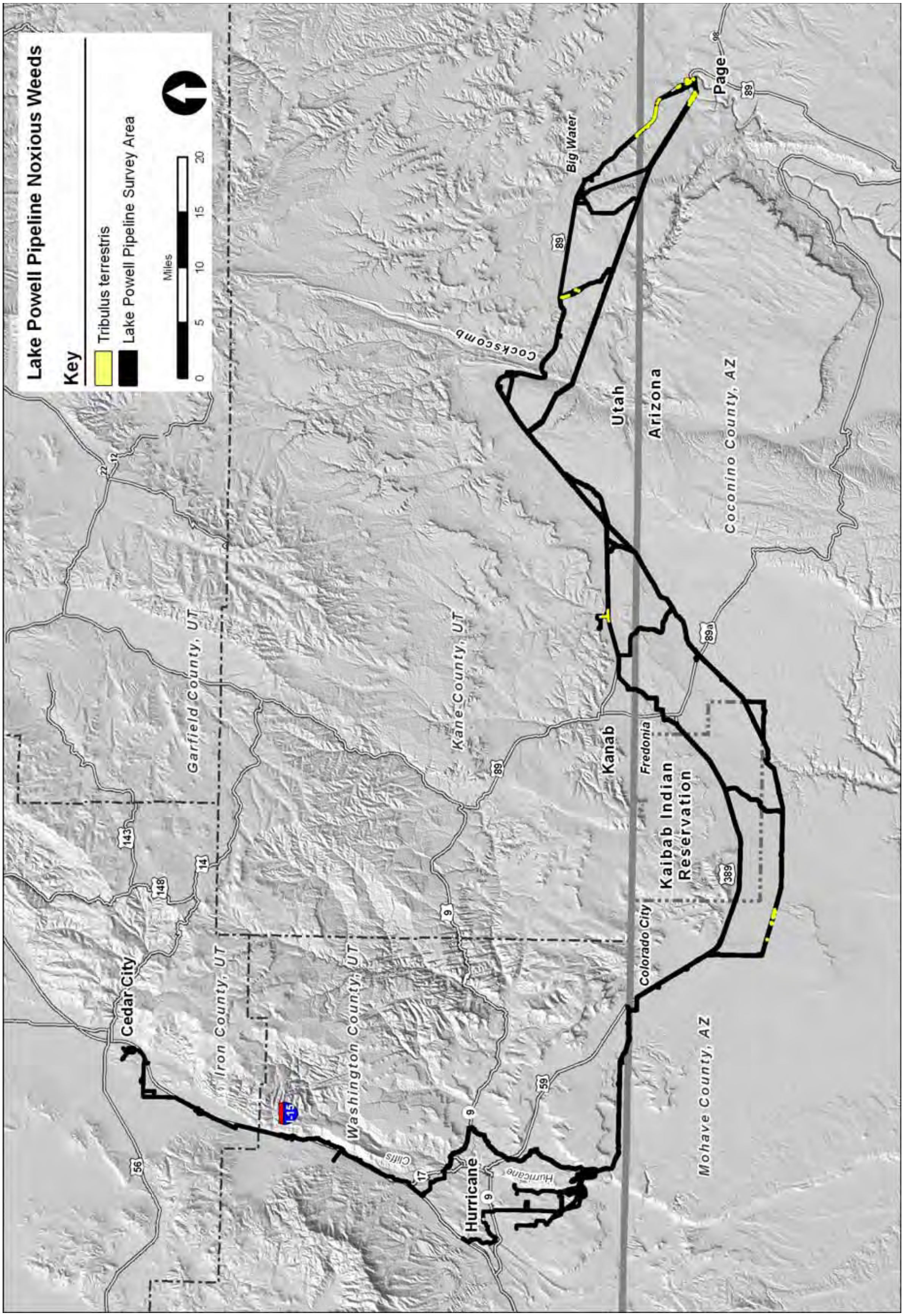
5.5.17.2 Survey Results

Tribulus terrestris was encountered infrequently within the survey area, occurring sporadically between the Colorado River at Glen Canyon Dam and the Virgin River (Map 5-142). The species was encountered in nine reaches (Map 5-143to Map 5-151). It was found at the Glen Canyon Substation, in the southeastern-most extent of the Glen Canyon to Buckskin Transmission Line Reach, and in the BPS-2 Transmission Line Alternative Reach. In the Water Conveyance System Reach, *T. terrestris* was encountered frequently near the Colorado River at Glen Canyon Dam and in several locations in the vicinity of Greenhaven. In the BPS-3 Transmission Line South Reach, the species was found south of Cottonwood Canyon Road. It was found in the Hydro System Existing Highway Alternative Reach in the vicinity of Johnson Canyon, and in the Kane County Pipeline System Reach. In the Hydro System South Alternative Reach, *T. terrestris* was encountered in the area of Moonshine Ridge. The species was also encountered at one location northwest of the Hurricane Airport (east of Virgin River) in the Hurricane West Substation. *Tribulus terrestris* was mostly encountered while conducting special status species and noxious weed surveys; however, the species was also detected in two 50-meter belt transects (Transects # 127 and 221).

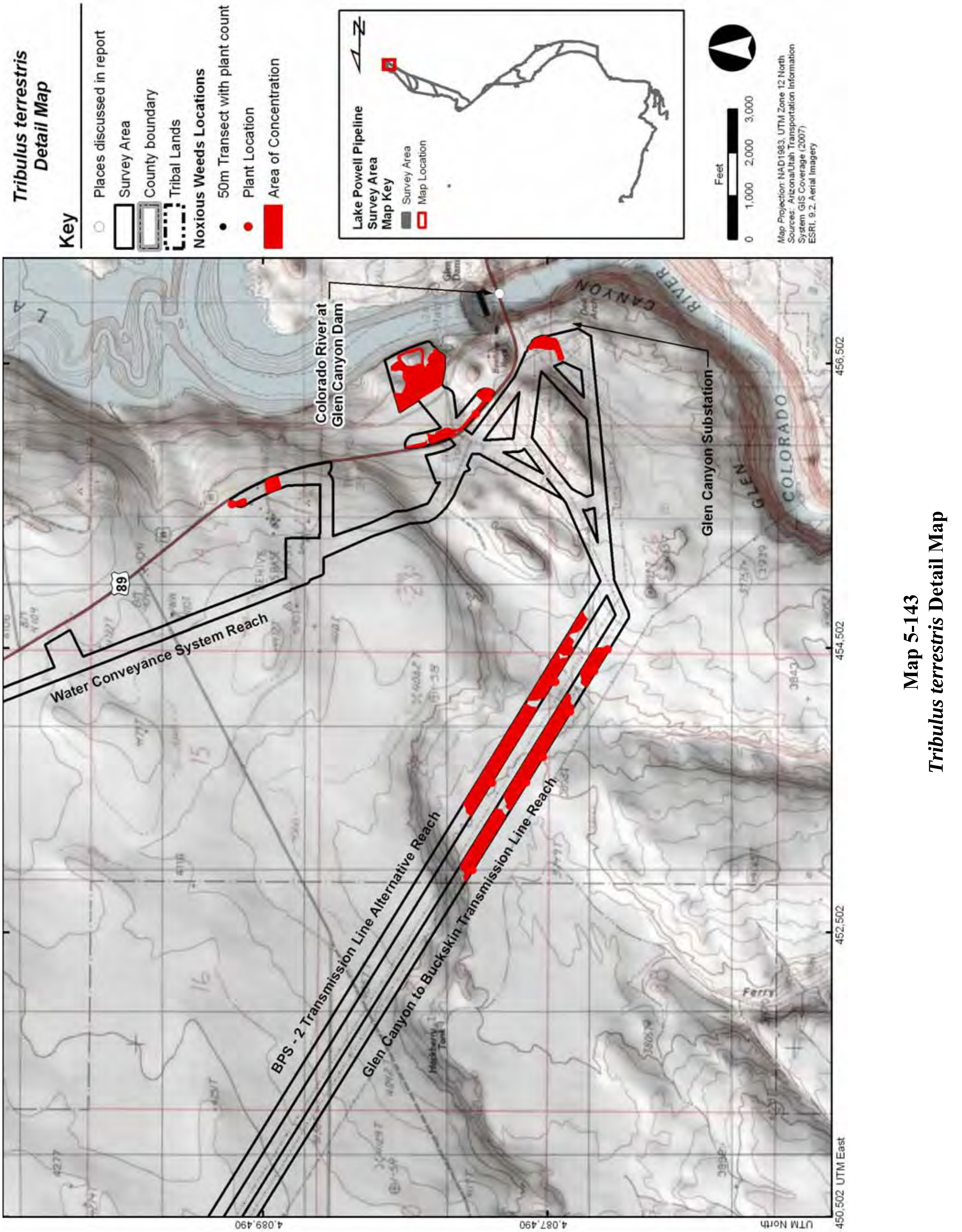
Tribulus terrestris was found in the Colorado Plateau Ecological Region, in eight ecological systems, and three anthropogenic lands. On the Colorado Plateau it was encountered in Active and Stabilized Dune, Blackbrush-Mormon-tea Shrubland, Grassland, Mixed Bedrock Canyon and Tableland, Mixed Desert Scrub, Pinyon-Juniper Woodland, Shrub-Steppe, and Colorado Plateau Wash. Anthropogenic lands which supported *T. terrestris* included Developed Road, Developed Land, and Ruderal Vegetation. The species occurred most frequently on the Colorado Plateau, in Active and Stabilized Dune and Blackbrush-Mormon-tea Shrubland, and in communities dominated or co-dominated by *Artemisia filifolia*, *Coleogyne ramosissima*, *Ephedra nevadensis*, or *Psorothamnus juncea*, and was commonly found along roadsides. *Tribulus terrestris* was encountered in both small quantities and large populations, but was never considered a dominant component of the ecological system.

5.5.17.3 Discussion

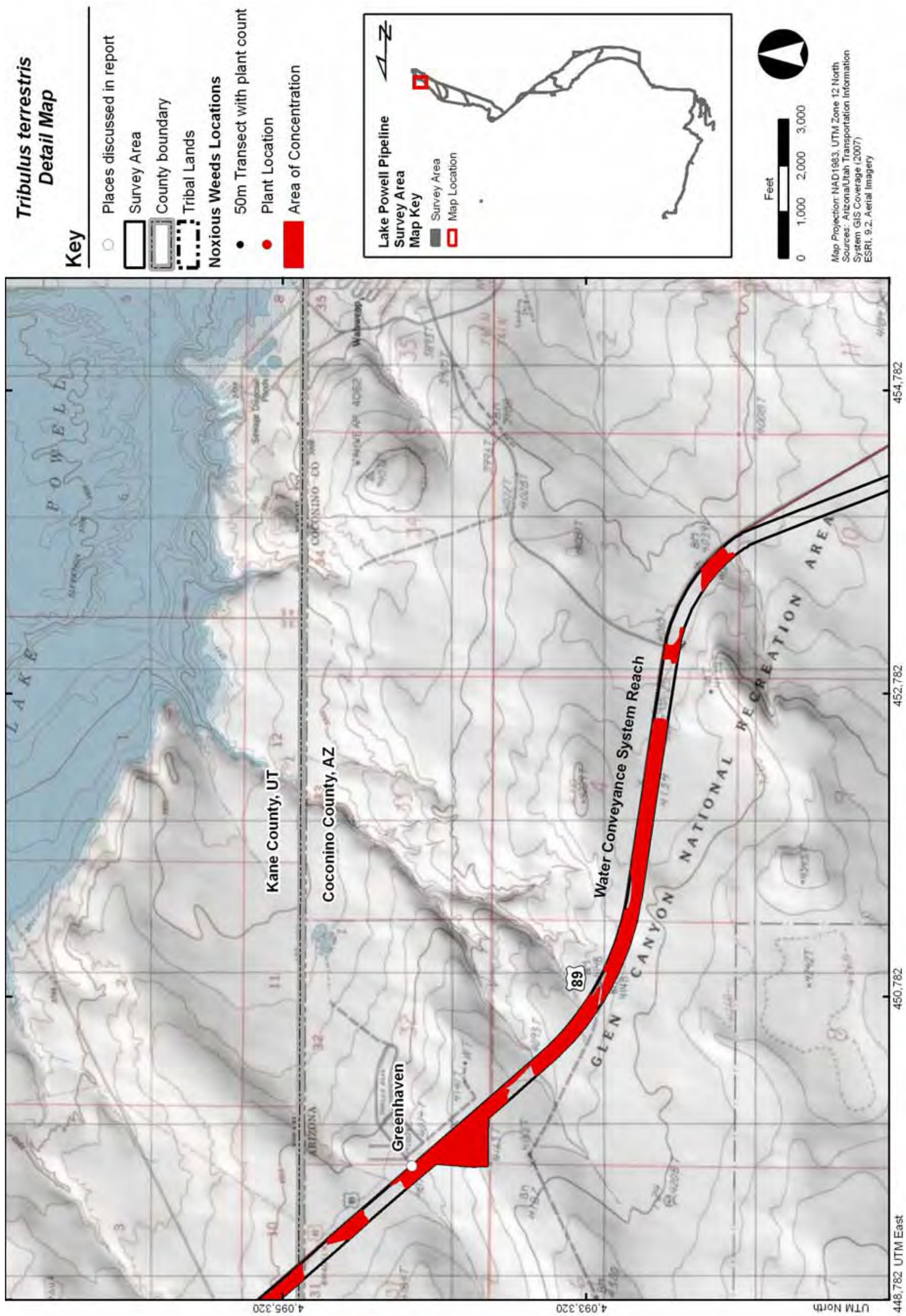
Tribulus terrestris occurred occasionally within the survey area, in a relatively small number of ecological systems. *Tribulus terrestris* easily invades disturbed areas; therefore, the project will undoubtedly contribute to the spread of the species within and adjacent to the survey area. Due to the ability of the seed heads to readily attach to vehicle tires and human clothing and shoes, it is highly recommended that vehicle tires be washed when departing infested areas, and that care be taken to check clothing for its obvious fruit.



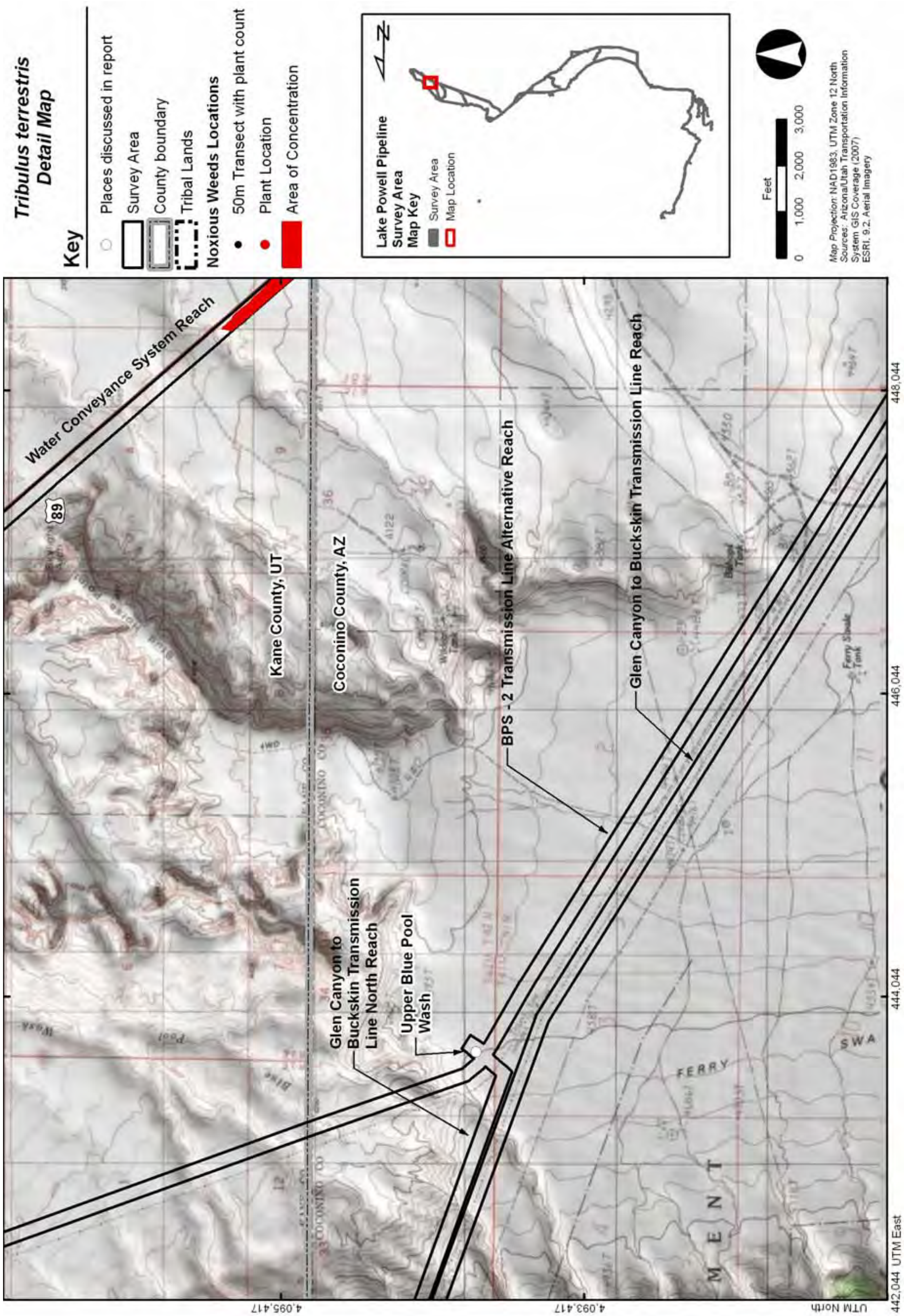
Map 5-142
***Tribulus terrestris* Overview Map**



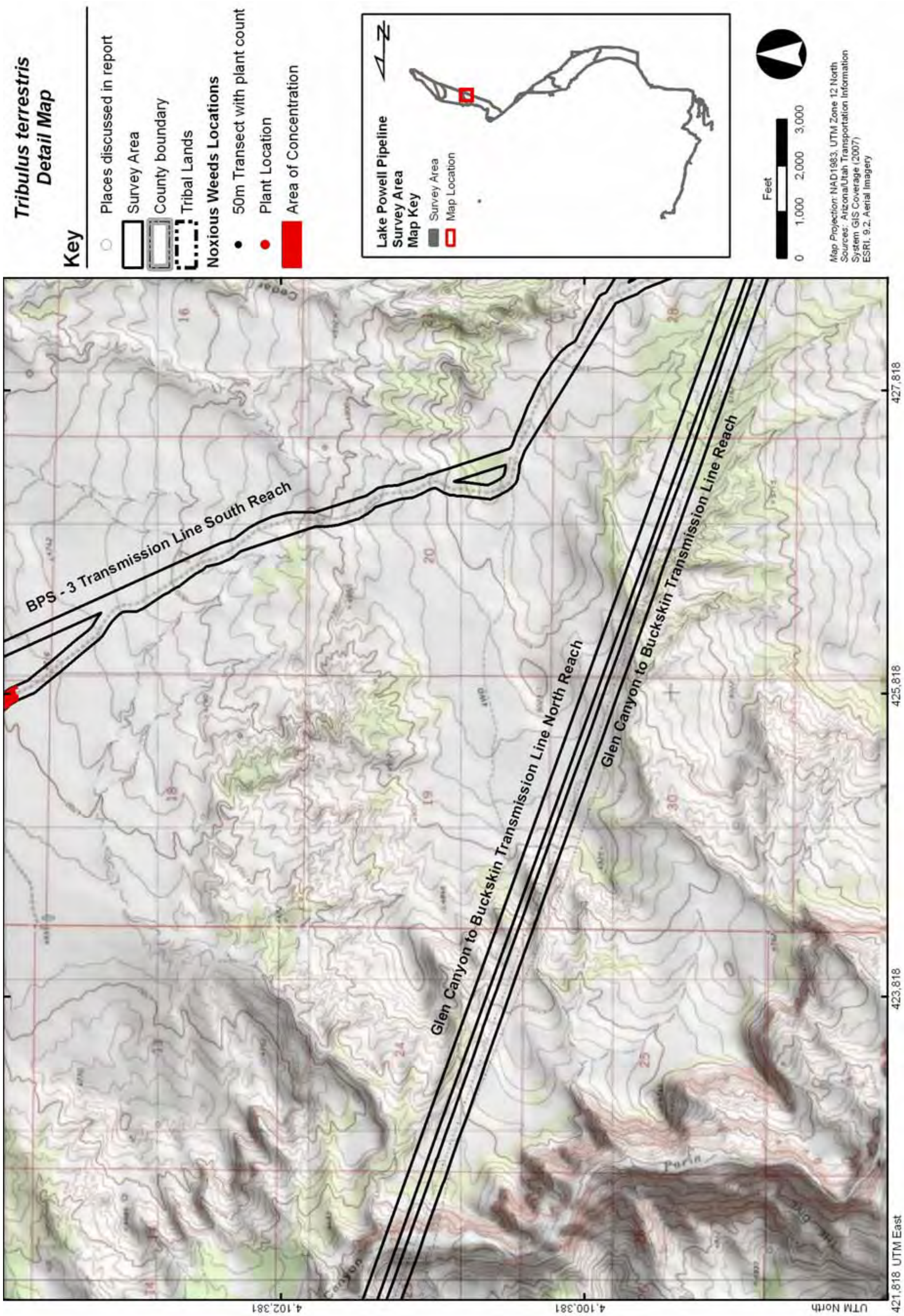
Map 5-143
***Tribulus terrestris* Detail Map**



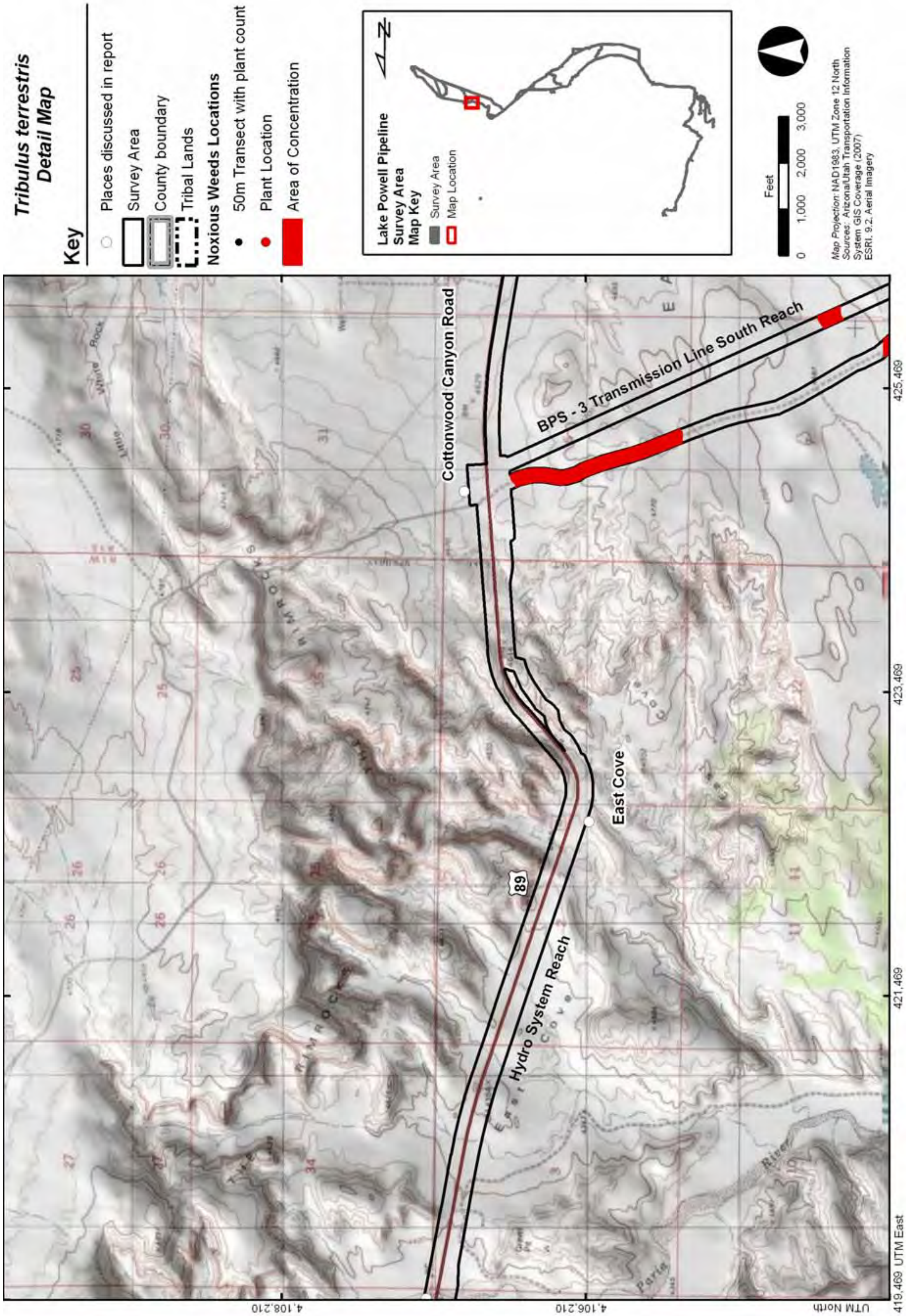
Map 5-144
***Tribulus terrestris* Detail Map**



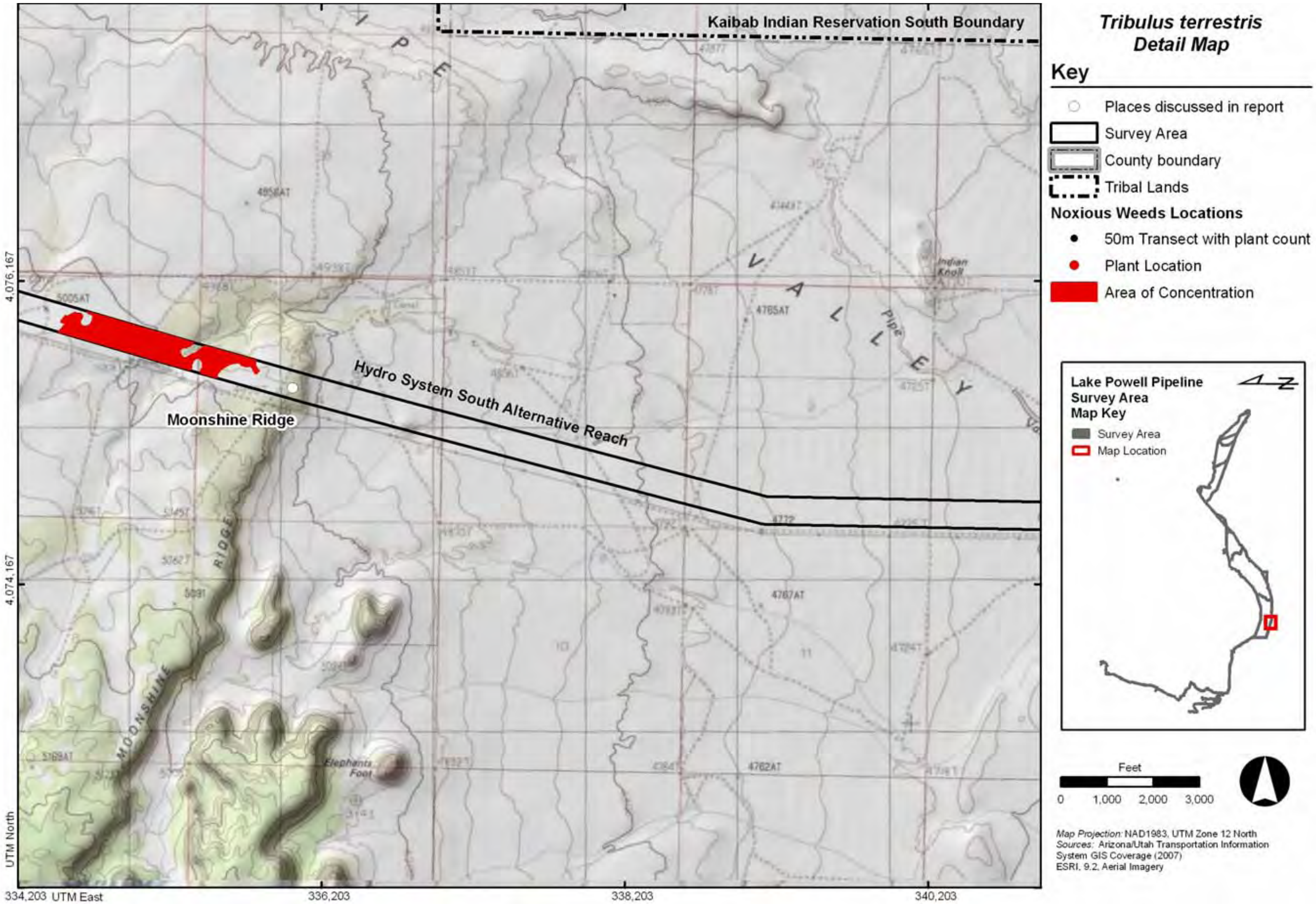
Map 5-145
***Tribulus terrestris* Detail Map**



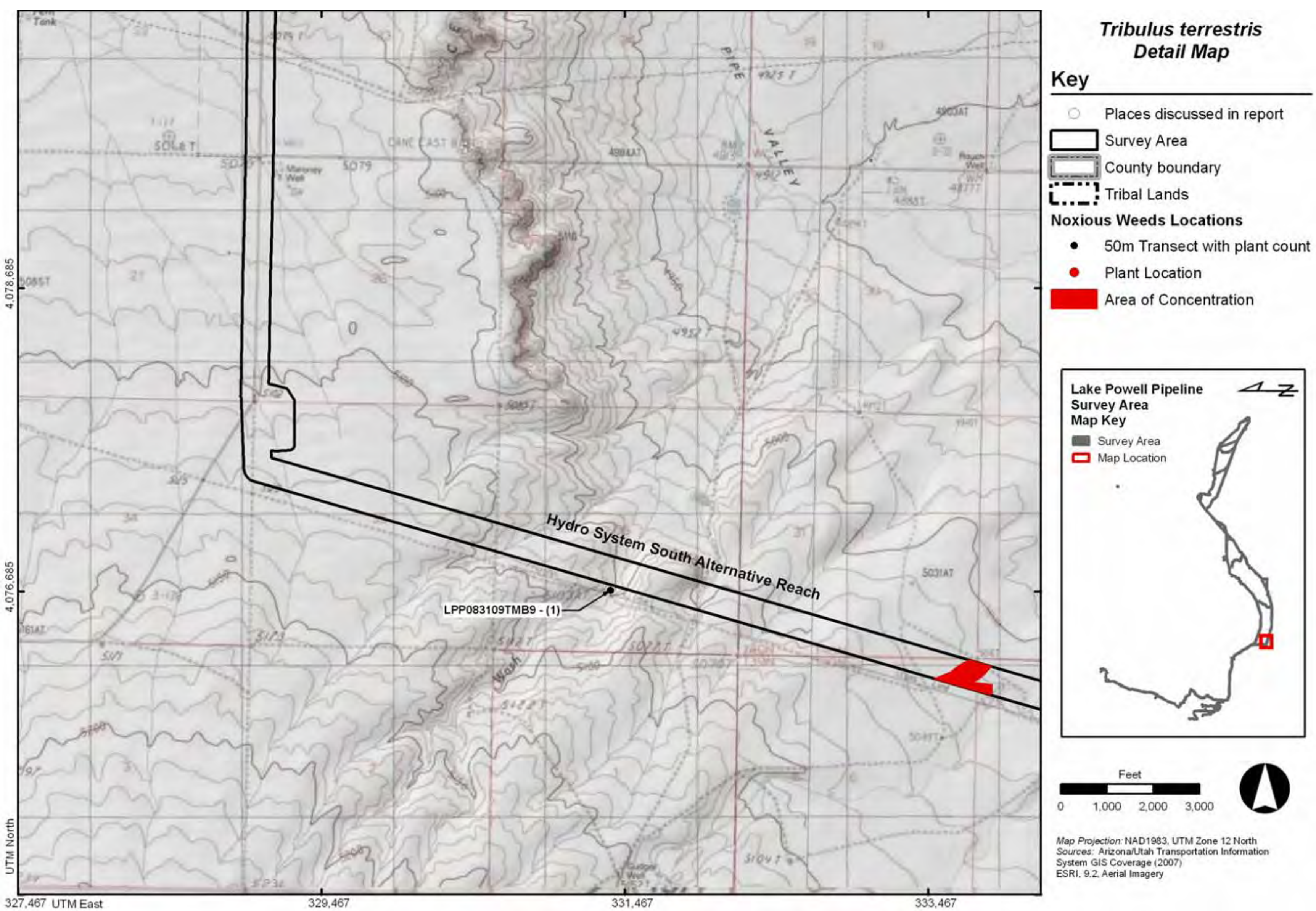
Map 5-146
***Tribulus terrestris* Detail Map**



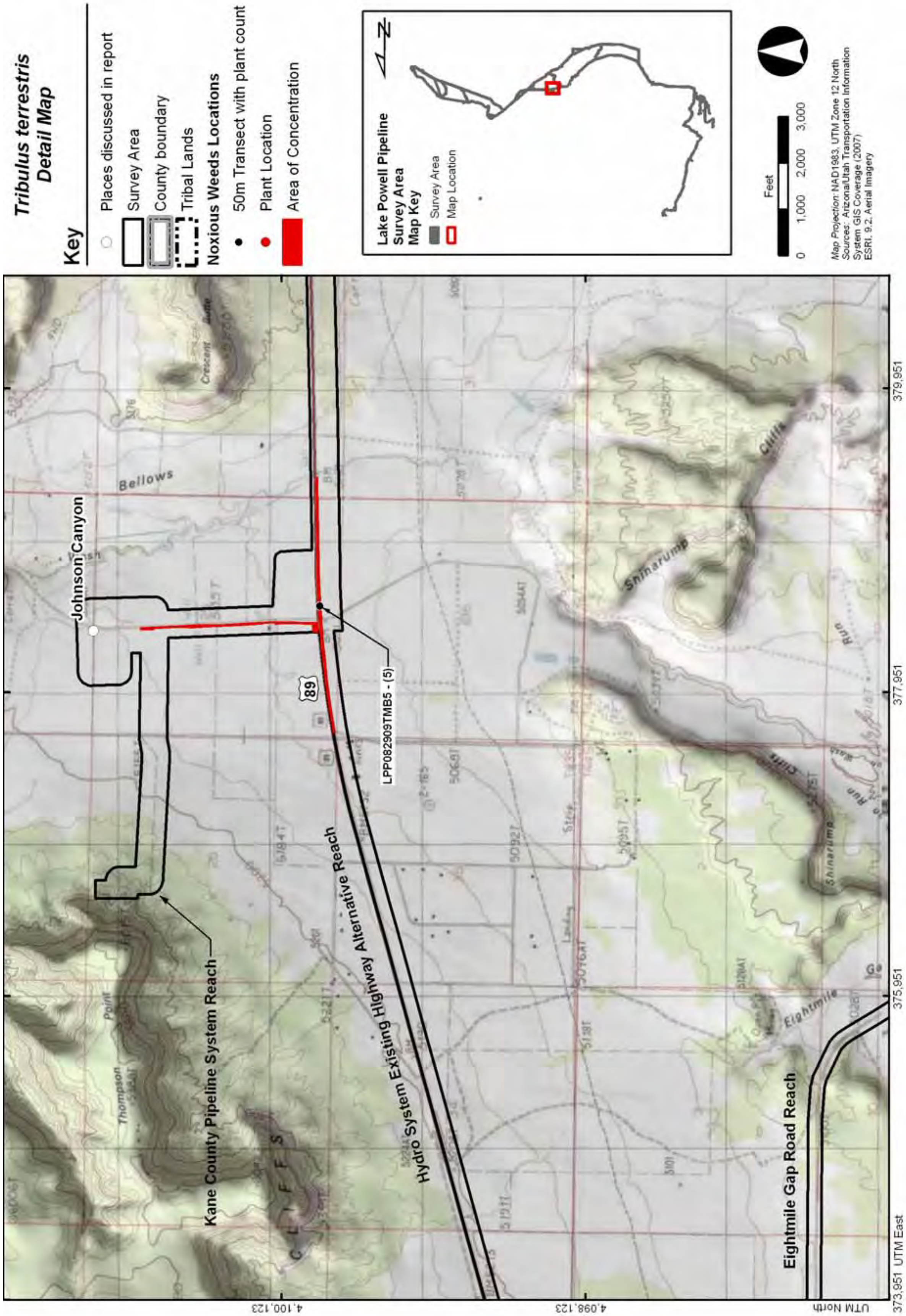
Map 5-147
***Tribulus terrestris* Detail Map**



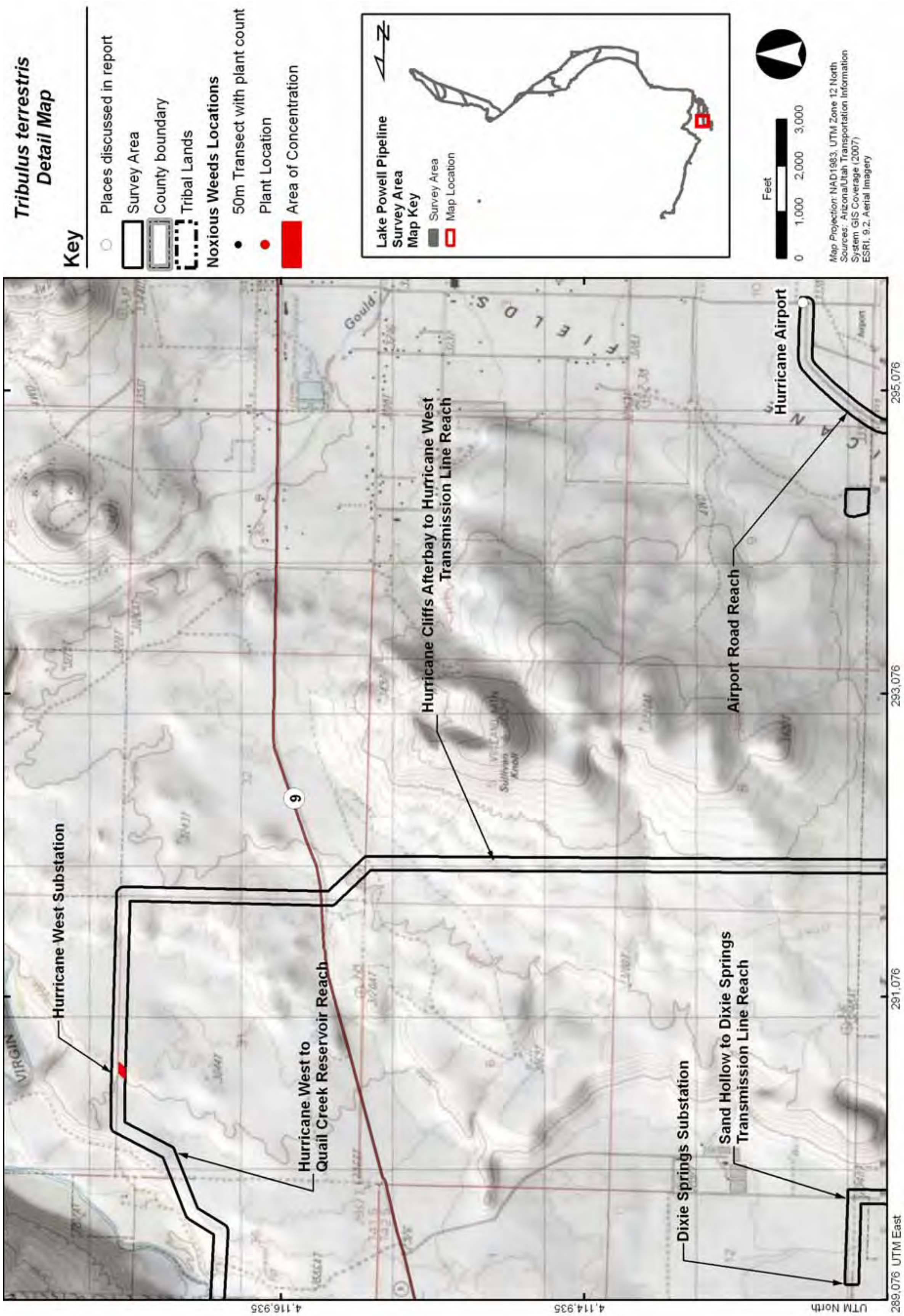
Map 5-148
***Tribulus terrestris* Detail Map**



Map 5-149
***Tribulus terrestris* Detail Map**



Map 5-150
***Tribulus terrestris* Detail Map**



Map 5-151
***Tribulus terrestris* Detail Map**

5.5.18 *Ulmus pumila* (Siberian elm)

5.5.18.1 Natural History

Figure 5-27
Close up view of *Ulmus pumila* within the survey area

Ulmus pumila is a deciduous fast-growing tree in the Ulmaceae (Elm family), which reaches a height of 50 to 70 feet (15 to 21 meters). The bark is fissured finely, gray or brown, and rough, with slender branchlets which support two rows of leaves. Leaves are 1 to 3 inches (2.5-7.5 cm) long, narrowly elliptic to lanceolate, smooth and dark green on the top surface, and glabrous on the bottom surface (Figure 5-27). In the spring, small, petal-less greenish flowers are produced, each with 8 stamens, and are borne in clusters. Fruits are samaras, 0.40 to 1.30 inch (10-33 mm) long and nearly as wide, obovate to rotund, and glabrous, and each contains multiple seeds (Welsh et al. 2008). Seeds are wind-disseminated (NDDA 2003).

Ulmus pumila was introduced from Asia and has been widely cultivated throughout the United States as a shade tree and as a windbreak. *Ulmus pumila* is now part of the established flora of Utah, growing in most, if not all counties, from 2,788 to 7,612 feet in elevation along streams and around lakes (Welsh et al. 2008). In Arizona, *U. pumila* invades grasslands, riparian areas, woodlands, and forests, where dry to mesic prairies and stream banks are vulnerable (The Sonoran Institute 2008). *Ulmus pumila* grows commonly in moist soils and along streams, but it is also able to invade dry, sandy habitats (NDDA 2003).

Ulmus pumila may appear similar to *U. americana*, but can be distinguished by its leaf. While *U. pumila* has leaves 0.5 to 2.5 inches (1.27 to 6.35 cm) in length, with entire or single-toothed margins, those of *U. americana* are over 2.75 inches (7.0 cm) long, and have double-toothed margins (NDDA 2003).

Ulmus pumila is highly competitive with native vegetation, as the species produces a multitude of seeds that easily germinate and become established (Welsh et al. 1993). *Ulmus pumila* is able to establish in a variety of habitats in both mesic and dry areas, particularly in well-drained soils, and can tolerate a range of climactic conditions, including drought, cold, and wind. The species is able to easily establish in grasslands, pastures, and along roadsides (NDDA 2003).

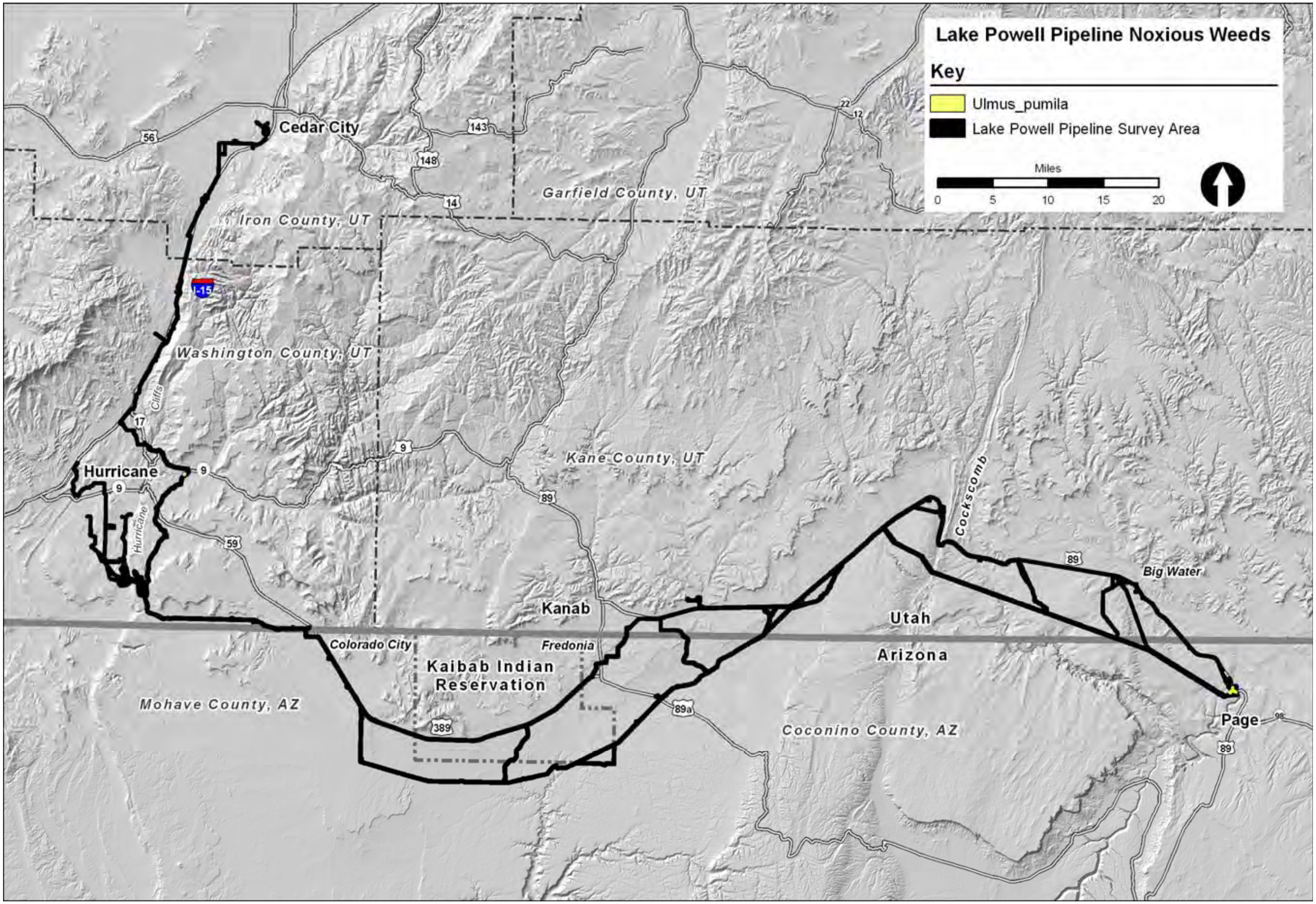
5.5.18.2 Survey Results

Ulmus pumila occurred rarely within the survey area (Map 5-152), within only two reaches (Map 5-153and Map 5-154). Individuals were found at the Colorado River at Glen Canyon Dam in the Glen Canyon Substation. In the Cedar Valley Pipeline System Reach it was encountered near Sheep Bridge Road at Highway 9. *Ulmus pulmila* was not detected on any 50-meter belt transects; all encounters occurred while conducting special status species and noxious weed surveys.

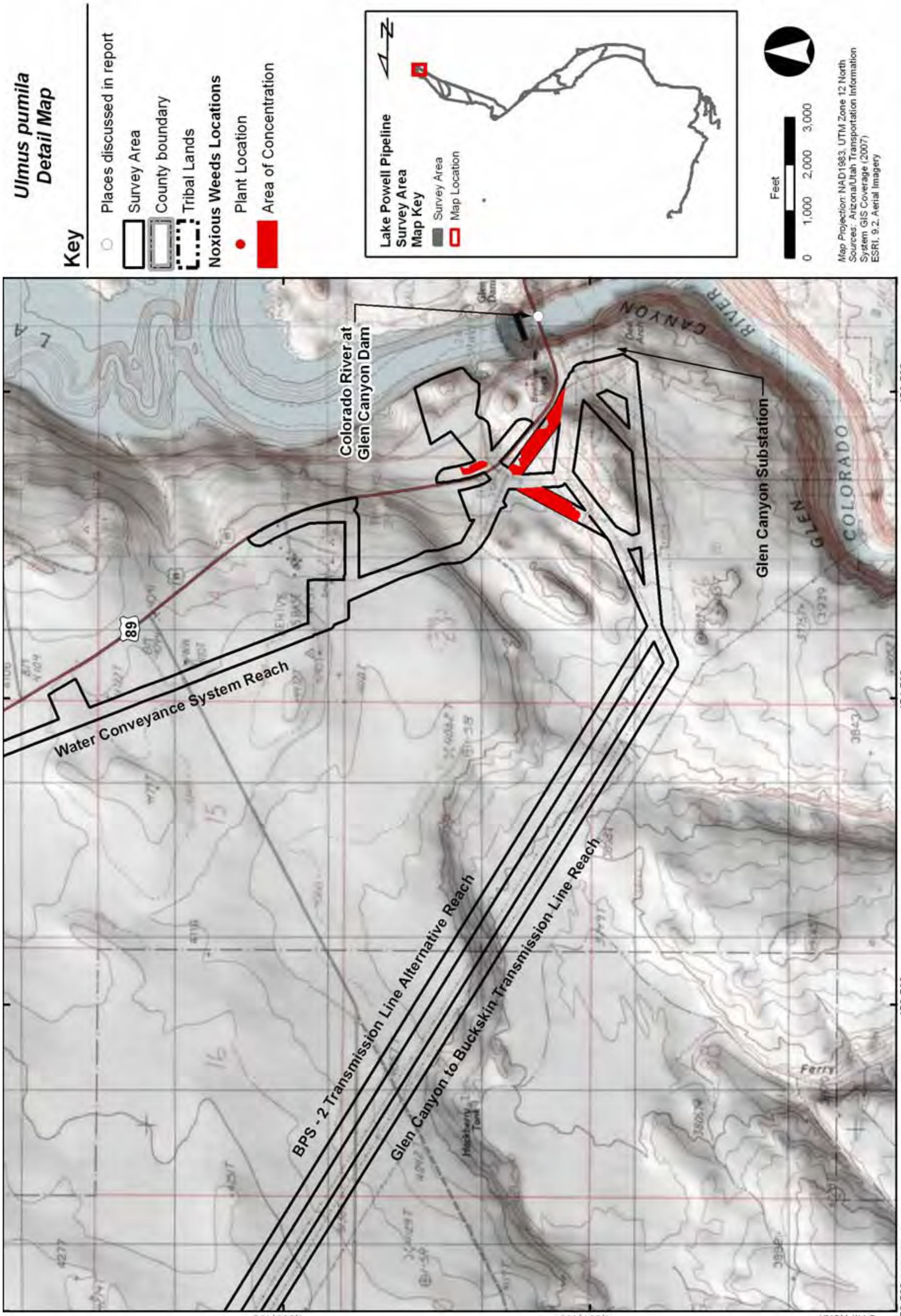
Ulmus pumila was only encountered in the Colorado Plateau Ecological Region, where it inhabited the Active and Stabilized Dune, Mixed Bedrock Canyon and Tableland, and Shrub-Steppe ecological systems. The species was also encountered in Agricultural Land and Invasive Upland Vegetation. Occurrences of the species were within communities dominated by native shrubs, including *Artemisia filifolia*, *Coleogyne ramosissima, Ephedra nevadensis*, *Eriogonum corymbosum* var. *nilesii*, and *Rhus trilobata* var. *simplicifolia*. The species was not encountered in any habitats classified as anthropogenic lands.

5.5.18.3 Discussion

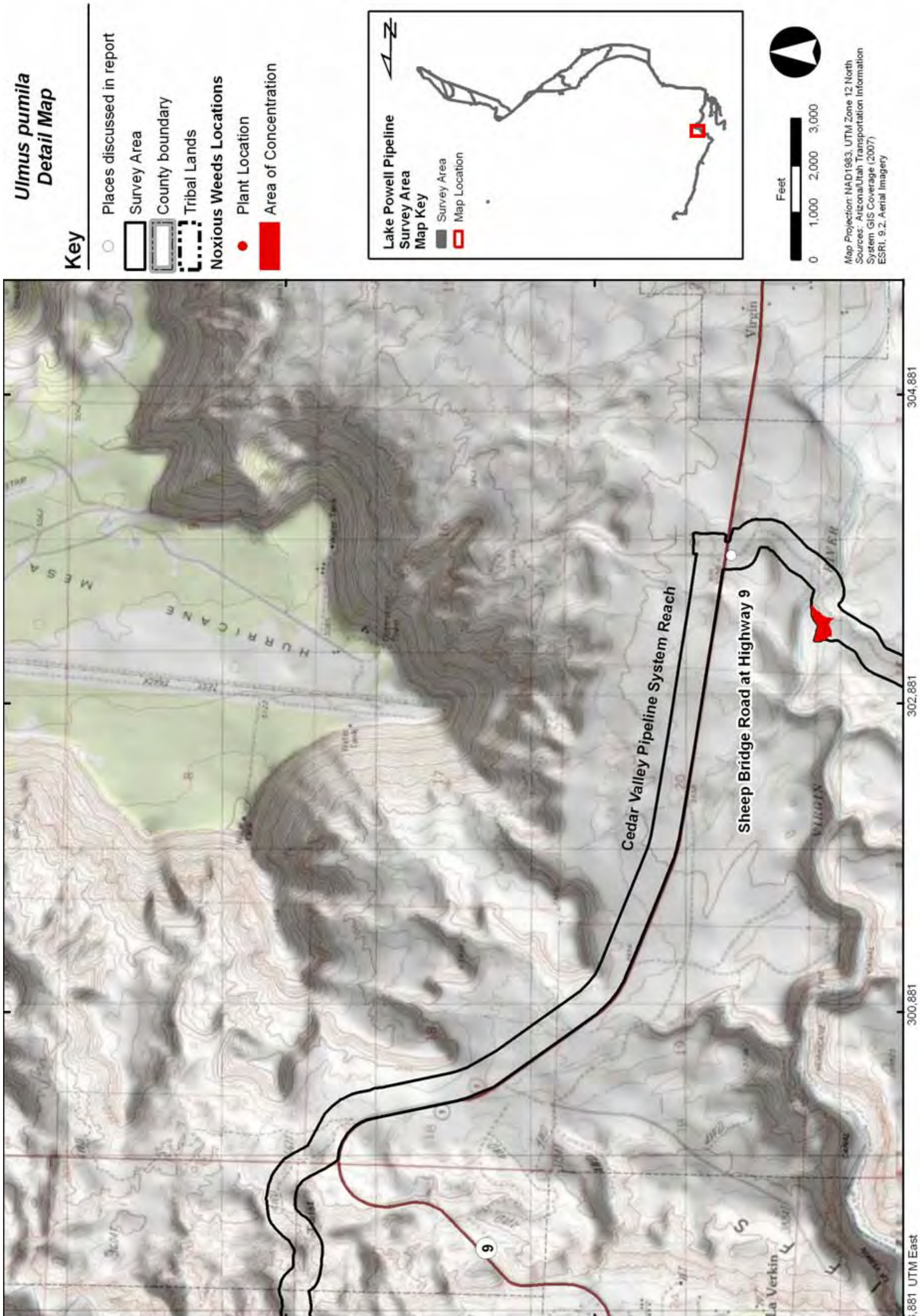
Ulmus pumila occurred very rarely within the survey area; however, its adaptability to a range of habitats, as well as its efficiency in seed dispersal render it important to control. The disturbance associated with the project is likely to enhance the spread of the species. Given the localized nature of its occurrence within the survey area, individuals could be destroyed when project work occurs in proximity of the species.



Map 5-152
***Ulmus pulmila* Overview Map**



Map 5-153
***Ulmus pulmila* Detail Map**



Map 5-154
***Ulmus pumila* Detail Map**

Chapter 6
Best Management Practices and Effects Analysis

6.1 Introduction to Best Management Practices

Best management practices (BMPs) institute the most effective and practical methods which minimize or eliminate construction impacts on naturally occurring landscapes. The implementation of BMPs during project design and construction, in combination with the education of project personnel and monitoring and enforcement of strategies, would serve to minimize project related impacts. The development of specific conservation strategies and protective measures, which strive to reduce impacts on focal species, may be developed when a construction footprint is identified.

BMPs would help minimize Lake Powell Pipeline project construction disturbances on the natural landscape, reduce impacts on known rare plants and sensitive habitats, aid in the prevention of noxious weed dispersal, and provide for the restoration of disturbed natural communities. Because of the complexity of the project area (number of species, sensitive habitats, potential for spread of invasive species) and the variety of construction activities (pipeline, transmission lines, pump stations, fore and after bays), conflicts would occur in attempting to implement all BMPs for every location potentially affected by a particular project-related activity. General BMPs are recommended for overall construction activities, the restoration/rehabilitation of disturbed areas, riparian, wetland and aquatic habitats, and invasive species control.

6.1.1 *General BMPs*

The following are general BMPs that may be considered for implementation for overall project related impacts:

BMP-G1: Employ a Resource Advisor to design (or develop) and recommend the implementation of specific conservation strategies and protective measures (endorsed by the land management agencies and USFWS) which will provide the greatest biodiversity protection. A designated resource advisor can also coordinate natural resource conflicts and concerns.

BMP-G2: On-site project personnel should be educated about federal and state listed and sensitive species and the importance of minimizing impacts to individuals and habitats. All project personnel should be informed of the BMPs, protective measures, and conservation strategies.

BMP-G3: All applicable BMPs, protective measures, and conservation strategies should be applied to all un-surveyed suitable habitats for sensitive species and habitats until surveys have been conducted to clear the project areas or prescribe appropriate and specific BMPs, protective measures, and conservation strategies.

BMP-G4: Crew camps, equipment staging areas, and fueling areas could be located outside of sensitive habitats, preferably in previously disturbed areas outside of areas with known noxious and invasive species occurrences.

BMP-G5: Use of motorized vehicles during construction should be limited to the construction (cleared) corridor or temporary site access routes. Temporary site access routes should be surveyed for presence of sensitive species and habitats and presence of invasive species. Appropriate BMPs should be implemented on temporary site access routes.

BMP-G6: When temporary access routes are required, construct on ridge tops, stable upper slopes, or wide valley terraces, if feasible. Stabilize soils on-site. Avoid slopes steeper than 70 percent. All temporary access routes should be rehabilitated to pre-disturbance conditions when use is no longer needed.

BMP-G7: Avoid soil-disturbing actions during periods of heavy rain or wet soils. Apply travel restrictions to protect soil and water. Install cross drains to disperse runoff into filter strips and minimize connected disturbed areas. Make cuts, fills, and road surfaces strongly resistant to erosion between each stream crossing and at least the nearest cross drain.

BMP-G8: Apply protective measures to all areas of disturbed, erosion-prone ground that is not to be further disturbed. These areas could be especially protected during snow melt or summer monsoon season to minimize erosion and sedimentation. This may include covering exposed ground with mulching, jute mats or containing with soil erosion fencing.

BMP-G9: Construct roads and other disturbed sites to minimize sediment discharge into streams, lakes, and wetlands.

BMP-G10: Equipment or vehicles should not be washed in streams or wetlands, as doing so increases sediment loads.

BMP-G11: Ensure that no servicing or refueling of equipment occurs within or immediately adjacent to wellheads, streams, reservoirs, or associated wetlands.

BMP-G12: Pipeline construction should attempt to not block, dam, or change the natural course of any drainage. If excavation or dredging occurs in a streambed, the streambed may be protected with suitable stabilizing materials. Mineral and silt accumulated due to construction activities should be deposited into settling areas adjacent to streambeds. If disturbance occurs, a streambed may be restored to its original configuration, including natural grade, condition, and alignment.

BMP-G13: Pipeline construction should not prevent prolonged free wildlife movement.

BMP-G14: Prevent wildlife and livestock mortality or injury by covering all construction-related pits and tanks to exclude wildlife, regardless of pit or tank size.

BMP-G15: Minimize raptor perching on transmission line poles in areas with Utah prairie dog colonies.

BMP-G16: Vegetation slash not containing noxious and invasive or special status plants can be disposed of by removal to an agreed upon location. In upland areas, vegetation could be disposed of by: piling and burning, burying, windrowing at the base of fill slopes, and chipping and scattering.

BMP-G17: Enclosed containment should be provided for all trash. All construction waste, including trash and litter, garbage, other solid waste, petroleum products, and other potentially hazardous materials should be removed to a disposal facility authorized to accept such materials.

6.1.2 *Restoration/Rehabilitation Measures*

Restoration treatments are an integral part of control and management of future invasions of invasive species, and to prevent further harm to sensitive plants and animals from disrupted local ecosystem function. Executive Order 13112 Section 2(a)2; charges federal agencies to "provide for restoration of native species and habitat conditions in ecosystems that have been invaded." Native vegetative communities can suffer cumulative impacts from the direct and indirect impacts of invasive species (2008-2012 National Invasive Species Management Plan National Invasive Species Council [NISC] August 2008) and environmental stressors from ground disturbing construction activities. Complex ecological relationships can be jeopardized by invasive species as well as human related processes, such as pipeline construction, that can potentially disrupt ecological processes. Disturbed site soil stabilization incorporated with site restoration serves as an ecological transition to recovery of native habitat components and ecosystem processes interrupted by project related impacts. The general restoration BMPs presented here are intended to provide a framework for meeting the intent of Executive Order 13112 and enhance probability of local ecosystem recovery from disturbance.

BMP-R/R1: The soil surface of a disturbed area could be re-vegetated with a mix of species that is best suited to meet the erosion control objective, with consideration for range, wildlife, timber, or fuels management objectives. Native shrubs, herbs and grasses could be used for re-vegetation.

BMP-R/R2: When rehabilitating sensitive habitats impacted by project related activities, seeds from regionally native or sterile non-native species of grasses and herbaceous vegetation should be used in areas where reseeding is necessary to stabilize soils, prevent erosion, or provide temporary wildlife forage and/or cover.

BMP-R/R3: Vehicles used during reseeding activities should follow BMP-G6.

BMP-R/R4: Sediment traps or other erosion control measures should be implemented in restoration areas to prevent soil or seed loss and to protect the restoration area from invasive species seed sources.

BMP-R/R5: Restoration areas could be monitored for germination, establishment of desired species and cover prescription, and presence of invasive species. Results of monitoring should be reported to the FWS, federal land management agencies, and state wildlife management agencies.

BMP-R/R6: Topsoil removed during construction could be salvaged and reapplied during reclamation and plant debris could be left on-site to serve as mulch. Disturbed soils should be reclaimed as quickly as possible or protective covers could be applied. Topsoil material could be segregated and not mixed or covered with subsurface material. Where cryptobiotic crust is present, the crust could be salvaged and dispersed on the surface of reclaimed soils as soon as possible to facilitate regeneration of the soils.

6.1.3 *Riparian Corridors, Wetlands, and Aquatic Habitats*

Riparian corridors, wetlands, and aquatic habitats are especially significant to maintaining biodiversity. Therefore, modifications to BMPs and the formulation of protective measures and conservation strategies may be recommended by the designated resource advisor. Riparian areas are generally described as areas of land directly influenced by permanent water that have visible vegetation or physical characteristics reflective of permanent water influence. Generally excluded are such sites as ephemeral streams or washes that do not exhibit the presence of vegetation dependent upon free water in the soil. Riparian areas may be considered the banks and adjacent water bodies, watercourses, seeps and springs, that provide soil moisture in excess of that otherwise available locally which create moister habitats than that of the contiguous floodplain and uplands.

BMP-RA1: Site specific implementation plans that include BMPs, protective measures, and conservation strategies that take into account riparian habitats, riparian obligate species, and the special concerns related to these habitats and species could be coordinated with the designated resource advisor.

BMP-RA2: Crew camps, equipment staging areas, and fueling areas could be located outside of riparian areas to prevent pollutants such as fuels, lubricants, bitumens, and other harmful materials from being discharged into streams and reservoirs. Vehicle and heavy equipment crossings of riparian corridors should occur on established roads.

BMP-RA3: No construction or project related water needs should be met using water drafted from stock tanks or any other body of water without coordination with the designated resource advisor and in compliance with existing water use rights and authorizations. Stock tanks or riparian areas should not be dewatered to meet construction related water needs.

BMP-RA4: Unused water brought to the project site from an off-site water source, fuels, or any other possible contaminant used in construction activities should not be pumped or spilled into existing riparian, wetland, or aquatic habitat areas. Use of appropriate containment systems and portable pumps that prevent spills and contamination of riparian, wetland or aquatic habitat areas may be recommended by the designated resource advisor.

BMP-RA5: Development and implementation of restoration plans for affected riparian habitats should be coordinated with the USFWS, federal land management agencies, and state wildlife agencies. Restoration plans could include long-term monitoring to document changes in conditions of riparian habitats, sediment and soil movement, species composition, and riparian health (functioning condition).

BMP-RA6: Project personnel should be educated about the importance of minimizing impacts to riparian, wetland, and aquatic habitats. All project personnel should be informed of the BMPs, protective measures, and conservation strategies to minimize project related impacts to biodiversity within riparian, wetland and aquatic habitats.

6.1.4 Special Status Plants

Special status plants are those plants whose survival is of concern due to their limited distribution, low number of individuals and/or populations, and potential threats to habitat. Special status plants include any species listed, or proposed for listing, as threatened or endangered by the USFWS under the provisions of the ESA; any species designated by the USFWS as a "listed," "candidate," "sensitive" or "species of concern," and any species which is listed by a federal or state land and resource management agency for special management consideration.

Threats to special status plants and their habitats include livestock grazing, development, noxious and invasive plant invasion, and environmental changes, such as drought. The implementation of the following BMPs could reduce the impacts of construction activities to special status species within the LPP corridor.

BMP-SS1: Protection by avoidance of known individuals and locations of habitats known to be occupied by ESA listed species.

BMP-SS2: Special status plant species present in the area of disturbance could be salvaged and transplanted into restoration areas.

BMP-SS3: Collect and grow perennial special status plant seeds in a greenhouse or seeded on-site. Maintain replacement stock in irrigated beds. Seeds could be collected from genetically identical populations as those plants lost to construction.

BMP-SS4: Avoid where possible routing pipeline and transmission line access roads through gypsum badlands with known special status plant populations and highly developed cryptobiotic soils.

BMP-SS5: Prevent livestock trampling and grazing of newly seeded areas by improving fencing and gates. Where fences, gates and cattle guards are present near special status plant populations, properly maintained gates would help keep livestock controlled, so long as construction activities do not defeat their purpose by leaving gates open, fences down, or cattle guards removed.

6.1.5 ***Noxious and Invasive Plants***

Noxious weeds and invasive plants readily colonize disturbed areas and habitat edges, such as transportation and river corridors. Once established in these areas, noxious and invasive plants often continue to spread to adjacent habitats. All invasive plant species are aggressive competitors with the ability to significantly reduce diversity of native plant and animal species. Eliminating or reducing the spread and establishment of noxious and invasive plants requires a proactive approach, in which there are two key elements. First, new introductions or expansion of existing infested habitats could be prevented to the maximum extent possible. Second, detection and eradication of undesirable species within the project area could reduce the potential for further expansion. The BMPs discussed below are applicable to all noxious and invasive weeds within the project area. When followed, these BMPs could reduce the likelihood of introducing noxious and invasive plants into new areas via construction and subsequent maintenance of the pipeline corridor. BMPs are most effective when they address site-specific weed issues; however, at this stage of the LPP project, detailed plans are not available on which recommendations can be made.

6.1.5.1 Invasive Species - Prevention and Monitoring

BMP-IS1: Minimize soil disturbance whenever possible. Invasive plants readily colonize areas of disturbed soil. Monitor recent work sites for the emergence of invasive plants for a minimum of two years after project completion.

BMP-IS2: Stabilize disturbed soils as soon as possible by seeding and/or using mulch, hay, rip-rap, or gravel that is free of invasive plant material. Seeds of native species should be used whenever possible. Efforts should be made as to not plant species on any associated agency's invasive plant list.

BMP-IS3: Newly constructed access routes could be monitored for noxious and invasive weed infestations and treated during construction.

BMP-IS4: Post-construction and post-decommissioning monitoring for invasive plant species.

6.1.5.2 Invasive Species - Excavated Material

BMP-IS5: Excavated material taken from sites that contain invasive plants cannot be used away from the site of infestation until all viable plant material is destroyed. Excavated material from areas containing invasive plants may be reused within the exact limits of the infestation.

BMP-IS6: Any excavated material that contains viable plant material and is not reused within the limits of the infestation could be stockpiled on an impervious surface until viable plant material is destroyed or the material could be disposed of by burying a minimum of three feet below grade.

BMP-IS7: Whenever possible, excavation should be avoided in areas containing invasive species.

BMP-IS8: Soil and other materials containing invasive plants should be covered during transport.

6.1.5.3 Invasive Species - Movement and Maintenance of Equipment

BMP-IS9: If work in areas containing noxious and invasive plants cannot be avoided, then the movement of maintenance and construction equipment should be from areas not infested to areas infested by noxious and invasive plants whenever possible. This is especially important during ditch cleaning and shoulder scraping activities.

BMP-IS10: To the extent possible, materials such as fill, loam, mulch, hay, rip-rap, and gravel should not be brought into project areas from sites where invasive plants are known to occur. If the absence of noxious and invasive plant parts in these materials cannot be guaranteed, recent work sites should be monitored for the emergence of invasive plants.

BMP-IS11: Locate and use staging areas that are free of noxious and invasive plants to avoid spreading seeds and other viable plant parts. If staging areas are located in an area with noxious and invasive plants, treat areas with an herbicide prior to initial use.

BMP-IS12: If equipment is used in areas where noxious or invasive plants occur, all equipment, machinery, and hand tools could be cleaned of all visible soil and plant material before leaving the project site. Equipment should be cleaned at the site of infestation. Conversely, if equipment is brought from areas where noxious or invasive weeds may occur, into areas where they do not occur, all equipment, machinery, and hand tools shall be cleaned of all visible soil and plant material before entering the project site. Acceptable methods of cleaning include, but are not limited to, portable wash station that contains runoff from washing equipment (containment needs to be in compliance with wastewater discharge regulations), high pressure air, brush, broom, or other hand tools (used without water).

6.1.5.4 Invasive Species - Disposal of Plant Materials

BMP-IS13: When noxious or invasive plants are cut or removed for roadside maintenance, construction, or control of plants, the spread of viable plant material could be avoided by rendering plant material nonviable. The following methods can be used to destroy plant material:

> ~~Drying/Liquefying~~: For large amounts of plant material or for plants with rigid stems, place the material on asphalt, tarps, or heavy plastic and cover with tarps or heavy plastic to prevent the material from blowing away. For smaller amounts of plant material or for plants with pliable stems, bag the material in heavy-duty (3-mil or thicker) garbage bags. Keep plant material covered or bagged for at least one month. Material is nonviable when it is partially decomposed, very slimy, or brittle. Once material is nonviable, it can be disposed of in a landfill or brush pile.
>
> ~~Brush Piles~~: Plant material from most invasive plants can be piled on site to dry out. Brush piles are recommended for woody shrubs, trees, and vines.
>
> ~~Herbicide~~: Herbicide applications can be carried out by a licensed applicator with a permit from the appropriate land management and state agencies.

BMP-IS14: When an herbicide is used to control vegetation, the climate, soil type, slope, and vegetation type could be considered in determining the risk of herbicide contamination.

BMP-IS15: Herbicide use should be limited to nonpersistent, immobile herbicides and should be applied only by licensed applicators in accordance with label and application permit directions and stipulations for terrestrial and aquatic applications.

BMP-IS16: Only herbicides with low toxicity to wildlife and wild horses and burros should be used.

BMP-IS17: Herbicides should not be applied during rain.

BMP-IS18: Appropriate herbicide-free buffer zones should be used for herbicides not labeled for aquatic use, based on BLM/Forest Service risk assessment guidance, which has minimum widths of 100 feet for aerial applications, 25 feet for applications dispersed by vehicle, and 10 feet for hand-spray applications.

6.2 Introduction to Effects Analysis

The effects analysis synthesizes the extensive data gathered during the LPP vegetation surveys, information on geology and soils obtained from GIS data, and land use history gleaned from literature reviews to present a thorough overview of the LPP project area. The overview provides the basis for a discussion of the anticipated impacts of the LPP project on special status species and noxious weeds, and appropriate BMPs detailed above (section 6.1.1-6.1.5) to address those impacts. This discussion is facilitated by dividing the LPP project area into 43 biogeographically distinct segments based on MWH reaches(Appendix F), which are generally ordered from east to west. A map of MWH reach names is contained in Appendix B.

6.3 Overview of Impacts on Special Status Species

The number of plants that may be impacted, lost, or displaced during the construction of the Lake Powell Pipeline depends on the future project footprint and the timing of construction. The highest potential for impacts on the most species of special status plants (six species) will occur within the Hydro System Existing Highway Alternative along Highway 389. Special status plant species were documented in 15 total reaches; these species are identified in Chapter 4 Special Status Species Results and summarized in Chapter 7 Conclusions by reach. Impacts on special status plants are likely within these reaches.

Special status plants may be impacted during LPP construction due to dust, loss of soil, or flooding due to altered drainage patterns. Displacement of pollinating species may affect special status plants seed production; cause direct habitat loss; and change vegetation community composition (by invasion of noxious weeds).

6.4 Overview of Impacts on Noxious Weeds

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 to 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.

6.5 Effects Analysis Segment Descriptions

The following is an analysis of potential project impacts relative to each of the 43 segments. Each segment description includes a general overview and description of the segment. The content of each segment description includes a discussion of the segment route, relevant land use history, ecological systems occurring within the segment, special status species encountered, and noxious weeds that were prevalent at the time of the survey (due to the high occurrence and densities of noxious and invasive weeds within the survey area, a comprehensive listing of noxious and invasive weeds is not included; please refer to the Chapter 5 for a complete discussion of all species occurring within the overall survey area). A discussion of potential impacts is also included, focusing on vegetation resourcs and particular concerns relative to soil stabilization and erosion. Specific BMP recommendations are also provided to assist in the minimization of potential impacts that are of particular concern.

6.5.1 Segment 1: Colorado River at Glen Canyon Dam to Big Water

Reach 4: Water Conveyance System

Overview:

The Colorado River at Glen Canyon Dam to Big Water Segment would include a pipeline, transmission line, and pumping station. The segment begins immediately north of Glen Canyon Dam at the Colorado River, and follows US Highway 89 in a northwesterly direction, ending at the community of Big Water (Appendix F). Lands within the segment are primarily part of the Glen Canyon National Recreation Area (GCNRA) and administered by the National Park Service (NPS); however, Arizona State Trust Lands (ASTL), Bureau of Reclamation (Reclamation) lands, and private lands also occur within the segment. In addition to GCNRA, Reclamation, and private lands, property in the vicinity of Big Water is also owned by the Utah School and Institutional Trust Lands Administration (SITLA). Two special status species were encountered in the segment, *Phacelia mammalariensis* and *Eriogonum corymbosum* var. *nilesii*. Noxious weeds also occurred in the segment, and included: *Tamarisk* spp., *Erodium cicutarium*, *Salsola tragus*, *Tribulus terrestris*, and *Ulmus pumila*. The pipeline footprint in the Colorado River at Glen Canyon Dam to Big Water Segment could result in impacts to special status species or their habitats, and may foster the spread of noxious weeds occurring within the segment.

Description:

Route:

The Colorado River at Glen Canyon Dam to Big Water Segment starts at the Colorado River (in an area that was heavily disturbed by the construction of the Glen Canyon Dam), then extends west and crosses US 89. West of the highway, the segment follows an abandoned paved highway for approximately 3 miles. The segment climbs an outcrop in the vicinity of a maintenance yard operated by the Arizona Department of Transportation (ADOT), continues north to US 89, and extends northwest along the southwest side of the highway. Along this path, the segment crosses an area of graded and disturbed land (at the junction of US 89 and Wahweap Road), an abandoned paved road, and dry washes which flow across the landscape from west to east. On the west side of the community of Greenhaven, the segment crosses a disturbed tract of ASTL, re-enters GCNRA lands immediately south of the Utah state line, continues through Blue Pool Wash and sparsely-vegetated rock outcrops, and ends at Big Water.

In addition to the proposed pipeline and transmission line, four proposed equipment sites would be placed within the Colorado River at Glen Canyon Dam to Big Water Segment. Three of these would be located in the vicinity of Big Water, and the fourth site is located north of the ADOT maintenance yard, in an area that has been utilized for sand excavation.

Land use history:

The segment crosses the 1776 Dominguez and Escalante Expedition Route, a route that crossed the Colorado River at the Crossing of the Fathers (between Lee's Ferry and Wahweap). At Big Water, the segment also crosses the route of the Old Spanish Trail. Travel along these routes may have caused disturbance and the expansion of native and invasive vegetation through enhanced seed dispersal. Lands in the area were also grazed by domestic livestock that were driven along the Old Spanish Trail. Development of the area began in the late 1950's. The graded and disturbed land located at the junction of US 89 and Wahweap Road was the former site of a store, and the abandoned road that occurs within the segment was the former alignment of US 89 (prior to the construction of the Glen Canyon Bridge).

Geology:

The Gunsight Butte Member of the Entrada Formation is represented as sandstone-slickrock in the area of Tower Hill and in the highlands west of the ADOT maintenance yard. Sand deposits are found in the dips among the slickrock, and younger alluvial material is represented in sand-dune topography. Entrada sandstone outcrops are also present in the segment. Surface geology includes alluvial and gravel deposits near Stud Horse Point, and bedrock exposures of the Dakota Formation at Blue Pool Wash and Jacobs Pools Wash. Judd Hollow Tongue of Navajo Sandstone also occurs at Jacobs Pools Wash, and Entrada Sandstone is found at Blue Pool Wash.

Ecological systems:

The Colorado River at Glen Canyon Dam to Big Water Segment occurs entirely within the Colorado Plateau Ecological Region. The proposed segment begins in the Mixed Bedrock and Tablelands Ecological System, in topography characterized by exposed sandstone outcrops, knolls and cliffs. These alternate with smaller areas of wind deposited sandsheets that are classified as the Active and Stabilized Dune Ecological System. North of Blue Pool Wash, the segment occasionally crosses Mixed Bedrock Canyon and Tableland with sparsely vegetated rock outcrops of Entrada sandstone and the Dakota Formation.

Blackbrush-Mormon-tea Shrubland occurs near Tower Hill, along the abandoned highway north of the Entrada Formation escarpment. Blackbrush-Mormon-tea Shrublan is comprised of *Ephedra nevadensis* occurring as a co-dominant species with *Coleogyne ramosissima* or *Artemisia* spp. Above the escarpment, where *Pleuraphis jamesii* is a dominant member in the understory, the vegetation is classified as Shrub-Steppe. High-quality Blackbrush-Mormon-tea Shrubland is comprised of *Coleogyne ramosissima* dominated shrublands on sandsheets, or on sparsely vegetated land dominated by *Ephedra nevadensis*. In areas where sand has been quarried along the pipeline corridor and in a proposed staging area, the vegetation is dominated by *Artemisia filifolia* and *Gutierrezia sarothrae*. *G. sarothrae* is typically dominant where invasive plants occur at high densities, and is a widespread shrub that colonizes disturbed sites. These somewhat disturbed lands are sufficiently natural to be classified as the Mixed Desert Scrub Ecological System, rather than ruderal vegetation. Along the southwest side of US 89, the Blackbrush-Mormon-tea Ecological System is interspersed with periodically-occurring dunes, and are mostly free of *Gutierrezia sarothrae*. Where sand dunes are active, *A. filifolia* is often dominant.

Where the segment crosses the abandoned paved highway, the landscape is periodically dissected by dry washes, which are sparsely vegetated and classified as the Colorado Plateau Wash Ecological System. Vegetation within these washes consists of either *Atriplex canescens* co-dominated by *Artemisia filifolia*, or are semi-natural associations dominated by *Tamarisk* spp. Vegetation is presently absent where the pavement remains from the abandoned highway. North of the ADOT station, varying amounts of road material persist. Much of the three miles of remnant roadbed is comprised of broken to totally absent tarmac, with gravel still present from the original roadbed. The dominant colonizing plants in these areas are *Gutierrezia sarothrae* and *Grindelia squarrosa*. Either side of the roadbed is a mixture of *Coleogyne ramosissima* and *Ephedra nevadensis* that occur as co-dominants.

A proposed pumping station would be situated on desert pavement adjacent to Glen Canyon Dam. The pavement characterizes an area heavily disturbed during the construction of the Dam in 1956-1964, and the colonizing vegetation is ruderal. The bedrock outcrops here are lightly disturbed, sparsely vegetated and dominated by *Ephedra nevadensis*. US 89 is built upon dunes which are exposed on their northeasterly slopes, and marginally stabilized by an *Artemisia filifolia* dominated shrubland. Along these extensions, the shoulder of the road is ruderal vegetation.

Special status plants:

Phacelia mammalariensis was found to occur in dunes, except where *Artemisia filifolia* dominated active dunes occur adjacent to the highway. Many *P. mammalariensis* individuals were found in the dunes around Tower Hill. Forty-six *P. mammalariensis* plants were observed in the *Coleogyne ramosissima-Ephedra nevadensis* Dwarf-shrubland Association around the ADOT facility. *P. mammalariensis* was locally occasional where *Artemisia filifolia* co-dominated with *E. nevadensis*. Notably, *P. mammalariensis* had not recolonized the abandoned roadbed, although the species was present adjacent to the road. In addition to the *P. mammalariensis* identified by the survey, individuals displaying intermediate characteristics between *P. mammalariensis* and *P. crenula* (a similar appearing species) were also encountered within the segment. For a discussion on the treatment of these individuals, refer to the *P. mammalariensis* species description in Chapter 4.

Approximately 500 *Eriogonum corymbosum* var. *nilesii* were inventoried during the survey, most of which occurred within this segment (and the US 89 at Glen Canyon Dam to Upper Blue Pool Wash Segment). Many individuals were located near Tower Hill, on sandstone slickrock and adjacent dunes, and occurred as co-dominant members of the vegetation community, along with *Coleogyne ramosissima* and *Ephedra nevadensis*. *E. corymbosum* var. *nilesii* was most common where there was contact with an impervious surface, allowing for increased rainwater run-off. These microhabitats include edges of abandoned roadways and the bases of slickrock slopes.

Invasive and noxious weeds:

Areas classified as Lower Montane Riparian Woodland and Shrubland are restricted to dry washes traversing the landscape. These washes increase in frequency where the segment nears Wahweap Creek. Occasionally, wash channels were invaded by *Tamarisk* spp., a serious invasive shrub of wetland habitats. These invaded areas occur most frequently in areas where culverts restrict channel flow downstream, and form intermittent pools of water at their intakes. Herbaceous vegetation in these localized areas was dominated by *Salsola tragus*. On higher sandsheets, *S. tragus* was absent to only occasional in abundance, where the occurrence of the species serves as an indicator of past grazing in *Ephedra nevadensis* and *Gutierrezia sarothrae* dominated dwarf shrublands. *S. tragus* was also found in a 0.4 mile long area which borders the ADOT maintenance yard, in *Coleogyne ramosissima* and *Ephedra nevadensis* co-dominated dwarf-shrubland. A vehicle washing area at the maintenance yard was a likely source for the dispersal of *S. tragus* seeds.

Tribulus terrestris was well established in the segment. *T. terrestris* was locally common in some areas dominated by *Coleogyne ramossisima*, and was locally abundant in ruderal vegetation along US 89. *Ulmus pumilia* was established, but infrequent, in the Tower Hill area. *Erodium cicutarium* was also found in scattered locations within the segment.

Impacts:

Phacelia mammalariensis and *Eriogonum corymbosum* var. *nilesii* individuals occurring within areas of proposed project activity, or their habitats, may be affected by the placement of the proposed pipeline, transmission line, and/or equipment sites.

Establishing and maintaining roads along the pipeline and transmission line corridors may provide a route for noxious and invasive weeds to colonize adjacent natural lands, and Invasive Upland Vegetation could serve as point sources for the spread of noxious and invasive weeds.

The creation of access roads, or other project-associated disturbance, through sand dunes could subject the dunes to destabilization, and localized erosion.

Stream channels could be impacted the proposed project activities. Modification of stream-bed morphology could occur, and sediment could be introduced into channels occurring within or adjacent to areas of impact.

Best management practices:

The following BMPs are recommended for proposed project activities to occur within the Colorado River at Glen Canyon Dam to Big Water Segment. Further discussion of each BMP has been provided in Section 6.1 above. The salvage of topsoil is not recommended for this or other segments with a sand dune or sandsheets typography, as these lack a salvageable surface horizon which can be preserved.

Protect erosion prone land (BMP-G8)
Prevent stream bed modification (BMP-G12)
Cover open trenches to prevent wildlife and livestock mortality or injury (BMP-G14)
Revegetate disturbed soils (BMP- R/R1)
Salvage and transplant perennial special status plants (BMP-R/R6)
Eriogonum corymbosum var. *nilesii* could be transplanted, but may require post construction monitoring and drip irrigation.
Prevent pollution discharge into streams (BMP-RA2)
Maintain livestock fencing and gates (BMP-SS3)
Control of equipment movement in areas with noxious or invasive plants (BMP-IS10)

6.5.2 Segment 2: US 89 at Glen Canyon Dam to Upper Blue Pool Wash

Reaches 2 and 3: Glen Canyon to Buckskin Transmission Line and BPS-2 Transmission Line Alternative

Overview:

The US 89 to Glen Canyon Dam to Upper Blue Pool Wash Segment would include a proposed transmission line and equipment site. The segment begins at US 89, crosses sandstone, slickrock, and sand dunes in a west-northwesterly direction, and ends at the upper tributaries of Blue Pool Wash. Lands occurring within the segment are owned primarily by the NPS and administered as GCNRA, and the BLM. A small area of Arizona State Trust Land also occurs in the segment. *Eriogonum corymbosum* var. *nilesii* and *Phacelia mammalariensis* are special status species that were encountered within the segment, in the vicinity of Tower Hill. Several noxious weed species were also identified in the segment, including *Erodium cicutarium, Salsola tragus*, *Tribulus terrestris*, and *Ulmus pumila.*

Description:

Route:

The Glen Canyon Dam to Upper Blue Pool Wash Segment begins near Page, and is a continuation of the Colorado River at Glen Canyon Dam to Big Water Segment. The segment crosses sandstone, slickrock, and sand dunes. At 0.27 miles, the proposed transmission line corridor splits into paired lines. One line would bypass a Page Formation sandstone hill and extend 0.71 miles west south-west, and the second line would circle the hill in a diamond-shaped alignment, intersecting with an existing substation at its eastern-most point. Continuing northwest for approximately 2.4 miles, the segment climbs sandstone cliffs, continues northwest, and at 3.3 miles, intersects an existing paved road leading west to a proposed equipment site. The segment crosses two US 89 access roads, at 6.6 and 6.75 miles. At 8.1 miles, the segment crosses Ferry Swale, which seasonally ponds and attracts livestock. The segment ends at 9.2 miles, just short of the upper reaches of the Blue Pool Wash on the eastern slopes of Cedar Mountain.

Land use history:

The Glen Canyon Dam to Upper Blue Pool Wash Segment crosses the 1776 Dominguez and Escalante Expedition Route near Ferry Swale Tank, a route that went between present day Lee's Ferry and Wahweap. The same route was subsequently used for livestock drives until the closing of open range. Portions of the eastern end of the segment have been excavated for sand, some of which were bulldozed beginning in 1957 for the construction of Glen Canyon Dam and the US 89 bridge and approaches. Excavated areas were left barren and are slowly undergoing natural revegetation. Abandoned paved roads and rarely used transmission tower access roads are also common, particularly at the eastern end of the segment. The area was also used historically for livestock grazing.

Geology:

Tower Hill is comprised of Navajo Sandstone, with sand deposits in depressions and lower elevation dunes below the Navajo Sandstone cliffs. Around the periphery of Tower Hill and Beehive Rock, the Gunsight Butte Member of the Entrada Formation caps the Navajo Sandstone on cliffs and slickrock. Younger alluvial material is represented in sandsheets and sand dunes above the Gunsight Butte Member sandstone slickrock. A small area outcrop of Entrada sandstone occurs southeast of Bishops Tank.

Ecological systems:

The Glen Canyon Dam to Upper Blue Pool Wash Segment occurs entirely within the Colorado Plateau Ecological Region. No vegetation surrounds the developed lands of the power substations at Tower Hill, and pockets of disturbed sand representing Active and Stabilized Dune occur at the base of the hill. At Ferry Swale, the sandsheet topography is classified primarily as Blackbrush-Mormon-tea Shrubland, and dominated in various areas by *Coleogyne ramosissima*, *Ephedra nevadensis*, *Ephedra viridis*, *Artemisia filifolia* and *Gutierrezia sarothrae*. Some disturbed areas are classified as Mixed Desert Scrub, which were dominated solely by *G. sarothrae*. Shrub Steppe was encountered in a localized area, where *Psoralidium junceum* occurred as a co-dominant species with *G. sarothrae*.

Special status plants:

A relatively large grouping of *Eriogonum corymbosum* var. *nilesii* was encountered to the north of Tower Hill. This location supported more than 500 individuals, the largest group of the species found in the LPP survey area. Individual plants extended throughout the sandstone slickrock areas, and were visible from the junction of US 89 and the abandoned former alignment. An unknown number of individuals were also present within the Colorado River at Glen Canyon Dam to Big Water Segment, where it follows that alignment through slickrock.

Phacelia mammalariensis was occasional to locally common in active dunes in sparse shrubland dominated by *Ephedra nevadensis* and *Artemisia filifolia*. The highest densities of *P. mammalariensis* were encountered in deep sand-filled drainages amid slickrock slopes. As the survey neared Hackberry Tank (a stock tank on BLM land 0.62 miles west of the GCNRA boundary), density of the species decreased. The fencing between a BLM cattle allotment and the park land was ineffective at the time of the survey, and may be detrimental to the viability of *P. mammilarensis* individuals in this area.

Noxious and invasive weeds:

Disturbed dunes provided habitat for *Tribulus terrestris*, *Salsola tragus* and *Ulmus pumila*. *Salsola tragus* and *Ulmus pumila* occurred rarely, in localized areas among the alternating dunes and slickrock which characterized much of the localized topography.

Erodium cicutarium and *Salsola tragus* were encountered 1.17 miles northwest of Bishops Tank, in Blackbrush-Mormon-tea Shrubland, where *E. cicutarium* was locally dominant and *Salsola tragus* occurred at a density of over 2400 plants per acre. Two large areas, one 4.2 acres, and the other 11.6 acres, were classified as Invasive Upland Vegetation, and likely supported even higher densities of *S. tragus*. In the northwest portion of the segment, as the vegetation transitions into Colorado Plateau Mixed Desert Scrub and Blackbrush-Mormon-tea Shrubland ecological systems, the density of *S. tragus* diminished.

Impacts:

The Glen Canyon Dam to Upper Blue Pool Wash Segment parallels an existing transmission line. Impacts from the proposed transmission line could be minimized by using existing access roads wherever possible. The construction of any additional access roads, and other disturbance associated with the proposed project, through sand dunes could subject them to destabilization. Roads and other disturbed areas created during construction and maintenance activities may also foster the introduction of invasive weeds into adjacent natural areas. Areas classified as Invasive Upland Vegetation may also serve as point sources for the spread of invasive weeds.

Best management practices:

The following recommendations are BMPs of particular applicability to this segment. Further discussion of each is provided in Section 6.1 above.

Protect erosion prone land (BMP-G8)
Protect wellheads from pollutants (BMP-G11)
Cover open trenches to prevent wildlife and livestock mortality or injury (BMP-G14)
Dispose of all construction waste (BMP-G17)
Revegetate disturbed soils (BMP-R/R1)
Salvage and transplant perennial special status plants (BMP-R/R7)
Salvage, seed collection and propagation of *Eriogonum corymbosum* var. *nilesii* is discussed in the Special Status Plants report.
Maintain livestock fencing and gates (BMP-SS4)
This BMP is particularly applicable in areas of potential impact which support *Phacelia mammalariensis,* an herbaceous special status species that may be subjected to grazing by nearby livestock. The maintenance of livestock fence gates and other controls should help to prevent livestock from trespassing onto NPS lands
Control equipment movement in areas with invasive plants (BMP-IS10)

6.5.3 Segment 3: Upper Blue Pool Wash to US 89 west of Big Water

Reach 3: BPS-2 Transmission Line Alternative

Overview:

The Upper Blue Pool Wash to US 89 west of Big Water Segment would include the placement of a pipeline and transmission line, and would parallel an existing transmission line. The segment begins on the eastern side of Cedar Mountain and extends to US 89 near Big Water (Appendix F). The landscape within the segment is predominately comprised of sand dunes dominated by *Artemisia filifolia* and *Ephedra nevadensis*. The portion of the segment within Arizona occurs on lands owned by the BLM, and the Utah portion occurs on a combination of

SITLA lands and private lands (in the vicinity of Big Water). No special status species were encountered in this segment, and no noxious or invasive weeds were dominant members of sampled vegetation communities.

Description:

Route:

The Upper Blue Pool Wash to US 89 west of Big Water Segment begins in Arizona on the eastern side of Cedar Mountain, and continues northwesterly, crossing an upper tributary of Blue Pool Wash at 0.25 miles, then into Utah, and another tributary at 0.74 miles. The segment then traverses many unnamed tributaries draining from Cedar Mountain, crosses Jacobs Tanks Draw at 5.79 miles. , and continues northwest, crossing the Cedar Mountain to US 89 Segment, and ending at US Highway 89, approximately 1.1 miles west of Big Water.

Land use history:

No references were found specific to historical land uses within this segment. Until the building of Glen Canyon Dam, there were few settlements in the region; Lees Ferry was established in 1871 and Adairville was abandoned around 1920. The communities of Page, Big Water (initially Glen Canyon City), and Church Wells were developed as dam worker towns in the late 1950s. The area was also known to have undergone disturbance due to the movement of livestock. Mead and Teal (1903) reported that approximately 3,000 head of cattle and 40,000 head of sheep occurred in Kane County in 1902.

Geology:

The Upper Blue Pool Wash to US 89 at Big Water Segment occurs in a valley formed by the Cedar Mountain Anticline, extending from Cedar Mountain to Jacob Tanks. The surface geology of this segment is predominantly comprised of mixed eolian and alluvial sand deposits, except where bedrock is exposed. The Judd Hollow Tongue of the Carmel Formation and Thousand Pockets Tongue of Page Sandstone are exposed at various locations descending from Cedar Mountain, particularly at Jacobs Tanks. Undifferentiated Carmel and Entrada Sandstone, younger alluvial material (mostly present as sand dunes), and Entrada Sandstone are also represented within the segment.

Ecological systems:

The Cedar Mountain to US 89 segment occurs exclusively in the Colorado Plateau Ecological Region, and the following ecological systems are represented: Active and Stabilized Dune, Blackbrush-Mormon-tea Shrubland, Mixed Bedrock Canyon and Tableland, Mixed Desert Scrub, Pinyon-Juniper Woodland, Shrub Steppe, and Colorado Plateau Wash.

Impacts:

The Upper Blue Pool Wash to US 89 at Big Water Segment parallels an existing transmission line. Impacts from the project could be minimized by utilizing the existing access road as much as possible. The construction of additional access roads and other disturbance associated with the proposed project could subject existing sand dunes to destabilization and may foster the colonization of invasive weeds into vegetation communities occurring within the segment.

Best management practices:

The following recommendations are BMPs of particular applicability to the Upper Blue Pool Wash to US 89 at Big Water Segment. Further discussion of each is provided in Section 6.1 above.

Protect erosion prone land (BMP-G8)
Protect wellheads from pollutants (BMP-G11)
Prevent stream bed modification (BMP-G12)
Cover open trenches to prevent wildlife and livestock mortality or injury (BMP-G14)
Dispose of vegetation slash (BMP-G16)
Dispose of all construction waste (BMP-G17)
Revegetate disturbed soils (BMP-R/R1)
Install and maintain sediment and seed traps (BMP-R/R4)
Salvage topsoil (BMP-R/R6)
Prevent pollution discharge into streams and reservoirs (BMP-RA2)
This BMP is particularly applicable to proposed work in the vicinity of Jacobs Tanks Draw, which feeds Wahweap Creek and subsequently discharges into Lake Powell.
Maintain livestock fencing and gates (BMP-SS4)
Control equipment movement in areas with noxious or invasive plants (BMP-IS10)

6.5.4 Segment 4: Cedar Mountain to US 89

Reach 6: BPS-2 Transmission Line

Overview:

The Cedar Mountain to US 89 Segment would include the placement of a transmission line. The segment begins at Cedar Mountain and extends north to US 89, near Big Water. An unimproved road traverses the segment, with access points at Big Water and Cedar Mountain; however, the route is nearly impassible in the vicinity of Jacobs Tanks. Lands within the segment are owned by SITLA, with a few small private tracts in the vicinity of Big Water. Pinyon-juniper woodland occurs as dominant vegetation along the segment, although sand dunes are present in the north end of the segment, which are dominated by *Artemisia filifolia* or *Ephedra nevadensis*. No special status species were encountered by the survey in this segment, and noxious and invasive weeds occurred minimally.

Description:

Route:

The Cedar Mountain to US 89 Segment starts on the top of Cedar Mountain, where it branches from the Upper Blue Pool Wash to Lower Paria River Segment. At 0.38 miles, the segment passes a telecommunications tower, and at 1.12 miles, crosses a four wheel drive road that provides access to Judd Hollow Spring and Judd Hollow. The segment intersects a wooded pole transmission line at 1.58 miles, and at 2.62 miles, crosses an unimproved road that continues to Flat Top. The segment continues north, reaching Jacobs Tanks Draw at 3.35 miles. The first of three alternate routes would begin at 5.64 miles, and the end of the segment would depend on which of these alternates is selected.

Land use history:

No references were found specific to historical land uses along this segment. Cedar Mountain was named for the cedars atop the peak, although woodlands are now sparse (Barnes 1988).A telecommunications tower stands near the crest of Cedar Mountain, and an existing wooden pole transmission line roughly parallels the segment. There are developed springs at Judd Hollow Spring, and an unnamed spring immediately east, which supplied water to livestock below Cedar Mountain. Developed stock tanks are also present between Judd Hollow and Jacobs Tanks. Impoundments or natural depressions in the slickrock occur at Jacobs Tanks Draw, which likely supported stock watering historically. With the development of Big Water, this water source became protected for what is presumably the town's municipal water supply.

Geology:

The surface geology of this segment is predominantly comprised of mixed eolian and alluvial sand deposits, except where bedrock is exposed. At Jacob Tanks, both the Judd Hollow Tongue of Carmel Formation and Thousand Pockets Tongue of Page Sandstone are represented as exposed bedrock.

Ecological systems:

The Cedar Mountain to US 89 segment occurs exclusively within the Colorado Plateau Ecological Region, and the following ecological systems are represented: Active and Stabilized Dune, Blackbrush-Mormon-tea Shrubland, Mixed Bedrock Canyon and Tableland, Mixed Desert Scrub, Pinyon-Juniper Woodland, Shrub Steppe, and Colorado Plateau Wash. Various seral stages of pinyon-juniper woodland are predominate within the segment. Shrub-Steppe occurs on top of Cedar Mountain, and Mixed Desert Scrub is limited to the bend at the first crossing of Jacobs Tanks Hollow. Mixed Bedrock Canyon and Tableland occurs in a limited area at Jacobs Tanks, and coincides with the presence of sandstone outcrops. At the upper end of the segment, west of Jacobs Tanks and south of Jacobs Tanks Draw, there is a transition from Active and Stabilized Dunes to Blackbrush-Mormon-tea Shrubland.

Invasive and noxious weeds:

Little information was collected by the survey for invasive weeds between Cedar Mountain and Jacobs Tanks. *Salsola tragus* was noted in two locations, including one location where it was dominant (where the segment first crosses Jacobs Tanks Draw), and another where it was occasional in abundance (in dwarf shrublands occurring on sand).

Impacts:

While there are existing roads that provide access to an existing transmission line that occurs in this segment, the proposed project would likely require the construction of new access roads in some portions of the area. However, any new roads and other disturbance associated with the proposed project would subject sand dunes that occur within the segment to potential destabilization. Additionally, this disturbance could foster the colonization of invasive weeds.

Best management practices:

The following recommendations are BMPs of particular applicability to the Cedar Mountain to US 89 Segment. Further discussion of each is provided in Section 6.1 above.

Protect erosion prone land (BMP-G8)
Protect wellheads from pollutants (BMP-G11)
Cover open trenches to prevent wildlife and livestock mortality or injury (BMP-G14)
Dispose of vegetation slash (BMP-G16)
Dispose of all construction waste (BMP-G17)
The segment passes close to Jacobs Tanks, a presumed municipal water source.
Revegetate disturbed soils (BMP-R/R1)
Install and maintain sediment and seed traps (BMP-R/R4)
Prevent pollution discharge into reservoirs (BMP-RA2)
This BMP applies particularly to any activities proposed to occur in the vicinity of Jacobs Tank Draw, which drains into Lake Powell.

Maintain livestock fencing and gates (BMP-SS4)
Control equipment movement in areas with noxious or invasive plants (BMP-IS10)

6.5.5 Segment 5: Big Water to Cottonwood Canyon Road

Reach 4: Water Conveyance System

Overview:

The Big Water to Cottonwood Canyon Road Segment would include a pipeline, a transmission line, and an equipment site. The segment extends from the south side of US 89 (at the Utah Route 277 junction at Big Water) to the Cottonwood Canyon Road junction. The vegetation is primarily *Ephedra nevadensis* dwarf-shrubland (occurring on sandsheets), *Artemisia filifolia* shrubland (occurring on low sand dunes), and *Achnatherum hymenoides* (occurring in grassland). No special status species were encountered within the segment. Various noxious or invasive weeds were identified as dominant or co-dominant species in vegetation communities occurring within the segment. Lands in the segment are owned primarily by SITLA, but private lands occur in the vicinity of Big Water, Church Wells, and an unnamed subdivision east of Cottonwood Canyon Road.

Description:

Route:

The Big Water to Cottonwood Canyon Road Segment begins at the end of the Colorado River at Glen Canyon Dam to Big Water Segment, and at 0.18 miles, intersects the Cedar Mountain to US 89 Segment. At 0.42 miles, the segment includes an equipment site, and intersects two additional proposed transmission line corridors (one at 1.28 miles, which is a branch of the Cedar Mountain to US 89 Segment, and the other at 1.48 miles, the Upper Blue Pool Wash to US 89 at Big Water Segment). Continuing west north-west, at 2.42 miles, the segment crosses the first of a succession of culverts at Buck Tank Draw. Branches of Shittum Wash are crossed at 4.71, 5.00 and 5.56 miles. A proposed equipment site would occur within the Church Wells subdivision (which would be accessed at 6.08 miles). Church Well occurs south of US 89 at 6.33 miles, and provides water to livestock. A final culvert at Cedar Hollow is crossed at 7.56 miles. Another proposed equipment site would occur in an unnamed subdivision (which is accessed at the junction with Clark Bench Road at 9.54 miles). The segment ends where it joins the Flat Top to Cottonwood Canyon Road Segment at 10.25 miles.

Land use history:

Settlement within the region was relatively recent. Until the mid-1950s, the area was remote and not served by a paved highway; despite this, the area has a long history of livestock activity. Utah State Route 259 replaced a two-track route that, prior to 1954, roughly paralleled US 89 across the West Clark Bench. The route was realigned in 1959, after construction of the Glen Canyon Bridge. In approximately 1956, Glen Canyon City was platted for the housing of workers needed to build the Glen Canyon Dam, and in 1984, Glen Canyon City became Big Water. Church Wells was platted in 1958, after having been conceived as a town by the Consumer Water Agency. The segment crosses a large block of land which was assembled from a 1998 transfer of checker-boarded SITLA land within the boundaries of the Grand Staircase Escalante National Monument.

Geology:

The surface geology of the Big Water to Cottonwood Canyon Road Segment is based on Doelling (2006). Much of the segment consists of sand dunes and sandsheets, which are mapped geologically as mixed eolian and alluvial sand deposits. Bedrock is generally buried under the sand, but near Church Wells, the upper unit of the Carmel

Formation is represented in ridges. Outcrops of Entrada Formation sandstone occur near the western end of the segment.

Ecological systems:

The Big Water to Cottonwood Canyon Road Segment occurs entirely within the Colorado Plateau Ecological Region. The Active and Stabilized Dune Ecological System is found on dunes that represent the deepest sands, and transitions into Blackbrush-Mormon-tea Shrubland on sandsheets which represent more shallow sands. Sandsheet topography occurs within the segment near US 89, and supports Grassland and Shrub-Steppe ecological systems. Adjacent to US 89, bedrock outcrops support Mixed Bedrock Canyon and Tableland. Minor acreages of Pinyon-Juniper Woodland and Mixed Desert Scrub occur immediately west of Big Water, and numerous dry washes along the segment are classified as the Colorado Plateau Wash Ecological System. Invasive Upland Vegetation occurs within washes that cross under US 89, and Ruderal Vegetation was identified in road cuts.

Invasive and noxious weeds:

Tamarisk spp. occurred north of US 89, near the end of the segment, and *Salsola tragus* was found at high densities (over 4,400 plants per acre in some 50-meter transects) in the Colorado Plateau Blackbrush-Mormon-tea Ecological System. This high density was only encountered in 12 percent of the total 50-meter transects that were conducted throughout the survey area. At 1.25 miles west north-west of Buck Tank Draw, *S. tragus* was found at densities exceeding 5,800 plants per acre, within the Colorado Plateau Blackbrush-Mormon-tea Ecological System. *S. tragus* was a dominant species in Invasive Upland Vegetation occurring in an arroyo that crosses under US 89 via a culvert. *S. tragus* also was found in disturbed lands at Big Water, and on overgrazed rangeland. In addition to *Tamarisk* spp. and *S. tragus*, *Bromus tectorum* and *Erodium cicutarium* were encountered in the segment, although these species occurred at lesser densities.

Impacts:

The construction of access roads through sand dunes may subject the dunes to destabilization. Vegetation communities classified as Invasive Upland Vegetation or Ruderal Vegetation, and Developed Land could be point sources for the spread of invasive weeds. Trenching and back-filling pipeline trenches could result in erosion.

Best management practices:

The following recommendations are BMPs of particular applicability to this segment. Further discussion of each is provided in Section 6.1 above.

Protect erosion prone land (BMP-G8)
Protect wellheads from pollutants (BMP-G11)
This BMP is particularly applicable to activities proposed to occur in the vicinity of Church Well
Cover open trenches to prevent wildlife and livestock mortality or injury (BMP-G14)
Dispose of all construction waste (BMP-G17)
Revegetate disturbed soils (BMP-R/R1)
Install and maintain sediment and seed traps (BMP-R/R4)
Salvage topsoil (BMP-R/R6)
Maintain livestock fencing and gates (BMP-SS4)
Control equipment movement in areas with noxious or invasive plants (BMP-IS10)
Seeding the contoured ground near highway culverts could help to minimize the spread of *Salsola tragus*. These culverts function as points of dispersal for this noxious weed.

6.5.6 Segment 6: Upper Blue Pool Wash to Lower Paria River

Reaches 2 and 5: Glen Canyon to Buckskin Transmission Line and Glen Canyon to Buckskin Transmission Line North

Overview:

The Upper Blue Pool Wash to Lower Paria River Segment would include the placement of a transmission line in either of two proposed reaches. The segment begins on the east side of Cedar Mountain at Upper Blue Pool Wash, continues west north-west across Cedar Mountain, through Judd Hollow, across Flat Top, and ends just past the Paria River (Appendix F). Lands within the segment are primarily owned by SITLA, with the remaining lands owned by the BLM and administered as the Grand Staircase-Escalante National Monument. The landscape alternates between sand dunes, sandsheets, rocky or sandy pinyon-juniper woodlands and rim rock, and non-vegetated cliffs above semi-natural riparian vegetation. No special status species were encountered in this segment. Noxious weeds, including *Salsola tragus* and *Tamarisk* spp. were identified in the segment.

Description:

Route:

The Upper Blue Pool Wash to Lower Paria River Segment begins near the eastern base of Cedar Mountain (where it continues from the end of the US 89 at Glen Canyon Dam to Upper Blue Pools Wash Segment), and continues west northwest, ascends and then descends the top of Cedar Mountain, crosses Judd Hollow, and rises to Flat Top, where it meets the Flat Top to Cottonwood Canyon Road Segment. From Flat Top, the segment reaches the Paria River at the northern edge of a wilderness area, ending just west of the Paria River, 14.4 miles from the start.

Land use history:

No references were found regarding past land use history of this segment, although the survey encountered evidence of past and current grazing throughout the segment. Of note, rock ledges occurring within the Paria River Canyon appeared to have been ungrazed (due to the presence of nearly total cover of cryptobiotic soils).

Geology:

Undifferentiated Triassic-Jurassic aged strata occur on the east side of Cedar Mountain, younger alluvial material is represented in sand dunes, and Entrada sandstone is represented as a narrow outcrop at the base of Cedar Mountain (near the start of the segment). The surface geology within Utah is based on Doelling (2006). Navajo Sandstone is found in the Paria River Canyon, in deep drainages in Judd Hollow, and on the east side of Cedar Mountain. The Judd Hollow Tongue of Carmel Sandstone is expressed as wooded rimrock above the Paria River, in Judd Hollow, and on the east side of Cedar Mountain. The Thousand Pockets Tongue of Page Sandstone appears as outcrops within sand dunes. Mixed eolian and alluvial deposits are represented in the dunes and sandsheets on Flat Top and in Judd Hollow. The upper unit of the Carmel Formation occurs in deep drainages on Flat Top, with the Winsor Member (of the Carmel Formation) occurring on the west slope of Cedar Mountain. The top of Cedar Mountain is characterized by mixed alluvial gravels.

Ecological systems:

The Upper Blue Pool Wash to Paria River Segment occurs entirely within the Colorado Plateau Ecological Region. Ecological systems occurring within the segment include: Active and Stabilized Dune, Blackbrush-Mormon-tea Shrubland, Grassland, Mixed Bedrock Canyon and Tableland, Mixed Desert Scrub, Mixed Low Sagebrush Shrubland, Pinyon-Juniper Woodland, Shrub-Steppe, and Colorado Plateau Wash. Invasive Upland

Vegetation also occurs in the segment. Ledges along the west side of the Paria River canyon support nearly total cryptobiotic cover of soils.

Invasive and noxious weeds:

Salsola tragus occurred in localized pockets on sand dunes, and *Tamarisk* spp. was encountered as a locally dominant species along the Paria River. Colonization of these noxious and invasive weeds is likely attributed to grazing. The presence of high densities of cryptobiotic soils likewise serve as evidence of a lack of grazing.

Impacts:

The establishment of access roads within the segment may provide a route for noxious and invasive weeds to colonize adjacent natural lands. Areas which are classified as Invasive Upland Vegetation could act as point sources for the introduction of invasive weeds. Access roads and disturbance associated with the proposed project may lead to the destabilization of sand dunes that occur within the segment, and may open up remote areas to off highway vehicle use.

Routing the proposed transmission line through habitat supporting sensitive cryptobiotic soils could result in damage to these highly sensitive soils.

Best management practices:

The following recommendations are BMPs of particular applicability to this segment. Further discussion of each is provided in Section 6.1 above.

Protect erosion prone land (BMP-G8)
Cover open trenches to prevent wildlife and livestock mortality or injury (BMP-G14)
Dispose of vegetation slash (BMP-G16)
Dispose of all construction waste (BMP-G17)
Revegetate disturbed soils (BMP-R/R1)
Install and maintain sediment and seed traps (BMP-R/R4)
Salvage topsoil (BMP-R/R6)
This segment is mostly comprised of sandsheet and sand dune topography, so salvageable soils are limited to those soils with cryptobiotic crust.
Prevent pollution discharge into streams and springs (BMP-RA2)
This includes two springs along the segment
Maintain livestock fencing and gates (BMP-SS4)
Control equipment movement in areas with noxious or invasive plants (BMP-IS10)

6.5.7 Segment 7: Flat Top to Cottonwood Canyon Road

Reach 8: BPS-3 Transmission Line South

Overview:

The Flat Top to Cottonwood Canyon Road would include a proposed transmission lineThe segment originates at Flat Top, and extends north to US 89 (at the Cottonwood Canyon Road junction). Lands occurring within the segment are owned by SITLA, with lands leased for cattle ranching. There were no special status species found in this segment. *Salsola tragus* was concentrated in localized areas where livestock gather, such as in watering areas and under shade trees. Occupied borrowing owl habitat was also encountered in the segment.

Description:

Route:

The Flat Top to Cottonwood Canyon Road Segment begins as a branch off of the Upper Blue Pool Wash to Paria River Segment. Fences, cattle guards and occasional branching roads are present, although no named landmarks exist. The segment ends at US 89 near the Cottonwood Canyon Road junction (5.7 miles from the start), where it joins the Big Water to Cottonwood Canyon Road Segment.

Land use history:

While no historical accounts were found specific to this segment, Sprangle (2007), and Altschul and Fairly (1989) write that the Arizona Strip ranchers managed water sources in the area, which is applicable to this segment, in which no natural water sources are known to occur. The establishment of an informal and open water policy encouraged use of the range. Among the competing users were cowboys that were driving stock west to markets, or moving stock from winter range to summer range and back.

Land ownership:

Prior to the establishment of the Grand Staircase-Escalante National Monument and the consolidation of SITLA in 1998, lands occurring within the Flat Top to Cottonwood Canyon Road segment were administered by the BLM. Today, these lands are owned by SITLA, with leased lands for cattle ranching.

Geology:

Mixed eolian and alluvial sands are represented in the segment as frequent sand dunes and sandsheets. Bedrock exposures also occur in the segment; in the southern half, the bedrock is infrequent, and comprised of the Upper Unit of the Carmel Formation; in the northern half, the bedrock is composed of Entrada Sandstone.

Ecological systems:

The Flat Top to Cottonwood Canyon Road Segment occurs entirely within the Colorado Plateau Ecological Region. The alternating sand dune and sandsheet topography supports vegetation classified as Active and Stabilized Dune, Blackbrush-Mormon-tea Shrubland, and Grassland (dominated by *Achnatherum hymenoides*). Also present within the segment are localized areas of Juniper Savanna, Mixed Desert Scrub, Pinyon-Juniper Woodland with diverse understories, and Shrub-Steppe. Invasive Upland Vegetation was also identified in the segment.

Impacts:

Areas which are classified as Invasive Upland Vegetation could serve as point sources for the spread of invasive weeds. The establishment and maintenance of along the proposed transmission line may provide a route for invasive weeds to colonize adjacent natural lands, and may also subject sand dunes to destabilization.

Best management practices:

The following recommendations are BMPs of particular applicability to this segment. Further discussion of each is provided in Section 6.1 above.

Protect erosion prone land (BMP-G8)
Revegetate disturbed soils (BMP-G12)
Dispose of vegetation slash (BMP-G16)
Dispose of all construction waste (BMP-G17)
Install and maintain sediment and seed traps (BMP-R/R4)

Salvage topsoil (BMP-R/R6)
Maintain livestock fencing and gates (BMP-SS4)
Control equipment movement in areas with noxious or invasive plants (BMP-IS10)

6.5.8 Segment 8: Lower Paria River to House Rock Valley Road

Reaches 2 and 5: Glen Canyon to Buckskin Transmission Line and

Glen Canyon to Buckskin Transmission Line North

Overview:

The Lower Paria River to House Rock Valley Road Segment encompasses two reach alternatives with the potential to include the placement of a proposed transmission line. The segment extends from the Paria River, across West Clark Bench, and over the Cockscomb, ending at House Rock Valley Road (Appendix F). Lands within the segment are managed by the BLM and administered as the Grand Staircase-Escalante National Monument. The geology occurring in the segment is diverse and complex, particularly at the Cockscomb. Pinyon-juniper woodlands, wooded shrublands and wooded sparse vegetation predominates the segment, except on dunes which are dominated by *Artemisia filifolia*. *Eriogonum corymbosum* var. *nilesii*, a special status species and candidate for federal listing, was confirmed. However, construction associated with the proposed project is not be expected to impact *E. corymbosum* var. *nilesii* individuals occurring within the segment, as these shrubs did not appear to extend into the potential area of impact. The segment was relatively free of invasive weeds.

Description:

Route:

The Paria River to House Rock Valley Road Segment begins at the end of the Upper Blue Pool Wash to Paria River Segment. The northern alternative reach crosses the Paria River at 0.0 miles and then runs west northwest. The southern alternative crosses over Calf Springs at 0.75 miles. Both alternatives then cross Long Canyon and the crest of the Cockscomb at 6.1 miles, then steeply descend to House Rock Valley Road, where the segment ends at 6.35 miles from the start.

Land use history:

There were no historic records found on land use specific to the canyon for this segment. Some records list a “Utah Arizona Road” through the Paria River canyon, but this is not confirmed, as the road would have had to traverse quicksand that occurs in the canyon. Adairville was established on the river near the state line in 1892, but was later abandoned (likely the result of frequent flooding). For more than 40 years, the Paria Canyon has been a popular location for day hiking and backpacking.

Geology:

The surface geology for the Paria River to House Rock Valley Road segment is from Doelling (2006) and Utah Geological Survey (n.d.). The walls of the Paria Canyon are Navajo Sandstone, while Long Canyon and the canyons in its vicinity are comprise of the Upper Unit of the Carmel Formation. Slickrock found in the vicinity of Calf Springs is Page Sandstone of Thousand Pockets Tongue. A small plateau and other areas of moderate slopes were mapped as alluvial gravel, but were field verified as sands. Mixed eolian and alluvial sands are represented in frequent sand dunes along the segment, most often occurring as narrow bands. At the Cockscomb, the geology becomes complex. From east to west, the formations are: a terrace comprised of sands rather than the mapped gravels, Navajo Sandstone, the main body of the Kayenta Formation, the Moenave Formation (at the access road switchbacks), badlands of the Petrified Forest Member of the Chinle Formation (only in the southern alternative route), and a mosaic of Moenkopi Formation with sands. The Upper Member of the Chinle Formation is also present.

Ecological systems:

The Paria River to House Rock Valley Road Segment occurs entirely within the Colorado Plateau Ecological Region. Ecological systems identified within the segment include: Active and Stabilized Dune, which is intermixed with Mixed Bedrock Canyon and Tableland throughout; Pinyon-Juniper Woodland (where dunes are wooded); Mixed Desert Scrub in degraded habitat; Shrub-Steppe; and Colorado Plateau Wash in canyon bottoms. A small area of Invasive Upland Vegetation was also identified at Calf Springs.

Special status plants:

Approximately 100 *Eriogonum corymbosum* var. *nilesii* plants were found where the segment crosses Long Canyon (in both of the proposed transmission line alternatives). Individuals were identified on the Upper Unit of the Carmel Formation, and on the Thousand Pockets Tongue of the Page Sandstone (although this formation also occurs around Calf Springs, no individuals were found there). At the west end of the segment, near the last dry wash before the slope to the Cockscomb, the geology may support *E. corymbosum* var. *nilesii*; however, this area was not surveyed. The best chance of finding potential plants would be to concentrate on canyons with outcrops comprised of the Thousand Pockets Tongue of Page Sandstone Formation, especially those where thin layers of gypsum are evident.

In addition to *Eriogonym corymbosum* var. *nilesii*, two other special status species were potentially encountered within the segment, *Lupinus caudatus* var. *cutleri* and *Penstemon laevis.* Confirmation of these species was not confirmed, as individuals were not in flower at the time of the survey (flowers containing distinct morphological characteristics are necessary for positive identification). Thirty-three potential *Lupinus caudatus* var. *cutleri* individuals were encountered east of Long Canyon. These plants were found on dune slopes below a ridge with northwestern exposure, and occurred in *Juniperus osteosperma*/*Artemisia filifolia* Sparse Woodland. Sixteen potential *Penstemon laevis* individuals were also encountered, also east of Long Canyon, in *Juniperus osteosperma*/*Shepherdia rotundifolia* Sparse Woodland. Judd Hollow Spring and an unnamed spring 0.4 miles to the east were surveyed for special status species with an affinity for springs and seeps, but no special status species were encountered.

Impacts:

The construction and maintenance of roads along the proposed transmission line alternatives could foster the colonization of invasive weeds into adjacent natural lands, and could open up remote areas to off-highway vehicle use. Sand dunes occurring within potentially impacted areas may also be subject to destabilization as a result of project related disturbance.

Best management practices:

The following recommendations are BMPs of particular applicability to this segment. Further discussion of each is provided in Section 6.1 above.

Protect erosion prone land (BMP-G8)

This BMP is particularly applicable to the potential *Lupinus caudatus* var. *cutleri* individuals encountered by the survey; this cluster of plants occurs below a sandy ridge; project construction may result in sand cascading down slope, burying the plants
Prevent stream bed modification (BMP-G12)
Cover open trenches to prevent wildlife and livestock mortality or injury (BMP-G14)
Dispose of vegetation slash (BMP-G16)
Dispose of all construction waste (BMP-G17)
Revegetate disturbed soils (BMP-R/R1)
In addition to revegetation of soils disturbed by proposed project activities, Calf Springs is degraded by cattle trespass, and has potential for restoration to a more natural plant community
Install and maintain sediment and seed traps (BMP-R/R4)
Salvage topsoil (BMP-R/R6)
Prevent pollution discharge into streams (BMP-RA2)
This BMP is also applicable to springs occurring within the segment
Salvage and transplant perennial special status plants (BMP-SS1)
Maintain livestock fencing and gates (BMP-SS4)
Control equipment movement in areas with noxious or invasive plants (BMP-IS10)

6.5.9 Segment 9: Cottonwood Canyon Road to Cockscomb

Reach 9: Hydro System

Overview:

The Cottonwood Canyon Road to Cockscomb Segment would include a potential pipeline and transmission line. The segment begins at Cottonwood Canyon Road and extends west along US 89, ending at the east side of the Cockscomb (Appendix F). Lands occurring in the segment are owned primarily by the BLM, and administered as the Grand Staircase-Escalante National Monument. There are various contiguous private tracts of land in the vicinity of the Paria River. The vegetation is highly variable across the segment. No special status species were encountered. *Salsola tragus* and *Tamarix* spp. both occurred as dominant species in localized areas within the segment.

Description:

Route:

The Cottonwood Canyon Road to Cockscomb Segment begins adjacent to US 89, at Cottonwood Canyon Road, and proceeds to the west. At 0.13 miles, the segment intersects the Flat Top to Cottonwood Canyon Road Segment. The segment crosses the West Clark Bench plateau, and becomes relatively level by 1.4 mile at East Cove. At 3.24 miles, the segment crosses the White House Trailhead Road and BLM Visitor Center access roads, at 3.86 miles, the segment crosses the Paria River, and then intersects the Long Canyon access road at 3.83 miles. After passing a guest ranch, the proposed pipeline and transmission line alignments would split, running both south and north of Johnson Store Butte (at 4.41 miles). They would rejoin after passing the Johnson Store Butte, and cross Sand Gulch at 6.31 miles while traversing West Cove. The segment ends at the east side of the road cut into the Cockscomb (at 6.99 miles).

Land use history:

Adairville was established on the river near the state line in 1892, but was later abandoned (likely the result of frequent flooding). The community of Pahreah was also settled on the northern banks of the Paria River, but was also abandoned. The segment parallels an early unimproved road which was known as the Paria Road, and originally extended to the Paria River. Subsequent to that, an unimproved road was extended east. Both reaches were realigned as Utah Highway 259, which was realigned as US 89 in 1960, and followed a new road cut through the Cockscomb.

Geology:

The surface geology for the Cottonwood Canyon Road to Cockscomb segment is from Doelling (2006) and Utah Geological Survey (n.d.). This segment occurs within the Kaiparowits Basin physiographic section (Doelling et al. 2000), and begins in mixed eolian and alluvial deposits, then crosses Entrada Sandstone atop the Rim Rocks. The Rimrocks cliffs and Johnson Store Butte monolith represent the Upper Unit of the Carmel Formation, which also outcrops near the Cockscomb and in Long Canyon (although there is some disagreement to this classification). West from the Rim Rocks decent, East Cove consists of mixed eolian and alluvial deposits, and the Paria River is composed of alluvium. The valley of West Cove contains mixed eolian and alluvial deposits, and the Thousand Pockets Tongue of Page Sandstone is represented where the segment ends at the Cockscomb.

Ecological systems:

The Cottonwood Canyon Road to Cockscomb Segment occurs entirely within the Colorado Plateau Ecological Region. A wide diversity of ecological systems have been classified within the segment, and include: Active and Stabilized Dune, Blackbrush-Mormon-tea Shrubland, Grassland, Greasewood Flat, Lower Montane Riparian Woodland and Shrubland (along the Paria River), Mixed Bedrock Canyon and Tableland, Mixed Desert Scrub, Pinyon-Juniper Woodland (in a localized area at the mouth of the Cockscomb), Shrub-Steppe, and a few areas of Colorado Plateau Wash. Agricultural lands were classified in the vicinity of the Paria River, and old fields identified as Invasive Upland Vegetation were dominated by *Salsola tragus*. Ruderal Vegetation was classified in reseeded areas along US 89.

Invasive and noxious weeds:

Adjacent to the Paria River and in washes, *Tamarix* spp. was locally common. *Salsola tragus* occurred in very high densities at three places along the segment: at 0.24 miles (west of the Flat Top Road junction), in Mixed Desert Scrub, the species was identified at over 11,000 plants per acre; at East Cove (1.17 miles east south-east of the Paria River crossing on US 89), in Blackbrush-Mormon tea vegetation, *S. tragus* occurred at over 8,400 plants per acre; and at 1.24 miles northwest of the Paria River crossing on US 89, in Mixed Desert Scrub, the species was encountered at an estimated 7,300 plants per acre.

Impacts:

Agricultural lands and areas classified as Invasive Upland Vegetation or Ruderal Vegetation could serve as point sources for the spread of invasive weeds. Additionally, the pipeline and transmission lines proposed within this segment could act as travel corridors for invasive weeds to colonize adjacent natural lands. Trenching and backfilling activities could also lead to erosion.

Best management practices:

The following recommendations are BMPs of particular applicability to this segment. Further discussion of each is provided in Section 6.1 above.

Protect erosion prone land (BMP-G8)
Protect wellheads from pollutants (BMP-G11)
Prevent stream bed modification (BMP-G12)
Cover open trenches to prevent wildlife and livestock mortality or injury (BMP-G14)

Dispose of all construction waste (BMP-G17)
Revegetate disturbed soils (BMP-R/R1)
Install and maintain sediment and seed traps (BMP-R/R4)
Salvage topsoil (BMP-R/R6)
Prevent pollution discharge into streams (BMP-RA2)
Maintain livestock fencing and gates (BMP-SS4)
Control equipment movement in areas with noxious or invasive plants (BMP-IS10)

6.5.10 Segment 10: Cockscomb to Kimball Valley

Reaches 9, 10, 4, and 12: Hydro System, BPS-3, Water Conveyance System, and the Paria Substation

Overview:

The Cockscomb to Kimball Valley Segment would be occupied by a proposed pipeline and transmission line. The segment starts at the east side of the Cockscomb and follows the alignment of US 89 west and north through Fivemile Valley, past the Paria Townsite Road junction, and ending near a substation in Kimball Valley. The segment primarily occurs within the boundaries of the Grand Staircase-Escalante National Monument, on lands administered by the BLM, although a number of large private tracts are also present. Three special status species were identified, including *Lupinus caudatus* var. *cutleri, Penstemon laevis*, and *Camissonia exilis*, and cryptobiotic soils are present within the segment. Noxious weeds encountered by the survey included *Convolvulus arvensis, Erodium cicutarium*, *Salsola tragus*, and *Tamarix* spp.

Description:

Route:

The Cockscomb to Kimball Valley Segment begins at the east side of the Cockscomb, and is a continuation of the Cottonwood Canyon to Cockscomb Segment. From the Cockscomb, the segment continues east through the US 89 road cut, crosses Five Mile Valley, and passes the junction of the House Rock Valley Road at 1.0 mile. Continuing north through Fivemile Valley, at 4.05 miles, the segment reaches the junction of the Fivemile Valley to Kimball Valley Segment. At the junction of these two segments, a road leads northeast to the proposed Paria Substation. The segment reaches its northern-most point at 5.8 miles, near the junction with the Paria Townsite road, and ends at 7.52 miles.

Land use history:

The Cockscomb to Kimball Valley Segment parallels the historic Paria Road, a pioneer road that connected Kanab and Pareah (a settlement on the Paria River) (Barnes 1988). The road branched along Fivemile Valley, then through the Cockscomb to the community of Adairville. The Paria Road remained the major travel route until Utah Route 259 was built to service the construction of Glen Canyon Dam. In 1960, Utah Route 259 was realigned as US 89. The Radiance uranium mines were also located in the segment, 0.40 miles north of the junction of House Rock Valley Road and US 89. This mine was developed prior to World War I, in order to exploit fractures coated with radioactive minerals in the Moenave Formation sandstones (Doelling et al. 2000). Mining ceased in about 1973. Two wildfires also occurred in the segment, one prior to 1993, and the other prior to 2009. The former fire crossed US 89 to the west, burning areas presently classified as Invasive Upland Vegetation. Lands within this segment were also utilized for grazing, which still continues.

Geology:

The surface geology for the Cockscomb to Kimball Valley segment is from Doelling (2006) and Utah Geological Survey (n.d.). This pipeline segment lies within the Grand Staircase physiographic section. The Cockscomb serves as the boundary between the Grand Staircase and Kaiparowits Basin section, and consists of sharply-folded downward strata occurring along the East Kaibab monocline (Doelling et al. 2000). Also represented in the segment are Eolian sand deposits, relatively recent alluvium deposits, and alluvial deposits. Bedrock consists of Page Sandstone, Thousand Pockets Tongue, Navajo Sandstone, Kayenta Formation, Judd Hollow Tongue of Carmel Formation, Timpoweap Member of the Moenkopi Formation, Shnabkaib Member of the Moenkopi Formation, Middle Red Member of the Moenkopi Formation, Lower Red Member of the Moenkopi Formation, and the Upper Member of the Chinle Formation.

Ecological systems:

The Cockscomb to Kimball Valley Segment occurs entirely within the Colorado Plateau Ecological Region, and includes the following ecological systems: Active and Stabilized Dune, Big Sagebrush Shrubland, Blackbrush-Mormon-tea Shrubland, Juniper Savanna, Mixed Bedrock Canyon and Tableland, Mixed Desert Scrub, Pinyon-Juniper Woodland, and Colorado Plateau Wash. Dunes dominated by *Juniperus osteosperma*, and Blackbrush-Mormon-tea Shrubland dominated by *Artemisia filifolia* are centered in Fivemile Valley around an existing GarKane Energy Cooperative substation. Pinyon-Juniper Woodlands occur primarily on rocky outcrops of Fivemile Mountain. Woodlands are dominated by *Juniperus osteosperma* with a wide variety of understory shrubs as co-dominants, and the Colorado Plateau Wash systems are comprised of a combination of *Ericameria nauseosa*, *Juniperus osteosperma* and *Artemisia tridentata* dominated vegetation. Cryptobiotic soils are present, and support habitat for *Camissonia exilis*. Invasive Upland Vegetation and Ruderal Vegetation are also located in the segment.

Special status plants:

Three special status plants were encountered in the Cockscomb to Kimball Valley Segment. *Lupinus caudatus* var. *cutleri* was identified in a sand dune. A sandy-bottomed dry wash also supported both *L. caudatus* var. *cutleri*, and *Penstemon laevis. Camissonia exilis* was encountered growing on cryptobiotic soil on an outcrop of the Middle Red Member of the Moenkopi Formation, along the east-facing side of Five Mile Valley.

Invasive and noxious weeds:

Erodium cicutarium and *Salsola tragus* were pervasive throughout the segment. Invasive Upland Vegetation occurs in overgrazed areas in Fivemile Valley, which was dominated by *E. cicutarium* and *S. tragus* at the time of the survey. Invasive Upland Vegetation was also classified in a location where the Utah 259 alignment crosses US 89. Juniper Savanna ecological systems occurring within the segment are semi-natural, with understory vegetation dominated by *S. tragus*. Re-seeded right-of-ways occurring along US 89 are classified as Ruderal Vegetation, and at one location, *Convolvulus arvensis* was noted. *Tamarix* spp. was also identified in a dry wash south of the GarKane substation.

Impacts:

Areas categorized as Invasive Upland Vegetation and Ruderal Vegetation may act as point sources for the spread of invasive weeds. Disturbance associated with the proposed project may foster the colonization of invasive weeds into adjacent natural areas. Routing the proposed pipeline and transmission line through habitat supporting special status species could adversely impact the viability of groups occurring within proposed affected areas, and could damage highly sensitive cryptobiotic soils. Trenching and other construction activities may lead to erosion.

Best management practices:

The following recommendations are BMPs of particular applicability to this segment. Further discussion of each is provided in Section 6.1 above.

Protect erosion prone land (BMP-G8)
Protect wellheads from pollutants (BMP-G11)
Prevent stream bed modification (BMP-G12)
Cover open trenches to prevent wildlife and livestock mortality or injury (BMP-G14)
Minimize raptor perching on transmission line poles (BMP-G15)
Dispose of vegetation slash (BMP-G16)
Dispose of all construction waste (BMP-G17)
Revegetate disturbed soils (BMP-R/R1)
Install and maintain sediment and seed traps (BMP-R/R4)
Salvage topsoil (BMP-R/R6)
Prevent pollution discharge into streams (BMP-RA2)
Salvage and transplant perennial special status plants (BMP-SS1)
Avoidance of gypsum badlands with special status plants (BMP-SS3)
This includes areas with cryptobiotic soils, whether or not they are classified as gypsum badlands.
Maintain livestock fencing and gates (BMP-SS4)
Control equipment movement in areas with noxious or invasive plants (BMP-IS10)

6.5.11 Segment 11: Fivemile Mountain Road

Reach 2: Glen Canyon to Buckskin Transmission Line and

Reach 5 Glen Canyon to Buckskin Transmission Line North

Overview:

A transmission line would occupy this segment. The Fivemile Mountain Road segment roughly follows Fivemile Mountain Road from its junction with House Rock Valley Road to its junction with US 89 (Appendix F). Land ownership is by the BLM administered as the Grand Staircase-Escalante National Monument. The vegetation is primarily Pinyon-Juniper Woodland with burned and chained areas of herbaceous vegetation on the western end. No special status plants were located in this segment. *Salsola tragus* dominates around a stock pond in the western end of the segment.

Description:

Route:

The Fivemile Mountain Road segment is a continuation of the Paria River to House Rock Valley Road segment. The proposed alignment would parallel an existing transmission line. There are two proposed alternative transmission line alignments within this segment: the Glen Canyon to Buckskin Transmission Line and the Glen Canyon to Buckskin Transmission Line North. The segment tends northwest up Fivemile Mountain. The segment would end at US 89, 6.0 miles from the start; from here it would continue on as the Kimball Valley to Telegraph Flat pipeline segment.

Land use history:

No references were found on land use history specific to this segment. The eastern end of the segment has had trees removed under the existing transmission line. The western end of the segment had been subject to chaining of pinyon-juniper and/ or impacted by wildfires; both of these had large areas of herbaceous vegetation.

Geology:

The geologic formations are relatively recent alluvium deposits; alluvial gravels, undifferentiated; Timpoweap Member of the Moenkopi Formation; Middle Red Member of the Moenkopi Formation; Lower Red Member of the Moenkopi Formation; and Undifferentiated Moenkopi Formation.

Ecological systems:

All of the ecological systems in this segment are in the Colorado Plateau Ecological Region. They include: Active and Stabilized Dune dominated by *Artemisia filifolia*, Big Sagebrush Shrubland, Mixed Desert Scrub, and Pinyon-Juniper Woodland.

Invasive and noxious weeds:

There is an area dominated by *Salsola tragus* at a stock pond in the western end of the segment. This area is classified as Invasive Upland Vegetation.

Impacts:

Trees along the corridor below the transmission line might be pruned or removed entirely. This could result in fragmentation of deer habitat.

Establishing and maintaining roads along transmission line corridors provides a route for noxious and invasive weeds to colonize adjacent natural lands.

Creating access roads through sand dunes subjects the dunes to destabilization.

Best management practices:

The following recommendations are BMPs of particular applicability to this segment. Further discussion of each is provided in Section 6.1 above.

Protect erosion prone land (BMP-G8)
Cover open trenches to prevent wildlife and livestock mortality or injury (BMP-G14)
Dispose of vegetation slash (BMP-G16)
Dispose of all construction waste (BMP-G17)
Revegetate disturbed soils (BMP-R/R1)
Install and maintain sediment and seed traps (BMP-R/R4)
Maintain livestock fencing and gates (BMP-SS4)
Control equipment movement in areas with noxious or invasive plants (BMP-IS10)

6.5.12 Segment 12: Fivemile Valley to Kimball Valley

Reach 11: Buckskin to Paria Transmission Line

Overview:

A transmission line would occupy this segment. The Fivemile Valley to Kimball Valley segment begins along US 89 at the sand dunes in Fivemile Valley and parallels BLM Route 4195 and an existing transmission line for 2.3 miles as it travels west north-west across Fivemile Mountain to US 89 in the Kimball Valley (Appendix F). Land ownership is mostly by the BLM administered as the Grand Staircase-Escalante National Monument. There is a small area of private ownership at the start. There were no special status plants in this segment. *Erodium cicutarium* is the sole invasive species.

Description:

Route:

The Fivemile Valley to Kimball Valley transmission line segment connects the Paria substation in Fivemile Valley to the Water Conveyance System along the Kimball Valley to Telegraph Flat segment. It would provide a shorter route than following US 89 around the Paria Townsite Road turnoff.

Land use history:

No references were found on land use history specific to this segment. The trees below the existing transmission line were recently removed to keep them from reaching the transmission lines. The transmission line is at least two decades old.

Geology:

The name Buckskin Mountain is derived from the longer mountains which lie southwest of Fivemile Mountain. The segment begins in the Lower Red Member of the Moenkopi Formation and alluvial deposits. The slopes of Fivemile Mountain are the Timpoweap Member of the Moenkopi Formation. There is a large area of windblown sands at the top of the mountain. The geology on the west end of the segment is identical to the east end with the Lower Red Member of the Moenkopi Formation and alluvial deposits at the lowest point.

Ecological systems:

All of the ecological systems in this segment are in the Colorado Plateau Ecological Region. Most of the segment is classified as Pinyon-Juniper Woodland, dominated by *Juniperus osteosperma* with *Artemisia tridentata* commonly the understory shrub dominant. It transitions into Big Sagebrush Shrubland. The Colorado Plateau Wash is dominated by *Ericameria nauseosa*.

Invasive and noxious weeds:

Erodium cicutarium is the sole invasive species.

Impacts:

The proposed transmission line could widen the woodland opening of the existing transmission line corridor.

Trees along the corridor below the transmission line might be pruned or removed entirely. This could result in fragmentation of deer habitat.

Establishing and maintaining roads along transmission line corridors provides a route for noxious and invasive weeds to colonize adjacent natural lands.

Best management practices:

The following recommendations BMPs of particular applicability to this segment. Further discussion of each is provided in Section 6.1 above.

Protect erosion prone land (BMP-G8)
Cover open trenches to prevent wildlife and livestock mortality or injury (BMP-G14)
Dispose of vegetation slash (BMP-G16)
Dispose of all construction waste (BMP-G17)

Revegetate disturbed soils (BMP-R/R1)
Install and maintain sediment and seed traps (BMP-R/R4)
Maintain livestock fencing and gates (BMP-SS4)
Control equipment movement in areas with noxious or invasive plants (BMP-IS10)

6.5.13 Segment 13: Kimball Valley to Telegraph Flat

Reach 4: Water Conveyance System

Overview:

A pipeline and transmission line would occupy this segment. The Kimball Valley to Telegraph Flat segment parallels US 89 from the Kimball Valley to nearly Petrified Hollow Wash (Appendix F). Land ownership is mostly by the BLM administered as the Grand Staircase-Escalante National Monument (GSENM); with a minor inclusion of private land north of Jepson Ranch. Vegetation is predominately *Artemisia tridentata*, with *Juniperus osteosperma* woodlands and wooded shrublands on higher Moenkopi Formation soils. Special status plants occurring in this segment are *Camissonia exilis*, *Pediomelum epipsilum,* and *Lupinus caudatus* var. *culteri*. Noxious species along the segment includes *Erodium cicutarium*, *Salsola tragus*, *Tamarix* spp.*,* and *Halogeton glomeratus*.

Description:

Route:

The Kimball Valley to Telegraph Flat segment is a continuation of the Cockscomb to Kimball Valley segment. The segment begins at the junction with the Fivemile Valley to Kimball Valley segment and continues southwest along US 89. This segment intersects with the Fivemile Road segment at the junction of Fivemile Mountain Road and US 89; passes two quarries; and crosses Buckskin Gulch and Telegraph Wash. The Kimball Valley to Telegraph Flat segment continues along US 89 as the Telegraph Flat to Seaman Wash segment.

Land use history:

The Kimball Valley to Telegraph Flat segment parallels the old Paria Road; this transportation route was realigned when US 89 was completed in 1960. The closest old ranch to the segment is Jepson Ranch. The ranch land is still used for livestock grazing as well as deer management. For over two decades there has been deer habitat improvements (tree and shrub thinning) in localized areas of both *Artemisia tridentata* shrubland and *Juniperus osteosperma* woodland. The segment crosses a historic irrigation canal system; this canal was part of a large system pumping water from Seaman Spring in the upper reaches of Seaman Wash. It fed stock water tanks north and south of this segment from Clayhole Wash to School Section Ranch. The canal was not shown on the Telegraph Flat 15' topographic map issued in 1954, thus the increased grazing it afforded impacted the range after 1954. Prior to the canal it appeared that reservoirs captured rain and snow melt and were the primary ways of watering livestock. The distance to the nearest source of livestock water is directly related to range quality; as distances increased, the quantity and quality of forage required increased. The southwest end of Telegraph Flat is the furthest from water.

Geology:

According to the geological road guide to the GSENM (Doelling et al. 2000), this segment is within the Grand Staircase physiographic section of GSENM. It has poor representations of the Middle Red Member of the

Moenkopi Formation. This is reflected in the vegetation by a lack of areas classified to the Colorado Plateau Gypsum Badlands Ecological Systems.

The surface geology of the Kimball Valley to Telegraph Flat segment is based on Doelling et al. (2006) and Utah Geological Survey (n.d.). Nearly half the segment was alluvial soils, including Intermediate aged and relatively recent alluviums. Equal amounts were in two different Moenkopi Formations the Middle Red Member and the Lower Red Member. Minor acreages occurred of young alluvium at Buckskin Gulch, the Shnabkaib Member of the Moenkopi Formation near the end of the segment and the Timpoweap Member of the Moenokopi Formation at the start of the segment.

Any plant found on relatively recent alluviums means they colonized there after 1200 AD, since these alluvial deposits date from 1200 to 1880 AD. For LPP project areas in Kane County, the special status species found on these relatively recent alluviums include: *Camissonia exilis*, *Pediomelum epipsilum*, *Phacelia pulchella* var. *atwoodii*. Adjacent to recent alluviums along this segment are Lower Triassic era units and the Shnabkaib member of the Moenkopi Formation. These 250-256 million year old formations are where gypsum badlands can typically be found. *Camissonia exilis*, *Pediomelum epipsilum*, and *Phacelia pulchella* var. *atwoodii* were most commonly found in the Middle Red Member of the Moenkopi Formation and Shnabkaib Member of the Moenkopi Formation.

Comparing the relative frequency of occurrence for these plants from project surveys done in the Middle Red Member of the Moenkopi Formation/Shnabkaib Member of the Moenkopi Formation versus recent alluviums, *Pediomelum epipsilum* was much more likely to be found in the older geologic strata mapped as the Middle Red Member of the Moenkopi Formation or Shnabkaib Member of the Moenkopi Formation. *Phacelia pulchella* var. *atwoodii* was more likely in Middle Red Member of the Moenkopi Formation/Shnabkaib Member of the Moenkopi Formation. *Camissonia exilis* equally likely in Middle Red Member of the Moenkopi Formation/Shnabkaib Member of the Moenkopi Formation vs. the younger recent alluviums. Comparing plant densities, all three were much more likely to occur on Middle Red Member of the Moenkopi Formation/Shnabkaib Member of the Moenkopi Formation versus recent alluviums, indicating that the older geological substrates were the preferred habitats for these species.

Ecological systems:

All of the ecological systems were in the Colorado Plateau Ecological Region. The greatest amount of acreage was in Big Sagebrush Shrubland, which was typically in flats and valley bottoms, including the Colorado Plateau Wash Ecological System. Pinyon-Juniper Woodland occurred in the southwest end of the segment, with an additional minor area near the Fivemile Road junction. Mixed Low Sagebrush Shrubland was limited to shallow limestone soils at Buckskin Gulch. Mixed Desert Scrub was a minor component of the vegetation communities. Areas of herbaceous vegetation dominanced by *Salsola tragus* were mapped as Invasive Upland Vegetation. Ruderal Vegetation was along the right-of-way of US 89, reflecting the result of a reseeding of the highway right-of-way.

Special status plants:

Over 150 *Camissonia exilis* were found along the Kimball Valley and Telegraph Flat segment. They occurred in *Artemisia tridentata* Shrubland in the Colorado Plateau Big Sagebrush Shrubland Ecological System.

Lupinus caudatus var. *culteri* was identified in this segment at Sand Gulch. Surveys identified 20 plants growing in the *Artemisia tridentata* ssp. *tridentata* Shrubland Alliance within the Colorado Plateau Wash Ecological System. Individuals were at the base of a reddish sand dune, from either the Cutler or Moenkopi formations.

Pediomelum epipsilum were found in *Artemisia tridentata* dominated shrubland, near a well and a concentration of stock ponds along Telegraph Wash. *Pediomelum epipsilum* is most abundant in *Juniperus osteosperma* woodlands on high clay content soils which fracture into blocks when dry. However, there are also hundreds of plants in *Artemisia tridentata* ssp. *tridentata* shrubland. They are both in and outside the US 89 right-of-way, immediately north of the Jepson Ranch tract. Further discussion on these taxa is available in Chapter 4.

Invasive and noxious weeds:

Erodium cicutarium and *Salsola tragus* were pervasive along this segment. *Tamarix* spp. was occasionally found along the highway, especially at Buckskin Gulch. That area was heavily grazed and also has *Halogeton glomeratus*.

Impacts:

Disturbing areas that are classified as Invasive Upland Vegetation could result in the spread of noxious and invasive weeds.

Routing the pipeline through special status plant habitat could adversely impact the species.

This segment will parallel the right-of-way of US 89. Impacts from construction could be minimized if widening the right-of-way into adjacent gypsum badland special status plant habitat is minimized.

The pipeline crossing at Buckskin Gulch is in soils which are heavily eroded and the wash channel incised. Precautions should be taken to stabilize the banks where the pipeline cross the wash or was buried.

Filling a pipeline trench could require revegetation, but can lead to a channel for erosion.

Best management practices:

The following recommendations are BMPs of particular applicability to this segment. Further discussion of each is provided in Section 6.1 above.

Protect erosion prone land (BMP-G8)
Prevent stream bed modification (BMP-G12)
Cover open trenches to prevent wildlife and livestock mortality or injury (BMP-G14)
Dispose of vegetation slash (BMP-G16)
Dispose of all construction waste (BMP-G17)
Revegetate disturbed soils (BMP-R/R1)
Install and maintain sediment and seed traps (BMP-R/R4)
Salvage topsoil (BMP-R/R6)
Prevent pollution discharge into streams (BMP-RA2)
Salvage and transplant perennial special status plants (BMP-SS1)
Pediomelum epipsilum are located in the footprint of the pipeline
Avoidance of gypsum badlands with special status plants (BMP-SS3)
Maintain livestock fencing and gates (BMP-SS4)
Control equipment movement in areas with noxious or invasive plants (BMP-IS10)

6.5.14 Segment 14: Telegraph Flat to Seaman Wash

Reach 15: Hydro System Existing Highway Alternative

Overview:

A pipeline and a transmission line would occupy this segment. The Telegraph Flat to Seaman Wash segment parallels US 89, for 3.9 miles, from Telegraph Flat to Seaman Wash (Appendix F). Land ownership is fully BLM, administered as the Grand Staircase-Escalante National Monument. The vegetation is mostly *Juniperus osteosperma* and *Artemisia tridentata* woodland and shrublands, both are found on gypsum badlands. *Camissonia exilis* and *Pediomelum epipsilum* are present as special status plants. *Erodium cicutarium*, *Salsola tragus*, *Halogeton glomeratus* and *Tamarix* spp. are present as noxious species.

Description:

Route:

The Telegraph Flat to Seaman Wash segment is the continuation of the Kimball Valley to Telegraph Flat segment. The West of Telegraph Wash south of US 89 east of Petrified Hollow segment lies to the south and intersects this segment at three points. Also intersecting the segment is the Seaman Wash to Eightmile Gap Road segment. The Telegraph Flat to Seaman Wash segment ends at the Seaman Wash to Eightmile Gap Road at US 89 segment.

Land use history:

The Telegraph Flat to Seaman Wash segment occupies the same general area as the Old Spanish Trail; Honeymoon Trail; and Kanab to Pareah and Kanab to Adairville historical roads. From eastern Arizona to St. George, Utah, the Honeymoon Trail was the route taken by Latter-day Saints from Arizona who wanted to marry in the St. George Temple. The Honeymoon Trail was one of many historic trails which served to disperse plants through the Arizona Strip. Presently the US 89 right-of-way has a distinctively different disturbance regime than the surrounding landscape. This is because a wide area of the right-of-way has been fenced from cattle for at least two decades.

Geology:

Sable and Hereford (2004) delineate two types of Quaternary alluvial deposits in the area covered by the Kanab 30x60’ geologic quadrangle. One includes Quaternary (Holocene) pre-1880 alluvial deposition from floods and the other is Quaternary (Holocene) post-1880 alluvial deposition. This distinction shows there were flash floods washing out of the canyons along the Vermillion Cliffs before Anglo settlement and they presently look different in cross sections. Therefore, we can see how severe the stream erosion has been since 1880.

Also found within the segment are the Shnabkaib Member of the Moenkopi Formation and Middle Red Member of the Moenkopi Formation. The latter is associated with gypsum badlands and is the primary habitat for the special status plants.

Ecological systems:

All of the ecological systems are in the Colorado Plateau Ecological Region. These include: Big Sagebrush Shrubland, Gypsum Badlands dominated by *Juniperus osteosperma* and *Artemisia tridentata*, Lower Montane Riparian Woodland and Shrubland dominated by *Tamarix* spp., Pinyon-Juniper Woodland and Wash dominated by *Ericameria nauseosa* and *Artemisia tridentata*. There is also abundant Ruderal Vegetation along the US 89 right-of-way.

Special status plants:

There are two special status plants in this segment: *Camissonia exilis* and *Pediomelum epipsilum*. The *Camissonia* is found on alluvial soils in *Artemisia tridentata* shrublands. The *Pediomelum* is most abundant in *Juniperus* *osteosperma* woodlands on high clay content soils. Further discussion on these taxa within this segment is available in Chapter 4.

Invasive and noxious weeds:

Erodium cicutarium and *Salsola tragus* are pervasive along this segment. *Halogeton glomeratus* and *Tamarix* spp. are also present.

Impacts:

Disturbing areas that are classified as Invasive Upland Vegetation could result in the spread of noxious and invasive weeds.

Routing the pipeline through special status plant habitat could adversely impact the species.

Filling a pipeline trench could require revegetation, but can lead to a channel for erosion.

Best management practices:

The following recommendations are BMPs of particular applicability to this segment. Further discussion of each is provided in Section 6.1 above.

Protect erosion prone land (BMP-G8)
Protect wellheads from pollutants (BMP-G11)
Prevent stream bed modification (BMP-G12)
Cover open trenches to prevent wildlife and livestock mortality or injury (BMP-G14)
Dispose of vegetation slash (BMP-G16)
Dispose of all construction waste (BMP-G17)
Revegetate disturbed soils (BMP-R/R1)
Install and maintain sediment and seed traps (BMP-R/R4)
Salvage topsoil (BMP-R/R6)
Prevent pollution discharge into streams (BMP-RA2)
Salvage and transplant perennial special status plants (BMP-SS1)
Avoidance of gypsum badlands with special status plants (BMP-SS3)
Maintain livestock fencing and gates (BMP-SS4)
Control equipment movement in areas with noxious or invasive plants (BMP-IS10)

6.5.15 Segment 15: West of Telegraph Wash south of US 89 to east of Petrified Hollow

Reach 14: Hydro System High Point Alignment Alternative and

extensions to Hydro System

Overview:

A pipeline and a transmission line would occupy this segment. The West of Telegraph Wash south of US 89 to east of Petrified Hollow segment follows an abandoned state highway which preceded US 89 (Appendix F). It offers a lower elevation pipeline route which eliminates the need for a pumping station at the Cockscomb. Land ownership is BLM, administered as the GSENM. The vegetation of this segment is primarily pinyon-juniper woodland and sagebrush. It is a major deer migration corridor, with vegetation managed in some areas to increase browse. A regulating tank and alternate pumping station are proposed along the segment in special status plant habitat. Three special status plant species, *Pediomelum epipsilum, Camissonia exilis* and *Phacelia pulchella* var.

atwoodii are found in large numbers throughout the segment, mostly in areas where there are gypsum badlands geologically associated with the Moenkopi Formation. Three invasive weeds occurred within the segment; *Convolvulus arvensis, Asclepias subverticillata,* and *Salsola tragus* are present as dominants in Invasive Upland Vegetation.

Description:

Route:

The West of Telegraph Wash south of US 89 to east of Petrified Hollow segment begins on the southeastern side of US 89, along the Kimball Valley to Telegraph Flat segment at the intersection of a short, unnamed graded road connecting the segment to the former roadbed of Utah State Route (SR) 136. There is an inactive aggregate quarry on the opposite side of the connector road which acts as a weed source. The segment abruptly turns to the southwest and follows the former route of Utah SR 136. At 2.3 miles, the segment reaches the proposed High Point Regulating Tank site. At 3.2 miles, the segment reaches its high point at 5,626 feet elevation, where it crosses a ridge representing the hydrologic divide between the Petrified Hollow and Telegraph Wash drainages. The segment crosses a historical irrigation canal system here. This canal system transported water from the Petrified Hollow and Telegraph Wash drainages into stock water tanks northeast of the crossing, as well as along the White Sage Wash drainage to the south of the remainder of the segment.

An alternate hydro station is proposed 3.5 miles from the start of the segment. At 5.3 miles from the segment start, a 0.6 mile segment branches off to the northwest along BLM Route 4000. This short branch ends at US 89. This branch represents the last passable road connection to US 89 from this segment. Thereafter, the segment would continue on the old Utah SR 136 for 1.8 miles as a cinder roadbed with washed out bridges. This segment ends 1.8 miles west of the junction of the aforementioned branch and 6.9 miles from the segment start; the segment continues as the Telegraph Flat to Seaman Wash Segment. There is a 0.2 mile connector to the northeast which is actually an extension of the Seaman Wash to Eightmile Gap Road segment. It is included here as a matter of convenience.

Land use history:

Buckskin Mountain lies to the southeast of this segment. It was named by early settlers because it was a traditional source for Navajos and other tribes for mule deer buckskin (Barnes 1988). Hods Ranch and School Section Ranch are the closest ranches. Both are approximately one mile south of the segment. Jepson Ranch is one mile east of the beginning of the segment. There were no historical accounts found for these ranches. While none were found to be occupied, the land is still used for livestock grazing as well as deer management. For over two decades there has been deer habitat improvements in localized areas of both *Artemisia tridentata* shrubland and *Juniperus osteosperma* woodland.

Geology:

The northeastern part of this segment lies along a boundary between the Shinarump Flats and Buckskin Mountain physiographic regions (Doelling 2008). Scattered along the survey area there are remnants of various members of the Moenkopi Formation. The hills, low knolls and ridges of these Moenkopi members resisted the erosion which left the flatter areas of this segment with alluvial deposited soils, mapped geologically as Quaternary Deposits – Alluvium (Doelling 2008). Near Telegraph Wash is the Lower Red Member of the Moenkopi Formation, followed by the Timpoweap Member of the Moenkopi Formation along the hilly lands adjacent to the eastern side of the road. Further southwest along the segment are Middle Red Member outcrops with some of the highest populations of the three special status plant species found on the segment (see below). Additional Middle Red

Member outcrops harbor localized population of these plants near the western terminus of this segment adjacent to US 89.

Ecological systems:

This segment lies entirely in the Colorado Plateau Ecological Region and has the following ecological systems: Big Sagebrush Shrubland, Gypsum Badlands, Pinyon-Juniper Woodland, Mixed Desert Scrub, and Colorado Plateau Wash.

The *Artemisia tridentata* ssp. *vaseyana* shrubland along this route is managed to increase deer browse, primarily through thinning of invading *Juniperus osteosperma*. While the irrigation canal system has been abandoned, the land is still used for cattle grazing, with some areas having been re-seeded to *Agropyron desertorum*. However, the range condition along the corridor appears to be fair to poor, with little available forage for cattle.

The alluvial soils typically support Big Sagebrush Shrubland or Mixed Desert Scrub Ecological Systems. The Moenkopi Formation soils are in the Gypsum Badlands and Pinyon-Juniper Woodland Ecological Systems. The segment is dissected by dry washes, classified as Colorado Plateau Wash. The *Pinus edulis - Juniperus osteosperma/Chrysothamnus greenei/Pediomelum epipsilum* Gypsum Badland Woodland association is unique to this segment and represents a 16 acre area with many dense populations of *Pediomelum epipsilum*.

Special status plants:

The Moenkopi Formation provides the optimum geologic substrate for the special status plants which are found in this segment: *Pediomelum epipsilum, Camissonia exilis* and *Phacelia pulchella* var. *atwoodii*. This segment harbors the greatest numbers of these three taxa. Further discussion on these populations is provided in Chapter 4.

Invasive and noxious weeds:

Noxious species are generally restricted to the areas with abandoned quarries, the heaviest grazing pressure, highest road disturbance, or in incised drainages which are actively eroding. These are centered on shrublands dominated by *Krascheninnikovia lanata* or sagebrush near the canal crossing, southwest to Petrified Wash. *Salsola tragus* locally dominates sagebrush stands between 10 to 25 percent cover. *Salsola tragus* develops a rosette of leaves from spring rains and either dies out in the absence of sufficient late spring to summer rains, or flowers when there are such rains. This can deplete the soil moisture necessary for native plants to survive through the summer. *Convolvulus arvensis* is found in graded depressions and adjacent areas along the graded roads near Petrified Wash and the aqueduct.

Impacts:

Establishing and maintaining roads along the pipeline and transmission line provide a route for invasive weeds to colonize adjacent natural lands. Additionally, *Convolvulus arvensis* and *Asclepias subverticillata* can easily spread onto compacted soils through road grading.

Disturbing areas that are classified as Invasive Upland Vegetation could result in the spread of noxious and invasive weeds.

Routing the pipeline through special status plant habitat could adversely impact the species.

Filling a pipeline trench could require revegetation, but can lead to a channel for erosion.

Construction that occurs within eroded badlands topography of the Moenkopi Formation, as well as soils with intact cryptobiotic crusts could impact *Camissonia exilis* and *Phacelia pulchella* var. *atwoodii* that attain their highest densities on soils with gypsum present – a characteristic of the Moenkopi Formation and intact cryptobiotic crusts. The Middle Member of the Moenkopi is the most gypsum rich of any member, thus the habitat is more prone to construction impacts to *Camissonia exilis* and *Phacelia pulchella* var. *atwoodii*. However, gypsum rich soils were the least likely in the project area to have invasive species. Thus the risk was low of competition for invasive species limiting *Pediomelum epipsilum*, *Camissonia exilis* and *Phacelia pulchella* var. *atwoodii* populations after pipeline construction.

Best management practices:

The following recommendations are BMPs of particular applicability to this segment. Further discussion of each is provided in Section 6.1 above.

Protect erosion prone land (BMP-G8)
Cover open trenches to prevent wildlife and livestock mortality or injury (BMP-G14)
Dispose of vegetation slash (BMP-G16)
Dispose of all construction waste (BMP-G17)
Revegetate disturbed soils (BMP-R/R1)
Install and maintain sediment and seed traps (BMP-R/R4)
Salvage topsoil (BMP-R/R6)
Salvage and transplant perennial special status plants (BMP-SS2)
Avoid gypsum badlands with special status plants (BMP-SS4)
Maintain livestock fencing and gates (BMP-SS5)
Control equipment movement in areas with noxious or invasive plants (BMP-IS10)

6.5.16 Segment 16: Seaman Wash to Eightmile Gap Road

Reach 16: Hydro System South Alternative

Overview:

A pipeline and a transmission line would occupy this segment. The Seaman Wash to Eightmile Gap Road segment begins at three different points along US 89. The three join in two locations along Seaman Wash, than continue as one segment southwest to the junction with Eightmile Gap Road near Johnson Wash (Appendix F). The vegetation is predominately *Artemisia tridentata* shrubland, with a mix of *Juniperus osteosperma* in the north where the segment branches away from Seaman Wash. There are large patches of burned shrubland in the central and southern parts of the segment, where *Gutierrezia sarothrae* replaces *Artemisia*. Land ownership is predominately BLM, except for private ownership parcels on the western-most branch. At the extreme north end, the BLM administered the land as the GSENM. There were four special status plants (*Camissonia exilis*, *Pediocactus sileri*, *Phacelia pulchella* var. *atwoodii*, and *Pediomelum epipsilum)* and two noxious plants (*Salsola tragus* and *Erodium cicutarium*) found along this segment.

Description:

Route:

The Seaman Wash to Eightmile Gap Road segment is 9.6 miles long. At the north end it is a continuation of the West of Telegraph Wash south of US 89 to east of Petrified Hollow segment, the Telegraph Flat to Seaman Wash segment, and the Seaman Wash to Eightmile Gap Road at US 89 segment. Along the southwesterly course it follows the White Sage Wash and Johnson Run twin drainages in the valley. It ends at the junction of the

Eightmile Gap Road at US 89 to Johnson Run segment and Eightmile Gap Road to Kanab Creek Canyon segment.

Land use history:

Geologist H.E. Gregory photographed the northern end of this segment in 1944, from a viewpoint atop the Shinarump Cliffs southeast of Navajo Well. It shows similar vegetation patterning to the present, except that Seaman Wash has become deeply incised. The floodplain is dominated by sagebrush with shrub-less openings presently invasive annuals dominate and were potentially caused by siltation after overbank flows and flash flooding. The woodland canopies appear fuller than present on the remnant Moenkopi Formation hills east of the wash.

White Sage Wash parallels Seaman Wash in the northern part of the segment. It was "so called because it runs almost its entire length through a vast white sage flat" (Barnes 1988). Presently, white sage has been almost totally grazed and burned out of the valley.

Geology:

This segment has incorrect geologic mapping in the T_and_E_Geology_Clipped_ALL shapefile, especially in regards to under mapping and simplifying the members of Moenkopi Formation. The following strata are mapped on the more detailed Kanab 30 by 60 foot (Doelling et at. 2006) and Fredonia 30 by 60 foot (Billingsley et al. 2008) digital geologic quadrangles: Middle Red Member of the Moenkopi Formation; Upper Red Member of the Moenkopi Formation; Shnabkaib Member of the Moenkopi Formation; Shinarump Member of the Moenkopi Formation; Young terrace-gravel deposits and the younger; Young alluvial fan deposits; and Stream-channel deposits.

Ecological systems:

Agriculture is a frequent land use in this segment. All of the ecological systems in this segment are in the Colorado Plateau Ecological Region. These include: Big Sagebrush Shrubland, Grassland, Gypsum Badlands, Lower Montane Riparian Woodland and Shrubland, Mixed Desert Scrub, Pinyon-Juniper Woodland, Shrub-Steppe, and Colorado Plateau Wash.

Big Sagebrush Shrubland is almost exclusively dominated by *Artemisia tridentata* ssp. *vaseyana*. Grassland is dominated by *Pleuraphis jamesii*. Gypsum Badlands exhibit a variety of dominants and physiognomy types. Where wooded they are dominated by *Juniperus osteosperma*, often with *Artemisia tridentata* in the understory. Where shrublands, they are commonly dominated by *Eriogonum corymbosum* var. *corymbosum.* Shrub-Steppe is exclusively degraded vegetation with Gutierrezia *sarothrae* shrub dominance and Pleuraphis jamesii at least locally dominant in the understory. Pinyon-Juniper woodlands occasional have *Pinus edulis* co-dominating with the ubiquitious *Juniperus osteosperma*. Their understory shrub strata is *Artemisia tridentata*, which is also the dominant in Colorado Plateau Washes.

Special status plants:

Camissonia exilis, *Pediocactus sileri*, *Phacelia pulchella* var. *atwoodii*, and *Pediomelum epipsilum* are the special status plants found in this segment. *Pediomelum epipsilum* occupies the Gypsum Badlands Ecological System, 0.4 miles southwest of the Arizona-Utah state line. It is also in an *Artemisia tridentata* ssp. *vaseyana* dominated dry wash at the southern end of the segment. *Pediocactus sileri* was found in young alluvial fan deposits, 0.1 miles south of the edge of Middle Red Member of the Moenkopi Formation. It is close enough to be in a mud wash microhabitat where the muds originate within the Middle Red Member of the Moenkopi Formation outcrops upslope. The geologic and vegetation community affinities of *Camissonia exilis* and *Phacelia pulchella* var. *atwoodii* are not possible to determine since population censusing was performed over a variety of habitats and recorded as a total. Further discussion on these populations is provided in Chapter 4.

Invasive and noxious weeds:

Salsola tragus and *Erodium cicutarium* are pervasive in all but the gypsum badlands. Many of the areas classified as Invasive Upland Vegetation are dominated by *Salsola tragus*. The one area mapped as Lower Montane Riparian Woodland and Shrubland is semi-natural with *Tamarix* spp. dominant.

Impacts:

Establishing and maintaining roads along the pipeline and transmission line corridors provide a route for invasive weeds to colonize adjacent natural lands.

Creating access roads through sand dunes subjects the dunes to destabilization.

Disturbing areas that are classified as Invasive Upland Vegetation could result in the spread of noxious and invasive weeds.

The pipeline is aligned so that it would cut through the lower end of many gypsum badland ridges. Routing the pipeline through special status plant habitat could adversely impact the species.

The pipeline would be buried in highly eroded soils. Filling a pipeline trench can lead to a channel for erosion.

Construction roads would fragment lands where no roads presently exist. Creating pipeline and transmission tower access roads can open up remote areas to off highway vehicle use.

Best management practices:

The following recommendations are BMPs of particular applicability to this segment. Further discussion of each is provided in Section 6.1 above.

Protect erosion prone land (BMP-G8)
Prevent stream bed modification (BMP-G12)
Cover open trenches to prevent wildlife and livestock mortality or injury (BMP-G14)
Dispose of vegetation slash (BMP-G16)
Dispose of all construction waste (BMP-G17)
Revegetate disturbed soils (BMP-R/R1)
Install and maintain sediment and seed traps (BMP-R/R4)
Salvage topsoil (BMP-R/R6)
Prevent pollution discharge into streams (BMP-RA2)
Salvage and transplant perennial special status plants (BMP-SS1)
Avoid gypsum badlands with special status plants (BMP-SS4)
Maintain livestock fencing and gates (BMP-SS5)
Control equipment movement in areas with noxious or invasive plants (BMP-IS10)

6.5.17 Segment 17: Seaman Wash to Eightmile Gap Road at US 89

Reach 16: Hydro System South Alternative

Overview:

A pipeline and transmission line would occupy this segment. The Seaman Wash to Eightmile Gap Road at US 89 segment begins at Seaman Wash along US 89, parallels the highway, and ends at the junction with Eightmile Gap Road (Appendix F). Land ownership is mostly private land, with two small areas under the management jurisdiction of the BLM. There is a diversity of vegetation due in large part to many private owners and past land uses. Ground surveys were limited in coverage because of the acreage of private land. No special status plants were found. Three species of noxious or invasive plants were found; *Halogeton glomeratus*, *Elaeagnus angustifolia,* and *Tamarix* spp. are locally present along the segment.

Description:

Route:

The Seaman Wash to Eightmile Gap Road segment starts at Seaman Wash where the Telegraph Wash to Seaman Flat segment ends. At approximately 0.5 miles west on US 89, the segment crosses one of three alternates to the Seaman Wash to Eightmile Gap Road segment. Navajo Well is two-thirds of a mile to the southwest of the segment. The segment crosses both the road to The Seeps, a ranch 0.8 miles to the south and Johnson Wash at Hells Bellows. The segment also crosses Johnson Canyon Road; and terminates at the intersection of Eightmile Gap Road and US 89. The next segment that continues southwest is the Eightmile Gap Road at US 89 to Fredonia segment. The Eightmile Gap to Johnson Run segment also continues due south from this point.

Land use history:

Since the settlement of Johnson Canyon in 1871, this segment was either agriculture land, where irrigation water was available, or rangeland for grazing. Navajo Well was a major camp site along the Kanab to Pareah Road, as well as the Honeymoon Trail, appearing on many early maps of the region (US Geological Survey 1886). As a stop on livestock runs, the area around Navajo Well has had more grazing impact than areas without a year-round natural water source.

At Hells Bellows is a wide floodplain of Johnson Wash with recent alluvial deposition. North and south of where the segment crosses Johnson Wash are deeply incised arroyos. Bailey (1935) was the first scientist to write that the causes of erosion and channeling in places on the Colorado Plateau like Johnson Wash, were due to reduction and modification of plant cover. Johnson Wash continues south along subsequent survey segments and the flood water and overbank deposition of soils gets deeper with concurrent loss of perennial plant cover.

Geology:

Surface geology for this segment is based on Doelling et al. (2006). It is geologically simple with only Young alluvial fan deposits and the Petrified Forest Member of the Chinle Formation, except for a small area of the Shinarump Member of the Chinle Formation on top of the Shinarump Cliffs at Seaman Wash.

Ecological systems:

The ecological systems in this segment are classified within the Colorado Plateau Ecological Region. There is no correlation of vegetation to geologic mapping. The systems present include: Big Sagebrush Shrubland, Grassland, Lower Montane Riparian Woodland and Shrubland, Mixed Desert Scrub, Pinyon-Juniper Woodland, and Shrub-Steppe.

Big Sagebrush Shrublands are typically dominated by *Artemisia tridentata*, but occasionally also by *A. filifolia*. Grassland is rare and has *Hesperostipa comata* as dominant. Mixed Desert Scrub, as the name implies, has a wide variety of dominant shrubs, including: *A. filifolia*, *Atriplex canescens*, *Ericameria nauseosa* and *Gutierrezia sarothrae*. Pinyon-Juniper Woodland has an *A. tridentata* understory and is almost exclusively *Juniperus* *osteosperma*, rather than *Pinus edulis* and *J. osteosperma* dominated. Shrub-Steppe is rare and has *Ericameria nauseosa* shrub dominance with *Sporobolus cryptandrus* understory dominance.

There is extensive agricultural land including fallow lands classified as Invasive Upland Vegetation. The re-seeded right-of-way along US 89 is classified as Ruderal Vegetation.

Invasive and noxious weeds:

Salsola tragus and *Erodium cicutarium* are pervasive along this segment. Invasive Upland Vegetation includes areas variously dominated as *Helianthus annuus*, *Agropyron cristatum*, and *S. tragus*. *Helianthus annuus* was either introduced to the area in 1865-1872, or was cultivated by the Kaibab Paiutes prior to then (Fowler and Fowler 1971). *Halogeton glomeratus* is rarely found along US 89. *Elaeagnus angustifolia* is present at the segment junction with Johnson Canyon Road. *Tamarix* spp. are abundant at the segment crossing of Seaman Wash. Areas mapped as Lower Montane Riparian Woodland and Shrubland are all semi-natural, with *Tamarix* spp.or *Elaeagnus angustifolia* dominant.

Impacts:

Establishing and maintaining roads along the pipeline and transmission line corridors provide a route for invasive weeds to colonize adjacent natural lands.

Creating access roads through sand dunes subjects the dunes to destabilization.

Disturbing areas that are classified as Invasive Upland Vegetation could result in the spread of noxious and invasive weeds.

Filling a pipeline trench could require revegetation, but can lead to a channel for erosion.

Best management practices:

The following recommendations are BMPs of particular applicability to this segment. Further discussion of each is provided in Section 6.1 above.

Protect erosion prone land (BMP-G8)
Protect wellheads from pollutants (BMP-G11)
Prevent stream bed modification (BMP-G12)
Cover open trenches to prevent wildlife and livestock mortality or injury (BMP-G14)
Dispose of vegetation slash (BMP-G16)
Dispose of all construction waste (BMP-G17)
Revegetate disturbed soils (BMP-R/R1)
Install and maintain sediment and seed traps (BMP-R/R4)
Salvage topsoil (BMP-R/R6)
Prevent pollution discharge into streams (BMP-RA2)
Salvage and transplant perennial special status plants (BMP-SS1)
Avoidance of gypsum badlands with special status plants (BMP-SS4)
Maintain livestock fencing and gates (BMP-SS5)
Control equipment movement in areas with noxious or invasive plants (BMP-IS10)

6.5.18 Segment 18: US 89 to Thompson Point

Reach 17: Kane County Pipeline System

Overview:

A pipeline and transmission line would occupy this segment. The US 89 to Thompson Point segment extends 1.8 miles north and west from US 89 along Johnson Canyon Road (BLM Route 501; Appendix F). It is entirely on private land, some of which is long abandoned agricultural fields dominated by *Artemisia filifolia* and *A. tridentata*. An extension to the west follows a service road leading to a pinyon-juniper woodland with a water tank at the eastern base of Thompson Point. That extension is on a combination of private and BLM land. No special status plants were encountered in this segment. Three noxious plants are present; *Elaeagnus angustifolia* has been planted within the segment and *Salsola tragus* and *Erodium cicutarium* are pervasive in this segment.

Description:

Route:

The segment, as described above, extends north from a point along the Seaman Wash to Eightmile Gap Road at US 89 segment and terminates at Thompson Point.

Land use history:

A Mormon settlement named Johnson was established in Johnson Canyon in 1871 (Barnes 1988). It has remained a well populated, agricultural orientated canyon since then. It was named after William Derby Johnson Jr., who served as an assistant cartographer and botanical assistant for the Powell Survey in 1871. Johnson's diaries (Clawson n.d.) provide insights into the condition of the rangeland in 1871, noting that the condition of even the best grazing lands deteriorated when grazed.

Johnson Canyon Road follows the route of the historic road from Kanab to Johnson. This was designed as Utah Route 11 in the 1910s, it appears on maps as old as 1886 (US Geological Survey 1886), but likely began as a trail used as a mail route beginning in 1871 (Clawson n.d.).

Geology:

Surface geology for this segment is based on Doelling et al. (2006). In the lowest areas along Hells Bottoms is Quaternary (Holocene) pre-1880 alluvial deposition from floods. Progressively gaining in elevation, the mapping units are: Young alluvial fan deposits and small areas of the Petrified Forest Member of the Chinle Formation and Moenave Formation at the base of Thompson Point.

Ecological systems:

All of the ecological systems in this segment are in the Colorado Plateau Ecological Region. Pinyon-Juniper Woodland is limited to the base of Thompson Point on young alluvial fan deposits, the Petrified Forest Member of the Chinle Formation and Moenave Formation geology. The woodlands are dominated by *Juniperus osteosperma*. The Mixed Desert Scrub was on historically grazed pastures, typically dominated by *Artemisia filifolia* and sometimes *Atriplex canescens*. Big Sagebrush Shrubland with a mix of *Artemisia tridentata*, *Ericameria nauseosa* or *A. filifolia* was on long abandoned agricultural fields.

Special status plants:

No special status plants are in this segment. Various specimens of *Thelypodiopsis ambigua* var. *erecta*, *Astragalus ampullarius,*and *Oenothera murkockii* were last collected in 1982 from the general area, however none were found during surveys of the potential habitat within this segment. Sand dunes within the segment were degraded and not as wind scoured as the sand dune habitat for *Astragalus ampullarius* north of Kanab.

Invasive and noxious weeds:

Elaeagnus angustifolia has been planted around a historic farmstead. *Salsola tragus* and *Erodium cicutarium* are pervasive in this segment.

Impacts:

Creating access roads through sand dunes subjects the dunes to destabilization.

Disturbing areas that are classified as Invasive Upland Vegetation could result in the spread of noxious and invasive weeds.

Filling a pipeline trench can lead to a channel for erosion. Since much of the segment is on existing road, revegetation would only be necessary in the right-of-way of Johnson Canyon Road.

Best management practices:

The following recommendations are BMPs of particular applicability to this segment. Further discussion of each is provided in Section 6.1 above.

Protect erosion prone land (BMP-G8)
Protect wellheads from pollutants (BMP-G11)
Revegetate disturbed soils (BMP-R/R1)
Install and maintain sediment and seed traps (BMP-R/R4)
Dispose of vegetation slash (BMP-G16)
Dispose of all construction waste (BMP-G17)
Salvage topsoil (BMP-R/R6)
Control equipment movement in areas with noxious or invasive plants (BMP-IS10)
Maintain livestock fencing and gates (BMP-SS5)
Cover open trenches to prevent wildlife and livestock mortality or injury (BMP-G14)

6.5.19 Segment 19: Eightmile Gap Road at US 89 to Fredonia

Reach 15: Hydro System Existing Highway Alternative

Overview:

A pipeline and a transmission line would occupy this segment. The Eightmile Gap Road at US 89 to Fredonia segment begins at the junction of US 89 and Eightmile Gap Road (Appendix F). The segment tends west on the roadbed of Old US 89 towards Spring Wash, where it continues southwest across rangeland to Lost Spring Gap and Shinarump Point. It then parallels Lost Creek Wash to Alternate US 89 in Fredonia. Land ownership is private throughout the Utah portion of the segment. In Arizona, it alternates between private and Arizona State Trust land. A one mile stretch has BLM lands on the south side of the segment and private lands occurring on the north side. The vegetation is diverse, but dominated by Invasive Upland Vegetation in areas that had been cultivated, on Greasewood Flats where the segment crosses bottomlands, and on Mixed Desert Scrub on grazed uplands. The geology is primarily Moenkopi Formation, with alluvial fan deposits and stream channel deposits. No special status plants were found. Three noxious and invasive plants were documented: *Tamarisk* spp., *Salsola tragus*, and *Halogeton glomeratus*.

Description:

Route:

The Eightmile Gap Road at US 89 to Fredonia segment begins in Utah at Eightmile Gap Road, where it is a continuation of the Seaman Gap to Eightmile Road at US 89 segment. Another segment would also start at this location, the Eightmile Gap Road at US 89 to Johnson Run segment. The Eightmile Gap Road at US 89 to Fredonia segment leaves the US 89 right-of-way and parallels it by following the roadbed of Old US 89 west to the Spring Wash culvert. From here it continues cross-country to the southwest towards Lost Spring Gap. After entering Arizona, the segment passes the base of Shinarump Point and follows Lost Creek Wash to its bridge under Alternate US 89. This is the end of this segment and the beginning of the Fredonia to Kaibab Indian Reservation at east boundary segment.

Land use history:

This segment closely follows the historic Armijo Route of the Old Spanish Trail, which became a commercial trade route after 1830. The segment was a cut-off route from Johnson to Fredonia in 1872, bypassing Kanab (Clawson n.d.). It is presently impassable due to dam breeches and washed out roads.

The first two miles of this segment is on a historic right-of-way. In the 1910s, the old Paria Road section from Kanab to Johnson (Canyon) was designated as a state highway. The state route was abandoned in 1959, and re-aligned as US 89.

During the latter decades of the nineteenth century, the agriculturalists permanently altered the ecology of the Arizona Strip; meadows were opened to livestock grazing and stream channels altered for irrigation. The land use around Lost Spring Gap appears to have included grazing and stream management, including the failure of dams at Lost Spring Gap.

Geology:

Surface geology follows Doelling et al. (2006) for Utah and Billingsley et al. (2008) for Arizona. The Chinle Formation occurred as outcrops on the higher ground of this segment. The Chinle Formation's Shinarump Member forms the upper part of Shinarump Point and its associated mesa. The sandstone cliffs below the Point are the Upper Red Member of the Moenkopi Formation. The base and eroded knolls throughout the southern half of the segment are the Schnabkaib Member of the Moenkopi Formation. There is a thin band of Middle Red Member of the Moenkopi Formation between Lost Spring Wash valley and a small power substation to the south. The white soils of the bend in the pipeline were the Schnabkaib Member of the Moenkopi Formation. Additionally, there are deposits of young alluvial fan on the bottomlands of Lost Spring Wash and stream-channel deposits in incised stretches of Lost Spring Wash.

Ecological Systems:

All of the ecological systems are in the Colorado Plateau Ecological Region. Both ends of this segment have large areas of young alluvial fan soils, with vegetation classified as either Invasive Upland Vegetation where it has been in cultivation, or as Greasewood Flat Ecological System. In the vicinity of the Shinarump Cliffs, the rangeland has been degraded by heavy grazing and the Middle Red Member of the Moenkopi Formation geology no longer corresponds to gypsum badlands; it is classified as Mixed Desert Scrub. However, gypsum badlands still occur further southwest in this segment, along Lost Spring Wash and north of a power substation. A small area of Pinyon-Juniper Woodland Ecological System occurs atop Shinarump Point. There are minor areas of Big Sagebrush Shrubland, especially along Old US 89. Washes that dissect the segment are classified as Colorado Plateau Wash.

Special Status Plants:

No special status plants were found on this segment. Given the 145 years of intensive grazing in the segment, there is a low probability that the two potentially occurring plants, *Cryptantha semiglabra* or *Pediocactus sileri* might be found in gypsum badlands on areas that are privately owned but not surveyed.

Invasive and noxious weeds:

Salsola tragus is frequently found on over-grazed land throughout this segment. It was locally dominant on over half the land area of the segment. *Tamarisk* spp. is common along ditches leading to Lost Gap Wash as well as in Lost Springs Gap. *Halogeton glomeratus* is found along Lost Gap Wash near the bluffs of Shinarump Point.

Impacts:

Pipeline construction could likely interrupt livestock movement on private lands and public grazing allotments.

Establishing and maintaining roads along the pipeline and transmission line corridors provide a route for invasive weeds to colonize adjacent natural lands.

Disturbing areas that are classified as Invasive Upland Vegetation could result in the spread of noxious and invasive weeds. However, given the abundance of *Salsola* in the surrounding landscape, its invasion onto disturbed project areas before and after construction would be likely.

Filling a pipeline trench could require revegetation, but can lead to a channel for erosion.

Creating pipeline and transmission tower access roads can open up remote areas to off highway vehicle use.

Best Management Practices:

The following recommendations are BMPs of particular applicability to this segment. Further discussion of each is provided in Section 6.1 above.

Protect erosion prone land (BMP-G8)
Protect wellheads from pollutants (BMP-G11)
Prevent stream bed modification (BMP-G12)
Cover open trenches to prevent wildlife and livestock mortality or injury (BMP-G14)
Dispose of vegetation slash (BMP-G16)
Dispose of all construction waste (BMP-G17)
Revegetate disturbed soils (BMP-R/R1)
Install and maintain sediment and seed traps (BMP-R/R4)
Salvage topsoil (BMP-R/R6)
Prevent pollution discharge into streams and reservoirs (BMP-RA2)
Avoid gypsum badlands with special status plants (BMP-SS4)
Maintain livestock fencing and gates (BMP-SS5)
Control equipment movement in areas with noxious or invasive plants (BMP-IS10)

6.5.20 Segment 20: Eightmile Gap Road at US 89 to Johnson Run

Reach 15: Hydro System South Alternative

Overview:

The Eightmile Gap Road at US 89 to Johnson Run segment extends south from US 89, following Eightmile Gap Road to Johnson Run. Land ownership includes both private and BLM. The vegetation is primarily *Artemisia tridentata* shrubland, shrublands with a wide mix of species, pinyon-juniper woodlands on the highlands, and agricultural land. *Tamarix* spp. is abundant near the former site of Chatterly Ranch. The geology is primarily Moenkopi Formation, with alluvial fan deposits and stream channel deposits. Two special status plants (*Phacelia pulchella* var. *atwoodii* and *Camissonia exilis*) and three noxious weeds (*Salsola tragus, Erodium cicutarium,* and *Tamarix* spp.) are found within this segment.

Description:

Route:

At the north end, the Eightmile Gap Road at US 89 to Johnson Run segment connects with the junction of the Seaman Wash to Eightmile Gap Road at US 89 segment to the east and the Eightmile Gap Road at US 89 to Fredonia segment to the west. It continues to the south for 8.3 miles through Eightmile Gap. The segment meets the Seaman Wash to Eightmile Gap Road segment to the east and the Eightmile Gap Road to Kanab Creek Canyon segment to the west. Eightmile Gap Road is marginally passable in dry weather, with at-grade crossings at Chatterly Ranch that is impassible in wet weather.

Land use history:

Two ranches were located along this segment: Chatterly Ranch and Buttons Ranch, as per the Shinarump 15' topographic quadrangle published in 1957. The lower part of the segment is also known as Muggins Flats. No other references were found regarding past land use history specific to this segment. Areas of over grazing were often associated with current and historic water sources. Some of the poorest condition land in the project area is located within this segment and to the southwest along Johnson Run. The terraces along these dry washes are silted in from flooding and the washes are deeply incised. Current land use includes residential subdivisions, agriculture, and grazing.

Geology:

Surface geology for this segment is based on Doelling et al. (2006) and Billingsley (2008). Major differences in interpretation exist where the maps join at the Arizona Utah state line. The bedrock geology includes the Shinarump Member of the Chinle Formation at the highest elevations on the segment. Various Moenkopi members outcrop, including the Upper Red Member of the Moenkopi Formation, Lower Red Member of the Moenkopi Formation, Shnabkaib Member of the Moenkopi Formation, and Middle Red Member of the Moenkopi Formation as gypsum badlands special plant habitat. The Quaternary geology includes: Relatively recent alluviums; Young terrace-gravel deposits; Stream-channel deposits; and Young alluvial fan deposits, sometimes as special plant habitat when near to Middle Red Member of the Moenkopi Formation.

Ecological systems:

All of the ecological systems in this segment are in the Colorado Plateau Ecological Region. Big Sagebrush Shrubland occurs on alluvial valley soils classified as Young alluvial fan deposits (Billingsley's) or Relatively recent alluviums (Doelling's). Gypsum Badlands are on Middle Red Member of the Moenkopi Formation and represent gypsum badlands special status plant habitat. The Lower Montane Riparian Woodland and Shrubland occurs in washes and stock ponds invaded with *Tamarisk* spp.. Mixed Bedrock Canyon and Tableland are represented by an unvegetated area associated with the Shinarump Member of the Chinle Formation. The talus slopes below the resistant Shinarump Cliffs is the Upper Red Member of the Moenkopi Formation. Mixed Desert Scrub appears in Young terrace-gravel deposits. Shrub-Steppe occurs in Young alluvial fan deposits adjacent to Middle Red Member of the Moenkopi Formation, as well as the Lower Red Member of the Moenkopi Formation past Johnson Wash. This type has *Pleuraphis jamesii* as the dominant grass in a mix of different shrubs as the overstory. Pinyon-Juniper Woodland occurs on Shinarump Member of the Chinle Formation, which is also a prime area for summer home building. *Juniperus osteosperma* was the dominant tree, with *Pinus edulis* rarely co-dominate. Greasewood Flat is dominated by *Sarcobatus vermiculatus* and *Atriplex confertifolia*.

There are agricultural lands in the northern-most part which are on Young alluvial fan deposits, as well as at Chatterly Ranch.

Special status plants:

Relative small populations of *Phacelia pulchella* var. *atwoodii* and *Camissonia exilis* occurred on gypsum badlands in the center of this section.

Invasive and noxious weeds:

Salsola tragus and *Erodium cicutarium* are pervasive along this segment. Invasive Upland Vegetation was extensive south of the Chatterly Ranch site, dominated by *S. tragus* or *E. cicutarium*. *Tamarix* spp. are abundant near the Chatterly Ranch site on semi-natural associations of the Lower Montane Riparian Woodland and Shrubland Ecological System.

Impacts:

This segment does not appear to be planned for either a transmission line or pipeline. Thus there is no information on intended purpose to determine an impact.

Best management practices:

Once an intended purpose has been identified for this segment, BMPs would be recommended to minimize potential impacts.

6.5.21 Segment 21: Eightmile Gap Road to Kanab Creek Canyon

Reach 16: Hydro System South Alternative and Reach 19: Hydro System Southeast Corner Alternative

Overview:

The Eightmile Gap Road to Kanab Creek Canyon segment roughly parallels an existing transmission line. The north end of this segment intersects the southern ends of two segments: the Seaman Wash to Eightmile Gap Road segment and the Eightmile Gap Road at US 89 to Johnson Run segment. At the eastern boundary of the Kaibab Band of the Paiute Indian Reservation (Reservation), the segment branches. One branch follows the alignment of the Hydro System South Alternative, turning south and then west, following the Reservation boundary, until it turns south-west to Kanab Creek Canyon. The other branch follows the alignment of the Hydro System Southeast Corner Alternative, angling across the southeast corner of the Reservation (Appendix F). A pipeline and transmission line would occupy this segment. The vegetation is primarily *Artemisia tridentata* with large areas of highly degraded floodplain showing thick flash flood and overbank deposition. Land ownership is predominantly BLM, with Reservation lands and Arizona State Trust lands. One special status plant species was found in this segment. A single plant of *Echinocactus polycephalus* var. *xeranthemoides* was located within Kanab Creek Canyon, although there were 53 plants immediately across the creek in an adjoining segment.

Description:

Route:

This segment begins at the south end of the Seaman Wash to Eightmile Gap Road segment. The junction is shared with the south end of the Eightmile Gap Road at US 89 to Johnson Run segment. The Eightmile Gap Road to Kanab Creek Canyon segment runs southwest, crossing a road to Johnson Reservoir at 0.09 miles. At 0.99 miles the segment crosses a bluff and enters the floodplain of an unnamed tributary of Johnson Wash. Johnson Reservoir, two-thirds of a mile north of the segment, is fed by this tributary. At 3.31 miles and again at 4.57 miles, the segment nears the incised channel of Johnson Wash, the latter distance at a point of *Tamarix* spp. invasion. At 5.26 miles the segment crosses US 89A. A construction staging area is proposed adjacent to US 89A, 0.37 miles northwest of the segment. At 5.57 miles the segment crosses an unnamed floodplain and at 6.65 miles it crosses Wildcat Canyon. At 8.30 miles the segment crosses FS Route 22. An equipment site is proposed to the northwest. The segment crosses Jacob Canyon at 9.63 miles and reaches the eastern boundary of the Reservation at 11.09 miles, where the segment branches. One branch runs south until the 12.84 mile mark, where the branch turns west and continues along the south side of the Reservation. There is minimal surface water development in the area, but a wildlife guzzler is located 0.45 miles to the east of the westerly turn. At 13.50 miles, the segment crosses an unnamed canyon. The other branch angles south-west 3.85 miles through the Reservation. The branch that crosses the Reservation would reduce the segment length by 1.38 miles and eliminate a canyon crossing. The two branches join at the 16.32 mile mark of the first branch. The end of the segment is at 18.24 miles, where the Kanab Creek to Mt. Trumbull Road segment begins.

Land use history:

This area has been subjected to livestock grazing since the 1870s. Areas closest to water are the most overgrazed, including Johnson Reservoir and the guzzler near the southeastern corner of the Reservation. It is also winter range for antelope and mule deer. Large expanses of *Artemisia tridentata* are dead from an unknown cause.

Sheep ranching on the Arizona Strip began about 1872. Altschul and Fairley (1989) described significant droughts in California in 1870 and 1871, and again in 1876 and 1877, that resulted in large numbers of sheep being driven into the Arizona Strip.

Geology:

The geology of the segment was referenced from Billingsley et al. (2004, 2008). The flood-plain deposits in Johnson Wash were a major geologic feature of this segment. The cause of the incision of Johnson Wash may be explained in Robinson (1972) where he described the cause and effect of a plowing event in Johnson Canyon. Following a low erosion period spanning from 1400 to 1880, Johnson Run was subjected to flash flooding, which resulted in overbank accumulations of sediments up to 30 feet in depth. Those deposits subsequently eroded as much as 20 feet (Billingsley et al. 2008). The Quaternary deposits on floodplains and in washes were a complex mosaic of younger alluvial terrace-gravel deposits, intermediate alluvial terrace-gravel deposits, stream-channel deposits, young terrace-gravel deposits, and valley-fill deposits. Quaternary deposits on fans included young alluvial fan deposits and old alluvial fan deposits.

Bedrock exposures were from the Kaibab and Moenkopi Formations. The Harrisburg Member of the Kaibab Formation was exposed throughout the segment. The Fossil Mountain Member of the Kaibab Formation outcropped in Kanab Creek Canyon and in smaller canyons of dry washes and streams. The Timpoweap Member of the Moenkopi Formation was interspersed with the Harrisburg Member of the Kaibab Formation and valley-fill deposits in an unnamed canyon. The Lower Red Member of the Moenkopi Formation formed a conspicuous red soil.

Ecological systems:

All of the ecological systems in this segment are in the Colorado Plateau Ecological Region. Big Sagebrush Shrubland is widespread and associated with the Lower Red Member of the Moenkopi Formatio, Harrisburg Member of the Kaibab Formation, young alluvial fan deposits, and valley-fill deposits. Grasslands and Shrub-Steppe are associated with old alluvial fan deposits. Lower Montane Riparian Woodland and Shrubland are found in drainages such as Kanab Creek and Johnson Run, where they are semi-natural alliances dominated by *Tamarix* spp. Kanab Creek Canyon is predominately Mixed Bedrock Canyon and Tableland. Severely degraded areas are Mixed Desert Scrub or Invasive Upland Vegetation on young terrace-gravel deposits (see discussion under Noxious and invasive weeds). Mixed Low Sagebrush Shrubland is dominated by *Artemisia nova* and on very droughty soils. There are sparsely vegetated Washes throughout the segment.

Special Status Species:

A single plant of *Echinocactus polycephalus* var. *xeranthemoides* was located within Kanab Creek Canyon.

Invasive and noxious weeds:

Erodium cicutarium and *Salsola tragus* were abundant on the heavily grazed lands of this segment. *Tamarix* spp. was found in Johnson Wash. *Halogeton glomeratus* and *Onopordum acanthium* were found on terraces above Johnson Wash, especially in areas mapped to young terrace-gravel deposits

Impacts:

Establishing and maintaining roads within the pipeline and transmission line corridors could facilitate noxious and invasive weed colonization of adjacent natural lands.

Leaving disturbed areas classified as Invasive Upland Vegetation untreated could facilitate the spread of invasive weeds.

Construction activity could adversely impact the one specimen of *Echinocactus polycephalus* var. *xeranthemoides.*

Construction on the floodplain could leave areas vulnerable to erosion.

Although trenches would be backfilled and revegetated, any unstabilized soils could lead to erosion.

Constructing pipeline and transmission tower access roads can open up remote areas to off highway vehicle use.

Best management practices:

The following recommendations are BMPs of particular applicability to this segment. Further discussion of each is provided in the Best Management Practices section in the first part of this chapter.

Protect erosion prone land (BMP-G8)
Prevent stream bed modification (BMP-G12)
Cover open trenches to prevent wildlife and livestock mortality or injury (BMP-G14)
Dispose of vegetation slash (BMP-G16)
Dispose of all construction waste (BMP-G17)
Revegetate disturbed soils (BMP-R/R1)
Install and maintain sediment and seed traps (BMP-R/R4)
Salvage topsoil (BMP-R/R6)
Some of the best soils are in areas of valley-fill deposits where swales support thick stands of *Artemisia tridentata* ssp. *vaseyana*.
Prevent pollution discharge into streams (BMP-RA2)

Maintain livestock fencing and gates (BMP-SS5)
Control equipment movement in areas with noxious or invasive plants (BMP-IS10)

6.5.22 Segment 22: Fredonia to Kaibab Indian Reservation East Boundary

Reach 15: Hydro System Existing Highway Alternative

Overview:

The survey segment begins on the west side of US 89A in Fredonia, crosses Kanab Creek, and then continues south-west to Arizona Route 389 (Appendix F). The segment continues along the north side of the highway to the east boundary of the Kaibab Band of the Paiute Indian Reservation (Reservation). A pipeline and a transmission line would occupy this segment. Land ownership is Arizona State Trust Lands and private tracts. The segment is aligned through degraded riparian vegetation and heavily grazed rangeland, with many of the gypsum badlands in fair to poor range condition. Two special status plants were found in this segment: *Pediocactus sileri* and *Cryptantha semiglabra*.

Description:

Route:

The Fredonia to Kaibab Indian Reservation East Boundary survey segment begins at the US 89A bridge over Lost Spring Wash. It is a continuation of the Eightmile Gap Road at US 89 to Fredonia segment. The segment continues across Kanab Creek to the west and then turns south on Stagger Mountain Road, paralleling the gypsum badlands on the slopes of the Shinarump Cliffs. At Arizona Route 389 the segment turns west-southwest and follows the north right-of-way of the highway. It terminates at approximately 3.85 miles at the east boundary of the Reservation in an area called Red Sands. The segment continues as the Kaibab Indian Reservation along AZ 389 segment.

Land use history:

Fredonia was settled in 1865, at which time it was called Hardscrabble (Barnes 1988). Kanab Creek is named for the willows that were prevalent on its banks before damming upstream restricted the flow of water through the creek bed (Austin et al. 2005). Kanab means “willow” in the Paiute language. The Fredonia Field Dam impounded Kanab Creek as early as 1889, supplying irrigation water for 300 acres (Mead and Teal 1903). The dam was presumably at a point roughly west of the center of town, with the reservoir pool extending north over land which is part of the Fredonia to Kaibab Indian Reservation East Boundary segment.

Kanab Creek was initially the eastern boundary of the Reservation, as established in 1913. A Public Land Survey resurvey found Fredonia to be within the Reservation boundary (Austin et al. 2005), which led non-native American residents of Kanab and Fredonia to protest and continue to remove timber, use springs, and run their cattle on Reservation lands (Knack 1993). In 1917, twelve square miles on the west side of Kanab Creek where removed from the Reservation, even though the remaining acreage was insufficient to support the tribe (Sells 1917).

A dramatic difference in the range quality of the Shinarump Cliffs is evident between the Reservation and the private and Arizona State Trust land around Fredonia. After the Reservation was established in 1913, the Reservation lands east of Pipe Spring had less grazing intensity than the non-Reservation lands west of Fredonia. Coupled with relief from heavy grazing during the prolonged drought of the 1920s and 1930s, these Reservation lands were able to recover from the heavy grazing levels of 1865 to 1913. In contrast to the gypsum badlands on non-Reservation land, those within the present Reservation boundaries have the highest known concentrations of four special status plants.

Geology:

This segment begins in young alluvial fan deposits except where Kanab Creek is incised into the floodplain. There the geology is mapped as stream channel deposits. Where the segment turns south, there is a gradation into the Moenkopi Formation on the west side of the segment. The Shnabkaib Member has minor inclusions into the segment in the highest elevations, followed by the Middle Red Member of the Moenkopi Formation in the mid elevations, and young alluvial fan deposits in the lowest elevations on the east. The Middle Red Member of the Moenkopi Formation dominates the central part of the segment, which has the best expression of gypsum badlands. The segment transitions to young alluvial fan deposits near the junction with AZ 389 and remains so almost to the Reservation boundary. The Middle Red Member of the Moenkopi Formation reappears in the last 0.36 miles of the segment, although grazing has been so severe that it appears to lack characteristic gypsum badlands vegetation (this is private land, access to which was not granted by the landowner).

Ecological systems:

All of the ecological systems in this segment are in the Colorado Plateau Ecological Region. The stream channel along Kanab Creek is dominated by *Elaeagnus angustifolia* and is classified as a semi-natural association within the Lower Montane Riparian Woodland and Shrubland Ecological System. The floodplain is dominated by *Sarcobatus vermiculatus* and is classified as a Greasewood Flat. Where *Atriplex canescens* and *Artemisia tridentata* co-dominate on the edge of the floodplain, the vegetation is classified as Big Sagebrush Shrubland.

Badlands variously dominated by *Ephedra nevadensis, Eriogonum corymbosum* var. *corymbosum*, or *Atriplex confertifolia* are classified as Gypsum Badlands. Along AZ 389, near the Reservation boundary, heavily grazed areas of the Middle Red Member of the Moenkopi Formation are dominated by *Ericameria nauseosa* or *Gutierrezia sarothrae* and are classified as Mixed Desert Scrub. An active feedlot is classified as agricultural land. A small area of Active and Stabilized Dune occurs north of AZ 389 near the Reservation boundary. The highway right-of-way and old agricultural fields are classified as Ruderal Vegetation. Invasive Upland Vegetation is mapped where *Salsola tragus* dominates herbaceous vegetation.

Special status plants:

Seven *Cryptantha semiglabra* plants were observed in this segment. These were the only documented sightings outside of Reservation lands for the LPP survey area. All locations of this narrowly endemic plant occurred on the Middle Red Member of the Moenkopi Formation. Eight *Pediocactus sileri* were interspersed with the *Cryptantha* on the same geologic formation. An *Eriogonum mortonianum* hybrid and a possible *Eriogonum* hybrid, yet to be determined by Dr. James Reveal, were also recorded in this area. Dr. Reveal is the North American *Eriogonum* specialist, who originally collected and named the species and varieties of the three special status *Eriogonums* in the LPP survey area.

Invasive and noxious weeds:

Salsola tragus and *Erodium cicutarium* were pervasive within this segment, although in reduced abundance on gypsum badlands versus non-badlands. The Kanab Creek floodplain was formerly a reservoir pool where the segment crosses. *Elaeagnus angustifolia* was dominant along the present channel of Kanab Creek. *Tamarix* spp. was observed along the Kanab Creek floodplain, especially in the stock tanks. *Halogeton glomeratus* was found along Stagger Mountain Road as well as in a feedlot along AZ 389.

Impacts:

Establishing and maintaining roads along the pipeline and transmission line corridors provide a route for invasive weeds to colonize adjacent natural lands.

Creating access roads through sand dunes subjects the dunes to destabilization.

Leaving areas untreated which are classified as Invasive Upland Vegetation could result in the spread of invasive weeds.

Routing the pipeline through special status plant habitat could adversely impact *Pediocactus sileri*.

The disturbance associated with digging the trench for the pipeline could lead to erosion.

Creating pipeline and transmission tower access roads can open up remote areas to off highway vehicle use.

Best management practices:

The following recommendations are BMPs of particular applicability to this segment. Further discussion of each is provided in the Best Management Practices section in the first part of this chapter.

Protect erosion prone land (BMP-G8)
Protect wellheads from pollutants (BMP-G11)
Prevent stream bed modification (BMP-G12)
Cover open trenches to prevent wildlife and livestock mortality or injury (BMP-G14)
Dispose of vegetation slash (BMP-G16)
Dispose of all construction waste (BMP-G17)
Revegetate disturbed soils (BMP-R/R1)
Install and maintain sediment and seed traps (BMP-R/R4)
Salvage topsoil (BMP-R/R6)
Prevent pollution discharge into streams and reservoirs (BMP-RA2)
Salvage and transplant perennial special status plants (BMP-SS1)
Avoidance of gypsum badlands with special status plants (BMP-SS4)
Maintain livestock fencing and gates (BMP-SS5)
Control equipment movement in areas with noxious or invasive plants (BMP-IS10)

6.5.23 Segment 23: Kaibab Indian Reservation along AZ 389

Reach 15: Hydro System Existing Highway Alternative

Overview:

The Kaibab Indian Reservation along AZ 389 pipeline survey segment begins at the eastern boundary of the Kaibab Band of the Paiute Indian Reservation (Reservation), adjacent to Arizona Route 389, and terminates at the western boundary of the Reservation (Appendix F). A pipeline and a transmission line would occur in this segment. The land is owned by the Kaibab Band of the Paiute Indian tribe. The eastern-most 11.4 miles represent an area of high density for special status plants. Vegetation is predominantly shrubland and four of the five special status plants found in this segment are associated with the Colorado Plateau Gypsum Badland Ecological System. Noxious weeds were present throughout the segment.

Description:

Route:

The Kaibab Indian Reservation Along AZ 389 segment begins at the eastern end of the Reservation, where it is a continuation of the Fredonia to Kaibab Indian Reservation segment. The segment continues west along Arizona Route 389 through the Reservation. At 0.15 miles the segment reaches Six Mile Village Road, at approximately 0.3 miles it crosses Cottonwood Creek, and at approximately 0.92 miles the segment intersects the abandoned Fredonia to Pipe Spring roadbed.

The segment reaches the Riggs Flat aqueduct at the bottom of Riggs Flat at 3.54 miles. Stock watering reservoirs are within 0.3 mile on either side of AZ 389 and represent an area historically overgrazed. Mt. Trumbull Road intersects the segment at the 6.28 mile point. At 6.8 miles, the abandoned Fredonia to Pipe Spring Road again crosses the segment. The segment crosses Twomile Wash at 9.13 miles, 1.1 miles south of where a historic Indian village was located along the wash. At 11.34 miles the segment crosses Pipe Spring Road and passes a gas station, tribal headquarters, and a sewage treatment pond for the Pipe Spring tribal village. The segment crosses an old road alignment between Maroney Well and Pipe Spring at 14.68 miles. This road alignment was part of the route from Short Creek to Pipe Spring before the present day alignment of AZ 389 and served as the livestock driveway from the southwestern paddocks to stock water at Pipe Spring.

The segment ends at 18.52 miles, at the western boundary of the Reservation. Continuing west-northwest from here is the AZ 389 from the Kaibab Indian Reservation west boundary to Colorado City segment.

Land use history:

This segment parallels the route of the Old Spanish Trail. Spaniards moved up to 1,000 head of livestock through here on drives from what is now Los Angeles, California to Santa Fe, New Mexico.

Mormon sheepherders James A. Little and Royal Cutler first brought sheep to the area in 1871 from the Glendale area (Sprangler 2007). An April 1872 entry in Walter Clement Powell’s journal indicates 11,000 sheep were grazing near Pipe Springs at that time. The Kaibab Band run cattle on the Reservation and the entire segment was actively used for grazing. However, the stocking rate was well below those of the late Nineteenth Century (see also Mt. Trumbull Road segment).

Geology:

The surface geology of the segment was referenced from Billingsley et al. (2004). From a biodiversity viewpoint, the most significant geologic formation on the Reservation is the Middle Red Member of the Moenkopi Formation. No other bedrock formations are present within this segment. The Middle Red Member of the Moenkopi Formation forms a badlands topography rich in endemic plants. The topography is such that mud washes are created when thunderstorms saturate the surface horizon of the soil creating runoff. The runoff, often referred to as sheet erosion, is caused by slow permeability through the underlying gypsum horizons; the horizons were approximately three feet apart, as noted from various exposed profiles. The runoff can carry fine textured soil material with it and deposit the soil downslope onto mud washes. This process appears to foster seed dispersal but can also bury plants or cake them with mud to where their stomatas are not able to transfer gasses and can no longer photosynthesize. Examination of other areas on or near the LPP survey area with Middle Red Member of the Moenkopi Formation geology, indicates that the topography in this area fosters mud washes. Rugged badlands, with up to 20 feet of vertical exposure, as well as very gradual slopes, were present in the badlands. In the former, gypsum beds were exposed every three feet. In the latter, there were long horizontal runs before gypsum was exposed. The former provides optimal habitat for the special status plants *Pediocactus sileri*, *Eriogonum mortonianum* and *Cryptantha semiglabra*. The latter provides optimal habitat for *Eriogonum thompsonae* var. *atwoodii*. In the only other known location for *E. thompsonae* var. *atwoodii*, Antelope Spring above the Hurricane Cliffs, the Middle Red Member of the Moenkopi formation has the same long horizontal run topography.

The Quaternary geology includes the following mapping units: Young alluvial fan deposits, Intermediate alluvial fan deposits, Eolian sand sheet deposits, artificial fill and quarries, Eolian sands, Young alluvial terrace-gravel deposits, Ponded sediments, and Stream-channel alluvium deposits. The latter deposits were mapped at Twomile Wash where a "1942 flood, reminiscent of the floods of the late 1800s, swept through Two Mile Wash on the Kaibab Reservation, causing severe downcutting" (Austin et al. 2005), from a 2004 interview with Paiute elder Walter Mayo of Moccasin.

Ecological systems:

All of the ecological systems are in the Colorado Plateau Ecological region. *Pediocactus sileri*, *Eriogonum mortonianum* and *Cryptantha semiglabra* prefer the Gypsum Badlands Ecological System, although mud washes off of gypsum badlands can deposit seeds of these special status species onto adjacent areas of different geology and ecological systems.

The ecological system Active and Stabilized Dune occurs on Intermediate alluvial fan deposits sand dunes along Twomile Wash, with *Artemisia filifolia* as the dominant. Big Sagebrush Shrubland has *Artemisia tridentata* ssp. *vaseyana* dominant and is restricted to the Mt. Trumbull Road junction. Mixed Desert Scrub is common and a variety of shrubs dominate: *Krascheninnikovia lanata*, *Atriplex canescens*, *A. confertifolia*, and in degraded habitats *Gutierrezia sarothrae* and *Ericameria nauseosa*. Pinyon-Juniper Woodland is found at the west end of the segment and is dominated by *Juniperus osteosperma* . Shrub-Steppe is sometimes present as a semi-natural Mixed Desert Scrub association with an invasive grass understory, but more commonly occurs as natural associations of *Pleuraphis jamesii* with *Krascheninnikovia lanata* or Mixed Desert Scrub. Grassland is restricted to a single occurrence of *Pleuraphis jamesii* Herbaceous Vegetation. Juniper Savanna with *Pleuraphis jamesii* as the understory is also restricted to a single example.

Less common ecological systems and anthropogenic types are as follows: Wash systems are infrequent and represent a variety of shrubland types; Invasive Upland Vegetation is common and mostly is represented by the *Salsola tragus* Semi-natural Herbaceous Alliance; Ruderal Vegetation is common along AZ 389.

Special status plants:

Past surveys of the plants endemic to these gypsum badlands had been confined to the ADOT right-of-way. Prior approval and the presence of monitors for non tribal members were required to study Reservation lands. Permission was obtained and the LPP project was afforded the opportunity to survey the area extending 600 feet north from the highway

The following special status plants were found in this segment: *Pediocactus sileri, Eriogonum mortonianum, Eriogonum thompsonae* var. *atwoodii, Cryptantha semiglabra,* and *Penstemon laevis.* Detailed information on the number of individuals found in various vegetation types can be found in the Special Status Species and Noxious Weeds Survey Chapter (Chapter 4). The geology discussion above provides more specific details about the habitat preferences for *Pediocactus sileri, Eriogonum mortonianum, Eriogonum thompsonae* var. *atwoodii,* and *Cryptantha semiglabra*. A microhabitat by species matrix was developed for the survey area between Cottonwood Creek and Riggs Flat; with a relative abundance code given for those species occurring in that type.

Within this segment, microhabits for each of the special stauts species were identified and relative abundance for each species was noted. The microhabitats included: cryptobiotic crests and knoll, non-cryptobiotic crests and benches, slopes below outcrops, mud washes, bajadas, gypsum outcrops, and arroyos. *Pediocactus sileri* was occasional on slopes below outcrops and on gypsum outcrops; and rare on cryptobiotic crests and knolls, often occurring only in the best expression of this microhabitat. *Eriogonum mortonianum* was abundant in the mud washes; common on the gypsum outcrops; occasional on slopes below outcrops; locally occasional in arroyos; and rare to locally occasional on the bajadas. *Eriogonum thompsonae* var. *atwoodii* was localy dominant in mud washes but only on the west side of a crest where the badlands face Riggs Flat; and rare on the gypsum outcrops. *Cryptantha semiglabra* was locally abundant on the slopes below outcrops; locally common on mud washes; occasional on gypsum outcrops; and rare in arroyos.

These data support a hypothesis that *Eriogonum thompsonae* var. *atwoodii* is adapted to withstanding heavy grazing and has evolved under a natural disturbance regime of repeated deposition of silts and clays from mud washes. This is one of only two known populations of *E. t.* var. *atwoodii* in the world. Both populations occur on mud washes adjacent to areas with livestock watering structures and have a 140 year history of livestock grazing. Gypsum is pesent at shallow depths at both population locations, but generally does not outcrop because the topography in this area consists of gentle slopes extending from a ridge. Livestock have been driven between these sites which lie on the Old SpanishTrail, Honeymoon Trail, and within confirmed stock movement routes. As a result, seeds from either population could have dispersed from one site to the other via animal digestive systems. This area supports Eriogonum hybrids, making the area, and the gypsum badlands at Fredonia, centers for speciation in the genus.

The Reservation harbors the largest known populations of *Pediocactus sileri*, a federally threatened species, plus *Cryptantha semiglabra* and *Eriogonum mortonianum,* which are both narrowly endemic federal candidate species. These species appear to benefit from the mud wash natural disturbance regime via enhanced seed dispersal. However, this disturbance regime may have also increased the mortality of *Pediocactus sileri*; approximately half of the population identified in this area was dead, with much of the mortality apparently from being mud-covered.

Penstemon laevis was found in limited quantities in the western part of the reservation on Young alluvial fan deposits and Eolian sand sheet deposits. The rarity of the plant in this area may be attributable to grazing history.

Invasive and noxious weeds:

Salsola tragus and *Erodium cicutarium* are pervasive within all the ecological systems in this segment except Gypsum Badlands, where the weeds are present on some microhabitats, but locally occasional,at best. *Halogeton glomeratus* occurs at Sand Wash near Mt. Trumbull Road and on badlands around the sewage treatment ponds. *Tamaris* sp. dominates at Cottonwood Creek and Twomile Wash where the habitat is classified as Lower Montane Riparian Woodland and Shrubland. *Tamarix* spp. is also present in Riggs Flat, in dry washes between Sand Wash, and at the sewage treatment ponds. *Convolvulus arvensis* occurs along the abandoned Fredonia to Pipe Spring roadbed and the right-of-way of AZ 389 at Pipe Spring, where *Elaeagnus angustifolia* is also present.

Impacts:

Establishing and maintaining roads along the pipeline and transmission line corridors provide a route for invasive weeds to colonize adjacent natural lands.

Leaving areas untreated which are classified as Invasive Upland Vegetation can result in the spread of invasive weeds.

Routing the pipeline through special status plant habitat can adversely impact the species.

Routing the pipeline through habitats supporting cryptobiotic crusts could result in damage to these highly sensitive soils.

The disturbance associated with trenching for installation of the pipeline may lead to erosion.

Creating pipeline and transmission tower access roads can open up remote areas to off highway vehicle use.

Best management practices:

Avoidance of gypsum badland habitat is the single most important BMP in this segment. The following recommendations are BMPs of particular applicability to this segment. Further discussion of each is provided in the Best Management Practices section in the first part of this chapter.

Protect erosion prone land (BMP-G8)
Special attention needs to be given so that the natural disturbance regime of mud washes after thunderstorms is maintained on gypsum badlands.
Prevent stream bed modification (BMP-G12)
Cover open trenches to prevent wildlife and livestock mortality or injury (BMP-G14)
Dispose of all construction waste (BMP-G17)
Revegetate disturbed soils (BMP-R/R1)
Install and maintain sediment and seed traps (BMP-R/R4)
Salvage topsoil (BMP-R/R6)
    This includes harvesting cryptobiotic crusts and replacing them on fill as soon as practical.
Prevent pollution discharge into streams (BMP-RA2)
Salvage and transplant perennial special status plants (BMP-SS1)
While practical and proved successful in Las Vegas for *Eriogonum corymbosum* var. *nilesii*, there is no information available for doing this with the other species.
Maintain livestock fencing and gates (BMP-SS5)
Control equipment movement in areas with noxious or invasive plants (BMP-IS10)

6.5.24 Segment 24: Kanab Creek Canyon to Mt. Trumbull Road

Reach 16: Hydro System South Alternative

Overview:

The survey segment extends from Kanab Creek to Mt. Trumbull Road (Appendix F). A pipeline and transmission line would occupy this segment. Land ownership is entirely BLM. The vegetation is classified primarily as Colorado Plateau Grassland and Shrub-Steppe Ecological System. *Echinocactus polycephalus* var. *xeranthemoides,* a special status plant, occurs in Kanab Creek Canyon. *Tamarix* spp. is dominant in Kanab Creek and Bitter Seeps Wash.

Description:

Route:

The 5.2 miles long Kanab Creek to Mt. Trumbull Road segment is a continuation of the Eightmile Gap Road to Kanab Creek Canyon survey segment. There are few named places along the segment, with the exception of Bitter Seeps Wash. The segment ends at Mt. Trumbull Road, where the Mt. Trumbull Road segment continues northward, and the Mt. Trumbull to Yellowstone Road segment continues to the west.

Land use history:

While few references were found regarding past land use history of this segment, it has likely been grazed for 140 years. Grazing would have been particularly heavy along Bitter Seeps Wash, where a windmill is located 0.46 miles upstream and many surface water impoundments are found. A corral is located one mile northeast of the Mt. Trumbull Road junction

Austin et al. (2005) wrote that “It was common for pinyon trees to be removed from the rangelands, and sensitive plants such as Indian rice grass [*Oryzopsis hymenoides*] were quickly destroyed.” This seems particularly applicable to this segment. Kaibab Paiutes burned the range to increase *Oryzopsis hymenoides* seed production, which they harvested as an important component of their diet (Stoffle and Evans 1976).

Geology:

The geology of the segment is referenced from Billingsley et al. (2004, 2008). The predominant bedrock is the Lower Red Member of the Moenkopi Formation. The Harrisburg Member of the Kaibab Formation occurs at lower elevations around Bitter Seeps Wash and Kanab Creek. The Fossil Mountain member of the Kaibab Formation occurs in Kanab Creek Canyon. Adjacent to the creeks are Intermediate alluvial terrace-gravel deposits and Younger alluvial terrace-gravel deposits. Stream-channel deposits occur in the dry washes and streams in canyons.

Ecological systems:

All of the ecological systems in this segment are in the Colorado Plateau Ecological Region. Grassland and Shrub-Steppe are closely associated with the Lower Red Member of the Moenkopi Formation. At Kanab Creek Canyon, there is very limited acreage of Big Sagebrush Shrubland, Mixed Bedrock Canyon and Tableland and Mixed Desert Scrub. The Lower Montane Riparian Woodland and Shrubland system occurred at Kanab Creek and Bitter Seeps Wash.

Special status plants:

Echinocactus polycephalus var. *xeranthemoides* occurred in Kanab Creek Canyon and totaled 53 plants within the survey area. The plants were found in Shrub-Steppe habitat dominated by *Eriogonum corymbosum*, as well as sparsely vegetated Mixed Bedrock Canyon and Tableland dominated by *Ephedra nevadensis*.

Noxious and invasive weeds:

Salsola tragus and *Erodium cicutarium* were pervasive within this segment. *Tamarix* spp. was dominant in Kanab Creek and Bitter Seeps Wash in semi-natural Lower Montane Riparian Woodland and Shrubland.

Impacts:

Establishing and maintaining roads along the pipeline and transmission line corridors provide a route for noxious and invasive weeds to colonize adjacent natural lands.

Leaving areas untreated which are classified as Invasive Upland Vegetation can result in the spread of noxious and invasive weeds.

Routing the pipeline through special status plant habitat can adversely impact individuals.

The disturbance associated with digging the trench for the pipeline could lead to erosion.

Best management practices:

The following recommendations are BMPs of particular applicability to this segment. Further discussion of each is provided in the Best Management Practices section in the first part of this chapter.

Protect erosion prone land (BMP-G8)
Prevent stream bed modification (BMP-G12)
Cover open trenches to prevent wildlife and livestock mortality or injury (BMP-G14)
Dispose of all construction waste (BMP-G17)
Revegetate disturbed soils (BMP-R/R1)
Install and maintain sediment and seed traps (BMP-R/R4)
Salvage topsoil (BMP-R/R6)
Prevent pollution discharge into streams (BMP-RA2)
Salvage and transplant perennial special status plants (BMP-SS1)
Maintain livestock fencing and gates (BMP-SS5)
Control equipment movement in areas with noxious or invasive plants (BMP-IS10)

6.5.25 Segment 25: Mt. Trumbull Road

Reach 20: Mt. Trumbull Road

Overview:

The survey segment begins at Arizona Route 289 and extends south along either side of Mt. Trumbull Road to a point 1.5 miles south of the Kaibab Band of the Paiute Indian Reservation (Reservation) (Appendix F). The land is primarily alluvial fan with some hills of sandstone and limestone bedrock exposures. No special status plants were found in this segment. Land ownership is tribal, with Arizona state trust lands and BLM south of the Reservation boundary. Mixed Desert Scrub is the dominant ecological system in this segment, although there is notable acreage in Shrub-Steppe and Mixed Low Sagebrush Shrubland. Noxious or invasive species present in this segment include: *Tamarix* spp., *Salsola tragus*, *Bromus tectorum,* and *Convolvulus arvensis*.

Description:

Route:

This segment begins at the north end of Mt. Trumbull Road, at the junction with AZ Route 389. It branches from the Kaibab Indian Reservation along AZ 389 segment. The segment continues south along the Mt. Trumbull Road alignment, paralleling Sand Wash until the segment crosses Twomile Seep. Sand Wash and Twomile Wash merge just above the crossing and are renamed Bitter Seep Wash, which continues to the southeast. At 2.86 miles, a side road leads a short distance to a gravel pit, which is an invasive species seed source. The segment continues along Mt. Trumbull Road, twisting around remnant hills. The south Reservation boundary is crossed at a cattle guard 5.64 miles from the start of the segment. At 5.94 miles, across from a proposed equipment site, a side road leads northeast to Bitter Seep Wash. The segment terminates at 6.13 miles, at the junction of the Kanab Creek to Mt. Trumbull Road and Mt. Trumbull Road to Yellowstone Road segments.

Land use history:

This segment crosses the historic Armijo Route of the Old Spanish Trail, which became a commercial trade route after 1830. The Armijo Route was a shortcut to the route the Dominguez and Escalante Expedition had taken through the Arizona Strip. Forty years later, the Kanab Wagon Road connected Fredonia with Pipe Spring. The abandoned road bed crosses the segment 0.11 miles south of AZ Route 389. Mt. Trumbull Road dates to the period of 1871 to 1877 when lumber was cut at Mt. Trumbull for the erection of the St. George Temple. This is one of three major routes to Mt. Trumbull and the most reliable in the winter. In 1928 Mt. Trumbull Road was improved and has been continuously maintained as a route to the Toroweap Overlook of the Grand Canyon (Austin et al. 2005).

The lands crossed by this segment are mostly within the Reservation. The Southern Paiutes have occupied the region since AD 1150. They were skilled at hunting. They also utilized a wide variety of plants and cultivated small tracts, according to the historical record of the Dominguez and Escalante Expedition. The Southern Paiutes barely survived European settlement and "evidence indicates that the loss of 82 percent of Kaibab Paiute population occurred because they lost essential subsistence resources during a ten-year period [1863-1873] of resource competition" (Stoffle and Evans 1976).

The first person to describe the vegetation of this segment was William D. Johnson, Jr., a local resident who joined the Powell Expedition in 1872. He crossed Pipe Valley on March 21, 1872 and wrote: "Leaving Windsor Castle we took our course S.W. to Mount Trumbull, 50 miles distant...traveling all day over a desert-looking, pebbly and clayey plain (covered with stunted sage brush and grass) of 20 miles." (Clawson n.d.). This was likely *Artemisia nova* or *A. bigelovii*, with *Achnatherum hymenoides* and *Pleuraphis jamesii* (see Ecological Systems discussion).

Geology:

The surface geology of the segment is referenced from Billingsley et al. (2004, 2008). The segment begins at AZ 389 as Intermediate alluvial fan deposits. The segment transitions into Intermediate alluvial terrace-gravel deposits on the west side and Eolian sand sheet deposits on the east side. The three deposits intermingle with Young alluvial terrace-gravel deposits as the segment approaches the Local stream-channel alluvium at Twomile Seep. After passing another Eolian sand sheet deposits sand sheet on the south side of Twomile Seep, the segment enters the white soils of the Virgin Limestone member of the Moenkopi Formation. Here the vegetation distinctively changes to dwarf-shrubland dominated by *Artemisia nova*. A limestone quarry mapped as Artificial fill and quarries enters the edge of the segment. A dip between the Virgin Limestone Member of the Moenkopi Formation passes through Young alluvial fan and Intermediate alluvial fan deposits. The next Virgin Limestone Member of the Moenkopi Formation outcrop is elevated, with the sides being an exposure of Lower Red Member of the Moenkopi Formation. Missing from this stratigraphy is the Middle Red Member of the Moenkopi Formation, which helps explain the lack of special status gypsum badlands plants. Heading south, the segment moves through the Virgin Limestone member of the Moenkopi Formation and Lower Red Member of the Moenkopi Formation into a long stretch of Young alluvial fan. After a dry wash of Stream-channel alluvium deposits, the segment terminates on the Lower Red Member of the Moenkopi Formation.

Ecological systems:

All of the ecological systems are in the Colorado Plateau Ecological Region. Mixed Desert Scrub is the dominant ecological system in this segment. It is dominated by *Atriplex canescens* or *Chrysothamnus greenei* and occurs on the alluvial fans of Pipe Valley. The Shrub-Steppe Ecological System occurs where grasses such as *Pleuraphis jamesii* and *Achnatherum hymenoides* still co-dominate with a shrub cover. The same grasses dominate in Grassland Ecological System, which occurs in the southern part of the segment on sand sheets and low dunes of the Sand Dunes Plateau. Here the shrubs are mostly less than one percent of the cover. Some areas of greater shrub cover on dunes are classified as Active and Stabilized Dune. More limited in acreage is the Gypsum Badlands Ecological System on the slopes of remnant hills in the Lower Red Member of the Moenkopi Formation. The flat tops of those hills are Mixed Low Sagebrush Shrubland Ecological System, dominated by *Artemisia nova* or *Artemisia bigelovii* dwarf-shrubs. These are mapped geologically as the Virgin Limestone

Member of the Moenkopi Formation and are particularly droughty. The alluvial soils of Bitter Seep Wash support a Lower Montane Riparian Woodland and Shrubland Ecological System.

Noxious and invasive weeds:

Noxious or invasive species present in this segment included: *Tamarix* spp., *Salsola tragus*, *Bromus tectorum,* and *Convolvulus arvensis*. *Salsola tragus* and *B. tectorum* were widespread and frequently co-dominanted where grasses had been heavily grazed. While the tribe implements a weed control protocol requiring power washing of vehicles entering tribal lands on back roads, Mt. Trumbull Road is exempt. *Convolvulus arvensis* was observed along Mt. Trumbull Road, 1.44 miles south of Twomile Seep. *Tamarix* spp. dominated the dry wash at Twomile Seep and was established where Mt. Trumbull Road crosses dry washes. There were abundant sources for seed dispersal on tribal lands adjacent to the segment in Sand Wash and Twomile Wash.

Impacts:

This segment does not appear to be planned for either a transmission line or pipeline. Thus there is no information on intended purpose from which to determine impacts.

Best management practices:

Once an intended purpose has been identified for this segment, BMPs would be recommended to minimize potential impacts.

6.5.26 Segment 26: Mt. Trumbull Road to Yellowstone Road

Reach 16: Hydro System South Alternative

Overview:

The survey segment begins at Mt. Trumbull Road, crosses Pipe Valley and Moonshine Ridge, and ends at Yellowstone Road (Appendix F). It is characterized by grassland, mixtures of grasses and shrubs, and a small area of woodland. Geologically the segment begins with water-deposited soils on flat valley bottoms and isolated bedrock exposures on knolls and rolling hills through Pipe Valley. There are low sandstone cliffs at Moonshine Ridge, followed by a higher elevation, flat plateau with gravity-deposited soils. A pipeline and transmission line would occupy this segment. Ownership is alternating Arizona State Trust land and private, with minor BLM acreage. One special status plant - *Pediomelum epipsilum* - was observed in the valley. Invasive weeds are widespread due to a long history of livestock grazing.

Description:

Route:

This segment begins at Mt. Trumbull Road, approximately 1.5 miles south of the boundary of the Kaibab Band of the Paiute Indian Reservation (Reservation). This segment is a continuation of the Kanab Creek to Mt. Trumbull Road segment. The junction also includes the southern terminus of the Mt. Trumbull Road segment. The eastern part of the segment traverses Pipe Valley, which is drained in the survey area by Pipe Valley Wash and its tributaries. The segment crosses Pipe Valley Wash at 4.14 and 4.23 miles, where the wash occupies parallel, incised channels through highly erodible soils. Continuing west, the segment crosses its most prominent topographic feature, Moonshine Ridge, at 8.83 miles. Here the physiographic region changes from Kanab Plateau to the higher elevation Uinkaret Plateau (Billingsley, et al. 2004). At 9.38 miles, the segment crosses a wooded tributary of Pipe Valley Wash. The segment terminates at Yellowstone Road, 13.39 miles west of its starting point. This would be the site for another pipeline construction staging area. The Yellowstone Road segment continues north.

Land use history:

Pipe Valley has been subjected to heavy livestock grazing pressure since settlement of the area in 1863. Livestock numbers far in excess of range capacity peaked after Winsor Castle was sold, a sale forced by the Edmunds-Tucker Act of 1887 (Pikyavit, pers. comm.). Overgrazing continued through subsequent private ownership of the ranching operation, culminating with gradual loss of forage and eventual establishment of Pipe Spring National Monument in 1923 (two miles north of the segment). "Between 1905 and 1920, the Grand Canyon Cattle Company, a Los Angeles-based corporation, routinely watered its herds of over 60,000 cattle at Pipe Spring before driving them south to winter ranges on the public domain between there and the Grand Canyon, a large area whose use it totally dominated" (Rider and Paulsen 1985). Presently the land use for this segment is livestock grazing.

Geology:

The geology of the segment is from Billingsley et al. (2004, 2008). The segment begins in the east on the Lower Red Member of the Moenkopi Formation. The segment descends slowly into the Pipe Valley Quaternary deposits with occasional remnants of formations. Young alluvial fan deposits transition to Eolian sand sheet deposits and back to Young alluvial fan deposits before reaching Pipe Valley Wash. A small exposure of the Virgin Limestone Member of the Moenkopi Formation occurs on the edge of the segment in the sand sheet. Pipe Valley Wash is composed of Stream-channel deposits in its incised canyon, with Young alluvial terrace-gravel deposits on the west side. After passing the main channel of Pipe Valley Wash, the segment crosses a broad expanse of Young alluvial fan deposits with scattered inclusions of Virgin Limestone Member of the Moenkopi Formation, Intermediate alluvial fan deposits, Shnabkaib Member of the Moenkopi Formation, Artificial fill and quarries, and Eolian sand sheet deposits before reaching Moonshine Ridge. The lower slopes of the ridge are Upper Red Member of the Moenkopi Formation. The upper slopes are Shinarump Member of the Chinle Formation. Between the cliff and a dry wash is an area of Mixed eolian and fluvial deposits. The dry wash is an interesting woodland with mixed geology Stream-channel deposits in the wash except where it is bedrock exposure of the Shinarump Member of the Chinle Formation, and Young alluvial terrace-gravel deposits in a small area on the east side of the wash. A smaller dry wash to the west consists of Intermediate alluvial fan deposits with Stream-channel deposits and Young alluvial terrace-gravel deposits. The remainder of the segment is primarily Colluvial deposits, Intermediate alluvial fan deposits, Petrified Forest Member of the Chinle Formation on steeper slopes, and Stream-channel deposits in dry washes.

Ecological systems:

All of the ecological systems in this segment are in the Colorado Plateau Ecological Region. Remnant grasslands exist in the vicinity of Mt. Trumbull Road. They are classified as the Grassland Ecological System and are dominated by *Achnatherum hymenoides* and *Pleuraphis jamesii*. Grassland extends west along the segment for 1.8 miles, to just beyond a corral. The Grassland Ecological System corresponds closely to the area of Lower Red Member of the Moenkopi Formation geology. To the west, the range has been degraded to Mixed Desert Scrub and Shrub-Steppe. Mixed Desert Scrub is often associated with Young alluvial fan deposits geology. In Shrub-Steppe, dominant shrubs such as *Chrysothamnus greenei* are annually grazed and browsed, resulting in dwarfed plants covering less than 10% of the ground, and exceeded in height by native grasses when the latter are flowering. Grasslands are limited on the Uinkaret Plateau, where they are dominated by *Pleuraphis jamesii* and surrounded by the Blackbrush-Mormon-tea Shrubland, Shrub-Steppe, and Mixed Desert Scrub Ecological

Systems. One area of the Pinyon-Juniper Woodland Ecological System is found adjacent to the tributary of the Pipe Valley Wash where it descends down Moonshine Ridge through the Shinarump Member of the Chinle Formation geology. Washes are associated with Eolian deposits geology.

Special status plants:

Only one special status plant species was found within this segment. Eleven *Pediomelum epipsilum* plants were located 1.24 miles west of the segment start, in the vicinity of a livestock corral. They were in high clay content soils associated with the Lower Red Member of the Moenkopi Formation. Despite the presence of small areas elsewhere in this segment of the other members of the Moenkopi Formation, special status plants which prefer gypsum-bearing soils were notably absent. For example, *Pediocactus sileri* was not found in this segment despite the presence of suitable habitat. The historical record of 140 years of grazing, including over-grazing during drought, may be a major factor in the plant's absence.

Noxious and invasive weeds:

Grazing pressure has resulted in invasion by exotic plants. *Salsola tragus* dominates degraded areas on the Kanab Plateau, along with *Erodium cicutarium* on the Uinkaret Plateau. Siltation from flooded washes has also contributed to high *Salsola* densities on the Kanab Plateau. Alluvial lands, as mapped by Billingsley, et al. (2004) are more prone to invasive dominance than residual bedrock lands mapped into the various members of the Moenkopi Formation. Since alluvial soils prevail along Pipe Valley Wash, the problem is so widespread and severe here as to bring into question the ability to control weeds along the pipeline corridor after pipeline construction. The flatness of Pipe Valley makes it especially prone to seed dispersal from windblown, "tumbling" *Salsola* which disperse seeds even after breaking free of the ground.

Impacts:

Establishing and maintaining roads along the pipeline and transmission line corridors provide a route for noxious and invasive weeds to colonize adjacent natural lands.

Leaving areas untreated which are classified as Invasive Upland Vegetation can result in the spread of noxious and invasive weeds.

Routing the pipeline through special status plant habitat can adversely impact individual plants.

The disturbance associated with digging the trench for the pipeline could lead to erosion.

Best management practices:

The following recommendations are best management practices of particular applicability to this segment. Further discussion of each is provided in the Best Management Practices section in the first part of this chapter.

Protect erosion prone land (BMP-G8)

Stream incision by flash floods is so pervasive in this landscape (Webb, et al. 1992) that pipeline crossings of washes need to be designed to withstand erosion. Best management practice would re-establish stabilizing vegetation along dry washes at crossings. With proper selection of plants, this could have the added benefit of improving wildlife habitat.

Protect wellheads from pollutants (BMP-G11)
Prevent stream bed modification (BMP-G12)
Cover open trenches to prevent wildlife and livestock mortality or injury (BMP-G14)

Dispose of vegetation slash (BMP-G16)
Dispose of all construction waste (BMP-G17)
Revegetate disturbed soils (BMP-R/R1)
Vegetation restorations would need to be protected from grazing in order to become established. Without a reduction in livestock stocking in Pipe Valley, the corridor would become preferred pasture and the re-seeding might not be successful. Where the pipeline crosses the woodland, construction activities should maintain as much tree cover as possible to preserve its function as a wildlife corridor. Bedrock exposures here provide excellent cacti habitat. With minor rerouting to the north, the pipeline would avoid the cliffs and woodland in a gradual climb up the Uinkaret Plateau to Yellowstone Road.
Install and maintain sediment and seed traps (BMP-R/R4)
Salvage topsoil (BMP-R/R6)
Prevent pollution discharge into streams (BMP-RA2)
Salvage and transplant perennial special status plants (BMP-SS1)
Avoidance of gypsum badlands with special status plants (BMP-SS4)
Maintain livestock fencing and gates (BMP-SS5)
Control equipment movement in areas with noxious or invasive plants (BMP-IS10)

6.5.27 Segment 27: Yellowstone Road

Reach 16: Hydro System South Alternative

Overview:

The Yellowstone Road survey segment is named for the road that is centered within the segment, for a distance of 4.77 miles south of Arizona route 389 (Appendix F). A pipeline, transmission line, and equipment site would occupy this segment. Land ownership is private, Arizona State Trust Land, and BLM. The vegetation consists of mostly low quality forage species in the Colorado Plateau Mixed Desert Scrub Ecological System. No special status plants were observed within this segment.

Description:

Route:

The Yellowstone Road survey segment makes a 90-degree turn northward from the previous segment, the Mt. Trumbull Road to Yellowstone Road segment. It continues north 4.77 miles along the centerline of Yellowstone Road to its junction with Arizona Route 389, where it intersects the AZ 389 from the Kaibab Indian Reservation West Boundary to Colorado City segment.

Land use history:

Livestock grazing has been the primary land use within this segment since the 1870s. Maroney Well is a private well within the segment and one of the only wells in the LPP survey area. It occurs at a crossroads on the original Kaibab Wagon Road through Pipe Springs. The well was on one end of a cattle driveway used by ranches still grazing Reservation lands into the early 1930s. No record was found to indicate when this or any other well was installed on the Arizona Strip. Wells would have changed the previous patterns of livestock grazing by more effectively utilizing areas which had previous required hauling water.

Land ownership:

Ownership is typically different on opposite sides of Yellowstone Road. The entire east side is private, with the exception of the northern-most half mile, which is Arizona State Trust Land. The west side is alternately trust land and BLM.

Geology:

This segment lies wholly within the Uinkaret Plateau, as named by John Wesley Powell (Barnes 1988). Uinkaret is a Paiute word meaning "where the pines grow" (Mahanay 1997-2007). Most of the surface geology in the segment is mapped as Colluvial deposits. A depression of Valley-fill deposits extends to Maroney Well, which is characterized by Dune sand and sand sheet deposits. At the north end of the segment is a small area of Petrified Forest Member of the Chinle Formation, surrounded by Colluvial deposits and Dune sand and sand sheet deposits.

Ecological systems:

All of the ecological systems in this segment are in the Colorado Plateau Ecological Region. This segment has undergone vegetation type conversion from 140 years of heavy grazing. Much of it presently classifies as degraded Mixed Desert Scrub. A small area classifies as Blackbrush-Mormon-tea, perhaps proving insight into a prior vegetation type which may have been either burned off or grazed out.

Noxious and invasive weeds:

Erodium cicutarium is pervasive along this segment, with *Salsola tragus* nearly as abundant. *Halogeton glomeratus* is localized within the segment.

Impacts:

Establishing and maintaining roads along the pipeline and transmission line corridors provide a route for noxious and invasive weeds to colonize adjacent natural lands.

Creating access roads through sand dunes subjects the dunes to destabilization.

Leaving areas untreated which are classified as Invasive Upland Vegetation can result in the spread of noxious and invasive weeds.

The disturbance associated with digging the trench for the pipeline could lead to erosion.

Best management practices:

The following recommendations are best management practices of particular applicability to this segment. Further discussion of each is provided in the Best Management Practices section in the first part of this chapter.

Protect erosion prone land (BMP-G8)
Protect wellheads from pollutants (BMP-G11)
Cover open trenches to prevent wildlife and livestock mortality or injury (BMP-G14)
Dispose of all construction waste (BMP-G17)
Revegetate disturbed soils (BMP-R/R1)
Install and maintain sediment and seed traps (BMP-R/R4)
Salvage topsoil (BMP-R/R6)
Maintain livestock fencing and gates (BMP-SS5)
Control equipment movement in areas with noxious or invasive plants (BMP-IS10)

6.5.28 Segment 28: Arizona 389 from the Kaibab Indian ReservationWest Boundary to Colorado City

Reach 15: Hydro System Existing Highway Alternateand Reach 9: Hydro System

Overview:

The survey segment begins along Arizona Route 389 at the Kaibab Band of the Paiute Indian Reservation (Reservation) west boundary. It parallels the north side of AZ Highway 389 the entire length, with one equipment site on the south side. The segment ends in Colorado City (Appendix F). A pipeline, transmission line, and various sites for equipment, staging, and pumping occupy this segment. Ownership is mostly private land, with two tracts of Arizona State Trust land and a one tract of BLM land. The intensity of field surveys was limited on private lands. There is a wide diversity of vegetation. The special status plant *Penstemon laevis* was found at the base of Cedar Ridge.

Description:

Route:

This segment begins in Arizona at the west boundary of the Reservation, where it is a continuation of the Kaibab Indian Reservation along AZ 389 segment. The segment parallels AZ Route 389 and crosses a series of unnamed tributaries to Pipe Valley Wash in Pipe Valley. At approximately 3.9 miles, Pipe Valley ends at Cedar Ridge, where the segment raises to a higher elevation alluvial fan. At 5.69 miles the segment reaches Yellowstone Road (Mohave County Road 239), where the Yellowstone Road segment meets from the south. Cottonwood Wash is crossed at 8.16 miles and the junction of Mohave County Road 237 to Cane Beds (3.3 miles east) is encountered at 9.69 miles. At 11 miles, an equipment site lies directly west of Cottonwood Point on the alluvial fan of the Vermillion Cliffs. Short Creek crosses AZ 389 at 13.05 miles. The segment ends at 13.23 miles, where AZ Highway 389 meets Township Road. Here the Colorado City to the Divide segment begins.

Land use history:

Two towns are located in or near this survey segment. At the north end of this segment is Colorado City, previously named Short Creek. The Short Creek post office was established in 1914 (Barnes 1998). Hildale, a sister community to Colorado City, is on the Utah side of the state border. Hildale was founded in 1962 after the road from Hurricane was oiled (Alder and Brooks 2010). Presently the land uses include irrigated agriculture, livestock grazing, and residential development.

Geology:

Young alluvial deposits occur at the east end of the segment on flat lands below Cedar Ridge, mixed with thicker Eolian deposits. The Petrified Forest Member of the Chinle Formation is exposed on isolated outcrops of Cedar Ridge. Alluvial fan deposits occur on the wooded slopes of Cedar Ridge. Dune sand and sand sheet deposits occur on the slopes off Cedar Ridge, and on the Uinkaret Plateau above Cedar Ridge. Stream-channel deposits occur in dry washes, with Young terrace-gravel deposits adjacent to streams, or Flood-plain deposits in association with dry washes north of Yellowstone Road. Colluvial deposits occur on level ground above Cedar Ridge on the Uinkaret Plateau. A small area of Kayenta Formation occurs on a wooded knoll west of Yellowstone Road, surrounded by Dune sand and sand sheet deposits.

Ecological systems:

All of the ecological systems in this segment are in the Colorado Plateau Ecological Region. Much of the rangeland below Cedar Ridge is degraded Mixed Desert Scrub. This system has a combination of shrubs including *Artemisia filifolia*, *Atriplex canescens*, *Gutierrezia sarothrae*, and *Lycium pallidum*. Cedar Ridge is a Pinyon-Juniper Woodland, with Shrub-Steppe immediately below it. Above Cedar Ridge is a recently burned area of Invasive Upland Vegetation, dominated by *Erodium cicutarium*. Blackbrush-Mormon-tea Shrubland occurs in portions of that area which were not burned. Blackbrush-Mormon-tea Shrubland was also delineated in Dune sand and sand sheet deposits and Colluvial deposits. North of Yellowstone Road is an Active and Stabilized Dune on Dune sand and sand sheet deposits; the dune is dominated by *Artemisia filifolia*. Abandoned agricultural lands are classified as Ruderal Vegetation or Invasive Upland Vegetation. On the highest ground south of Colorado City is Pinyon-Juniper Woodland and Big Sagebrush Shrubland, dominated by *Artemisia tridentata*. *Juniperus osteosperma* dominates the woodlands, with *Pinus edulis* rarely as a co-dominant. The area where Short Creek crosses the segment is Lower Montane Riparian Woodland and Shrubland, with a semi-natural sparse woodland of *Populus fremontii* and *Elaeagnus angustifolia*. The vegetation occurs on Young terrace-gravel deposits and Stream-channel deposits geology, although the creek has terrace and creek bed disturbance from recent bulldozing. Washes occur throughout the segment and have *J. osteosperma*, *A. tridentata*, *Ericameria nauseosa*, or *G. sarothrae* dominant. Two tracts classified as Agricultural land are south of Colorado City.

Special status plants:

Cedar Ridge, which has both Arizona State Trust land and private land, is a known location for four special status plants (SEINet 2010 and searches of the herbaria at BLM offices in Kanab and St. George, Lake Mead National Recreation Area and the University of Nevada-Las Vegas). Cedar Ridge was fully botanized, despite mixed ownership. The area showed signs of recent grazing when surveyed on May 14, 2009. Only one of the four special status species taxa was confirmed on that date. The presence of special status plants cannot be ruled out because the plants may have been grazed prior to the survey. Follow-up survey of Cedar Ridge is presumed to not be possible, since private property access by a survey crew was refused by the presumed owner on May 15, 2009.

Penstemon laevis was documented by the survey team at the base of Cedar Ridge. Herbarium records indicate that the species was first collected there by Dixie College botany instructor Larry C. Higgins in May 2004, but apparently its abundance was not recorded. The location of the Dixie College herbarium specimen has likely been subjected to heavy grazing. The *Penstemon laevis* observed during the survey is on private land which has not been subjected to limits on stocking rates as set on federal lands since the Taylor Grazing Act of 1934.

Cycladenia humilis var. *jonesii* was not confirmed in this segment during the survey despite suitable habitat and prior collections in the area. Its rarity in the Arizona Strip District is likely due to grazing, including documented over-grazing nearby at Cane Beds, where ecologist Lee Hughes collected it and described it as “rare.” Hughes also collected *C. humilis* var. *jonesii* from “Woodbury Canyon-Cedar Ridge.” The T.40N., R.5W., sec. 5 or 8 location indicated is between 1.6 to 3 miles east or northeast of where the segment crosses Cedar Ridge. Section 8 is as close as 0.1 mile to the survey segment. No dates are provided on either of Hughes’ collections, but were before 2000 based on Dwayne Atwood’s dated verification notation of the specimen sheets.

Thelypodiopsis ambigua var. *erecta* was not confirmed in this segment nor in the Colorado City to the Divide segment, despite small areas of suitable Chinle Formation habitat in both. The aforementioned grazing history may be a factor in its rarity. *Thelypodiopsis ambigua* was first recorded at Cedar Ridge by BLM Botanist Ralph K.Gierisch in May 1987, but he didn’t indicate abundance on the herbarium label (Gierisch #5003). Varietal designations have not been made on the herbarium specimens, but Arizona Strip District occurrences can be assumed to be *T. ambigua* var. *erecta*, according Welsh et al. (2008).

Pediomelum aromaticum var. barnebyi was not confirmed in this segment nor in the Colorado City to the Divide segment, despite small areas of suitable Chinle Formation habitat in both. *Pediomelum aromaticum* was first recorded at Cedar Ridge by Larry C. Higgins in May 2005, but he didn't indicate abundance on the herbarium label (Higgins #26666). Like *Pediomelum aromaticum* collections from the region, varietal designations have not been made on herbarium specimens, but they can be assumed to be *P. aromaticum var. barnebyi* based on biogeographic limits to the range of the similar variety *tuhyi*. The historical record of 450 years of Kaibab Paiute harvesting of edible plants may be a factor in its rarity. Another factor might be the aforementioned grazing history.

Noxious and invasive weeds:

Salsola tragus and *Erodium cicutarium* were pervasive throughout the segment. Where dominant, they were classified as semi-natural plant associations within the Invasive Upland Vegetation system, named after one or the other species. *Tamarix* spp. and *Elaeagnus angustifolia* were established along Short Creek and Cottonwood Wash. *Tamarix* spp. also was established in a few unnamed dry washes.

Impacts:

Establishing and maintaining roads along the pipeline and transmission line corridors provide a route for noxious and invasive weeds to colonize adjacent natural lands.

Creating access roads through sand dunes subjects the dunes to destabilization.

Leaving areas untreated which are classified as Invasive Upland Vegetation can result in the spread of noxious and invasive weeds.

The disturbance associated with digging the trench for the pipeline could lead to erosion.

Best management practices:

The following recommendations are best management practices of particular applicability to this segment. Further discussion of each is provided in the Best Management Practices section in the first part of this chapter.

Protect erosion prone land (BMP-G8)
    This is especially important where the pipeline crosses Cedar Ridge
Prevent stream bed modification (BMP-G12)
    During 2009 and 2010 field surveys, Short Creek was observed to have been bulldozed at the Arizona Highway 389 bridge
Cover open trenches to prevent wildlife and livestock mortality or injury (BMP-G14)
Dispose of vegetation slash (BMP-G16)
Dispose of all construction waste (BMP-G17)
Revegetate disturbed soils (BMP-R/R1)
Install and maintain sediment and seed traps (BMP-R/R4)
Salvage topsoil (BMP-R/R6)
Prevent pollution discharge into streams and reservoirs (BMP-RA2)
Salvage and transplant perennial special status plants (BMP-SS1)
Maintain livestock fencing and gates (BMP-SS5)
Control equipment movement in areas with noxious or invasive plants (BMP-IS10)

6.5.29 Segment 29: Colorado City to The Divide

Reach 9: Hydro System

Overview:

The Colorado City to The Divide Segment would include a proposed pipeline and transmission line. The segment begins in Colorado City at Arizona Highway 389, continues east along the Utah/Arizona boundary through Short Creek at Canaan Gap, and ends at The Divide. Lands occurring within the segment are owned by ASTL, the BLM, and SITLA. The vegetation, landscape and geology within the segment is diverse. Two special status plants, *Pediocactus sileri* and *Eriogonum corymbosum* var. *nilesii*, were present in the segment. *Tamarisk* spp. was common to dominant at many dry wash crossings and stock tanks, and *Halogeton glomeratus* was scattered in overgrazed areas.

Description:

Route:

The segment begins at the junction of Township Road and AZ Highway 389 in Colorado City, Arizona, and is a continuation of the Kaibab Indian Reservation west boundary to Colorado City Segment. From Colorado City, the segment continues west for 1.06 miles, then north along an unimproved road to Uzona Ave at 1.72 miles, where it turns west, ending at 4.05 miles. The segment then follows an unnamed canyon formed by a tributary of Short Creek. At 6.37 miles, the segment reaches Canaan Wash, and crosses Short Creek at 7.60 and 8.72 miles, then parallels Short Creek on the south and the cliffs of Little Creek Mountain on the north. The segment follows an existing road at 15.64 miles, and crosses a stock tank at 16.52 miles (at the junction with Honeymoon Trail Road), from where the segment turns north. The segment continues north between the Hurricane Cliffs on the west and Little Creek Mountain on the east, and at 17.04 miles, crosses a spring-fed wash, then continues northerly, ending at the top of The Divide, at 19.46 miles.

Land use history:

The middle portion of the Colorado City to The Divide Segment parallels the route of the Old Spanish Trail. The entire Canaan Valley became heavily grazed after the 1878 merger of Winsor and Canaan Cattle Company (Garrett 1994). The Arizona Strip area also supported a sheep industry, with numbers estimated at one million head in 1930, although heavy snows in the winter of 1936-1937 decimated much of the population (Austin et al. (2005)). Presently, the area continues to be grazed rangeland.

Geology:

The surface geology of the Colorado City to The Divide Segment is based on Billingsley (2008), Hayden (2004, 2004a), and Moore and Sable (2001). The segment begins in Colorado City on Colluvial deposits, which grade into Channel alluvium. Existing sewage treatment ponds and the immediate vicinity are on the Petrified Forest Member of the Chinle Formation, and Alluvial fan deposits. The unnamed canyon and vicinity are derived from the cliff-forming Shinarump Member of the Chinle Formation. Level lands occurring at the mouth of the canyon are comprised of highly erodible Alluvium and colluvium, which continues through Canaan Gap and across Short Creek. The incised channels of Short Creek are comprised of Channel alluvium and Terrace alluvium, while the valley bottom is a complex matrix of Mixed thicker alluvial and eolian deposits and Alluvial deposits, Alluvium and colluviums, and Mixed alluvial and eolian deposits. Eventually, the valley bottom becomes strictly Mixed eolian and alluvial sand, until reaching the southern-most promontory of Little Creek Mountain. A bajada follows to the west, in which younger material is deposited in swales and minor drainages, while older Mixed alluvial and colluvial deposits form incised, inactive, gently sloping surfaces down-slope from talus deposits. The eastern edge of this bajada is the site where *Pediocactus sileri* was encountered, showing the influence of the Middle Red Member of the Moenkopi Formation a quarter mile north. Beyond the western edge of these deposits, but still occurring as inclusions, are outcrops of the Lower Red Member of the Moenkopi Formation and the Virgin Limestone Member of the Moenkopi Formation.

As the pipeline segment heads north along the road to The Divide, the Timpoweap Member of the Moenkopi Formation is located on the west, and the Lower Red Member of the Moenkopi Formation is present on the east, except where it crosses drainages mapped as Mixed alluvial and colluvial deposits. Nearing the mesa south of The Divide, the road climbs back into Virgin Limestone Member of the Moenkopi Formation geology, with a few pockets of alluvium present. Upon reaching The Divide, the segment crosses Talus and threads between two basalt buttes.

Ecological systems:

The Colorado City to The Divide Segment occurs entirely within the Colorado Plateau Ecological Region. *Artemisia tridentata* was a dominant species in Big Sagebrush Shrubland present on sands near Colorado City, and in three other areas near The Divide. Pinyon-Juniper Woodland and Gypsum Badlands occur at opposite ends of the segment, in the gap descending to Short Creek and along the road to The Divide. Gypsum Badlands are also present on outcrops comprised of the Lower Red Member of the Moenkopi Formation. Mixed Desert Scrub is commonplace along Short Creek (in the vicinity of ranches), and a small area of Greasewood Flat is located on a terrace adjacent to the creek. Grasses such as *Pleuraphis jamesii* are frequently present in herbaceous understories, with densities increasing with distance from watering sources. *Pleuraphis jamesii* is dominant in the Shrub-Steppe Ecological System. Blackbrush-Mormon-tea Shrubland occurs in some areas that are comprised of mixed alluvial and colluvial deposits, the Timpoweap Member of the Moenkopi Formation, and the Lower Red Member of the Moenkopi Formation. Washes occur periodically across the segment. *Tamarisk* spp. was well established in washes, dominating semi-natural associations of Lower Montane Riparian Woodland and Shrubland, particularly in the vicinity of Canaan Gap (on a tributary to Short Creek). Mixed Bedrock Canyon and Tableland is present on non-vegetated sandstone south of Canaan Gap, and Volcanic Rock and Cinder Land is found on the basalt ridges of The Divide.

Two areas within the segment were classified as Agricultural Land. One of these areas occurs near the start of the segment, and the other area is in the vicinity of Canaan Gap. In these areas, much of the vegetation has undergone type conversion resulting in part from a 140 year history of heavy grazing.

Special status plants:

Pediocactus sileri occurrences within the segment were rare, and limited to private lands near the southern slopes of Little Creek Mountain. Seven live cacti were identified in the Colorado Plateau Shrub-Steppe Ecological System, in the *Atriplex confertifolia* / *Pleuraphis jamesii* dwarf-shrubland association. The small size of the grouping is possibly due to a reduction of gypsum in the soils (the site is a quarter mile distance from the Middle Red Member of the Moenkopi Formation), and/or trampling from prolonged livestock grazing pressures. Potential habitat also occurs north of the segment (extending to the base of Little Creek Mountain).

Eriogonum corymbosum var. *nilesii* was encountered in the segment in dry washes and roadsides, on the southwest side of Little Creek Mountain (particularly north of the stock tank where the road turns north to follow the Hurricane Cliffs). One individual was located east south-east of the tank, on private land. Potential habitat also occurs along the south side of Little Creek Mountain, perhaps as far south as the survey segment. The segment was surveyed for special status species on April 28 and May 3-6, 2009. At that time, no varieties of *E. corymbosum* could be determined, as the species blooms in fall and the yellow flower color is a critical diagnostic character of variety. This segment was again sampled to collect 50 meter transect data on September 11, 2009, at which time a collection was tentatively determined as *E. corymbosum* var. *nilesii*. The variety was added to the special status species list after the 2009 field season, and ultimately verified from the LPP project area after specimen examination by Dr. James Reveal in June 2010. Reconnaissance re-surveys conducted September 18-19 and October 9, 2010 verified additional populations from La Verkin, UT to Page, AZ. While this reconnaissance provided locations and densities, locating all existing populations would require more complete surveys timed for September and October flowering.

Noxious and invasive weeds:

Erodium cicutarium and Salsola tragus are ubiquitous in the segment. *Tamarisk* spp. was common to dominant at many dry wash crossings and at stock tanks. *Halogeton glomeratus* was scattered in overgrazed areas.

Impacts:

Routing the pipeline through habitat supporting special status species could adversely impact the viability of individuals located within or adjacent to the affected areas.

Areas classified as Agricultural Land may serve as point sources for the spread of noxious and invasive weeds. The establishment and maintenance of roads in association with the proposed project may provide a route for noxious and invasive weeds to colonize adjacent natural lands. Access roads created through sand dunes occurring within the segment could also subject dunes to destabilization.

Disturbance associated with the proposed project, including the creation and filling of trenches, may lead to erosion.

Creating pipeline and transmission tower access roads can open up remote areas to off highway vehicle use.

Best management practices:

The following recommendations are best management practices of particular applicability to this segment. Further discussion of each is provided in Section 6.1 above.

Protect erosion prone land (BMP-G8)
Protect wellheads from pollutants (BMP-G11)
Prevent stream bed modification (BMP-G12)
Cover open trenches to prevent wildlife and livestock mortality or injury (BMP-G14)
Minimize raptor perching on transmission line poles (BMP-G15)
Dispose of vegetation slash (BMP-G16)
Dispose of all construction waste (BMP-G17)
Revegetate disturbed soils (BMP-R/R1)
Install and maintain sediment and seed traps (BMP-R/R4)
Salvage topsoil (BMP-R/R6)
Prevent pollution discharge into streams and reservoirs (BMP-RA2)
Avoidance of gypsum badlands with special status plants (BMP-SS2)
Salvage and transplant perennial special status plants (BMP-SS3)
Maintain livestock fencing and gates (BMP-SS5)
Control equipment movement in areas with noxious or invasive plants (BMP-IS10)

6.5.30 Segment 30: Forebay

Reach 21: Forebay

Overview:

The Forebay survey segment occurs in a valley above the Hurricane Cliffs. It is bounded on the west by the Hurricane Cliffs and on the east by a road at the base of Little Creek Mountain. A western extension of the Forebay segment encompasses part of the cliff face (Appendix F). The high point in elevation is at the northern end of the Forebay. A reservoir with various pipelines and tunnels would occupy this segment. The land ownership is primarily Bureau of Land Management, with the exception of some Utah School and Institutional Trust Lands Administration in the very northern extension. The vegetation consists primarily of shrub-steppe, pinyon-juniper woodlan,d and mixed desert scrub. No special status plants were found within this segment even though suitable habitat is present. Weeds are prevalent throughout the segment, particularly *Erodium cicutarium* and *Salsola tragus*.

Description:

Route:

The Forebay segment begins at the terminus of the Colorado City to the Divide segment. Continuing from the north end of the Forebay is the Divide to La Verkin Creek segment. The Forebay and Afterbay segments would be linked by a tunnel through the Hurricane Cliffs.

Land use history:

No references specific to the land use history of the Forebay were found. However, it probably was a part of the large ranching operation out of Gould Ranch. The valley was the site for a large stock water reservoir with its dam comprised of the same highly erodible soil as the valley bottom. The dam was breeched by floodwater. Cattle were observed grazing the area in 2010.

Geology:

The geology of the Afterbay is complex. Mixed alluvial and Eolian deposits correspond to areas classified as Colorado Plateau Shrub-Steppe vegetation. Slightly higher land in the valley is in Mixed alluvial and colluvial deposits.

A small plateau dominates the east side of the Forebay, outside the footprint of the proposed reservoir. It is capped by the Virgin Limestone Member of the Moenkopi Formation, with slopes on its western periphery of Lower Red Member of the Moenkopi Formation.

The Timpoweap Member of the Moenkopi Formation forms the upper terrace of the Hurricane Cliffs and then transitions to Undifferentiated Timpoweap Member and Rock Canyon Conglomerate of the Moenkopi Formation. The Harrisburg Member of the Kaibab Formation (Pkh) is evident on steep cliff faces.

At the southern tip of the segment mixed alluvial and colluvial deposits occur, older than Mixed alluvial and colluvial deposits with arroyos present. Basalt flow and cinder cones are found at the north end of the Forebay, with Talus at the base of the Basalt flow.

Ecological systems:

All of the ecological systems in this segment are in the Colorado Plateau Ecological Region. Volcanic Rock and Cinder Land is limited to the north end where burn-over land is dominated by re-sprouting *Yucca baccata* and *Salsola tragus*. Invasive Upland Vegetation occurs on the most severely burned land where only *Salsola* is present. The valley is variously Shrub-Steppe or Mixed Desert Scrub, with the latter having the grasses grazed out. The plateau on the east is variously Pinyon-Juniper Woodland, Blackbrush-Mormon-tea Shrubland and Big

Sagebrush Shrubland. A strip of *Tamarix* spp. in an incised dry wash is classified as Lower Montane Riparian Woodland and Shrubland.

Invasive and noxious weeds:

Salsola tragus and *Erodium cicutarium* were pervasive in this segment, especially on burned lands. The aforementioned *Tamarix* spp. was localized.

Impacts:

Development of a reservoir might attract recreational camping and increased use of off highway vehicles in the area.

Establishing and maintaining roads along the pipeline and transmission line corridors provide a route for invasive weeds to colonize adjacent natural lands.

Leaving areas untreated which are classified as Invasive Upland Vegetation can result in the spread of invasive weeds.

Best management practices:

The following recommendations are best management practices of particular applicability to this segment. Further discussion of each is provided in the Best Management Practices section in the first part of this chapter.

Protect erosion prone land (BMP-G8)
Cover open trenches to prevent wildlife and livestock mortality or injury (BMP-G14)
Revegetate disturbed soils (BMP-R/R1)
Install and maintain sediment and seed traps (BMP-R/R4)
Maintain livestock fencing and gates (BMP-SS5)
Control equipment movement in areas with noxious or invasive plants (BMP-IS10)

6.5.31 Segment 31: Afterbay

Reach 21: Afterbay

Overview:

A reservoir, various pipelines and transmission lines, tunnels, tailrace channels, powerhouse switchyards, and a pumping station would occur in this segment. The segment also includes lands representing the 2009 footprint of the reservoir, which has since been reconfigured. The survey segment lies between the Hurricane Cliffs on the east and the Grass Valley cinder cone and Navajo Sandstone outcrops on the west (Appendix F). Ownership is mostly BLM, with a small part in SITLA lands. There are no special status plants found in this segment. *Bromus rubens*, *Salsola tragus* and *Erodium cicutarium* are pervasive as weeds. The Afterbay is Mohave desert tortoise habitat, which would be partly inundated by a reservoir.

Description:

Route:

The Afterbay segment will be connected to the Forebay segment via a tunnel. Three other segments originate from the Afterbay segment. The Afterbay to Hurricane Airport segment extends north from the Afterbay segment.

The Afterbay to Sand Hollow Reservoir Pipeline segment and the Afterbay to Sand Hollow Reservoir Transmission Line segment begin on the west side of the Afterbay and continue in a northwesterly direction.

Land use history:

This segment has been grazed by domestic cattle and sheep and feral horses. Two berms were created here at an unknown date to impound surface water for open range livestock; the berms are still operational. A wildfire burned much of the northern and eastern portions of this segment.

Geology:

Much of the eastern half of the Afterbay segment lies on Young alluvial fan deposits. The southern portion is an area of Older alluvial fan deposits. There are ridges of Eolian sand deposits immediately west of the alluvial fans. Mixed alluvial and colluvial deposits extend down the center of the valley, through which dry washes are incised locally. The Mixed alluvial and colluvial deposits strata would pass under the reservoir berm. An outcrop of Navajo Sandstone dominates the southwest part of the Afterbay and lies in the lowest part of the valley. Some of that outcrop is non-vegetated slickrock.

Ecological systems:

All of the ecological systems are in the Mohave Desert Ecological Region. The dominant vegetation is Creosotebush-White Bursage Desert Scrub. The Bedrock Cliff and Outcrop system occurs on the complex geology of the Hurricane Cliffs and in talus deposits. The basalt talus and cliffs of the Grass Valley cinder cone also support a small amount of acreage in Blackbrush-Mormon-tea Shrubland. The Mixed Desert Scrub is heavily grazed land on older alluvial fans. The Grass Valley lava flow is classified as a Volcanic Rock and Cinder Land system. Wash vegetation occurs on Mixed alluvial and colluvial deposits, as does Ruderal Vegetation in the disturbed roadside at the northern end of the segment.

Impacts:

The Afterbay contains Mohave desert tortoise habitat, portions of which would be inundated by a reservoir. Other development in the Afterbay segment would include a pumping station, powerhouse switchyards, and tailrace channels.

Establishing and maintaining roads along the reservoir and pipeline and transmission line corridors provide a route for invasive weeds to colonize adjacent natural lands.

Leaving areas untreated which are classified as Invasive Upland Vegetation can result in the spread of invasive weeds.

The disturbance associated with digging the trench for the pipeline could lead to erosion.

Creating transmission tower access roads can open up remote areas to off highway vehicle use.

Leaving open trenches in Mohave desert tortoise habitat creates the possibility of a tortoise being trapped in a trench.

Best management practices:

Development of this segment as a reservoir may require translocation of Mohave desert tortoises to suitable habitat.

The following recommendations are best management practices of particular applicability to this segment. Further discussion is provided in the Best Management Practices section in the first part of this chapter.

Protect erosion prone land (BMP-G8)
Cover open trenches to prevent wildlife and livestock mortality or injury (BMP-G14)
Minimize raptor perching on transmission line poles in areas with prairie dog colonies and within Mohave desert tortoise habitat (BMP-G15)
Dispose of all construction waste (BMP-G17)
Revegetate disturbed soils (BMP-R/R1)
Install and maintain sediment and seed traps (BMP-R/R4)
Control equipment movement in areas with noxious or invasive plants (BMP-IS10)

6.5.32 Segment 32: Afterbay to Hurricane Airport

Reach 32: Airport Road

Overview:

The survey segment begins at the north end of the Afterbay segment. It follows existing roads north to the Hurricane Airport (Appendix F). A transmission line would occupy this segment. Ownership is mostly private, with a small area of BLM land at the south end and City of Hurricane on the north. The surface geology is a combination of water, wind and gravity transported materials, with two small areas of former lava flow. There are no special status plants within this segment. A number of noxious and invasive species occur in this segment and present the risk of spreading as a result of proposed construction activities.

Description:

Route:

This segment begins 0.75 miles south of Sand Mountain Road and follows existing paved and gravel roads northward. The segment tends north, reaching at 0.24 miles a boundary with BLM land on the south and private land on the north. At 0.36 miles there is a dry waterfall immediately west, where floodwaters tumble down a basalt cliff. The alluvial fan at the base is the result of erosion from this segment after the 2006 wildfire. At 0.44 miles the segment meets the Sand Mountain Road segment, which extends to the west. At 0.75 miles is the south end of the Sky Ranch Airport community (Grassy Meadows/Sky Ranch Landowners Association Airport) and a junction with the graded Sand Mountain Road. This road provides access to other segments to the west. The Afterbay to Hurricane Airport segment continues northerly through subdivisions. At 2.65 miles, the route reaches a pass through low hills, leaving Grass Valley and entering Hurricane Fields. This represents a hydrologic divide between canal source irrigation water to the north and ground water source irrigation to the south. At 4.41 miles, the segment reaches W 2300 S, where an equipment site is 0.28 miles east. The segment terminates at 5.01 miles, where it reaches S 700 W, at the northeast corner of the Hurricane Airport (General Dick Stout Field).

Land use history:

Grass Valley and Hurricane Fields have historically been agricultural areas. Hurricane was settled and a 2,000 acre area of Hurricane Fields (Mead and Teal 1903) was put into irrigated agriculture in 1906, following completion of the Hurricane Canal in 1904 (Utah State History 2010a). Agriculture began declining in the 1960s and the Hurricane Canal was decommissioned in 1985. Water rights owned by the Hurricane Canal Company were transferred to the Washington County Water Conservation District and Virgin River water was thereafter transferred by pipe from the original Virgin River diversion dam to Quail Creek and Sand Hollow Reservoirs (Utah State Parks 2010).

General Dick Stout Field is a public airport which was built within Hurricane Fields in 1964. With the decommissioning of Hurricane Canal in 1985, Hurricane Fields has been progressively urbanizing, although there is still active irrigated agriculture from ground water pumping. The Grassy Meadows/Sky Ranch Landowners Association Airport was built in 1983. The private airport and the surrounding subdivision of homes with airstrip access were built from the former Sky Harbor Ranch.

Geology:

The surface geology is based on Hayden (2004) and Beik (2004). This segment is primarily a mix of alluvial, eolian, and colluvial transported materials. Stout Field was built on the coarser-textured soils of an older alluvial fan at the base of Hurricane Cliffs. Sky Ranch subdivision is mostly on younger alluvial fan – a preferred material for irrigated agriculture. There are two areas of former lava flow at the south end, located above a dry waterfall and in the hilly middle of the segment between the valleys. The lava flows are part of the Remnants lava flow.

Ecological systems:

This segment has predominantly been developed as subdivisions or remains active as agricultural land. Large areas of fallow land, as well as burned over land, are classified as Invasive Upland Vegetation. The fallow land was previously under irrigation.

Natural and semi-natural ecological systems are classified exclusively in the Mojave Desert Ecological Region. A wet area where the Frog Hollow drainage crosses the segment is degraded Lower Montane Riparian Woodland and Shrubland. Less fertile and rockier alluvial fans are in Creosotebush-White Bursage Desert Scrub and Mixed Desert Scrub. Washes through the fans are classified as Wash. Roadsides in agricultural areas are primarily Ruderal Vegetation, while those in the Sky Harbor Ranch subdivision still have remnants of Creosotebush-White Bursage Desert Scrub. Two quarries extend into the segment.

Noxious and invasive weeds:

The Afterbay to Hurricane Airport segment has a particularly high number of noxious or invasive weeds. These include: *Erodium cicutarium*, *Bromus rubens*, *Salsola tragus*, *Sorghum halepense, Convolvulus arvensis, Centaurea solstitialis, Tamarix* spp., and *Elaeagnus angustifolia*. The first three are well established in the segment on private rangelands, fallow agricultural areas, and abandoned areas of quarries. These areas are dispersal sites for seeds and seedlings which may become established in areas disturbed by construction activities. *Tamarix* spp. *and Elaeagnus angustifolia* are established around agricultural land and homesteads. *Sorghum halepense, Convolvulus arvensis,* and *Centaurea solstitialis* are established in roadside ditches, especially in the vicinity of the Hurricane Airport and the farms immediately south.

Impacts:

Establishing and maintaining roads along transmission line corridors provide a route for noxious and invasive weeds to colonize adjacent natural lands.

Leaving areas untreated which are classified as Invasive Upland Vegetation can result in the spread of noxious and invasive weeds.

Best management practices:

The following recommendations are best management practices of particular applicability to this segment. Further discussion of each is provided in the Best Management Practices section in the first part of this chapter.

Protect erosion prone land (BMP-G8)
Protect wellheads from pollutants (BMP-G11)
Prevent stream bed modification (BMP-G12)
Dispose of vegetation slash (BMP-G16)
Dispose of all construction waste (BMP-G17)
Revegetate disturbed soils (BMP-R/R1)
Install and maintain sediment and seed traps (BMP-R/R4)
Salvage topsoil (BMP-R/R6)
Prevent pollution discharge into streams and reservoirs (BMP-RA2)
Salvage and transplant perennial special status plants (BMP-SS1)
Control equipment movement in areas with noxious or invasive plants (BMP-IS10)
Maintain livestock fencing and gates (BMP-SS5)

6.5.33 Segment 33: Afterbay to Sand Hollow Reservoir Pipeline

Reach 23: Pump Storage Option

Overview:

The segment begins on the west side of the Afterbay and continues in a north-westerly direction to its conclusion at Sand Hollow Reservoir (Appendix F). A tunnel and pipeline would occupy this segment. Ownership is BLM for the southern half, thence private, BLM, and finally Utah State Parks and Recreation at the northern end. The vegetation is primarily Active and Stabilized Dune, Creosotebush-White Bursage Desert Scrub, and Shrub-Steppe. There are no special status plants along this segment. *Erodium cicutarium* occurs in more heavily-grazed areas.

Description:

Route:

The survey segment begins at the western edge of the Afterbay and extends to the northwest over a basalt hill, through sandsheet topography, and down sand dunes to Sand Hollow Reservoir in Sand Hollow State Park. Over the last 0.85 mile, the segment merges with a segment called the Afterbay to Sand Hollow Reservoir Transmission Line.

Land use history:

The Afterbay to Sand Hollow Reservoir Pipeline survey segment has historically been used by trucks and off highway vehicles (Utah State Parks 2010). Sand Hollow Reservoir is a water storage and ground water recharge reservoir built in 2002 and established as Sand Hollow State Park in 2003. Sand Hollow Recreation Area is a complex of recreation sites which includes Washington County Water Conservation District (WCWCD) lands surrounding Sand Hollow Reservoir and large portions from BLM’s Sand Mountain Special Recreation Management Area, established in 1997. The Utah Division of State Parks and Recreation manages, but does not own, the complex of lands through a cooperative agreement with BLM and WCWCD signed in 2002 (Utah State Parks 2010). Water for the reservoir is supplied by pipe from Quail Creek Reservoir, which in turn is supplied primarily from the Virgin River.

Geology:

The groundwater under this segment is managed under the Navajo Sandstone Aquifer Storage Project. Surface geology mapping of the segment is from Hayden (2004). There is an extensive area of Grass Valley lava flow west of the Afterbay. It is the highest elevation in the segment. Between Grass Valley and the dunes are Caliche and Eolian sand deposits. The Eolian sand deposits sandsheet is interspersed with Mixed alluvial and colluvial deposits. Mid-way through the segment a large outcrop of Navajo Sandstone occurs. Navajo Sandstone also outcrops in a dry wash where the segment crosses Grass Valley lava flow basalt. The lower slopes of that basalt consist of Talus deposits. Sand dunes mapped as Eolian-sand deposits occur in the northern end of the section.

Ecological systems:

All of the ecological systems in this segment are in the Mohave Desert Ecological Region. *Pleuraphis rigida* dominated Grassland occurs on Mixed alluvial and colluvial deposits. The Grass Valley lava flow corresponds to Volcanic Rock and Cinder Land dominated by *Coleogyne ramosissima* and *Larrea tridentata*. Mixed deposits support Creosotebush-White Bursage Desert Scrub and Shrub-Steppe. The single occurrence of a Wash is a sparsely- vegetated natural erosion cut through the basalt into Navajo Sandstone. There is a minor area of Agricultural land. The northern part is Active and Stabilized Dune dominated by *Artemisia filifolia*. It is on sand dunes geologically mapped as Caliche and Eolian sand deposits deposits. The segment terminates in a reservoir.

Impacts:

The pipeline in a portion of this segment would be contained within a tunnel, therefore, there are no anticipated impacts to the land surface above the tunnel.

Establishing and maintaining roads along the pipeline corridor provides a route for noxious and invasive weeds to colonize adjacent natural lands.

Creating access roads through sand dunes subjects the dunes to destabilization.

Leaving areas untreated which are classified as Invasive Upland Vegetation can result in the spread of noxious and invasive weeds.

The disturbance associated with digging the trench for the pipeline could lead to erosion.

Leaving open trenches in Mojave desert tortoise habitat creates the possibility of a tortoise being trapped in a trench.

Best management practices:

The following recommendations are best management practices of particular applicability to this segment. Further discussion of each is provided in the Best Management Practices section in the first part of this chapter.

Protect erosion prone land (BMP-G8)
Cover open trenches to prevent wildlife and livestock mortality or injury (BMP-G14)
Minimize raptor perching on transmission line poles (BMP-G15)
Dispose of all construction waste (BMP-G17)
Revegetate disturbed soils (BMP-R/R1)
Install and maintain sediment and seed traps (BMP-R/R4)
Salvage topsoil (BMP-R/R6)
Prevent pollution discharge into streams and reservoirs (BMP-RA2)
Maintain livestock fencing and gates (BMP-SS5)
Control equipment movement in areas with noxious or invasive plants (BMP-IS10)

6.5.34 Segment 34: Afterbay to Sand Hollow Reservoir Transmission Line

Reach 24: Hurricane Cliffs to Sand Hollow Transmission Line

Overview:

The Afterbay to Sand Hollow Reservoir Transmission Line survey segment begins at the western edge of the Afterbay and extends to Sand Hollow Reservoir in Sand Hollow State Park. Over the last 0.85 mile, the segment merges with a segment called the Afterbay to Sand Hollow Reservoir Pipeline (Appendix F). The land ownership is BLM, with the exception of the northern half of a short stretch near Sand Hollow Road, which is owned by Washington County Water Conservation District (WCWCD). Much of the area is managed as part of the Sand Mountain Special Recreation Management Area. There are no special status plants in this segment. *Erodium cicutarium* occurs in more heavily grazed areas.

Description:

Route:

The survey segment begins at the western edge of the Afterbay and extends northwest across a basalt hill, through sandsheet topography, and down sand dunes to Sand Hollow Reservoir in Sand Hollow State Park.

Land use history:

This segment has historically been used by trucks and off highway vehicles (Utah State Parks 2010). Sand Hollow Reservoir is a water storage and ground water recharge reservoir built in 2002, and established as Sand Hollow State Park in 2003. Sand Hollow Recreation Area is a complex of recreation sites which includes WCWCD lands surrounding Sand Hollow Reservoir and large portions from BLM's Sand Mountain Special Recreation Management Area. The Utah Division of State Parks and Recreation manages, but does not own, the complex of lands through a cooperative agreement with BLM and WCWCD signed in 2002 (Utah State Parks 2010).

Geology:

The groundwater under this segment is managed under the Navajo Sandstone Aquifer Storage Project.

Surface geology mapping of the segment is from Hayden (2004). An extensive area of lava flow occurs west of the Afterbay in Grass Valley. This is the highest elevation in the segment. Between Grass Valley and the dunes Caliche and Eolian sand deposits occur. The Eolian sand deposits sandsheet is interspersed with Mixed alluvial and colluvial deposits. A small area of Mixed alluvial and eolian deposits occurs at the northwestern base of the volcanic hill. The northern end of the segment decending to Sand Hollow Reservoir contains sand dunes mapped as Eolian-sand deposits. Navajo Sandstone outcrops midway through the segment and again in a dry wash where the segment crosses lava flow basalt. Talus deposits occur on the lower slopes of the lava flow basalt.

Ecological systems:

All of the ecological systems in this segment are in the Mohave Desert Ecological Region. *Pleuraphis rigida* dominated Grassland occurs primarily on Mixed alluvial and eolian deposits and secondarily on Mixed alluvial and colluvial deposits in a valley. The lava flow corresponds to Volcanic Rock and Cinder Land dominated by *Coleogyne ramosissima* and *Larrea tridentata*. Mixed deposits support Creosotebush-White Bursage Desert Scrub and Shrub-Steppe. There is a minor area of Agricultural land. In the northern part of the segment, Active and Stabilized Dune is dominated by *Artemisia filifolia*. The dunes are geologically mapped as Eolian sand deposits. The segment terminates in a reservoir.

Impacts:

Establishing and maintaining roads along the transmission line corridors provide a route for noxious and invasive weeds to colonize adjacent natural lands.

Creating access roads through sand dunes subjects the dunes to destabilization.

Creating transmission tower access roads can open up remote areas to off highway vehicle use.

Leaving open trenches in Mojave desert tortoise habitat creates the possibility of a tortoise being trapped in a trench.

Best management practices:

The following recommendations are additional best management practices of particular applicability to this segment. Further discussion of each is provided in the Best Management Practices section in the first part of this chapter.

Protect erosion prone land (BMP-G8)
Cover open trenches to prevent wildlife and livestock mortality or injury (BMP-G14)
Minimize raptor perching on transmission line poles (BMP-G15)
Dispose of all construction waste (BMP-G17)
Install and maintain sediment and seed traps (BMP-R/R4)
Revegetate disturbed soils (BMP-R/R1)
Prevent pollution discharge into reservoirs (BMP-RA2)
Maintain livestock fencing and gates (BMP-SS5)
Control equipment movement in areas with noxious or invasive plants (BMP-IS10)

6.5.35 Segment 35: Sand Mountain Road

Reach 25: Penstock from Afterbay to Sand Hollow Hydro for Peaking Option

Overview:

The Sand Mountain Road Segment runs east-west from the Sky Ranch Airport Community to Sand Mountain Road. Lands within the segment are owned privately and by the BLM. The predominant vegetation is Shrub-Steppe, with an herbaceous understory of *Pleuraphis rigida*. There were no special status species encountered in this segment. The noxious and invasive weed *Erodium cicutarium* was prevalent throughout the segment.

Description:

Route:

The short segment is 1.76 miles long, starts Sky Ranch Airport Community, heads west, and ends at Sand Mountain Road.

Land use history:

No references specific to the land use history of the segment were located. However, comments pertaining to adjacent segments located to the east and west are applicable.

Geology:

The groundwater under this segment is managed under the Navajo Sandstone Aquifer Storage Project.

Surface geology mapping of the segment is from Hayden (2004). There is an extensive area of Grass Valley lava flow in the segment, where Eolian sand deposits are represented in dunes. Caliche and Eolian sand deposits are present between Grass Valley and the dunes. A band of Mixed alluvial and colluvial deposits also occurs in the segment, and transitions into Colluvial deposits. Extending from the west side of Grass Valley to the base of a volcanic hill is a small area of Mixed alluvial and eolian deposits, and the east side of Grass Valley is comprised of Younger alluvial-fan deposits which extend south to the volcanic hill.

Ecological systems:

All of the ecological systems within the segment are in the Mohave Desert Ecological Region. Shrub-Steppe with an herbaceous understory of *Pleuraphis rigida* is prevalent in the segment. The Shrub-Steppe Ecological System occurs on substrates derived from Caliche and Eolian sand deposits, Colluvial deposits, and Eolian sand deposits, and in Grass Valley, Shrub-Steppe occurs on lava flow and sand/carbonate veneer over basalt . Unburned areas of Younger alluvial-fan deposits support Creosotebush-White bursage Desert Scrub.

Noxious and invasive weeds:

Erodium cicutarium is pervasive along the segment. Invasive Upland Vegetation occupies a burned area that was formerly *Larrea tridentata* shrubland. Where heavily grazed areas of Creosotebush-White bursage Desert Scrub have burned, *Bromus rubens* and *Erodium cicutarium* have replaced the native flora.

Impacts:

Areas classified as Invasive Upland Vegetation may serve as point sources for the spread of noxious and invasive weeds. The establishment and maintenance of roads in association with the proposed project may provide a route for noxious and invasive weeds to colonize adjacent natural lands.

The establishment and maintenance of access roads may open up remote areas to off highway vehicle use.

Creating access roads through sand dunes could subject the dunes to destabilization.

Project-related disturbance, such as trenching activities, may lead to localized erosion.

Best management practices:

The following recommendations are best management practices of particular applicability to this segment. Further discussion of each is provided in Section 6.1 above.

Protect erosion prone land (BMP-G8)
Protect wellheads from pollutants (BMP-G11)
Cover open trenches to prevent wildlife and livestock mortality or injury (BMP-G14)
Dispose of all construction waste (BMP-G17)
Revegetate disturbed soils (BMP-R/R1)
Install and maintain sediment and seed traps (BMP-R/R4)
Maintain livestock fencing and gates (BMP-SS5)
Control equipment movement in areas with noxious or invasive plants (BMP-IS10)

6.5.36 Segment 36: Sand Hollow Reservoir to Dixie Springs Substation

Reach 27: Sand Hollow to Dixie Springs Transmission Line
Reach 28: Dixie Springs Substation

Overview:

A transmission line would occupy this segment. The Sand Hollow Reservoir to Dixie Springs Substation segment starts at the southeastern edge of Sand Hollow Reservoir. It follows the eastern shoreline of the Reservoir and continues north on S 3400 W Road and west on W 2450 S Road to a terminus at the Dixie Springs Substation (Appendix F). Land ownership is split almost evenly between private land and Washington County Water Conservation District (WCWCD) land administered by Utah State Parks and Recreation as Sand Hollow State Park. The vegetation includes *Artemisia filifolia* on sand dunes in the south; *Larrea tridentata* and *Ambrosia dumosa* on basalt talus; and *Larrea tridentata* on grazed lands. There are no special status plants in this segment. *Tamarix* spp. was the only noxious or invasive documented.

Description:

Route:

This segment connects to the two Afterbay to Sand Hollow Hydro segments at the southeastern edge of Sand Hollow Reservoir. It than follows the shoreline of the reservoir on its east side and intersects S 3360 W Road at the Sand Hollow State Park boundary northeast gate. The segment continues north on S 3360 W until it reaches W 2450 S Road, where it turns west to the Dixie Springs Substation. This is the end of the transmission line.

Land use history:

No references were found regarding past land use history of this segment. The area appears to have long been in agricultural production north of the present day Sand Hollow Reservoir. Irrigation water may have come from the Hurricane Canal (see narrative for the Afterbay to Hurricane Airport segment [Segment 32]). Many areas have been left fallow and have become weed sources. The east side of Flora Tech Road (S 3400 W) has a newly buried pipeline.

Geology:

Surface geology mapping of the segment is from Hayden (2004) and Biek (2003). The segment is geologically a combination of Eolian sands on sand dunes at its south end; talus slopes below a basalt mesa in its middle portion where it borders Sand Hollow Lake; and both sand and eolian deposits at the north end.

Ecological systems:

Agricultural land dominates the northern part of this segment. The margins of the roads, especially where disturbances have occurred in the past, are Ruderal Vegetation.

All of the ecological systems in this segment are in the Mohave Desert Ecological Region. To the south of Sand Hollow Draw is Active and Stabilized Dune dominated by *Artemisia filifolia*. Creosotebush-White Bursage Desert Scrub dominates the lower parts of the basalt talus slopes and pastured shrublands to the north. Where there is an herbaceous understory of *Pleuraphis jamesii*, the vegetation is a Shrub-Steppe. Volcanic Rock and Cinder Land dominates the steeper areas of basalt talus which are a *Larrea tridentata – Ambrosia dumosa* Shrubland Alliance.

Noxious and invasive weeds:

Tamarix spp. dominates a small drawdown area on the Sand Hollow Reservoir shoreline. This area is classified as a semi-natural alliance within the Lower Montane Riparian Woodland and Shrubland Ecological System.

Impacts:

Establishing and maintaining roads along a transmission line corridor provide a route for noxious and invasive weeds to colonize adjacent natural lands.

Creating access roads through sand dunes subjects the dunes to destabilization.

Disturbing areas that are classified as Invasive Upland Vegetation could result in the spread of noxious and invasive weeds.

Best management practices:

The following recommendations are BMPs of particular applicability to this segment. Further discussion of each is provided in Section 6.1 above.

Protect erosion prone land (BMP-G8)
Cover open trenches to prevent wildlife and livestock mortality or injury (BMP-G14)
Dispose of all construction waste (BMP-G17)
Revegetate disturbed soils (BMP-R/R1)
Install and maintain sediment and seed traps (BMP-R/R4)
Salvage topsoil (BMP-R/R6)
Prevent pollution discharge into reservoirs (BMP-RA2)
Maintain livestock fencing and gates (BMP-SS5)
Control equipment movement in areas with noxious or invasive plants (BMP-IS10)

6.5.37 Segment 37: Sand Mountain to Virgin River

Reach 29: Hurricane Cliffs Afterbay to Hurricane West Transmission Line, Reach 30: Hurricane West Substation

Overview:

A transmission line would occupy this segment. The Sand Mountain to Virgin River segment begins on Sand Mountain at the junction of a number of other segments. The segment continues north and crosses Utah Route 9 immediately west of Hurricane. There it continues north then west to a terminus just south of the Virgin River (Appendix F). Land ownership is entirely private. There are no special status plants found along this segment. Noxious and invasive species include: *Erodium cicutarium, Tamarisk* spp., *Elaeagnus angustifolia, Convolvulus arvensis,* and *Typha* sp.

Description:

Route:

The Sand Mountain to Virgin River segment begins on Sand Mountain, 1.8 miles southeast of Sand Hollow Reservoir. The segment continues north passing Sand Hollow Draw on the west and Hurricane Fields on the east, and then crosses Bench Lake. Bench Lake is a twin berm water impoundment. The segment then passes the western slopes of Sullivan Knoll (Volcano Mountain) and crosses Utah Route 9 west of Hurricane. It continues north and crosses W 600 N, then turns west to its terminus just before the basalt cliffs south of the Virgin River.

Land use history:

Hurricane was settled in 1896, at the start of construction of the La Verkin (Hurricane) Canal. This canal provided water until 1985 for agriculture in the Hurricane Fields. Bench Lake is an irrigation lake built prior to 1903 which has supplied water for up to 2,500 acres of agricultural land on the Hurricane Bench (Mead and Teal 1903).

Geology:

The surfice geology is based on Hayden (2004) and Beik (2004). The geology is predominately Quaternary with older eolian sand and caliche deposits with up to 10 feet of sand over basalt; colluvial deposits; and alluvial and colluvial deposits. Locally there is Navajo sandstone; eolian and colluvial deposits; Ivans Knoll [lava] Flow; alluvial, eolian, and colluvial deposits; and 'Volcano Mountain' lava flow features. At the northern end of the segment the transmission line crosses basalt high cliffs.

Ecological systems:

Mixed Desert Scrub and irrigated agricultural land are the dominant types mapped in this segment. All of the ecological systems are in the Mohave Desert Ecological Region. These include: Creosotebush-White Bursage Desert Scrub dominated by *Larrea tridentata*; Mixed Desert Scrub dominated by *Gutierrezia sarothrae* or *Krascheninnikovia lanata*; Shrub-Steppe; and Volcanic Rock and Cinder Land dominated by *Coleogyne ramosissima*. The Shrub-Steppe is the most diverse ecological system in the segment, with *Pleuraphis rigida* dominating the herbaceous strata under a shrub cover of *L. tridentata*, *G. sarothrae*, *Ephedra nevadensis*, *C. ramosissima*, or *Psorothamnus fremontii*.

Special Status Plants:

No special status plants were found on this segment.

Noxious and invasive weeds:

Erodium cicutarium is pervasive along this segment. *Tamarisk* spp., *Elaeagnus angustifolia,* and *Convolvulus arvensis* and *Typha* sp. have become established over the last century in and adjacent to the wetlands at Bench Lake. There are no areas classified as Invasive Upland Vegetation, but Ruderal Vegetation is mapped along a road.

Impacts:

Establishing and maintaining roads along a transmission line access corridor provide a route for noxious and invasive weeds to colonize adjacent natural lands.

Creating access roads through sand dunes subjects the dunes to destabilization.

Disturbing areas that are classified as Invasive Upland Vegetation could result in the spread of noxious and invasive weeds.

Best management practices:

The following recommendations are BMPs of particular applicability to this segment. Further discussion of each is provided in Section 6.1 above.

Protect erosion prone land (BMP-G8)
Protect wellheads from pollutants (BMP-G11)
Prevent stream bed modification (BMP-G12)
Cover open trenches to prevent wildlife and livestock mortality or injury (BMP-G14)
Dispose of all construction waste (BMP-G17)
Revegetate disturbed soils (BMP-R/R1)
Install and maintain sediment and seed traps (BMP-R/R4)
Salvage topsoil (BMP-R/R6)
Prevent pollution discharge into streams and reservoirs (BMP-RA2)

Maintain livestock fencing and gates (BMP-SS5)
Control equipment movement in areas with noxious or invasive plants (BMP-IS10)

6.5.38 Segment 38: Virgin River to Harrisburg

Reach 31: Hurricane West to Quail Creek Reservoir

Overview:

The Virgin River to Harrisburg segment begins on the south side of the Virgin River, above a quarry. The segment continues west across the Virgin River and through Quail Creek State Park to the former site of Harrisburg (Appendix F). Land ownership is a mix of private and Quail Creek State Park. There are a wide variety of vegetation types reflecting the diverse geology and landscape of this segment. There is one special status plant in this segment: *Petalonyx parryi*. *Tamarisk* spp., *Halogeton glomeratus,* and *Brassica tournefortii* are the major noxious and invasive species.

Description:

Route:

The Virgin River to Harrisburg segment begins at the terminus of the Sand Mountain to Virgin River segment. From here the segment parallels a quarry on the south side of the Virgin River and crosses the River at Harrisburg Gap. It then crosses agricultural land, parallels a ranch access road, and crosses a ridge southwest of the impounded Harrisburg Gap. On the west side of the ridge it descends into Purgatory Flat below the dam for Quail Creek Reservoir. It crosses Purgatory Flat on a northwest course and then continues north along the Harrisburg Ridge to a gap created by Quail Creek. Continuing north in Harrisburg Flat, it terminates at the historic site for Harrisburg.

Land use history:

Harrisburg was settled at the confluence of Cottonwood and Quail Creeks by Mormon pioneers in 1859. The town was on the trade route of freighters who traveled to California via Las Vegas, Nevada from Utah (Mariger n.d.). Harrisburg was occupied until circa 1895.

An abandoned canal parallels part of N 5300 W, the main road through Quail Creek State Park. Quail Creek Reservoir was built in 1985 and is fed primarily from the Virgin River and supplies water to Sand Hollow Reservoir to the south. The original south berm (dam) gave way on January 1, 1989. It washed out the soils in Purgatory Flat, below the berm. The berm has been rebuilt to higher specifications.

The end of the segment is along old US 91, which is minimally maintained now that through traffic is carried by I-15.

Land ownership:

The segment starts on private land until reaching the eastern boundary of Quail Creek State Park, which is administered by Utah State Parks and Recreation. There are some private tracts along Harrisburg Bench on the west side of the reservoir. The final half mile, representing the former site of Harrisburg, is private.

Geology:

The surfice geology of this segment is based on Biek (2003, 2004). The segment starts in Alluvium and eolian deposits on top of the “Volcano Mountain” flows of lava, which form cliffs along the southern side of the Virgin

River. The cliffs become low and the pipeline descends into the floodplain. Here is a complex geology of Quaternary deposits, including Stream-terrace deposits, Alluvium and colluvial deposits, and Alluvial deposits, undifferentiated. A gravel pit here is mapped as Artificial fill. Upon crossing the River, the pipeline climbs the Shinarump Conglomerate Member of the Chinle Formation. On the western side of the crest it crosses the Upper Red Member of the Moenkopi Formation. In Purgatory Flat, the grey badlands is the Shnabkaib Member of the Moenkopi Formation. Continuing north along the east side of the Harrisburg Bench, the segment passes through Talus deposits. There is a small area of the Petrified Forest Member of the Chinle Formation on Harrisburg Flat, east of Harrisburg Bench just after passing through the gap formed by Cottonwood and Quail Creeks, which join just west of the gap.

Ecological systems:

All of the ecological systems in this segment are in the Mohave Desert Ecological Region. These include: Blackbrush-Mormon-tea Shrubland, Creosotebush-White Bursage Desert Scrub, Gypsum Badlands, Lower Montane Riparian Woodland and Shrubland, Mixed Desert Scrub, Shrub-Steppe, and Volcanic Rock and Cinder Land. Blackbrush-Mormon-tea Shrubland is co-dominated by *Coleogyne ramosissima* and an unknown *Ericameria* shrub, often with a non-native understory of *Bromus rubens* and *Erodium cicutarium*. Creosotebush-White Bursage Desert Scrub is almost exclusively dominated by *Larrea tridentata*, often co-dominant with *Ambrosia dumosa*. Half the acreage has a non-native understory of *B. rubens*. Gypsum Badlands are dominated by either *Ephedra torreyana* or a mix of *Psorothamnus fremontii*, *Hymenoclea salsola,* or *A. dumosa*, depending on landscape position. Mixed Desert Scrub are early seral communities dominated by *Gutierrezia sarothrae* or *Lepidium fremontii.* Shrub-Steppe has *Pleuraphis rigida* or *P. jamesii* dominating an understory of *A. dumosa* or *L. tridentata*. Volcanic Rock and Cinder Land is limited to the *Artemisia ludoviciana* Herbaceous Alliance.

Agricultural land is present along the Virgin River. Ruderal Vegetation is commonly mapped in this segment. These areas are disturbed and the vegetation succession is spontaneous with little resemblance to any native plant community.

Special status plants:

Petalonyx parryii was the only special status plant found in this segment. Fifteen plants occupy gypsum soils derived from the Shnabkaib Member of the Moenkopi Formation. It is found in the *Ephedra* (*nevadensis, torreyana*) Gypsum Badland Sparsely Vegetated Association within the Mohave Desert Gypsum Badlands Ecological System.

Noxious and invasive weeds:

Erodium cicutarium is pervasive throughout this segment. Areas classified as Invasive Upland Vegetation are dominated by combinations of *Bromus rubens*, *E. cicutarium* or *Salsola tragus*. *Tamarisk* spp. is found in nearly every riparian plant community, especially in Purgatory Flat on land scoured by the Quail Creek Reservoir berm failure. Where dominating in lieu of *Populus fremontii*, these semi-natural communities are classified as Lower Montane Riparian Woodland and Shrubland. *Halogeton glomeratus* is found on saline soils, especially along the abandoned irrigation canal. *Brassica tournefortii* is a recent introduction from the I-15 corridor and has colonized burned areas of the Harrisburg Ridge near Quail Creek.

Impacts:

It is unclear if the intent of this segment was for a transmission line or pipeline. Thus there is no information to determine impacts.

Best management practices:

Once an intended purpose has been identified for this segment, BMPs could be recommended to minimize potential impacts.

6.5.39 Segment 39: The Divide to La Verkin Creek

Reach 33: Cedar Valley Pipeline System

Overview:

The Divide to La Verkin Creek Segment would include a proposed pipeline and transmission line. The segment begins at The Divide and ends at La Verkin Creek (Appendix F). Lands occurring within the segment are owned primarily by the BLM, although SITLA and private lands also are present. Diverse vegetation occurs throughout the segment, a portion of the geology is volcanic in origin, and Moenkopi Formation badlands are visually distinctive. One special status species was encountered in the segment, *Eriogonum corymbosum* var. *nilesii.* Several noxious weeds were identified in the segment, including: *Elaeagnus angustifolia, Erodium cicutarium, Halogeton glomeratus, Salsola tragus,* and *Tamarisk* spp.

Description:

Route:

The Divide to La Verkin Creek Segment begins at The Divide, where it continues from the termination of the Colorado City to The Divide Segment. The segment continues northerly through gypsum badlands, between Little Creek Mountain on the east and the Hurricane Cliffs on the west. Upon reaching Gould Spring, the segment cuts through an ancient lava field and descends to Willow Spring, and then continues northwest past a former ranch, to a crossing of Utah Route 59 at Chinatown Wash. The segment then turns north-northeasterly over relatively level topography on Sheep Bridge Road, passing a sandstone quarry and crossing the Virgin River just downstream from the Narrows. Passing through a subdivision near the town of Virgin, the segment crosses Utah Route 9, and continues west along the highway route. At the Valley Gun Club range, the segment leaves the highway and descends into geologically striking land at Nephis Twist. At the bottom of Nephis Twist, the segment extends north for a short stretch, then crosses La Verkin Creek and ends within a subdivision, at 17.1 miles from the start.

Land use history:

Lands occurring within the segment have historically supported feral horses. The area was surveyed in 1871 by members of the John Wesley Powell survey, when it was noted that herds of wild horses made well defined trails in the dry plains and stationed themselves near water sources (Dellenbaugh 1908).

Gould Ranch was established in 1864 (Hinton 2001), and was the earliest mapped ranch atop the Hurricane Cliffs (Tunison 1881, US Geological Survey 1891). Between 1910 and 1931, Gould Ranch was the site of the world's largest sheep shearing operation, with 110,000 or more sheep sheared each spring (Hurricane Valley Sons of Utah Pioneers 2010). Diamond Ranch Academy, a teen residential treatment center, is presently situated on the site. Wetlands located to the east and southeast of the ranch have been profoundly degraded from a long history of livestock pressure, trampling, and failed impoundments, and are presently invaded by *Tamarix* spp. A wildfire prior to 1992 burned much of the rangeland west of the road between Diamond Ranch Academy and Utah 59, and repeated fires over the past 20 years has resulted in the degradation of vegetative cover.

Geology:

Surficial geology mapping units are from Biek (2004), Hayden (2004), and Haden and Sable (2008). The Divide, at 4820 feet elevation, is one of the highest points in the survey area. The geologic formation occurring at The Divide is named The Divide basalt flow and cinder cones, and continues west, eventually cascading over the Hurricane Cliffs (at the north end of the Forebay). The segment also traverses gypsum badlands of the Middle Red Member of the Moenkopi Formation. Flat-topped hills to the north of the segment are derived from limestones of the Virgin River Member of the Moenkopi Formation, and outcrops occurring below the hills are comprised of the Lower Red Member of the Moenkopi Formation. Across the Gould Wash basalt flow, the segment gains elevation and then follows the base of a cliff along a tributary stream that originates at Willow Spring. Continuing north along the segment to Utah 59, older alluvial and eolian deposits occur on flats and on slight slopes of the Lower Red Member of the Moenkopi Formation; within this composition, gypsum badlands are present. Stream deposits occur in Chinatown Wash.

From Chinatown Wash, the segment passes through gypsiferous alluvial and eolian deposits and a wide band of Mixed alluvial and eolian deposits, then increases in geologic complexity until the segment reaches Utah 9. In this area, the geology has scant resemblance to the ecological systems mapped, with two exceptions: eolian-sand deposits correspond to the *Artemisia filifolia* dominated Colorado Plateau Active and Stable Dunes Ecological System, and the Lower Red Member of the Moenkopi Formation corresponds to *Mahonia fremontii* dominated Colorado Plateau Gypsum Badlands. The lack of congruence between the geology and ecological systems is likely due to generalizations in geological mapping, and type changes in vegetation resulting from 145 years of heavy grazing.

Level 1 alluvial terrace deposits are represented in the canyon terraces along the Virgin River, at Sheep Bridge. From Sheep Bridge, the segment continues north through eolian sand deposits and an alluvial terrace deposit dating from 215,000 to 310,000 years old. Heading west along the north side of Utah 9, the badlands topography alternates between washes mapped as Mixed alluvial and colluvial deposits, and outcroppings of the Lower Red Member of the Moenkopi Formation. This geologic alternation pattern continues to Nephis Twist, where the pipeline descends a gorge, where several geologic units are represented, including: the Timpoweap Member of the Moenkopi Formation, the Virgin Limestone Member, the Middle Red Member of the Moenkopi Formation, and the Shnabkaib Member of the Moenkopi Formation. At the bottom of the gorge, the segment passes through the Petrified Forest member of the Chinle Formation, and Navajo Sandstone at La Verkin Creek.

Ecological systems:

All of the ecological systems in The Divide to La Verkin Creek Segment are in the Colorado Plateau Ecological Region. Active and Stabilized Dunes are present near the crossing of the Virgin River, and Lower Montane Riparian Woodland and Shrubland occur along the Virgin River and La Verkin Creeks. Mixed Desert Scrub represents a wide spread type conversion from historically heavy grazing and perhaps burning, and is associated with Gypsiferous alluvial and eolian deposits (although not exclusively). Shrub-Steppe is limited to lands immediately south of Utah Highway 59. Volcanic Rock and Cinder Land occurs in association with lava flows at The Divide. Pinyon-Juniper Woodland only occurs in the highest elevations ranging from north of The Divide to the vicinity of Gould Reservoir. Big Sagebrush Shrubland and Blackbrush-Mormon-tea Shrubland is interspersed in Pinyon-Junipier Woodland, and also occurs commonly above Nephis Twist. The Colorado Plateau Wash Ecological System is also present in many washes throughout the segment.

Old agricultural fields occurring in the vicinity of Virgin are classified as Agricultural Land and/or Ruderal Vegetation. A sandstone quarry is also located in the segment, just south of the Virgin River on Sheep Bridge Road, in Moenkopi Formation badlands.

Special status plants:

Eriogonum corymbosum var. *nilesii* is the only special status plant species found along The Divide to La Verkin Creek Segment. *E. corymbosum* var. *nilesii* occupied a variety of habitats, including cinder cones, steep eroded gypsum badlands slopes, and dry washes cutting through gypsum badlands that were formed in the Middle Red Member of the Moenkopi Formation. The highest densities of *E. corymbosum* var. *nilesii* occurred in areas that were least accessible for livestock grazing, suggesting that the long history of grazing documented for this segment has led to reduced quantities of the variety.

The cinder cone habitat of *Eriogonum corymbosum* var. *nilesii* is a steep east-facing slope located 0.5 miles north of The Divide, where individuals were found on The Divide basalt flow and cinder cones. Gypsum badlands occurring in the Gypsum Badlands Ecological System extend north from before The Divide, nearly to the Valley Gun Club. *E. corymbosum* var. *nilesii* individuals also occupied sites that are represented by the Lower Red Member of the Moenkopi Formation, the Timpoweap Member of the Moenkopi Formation, and limestone outcrops in the Virgin River Member of the Moenkopi Formation (the precision at which the plants were mapped using GPS exceeds the precision of the geologic mapping, so this list of bedrock types are subject to field verification; on a finer scale, many of these would likely be mapped as narrow bands of stream terrace deposits). Stream terrace deposits in dry washes are composed of weathered materials originating upstream, from a variety of geologic strata. Washes which are comprised of strata originating from the Middle Red Member of the Moenkopi Formation appear to have the highest probability of supporting *Eriogonum corymbosum* var. *nilesii*. Alluvial transport within these washes may have fostered the spread of the variety through enhanced seed dispersal. Seed dispersal by livestock may also have contributed to the distribution of the variety within the segment.

Noxious and invasive weeds:

Erodium cicutarium and *Salsola tragus* are pervasive throughout the segment, with the exception of gypsum badlands (field observations suggest that invasive weeds are not well adapted to these ecological systems). *Halogeton glomeratus* was established in many locations along Sheep Bridge Road, and was locally dominant at a stock tank 1.9 miles north of Route 59. *Tamarisk* spp. was widespread in washes, reservoirs and stock ponds, and *Elaeagnus angustifolia* was localized in dry washes. The portion of the segment between The Divide and the Virgin River is currently actively grazed.

Impacts:

The proposed pipeline and transmission line may remove many of the *Eriogonum corymbosum* var. *nilesii* individuals identified within the segment.

Areas that are classified as Invasive Upland Vegetation may serve as point sources for the spread of invasive weeds, and the establishment and maintenance of roads along the proposed pipeline and transmission line corridors could provide a route for invasive weeds to colonize adjacent natural lands.

Trenching and other disturbance associated with proposed project activities may lead to erosion.

Best management practices:

The following recommendations are best management practices of particular applicability to this segment. Further discussion of each is provided in Section 6.1 above.

Protect erosion prone land (BMP-G8)
Protect wellheads from pollutants (BMP-G11)

Prevent stream bed modification (BMP-G12)
Cover open trenches to prevent wildlife and livestock mortality or injury (BMP-G14)
Dispose of vegetation slash (BMP-G16)
Dispose of all construction waste (BMP-G17)
Revegetate disturbed soils (BMP-R/R1)
Install and maintain sediment and seed traps (BMP-R/R4)
Salvage topsoil (BMP-R/R6)
Prevent pollution discharge into streams and reservoirs (BMP-RA2)
Salvage and transplant perennial special status plants (BMP-SS1)
Avoid gypsum badlands with special status plants (BMP-SS4)
Maintain livestock fencing and gates (BMP-SS5)
Control equipment movement in areas with noxious or invasive plants (BMP-IS10)
Halogeton glomeratus is a Prohibited Noxious Weed in Arizona. While not listed as noxious in Utah, best management practices could minimize the potential for reinvasion of *H. glomeratus* after pipeline construction, specifically through the application of herbicide prior to construction.

6.5.40 Segment 40: La Verkin Creek to I-15 Toquerville Exit

Reach 33: Cedar Valley Pipeline System

Overview:

The La Verkin Creek to I-15 Toquerville Exit Segment includes a proposed pipeline and transmission line, and a portion of the segment follows an existing pipeline corridor. The segment begins at a subdivision west of La Verkin Creek, and extends to just south of the I-15 exit for Toquerville (Appendix F). Lands within the segment are primarily privately owned; BLM property is also present near Interstate 15. No special status species occurred in the segment. One noxious and invasive weed species was encountered, *Halogeton glomeratus.*

Description:

Route:

The La Verkin Creek to I-15 Toquerville Exit Segment begins in a subdivision adjacent to La Verkin Creek, and is a continuation of The Divide to La Verkin Creek Segment. From La Verkin Creek, the segment crosses Utah Route 17 at 0.47 miles, and Ash Creek at0.68 miles, where it begins to take a northerly route. Eventually turning northwest, the segment ends at Old Highway 91, 4.22 miles from the start.

Land use history:

The Dominguez-Escalante Expedition Route traversed through the area in 1776 (this route later became a major modern travel corridor); journals from the expedition noted the presence of Paiute fields and irrigation systems near Toquerville and Ash Creek (Utah State Parks 2010), and historical accounts describe agriculture among the Paiutes at the confluence of the Virgin River, La Verkin Creek, and Ash Creek (Hall 2010). In 1858, Toquerville was settled, and the area around La Verkin and Hurricane became utilized for winter cattle range (Hall 2010). The portion of the segment between Ash and La Verkin Creeks is presently utilized for irrigated agriculture. Sand dunes that occur in the final 1.4 miles of the segment have been heavily impacted by grazing and timber cutting that has resulted from over 155 years of settlement.

Geology:

Surface geology in the La Verkin Creek to I-15 Toquerville Exit Segment is based on Hurlow and Biek (2003). The segment is primarily comprised of Quaternary deposits, except for some bedrock outcrops of Navajo Sandstone which occur near La Verkin Creek and Old US 91. There are also a wide variety of deposits and basaltic flows. Eolian sand deposits and alluvial and eolian deposits predominate in the sand dunes occurring in the last 1.4 miles of the segment, with older alluvial fan deposits at the very end. Alluvial deposits are represented in dry washes that occur in sand dunes, and alluvial and colluvial deposits are represented in slopes between the dunes. Stream terrace deposits are presently in agricultural production. Pintura flow dominates the central part of the segment and the La Verkin Creek canyon, and colluvial deposits represent the base of the Hurricane Cliffs.

Ecological systems:

All of the ecological systems in the segment occur in the Mohave Desert Ecological Region. Active and Stabilized Dune systems, dominated by *Artemisia filifolia*, are present in the northwest end of the segment. Blackbrush-Mormon-tea Shrubland occurring in the segment is dominated by *Coleogyne ramosissima*. Creosotebush-White Bursage Desert Scrub is limited to colluvial deposits occurring at the base of the Hurricane Cliffs. The Lower Montane Riparian Woodland and Shrubland Ecological System is present along Ash and La Verkin Creeks, where *Populus fremontii* and *Fraxinus velutina* are dominant members of the vegetation community. The Mixed Desert Scrub occurring within the segment is primarily on lava flow, but was burned prior to 1992, and is presently dominated by *Gutierrezia sarothrae.* Pinyon-Juniper Woodland is primarily dominated by *Coleogyne ramosissima* and *Juniperus osteosperma*. Washes are sparsely vegetated, and Agricultural Land is found along creeks.

Noxious and invasive weeds:

At the time of the survey, *Erodium cicutarium* was pervasive throughout the segment, and *Halogeton glomeratus* was present along the edge of agricultural lands located east of Utah Route 17. Abandoned lands used for dryland farming are classified as either Ruderal Vegetation, or Mixed Desert Scrub, depending on age since abandonment.

Impacts:

Areas classified as Agricultural Land or Ruderal Vegetation may serve as point sources for the spread of invasive weeds. The establishment and maintenance of roads in association with the proposed pipeline and transmission line could provide a route for noxious and invasive weeds to colonize adjacent natural lands.

Disturbance associated with proposed project activities may lead to erosion, and could subject dunes occurring in the segment to destabilization.

Creating transmission tower access roads could open up remote areas to off highway vehicle use.

Best management practices:

The following recommendations are best management practices of particular applicability to this segment. Further discussion of each is provided in Section 6.1 above.

Protect erosion prone land (BMP-G8)
Protect wellheads from pollutants (BMP-G11)
Prevent stream bed modification (BMP-G12)
Cover open trenches to prevent wildlife and livestock mortality or injury (BMP-G14)
Dispose of vegetation slash (BMP-G16)
Dispose of all construction waste (BMP-G17)
Revegetate disturbed soils (BMP-R/R1)

Install and maintain sediment and seed traps
Salvage topsoil (BMP-R/R6)
Prevent pollution discharge into streams and reservoirs (BMP-RA2)Maintain livestock fencing and gates (BMP-SS5)
Control equipment movement in areas with noxious or invasive plants (BMP-IS10)

6.5.41 Segment 41: I-15 Toquerville Exit to Ash Creek Reservoir

Reaches 33 and 34: Cedar Valley Pipeline System and

CBPS-1 Transmission Line

Overview:

The I-15 Toquerville Exit to Ash Creek Reservoir includes a proposed pipeline and transmission line. The segment follows I-15 north from the Toquerville exit to the exit at Ash Creek Reservoir. Land ownership in the segment is a combination of many privately-owned small farms, SITLA lands, and lands owned by the BLM. One special status species was encountered in the segment, *Ceanothus greggii* var. *vestitus*. *Brassica tournefortii*, *Bromus rubens, B. tectorum*,and *Salsola tragus* are noxious and invasive species that were also present in the segment.

Description:

Route:

The I-15 Toquerville Exit to Ash Creek Reservoir Segment is a continuation of the La Verkin Creek to I-15 Toquerville Exit Segment. From the Toquerville exit, the segment passes through a canyon edged on the east by the Hurricane Cliffs. Ash Creek runs southerly along the mostly wooded canyon bottom, with I-15 routed to either side. South of Ash Creek Reservoir, a short offshoot of the segment extends to the northwest (to accommodate the proposed CBPS-1 Transmission Line).The segment ends below Ash Creek Reservoir.

Land use history:

As a major transportation corridor since Mormon settlement, the segment has experienced long-term anthropogenic disturbance. Additionally, periodic forest fires have resulted in large areas of dead trees, and a patchwork of age-stratified pinyon-juniper woodlands. The fires have also created chaparral habitat dominated by small trees and shrubs (this habitat supports *Ceanothus greggii* var. *vestitus*).

The I-15 Toquerville Exit to Ash Creek Reservoir Segment was the 1776 route of the Dominguez and Escalante Expedition. Flat lands in the segment currently house small farms that date back to 1858. In order to connect these and other settlements in southwestern Utah, an existing Indian trail was upgraded to a wagon road. A graded road along Ash Creek replaced this route in 1869, which was subsequently replaced (in 1925) by a two lane gravel road. The road became US 91, and eventually I-15 (Utah State History 2010b, US Geological Survey 1891). Due to eroded banks and rock outfalls, the 1869-1925 route along the creek is presently only passable in off highway vehicles. The proposed pipeline would be buried under this historic road along Ash Creek, between the I-15 exit on the south (at an existing sand quarry), and the Ash Creek Reservoir exit on the north.

Geology:

The landscape of the segment is characterized by Pintura lava flows, the Hurricane Fault, and valley cutting resulting from flows in Ash Creek. Extensive lava flows occur below the cliffs of the Hurricane Fault, perhaps making the segment the most geologically distinct in the LPP survey area.

The surface geology of the segment is based on Hurlow and Biek (2003) and Biek (2008). The segment begins in eolian and alluvial deposits/older alluvial-fan deposits. Minor amounts of alluvial and eolian deposits and Colluvial deposits transition into a large area of Older alluvial-fan deposits, which extend north to the Pintura Exit, and is interrupted only by the presence of a hill comprised of Quartz monzonite porphyry of the Pine Valley Mountains (near the Browse Exit). The segment continues north through agricultural land, into the floodplain and terraces along Ash Creek, alluvial fan deposits and stream deposits are represented. The short segment offshoot (the CBPS-1 Transmission Line Reach) passes over basalt of the Pintura flows. The geology between the sand quarry and the exit for Ash Creek Reservoir is comprised of level 1 alluvial terrace deposits that occur immediately below steep Talus slopes.

Ecological systems:

The I-15 Toquerville Exit to Ash Creek Reservoir occurs entirely within the Mohave Desert Ecological Region. Ecological systems present in the segment include Active and Stabilized Dune, Big Sagebrush Shrubland, Pinyon-Juniper Woodland, Lower Montane Riparian Woodland and Shrubland, Mixed Desert Scrub, Semi-Desert Grassland and Volcanic Rock and Cinder Land. Some areas in the segment are also classified as Invasive Upland Vegetation, Agricultural land, and Ruderal Vegetation, and a quarry is present.

The Active and Stabilized Dune Ecological System is dominated by *Artemisia filifolia*, and restricted to remnants of dunes that are present at the quarry. Big Sagebrush Shrubland is dominated by *A. tridentata*. The Great Basin Pinyon-Juniper Woodland, which is mostly dominated by *Juniperus osteosperma*, occurs on the basalt soils of the Pintura flows, as well as on monzonite quartz hills. The shrub understory of Great Basin Pinyon-Juniper Woodland is diverse, and includes the following species: *Arctostaphylos pungens*, *Gutierrezia sarothrae*, *Quercus gambelii*, *Ephedra nevadensis*, and *Coleogyne ramosissima*. These shrubs have diagnostic significance in determining the seral stage of the vegetation (as described in the Vegetation Communities Report). When the tree canopy is lacking, and the herbaceous cover is comprised of non-native species, Mixed Desert Scrub occurring in the segment is dominated by *C. ramosissima* and *G. sarothrae*. One location, dominated by *Pleuraphis rigida*, was classified as Semi-Desert Grassland. Volcanic Rock and Cinder Land was restricted to an area of unstable basalt talus dominated by *J. osteosperma* and *Q. turbinella*.

The Lower Montane Riparian Woodland and Shrubland Ecological System is present at Ash Creek, with *Fraxinus velutina* and *Populus fremontii* occurring as dominant species. The *P. fremontii – F. velutina* Woodland is a vegetation association native to the southwestern US and ranked as vulnerable to imperiled (G2G3) by NatureServe. Although the historic record supports an altered hydrological regime following impoundment of Ash Creek and logging dating from 1858, the *P. fremontii – F. velutina* Woodland presently exhibits a regenerating woodland canopy and provides habitat diversity to wildlife.

Special status plants:

Ceanothus greggii var. *vestitus* is the only special status species that was encountered in this segment. *C. greggii* var. *vestitus* is common on basalt talus in the Great Basin Chaparral Ecological System located north of the quarry, and in the vicinity of the segment offshoot (the CBPS-1 Transmission Line Reach).

Despite the presence of suitable habitat, *Epilobium nevadense* was not encountered in the segment. The historical record of 140 years of grazing, including over-grazing during drought, maybe a major factor in the absence of the species. However, not all suitable habitat was able to be surveyed, due to lack of access to private property.

Noxious and invasive weeds:

Portions of the large sand quarry have been abandoned, and now act as a seed source for noxious and invasive weeds. *Brassica tournefortii* and *Salsola tragus* both have colonized the quarry, and *Bromus tectorum* is pervasive in the segment (although density decreases with the presence of a juniper woodland canopy). *Bromus rubens* and *B. tectorum* also dominate lands that have recently been subjected to burns.

Impacts:

Areas classified as Invasive Upland Vegetation, Agricultural Land, and Ruderal Vegetation, in addition to the quarry located in the segment, may serve as point sources for the spread of noxious and invasive weeds. The establishment and maintenance of access roads in association with the proposed project may provide a route for noxious and invasive weeds to colonize adjacent natural lands.

Trenching and other disturbance associated with the proposed project may lead to erosion.

Creating transmission tower access roads could open up environmentally sensitive riparian zones to off highway vehicle use, particularly the *Fraxinus velutina* and *Populus fremontii* dominated riparian vegetation located in Ash Creek.

Best management practices:

The following recommendations are best management practices of particular applicability to this segment. Further discussion of each is provided in Section 6.1 above.

Protect erosion prone land (BMP-G8)
Protect wellheads from pollutants (BMP-G11)
Prevent stream bed modification (BMP-G12)
Construction activities could include attempts to retain canopy cover in the *Fraxinus velutina -Populus fremontii* riparian vegetation present in the segment, given the rarity and wildlife significance of this habitat
Cover open trenches to prevent wildlife and livestock mortality or injury (BMP-G14)
Revegetate disturbed soils (BMP-R/R1)
The use of species with an affinity for dunes, such as *Artemisia filifolia*, would best enhance revegetation efforts
Install and maintain sediment and seed traps (BMP-R/R4)
Salvage topsoil (BMP-R/R6)
Prevent pollution discharge into streams and reservoirs (BMP-RA2)
Salvage and transplant perennial special status plants (BMP-SS1)
Maintain livestock fencing and gates (BMP-SS5)
Control equipment movement in areas with noxious or invasive plants (BMP-IS10)

6.5.42 Segment 42: Ash Creek Reservoir to Cedar City

Reach 33: Cedar Valley Pipeline System,
Reach 35: CBPS - 2 Transmission Line,
Reach 36: CBPS - 3 Transmission Line,
Reach 37: CVP WTF Transmission Line

Overview:

A pipeline and transmission line would occupy various parts of this segment. The Ash Creek Reservoir to Cedar City segment begins east of I-15 at Ash Creek Reservoir and continues northerly along I-15 to just south of Cedar City, where the pipeline system heads west through a depression named The Bottoms, before continuing east then north to Cedar City (Appendix F). Land ownership includes BLM, Utah School and Institutional Trust Lands Administration (SITLA), and private. However, the majority of the land is privately owned, which locally limited the intensity of surveys for plants. The vegetation is variously *Artemisia tridentata*, Sarcobatus vermiculatus, or weedy herbaceous vegetation depending on how long the land has been fallow since cultivation. The segment passes back into pinyon-juniper woodland and sagebrush east of Hamiltons Fort to Cross Hollow Hills. The segment ends at two points in the Cross Hollow Hills. No special status plants are in this segment, although many noxious and invasive species are present.

Description:

Route:

The segment begins in Washington County below the spillway of Ash Creek Reservoir. It is a continuation of the I-15 Toquerville Exit to Ash Creek Reservoir segment. It continues northerly between I-15 and the Hurricane Cliffs, reaching the CBPS - 2 Transmission Line at 1.9 miles north of the start point. At 3.0 miles it crosses I-15, than parallels I-15 on the west. At 7.3 miles, the segment jogs west for 0.3 mile, than angles back to I-15 after bypassing a highway rest area. At 11.1 miles, the segment intersects CBPS - 3 Transmission Line. The segment continues north northeast along I-15 for 2.75 miles, than turns straight north. A 2009 alternate pipeline routing is reached 1.8 miles to the north. Either route is 0.5 miles long and rejoin as one route east of The Bottoms. Thence it is 0.4 mile east before reaching Old US 91, which is the centerline for the next mile. The segment than branches north north-east from Old US 91 along an existing water pipeline to storage tanks for Cedar City. Eventually the segment terminates at twin points: the end of a 0.4 mile segment is the site for a new Cedar City water treatment plant and the end of a 1.2 mile segment is a top the Cross Hollow Hills (CVP WTF Transmission Line).

Land use history:

The nothern area was settled by Mormons and has been in agricultural production beginning in 1852. Ranches developed in Cedar Valley at Shurtz (Sidon) Creek and in Harmony Valley at Old Harmony. Following battles with Indians, families relocated to Fort Harmony in 1853 and Hamiltons Fort in 1865. (Utah State History 2010c, Utah State History 2010d). When both forts were washed out by floods in 1862, some of the families moved and settled the Kanarraville area without further protection of forts. Thus agriculture re-dispersed across the valleys, with the least productive areas put into cultivation last. By 1902, all available water was being used and no flow was entering Ash Creek (Mead and Teal 1903).

Over the last few decades, acreage in intensive agriculture has been decreasing due to lowering of water tables from irrigation pumping, build up of salinity in the soils from decades of irrigation, and subdivision of existing farms into pockets of urbanization or vacation homes. Wooded areas are subject to wildfire and the segment near Cedar City located between Old US 91 and I-15 was burned in a wildfire circa 1992.

Land ownership:

The segment begins on BLM land near Ash Creek Reservoir. After 1.2 miles it reaches private agricultural land. At 1.9 miles there is a mix of private and BLM land. Upon nearly reaching the western-most edge of Zion National Park, the segment crosses I-15 and remains in private ownership until almost reaching Old US Highway 91 near Hamilton Fort. There it crosses 0.5 miles of SITLA before turning northeasterly along the old highway.

Where the segment leaves the old highways, it enters Utah SITLA land again. The large block of land in the north end is almost entirely state land, with the exception of private ownership along the east edge.

Geology:

The surface geology of the southern portion of the segment is based on Biek (2008). From its start just below Ash Creek Reservoir, the segment follows to the north the Hurricane Fault zone through talus deposits and eventually onto relatively level ground of younger coalesced alluvial-fan deposits. These alluvial-fan deposits continue to the north and are interpreted as middle piedmont-slope alluvium upon approaching Kanarraville.

Rowley (2008) typed the farm lands in the Kanarraville vicinity as middle piedmont-slope alluvium. Where the segment nears the Harmony Mountains west of the I-15 rest area, it crosses old-piedmont-slope alluviums, which are commonly woodlands at the base of the mountains.

The lowest areas in elevation along the Cedar Valley portion of this segment pass through mixed alluvial and eolian deposits. Near The Bottoms, the segment raises out of the edge of a depression into middle alluvial-fan deposits. Where the segment parallels I-15 near Cross Hollow Hills, it passes through middle piedmont slope alluvium, some of which had previously been in agricultural production. Cross Hollow Hills is a mosaic of basin-filled sedimentary rocks and basalt.

Ecological systems:

Agricultural lands dominate this segment. Disturbed lands include Invasive Upland Vegetation, Quarry, and Ruderal Vegetation. All of the natural and semi-naturally vegetated ecological systems are in the Great Basin Ecological Region; they include: Big Sagebrush Shrubland, Gambel Oak - Mixed Montane Shrubland, Greasewood Flat, Lower Montane Riparian Woodland and Shrubland, Mixed Desert Scrub, Pinyon-Juniper Woodland and Shrub-Steppe. Big Sagebrush Shrubland is dominated by *Artemisia tridentata* ssp. *vaseyana*. Gambel Oak - Mixed Montane Shrubland is variously dominated by *Quercus gambelii*, *Rhus trilobata*, *A. tridentate,* and *Juniperus osteosperma*. Mixed Desert Scrub is dominated by *Ericameria nauseosa* or *Gutierrezia sarothrae* and typically has an understory of non-native herbs. Pinyon-Juniper Woodland has dominance by *J. osteosperma*, most often in combination with either *Pinus edulis* or *P. monophylla*. *A. tridentata* or *A. nova* are the most common understory dominants. Shrub-Steppe is common in the Cross Hills area, where the dwarf shrub *A. nova* is associated with *Poa fendleriana*, a taller grass.

The early successional character of Mixed Desert Scrub is indicated by the inclusion of some lands which were in irrigation agriculture, or hayfields as late as the early 1990s. Some Big Sagebrush Shrubland was also cleared land at that time.

Noxious and invasive weeds:

There are a wide diversity of noxious and invasive weeds present in this segment, as expected in an area where agriculture is the predominant land use. Those present are: *Asclepias subverticillata*, *Bromus tectorum*, *Cardaria* draba, *Convolvulus arvensis*, *Elaeagnus angustifolia*, *Erodium cicutarium*, *Halogeton glomeratus*, *Onopordum acanthium*, *Salsola tragus*, and *Tamarix* spp.

Impacts:

Establishing and maintaining roads along the pipeline and transmission line corridors provide a route for noxious and invasive weeds to colonize adjacent natural lands.

Disturbing areas that are classified as Invasive Upland Vegetation could result in the spread of noxious and invasive weeds. However, given the abundance of non-native species in the surrounding landscape, their invasion onto disturbed project areas before and after construction would be likely.

Filling a pipeline trench could require revegetation, but can lead to a channel for erosion.

Best management practices:

The following recommendations are BMPs of particular applicability to this segment. Further discussion of each is provided in Section 6.1 above.

Protect erosion prone land (BMP-G8)
Prevent stream bed modification (BMP-G12)
Cover open trenches to prevent wildlife and livestock mortality or injury (BMP-G14)
Minimize raptor perching on transmission line poles (BMP-G15)
Dispose of vegetation slash (BMP-G16)
Dispose of all construction waste (BMP-G17)
Revegetate disturbed soils (BMP-R/R1)
Install and maintain sediment and seed traps (BMP-R/R4)
Salvage topsoil (BMP-R/R6)
Prevent pollution discharge into streams and reservoirs (BMP-RA2)
Avoid gypsum badlands with special status plants (BMP-SS4)
Maintain livestock fencing and gates (BMP-SS5)
Control equipment movement in areas with noxious or invasive plants (BMP-IS10)

Chapter 7
Conclusion

Surveys for vegetation resources, including special status species, noxious weeds, and vegetation communities, were conducted in the LPP survey area during 2008, 2009, and 2010. The survey area extends from Lake Powell on the east, to Hurricane, Utah on the west, and north to Cedar City, Utah.

A preliminary survey of areas likely to support special status plants was conducted in 2008. In 2009 the survey area represented the entire LPP project alignment, and surveys were conducted for special status plants, noxious weeds, and vegetation communities. New alignments were identified during the winter of 2009 to 2010, and were subsequently surveyed during the 2010 survey season.

In total, the survey covered 371.2 miles (191.6 miles of 600-foot wide corridor and 194.8 miles of 300-foot wide corridor) totaling 20,465 acres. These figure represent pipeline and transmission line alignments, as well as pump stations and equipment sites. Most of the area was covered on foot; windshield surveys were conducted in areas where access to private property was not granted. Binocular surveys were conducted from vantage points. 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). Five hundred transects 50 meters long by one meter wide were placed throughout the survey area to gather additional information on species occurrence.

The special status plants survey, the noxious weeds survey, and the vegetation communities inventory resulted in a significant amount of data. The results are presented in this report, as well as in the Vegetation Communities survey report.

7.1 Special Status Plants Locations

A list of special status species (as designated by federal and state land and resource management agencies) with the potential to occur in the LPP survey area was compiled as a starting point for the LPP field surveys. The special status plants on the list were evaluated for their potential to occur within the LPP survey area. Of these 101 species, 58 were found to have habitat requirements that coincided with the ecological parameters within the survey area. During surveys, fourteen special status species were observed; one species is listed as threatened under the ESA (*Pediocactus sileri*); six of the species are listed as sensitive by the BLM (*Camissonia exilis, Cryptantha semiglabra, Lupinus caudatus* var. *cutleri, Pediomelum epipsilum, Petalonyx parryi,* and *Phacelia pulchella* var. *atwoodii*); three of the species are listed as species of concern by GCNRA (*Ceanothus greggii* var. *vestitus, Echinocactus polycephalus* var. *xeranthemoides,*and *Phacelia mammalariensis*); three species have no federal agency status but were identified by the BLM and USFWS as species of concern (*Eriogonum mortonianum, E. thompsoniae* var. *atwoodii,* and *Penstemon laevis*); and one species included by USFWS as an ESA candidate species as of November 9, 2009 (*Eriogonum corymbosum* var. *nilesii*).

The field surveys identified 13,765,839 individual plants through direct counts and extrapolation based on transect data. The majority of special status plants fell on BLM lands (13,610,695 individuals) and on the Kaibab Indian Reservation (149,188 individuals). The most significant geologic formation for special status plants was the Middle Red Member of the Moenkopi Formation.

Special status plants were found within 15 of the 38 ecological systems occurring within the survey area. The Colorado Plateau Gypsum Badlands Ecological System supported the greatest diversity of special status species

(10 species). The Colorado Plateau Mixed Desert Scrub, Colorado Plateau Pinyon-Juniper Woodland, and Colorado Plateau Shrub-Steppe ecological systems each supported 5 species. The Colorado Plateau Big Sagebrush Shrubland Ecological System supported the highest counts for special status species (8,295,122 individuals); however, this is largely due to the observed density of *Phacelia pulchella* var. *atwoodii* (8,290,470 individuals) and *Pediomelum epipsilum* (2,423 individuals). The Colorado Plateau Gypsum Badlands Ecological System also supported high counts of special status species (5,196,582 individuals), although this is largely due to the density of *P. p.*var. *atwoodii* (4,934,547 individuals), *Eriogonum thompsoniae* var. *atwoodii* (85,734 individuals), and *E. mortonianum* (58,085 individuals). A listing of special status species by the reach in which they occurred is provided at the end of the conclusion section (Page 7-4).

The number of special status plants that may be impacted, lost, or displaced during the construction of the Lake Powell Pipeline depends on the future project footprint and the timing of construction. The highest potential for impacts to the most species of special status plants (six species) will occur within the Hydro System Existing Highway Alternative along Highway 389.

Special status plants may be impacted during LPP construction due to dust, loss of soil, or flooding due to altered drainage patterns. Displacement of pollinating species may impact special status plants by direct habitat loss, loss of seed set, and invasion of non-native species. Current threats to special status plants and their habitats include livestock grazing, development, noxious and invasive plant invasion, and environmental changes, such as drought. The implementation of the following key BMPs will reduce the impacts of construction activities to special status species within the LPP corridor.

BMP-SS1: Protection by avoidance of known individuals and locations of habitats known to be occupied by Endangered Species Act (ESA) listed species.

BMP-SS2: All special status plant species present in the area of disturbance should be salvaged and transplanted in restoration areas.

BMP-SS4: Avoid routing pipeline and transmission line access roads through gypsum badlands with known special status plant populations. Gypsum badlands should be avoided when an adjacent alternative across alluvial soils is available. While the suite of special status plants found on gypsum badlands can colonize alluvial and disturbed soils, the frequency in which this occurs and density of the resulting populations is less than those in badland habitat.

BMP-R/R6: Topsoil removed during construction should be salvaged and reapplied during reclamation and plant debris should be left on-site to serve as mulch. Disturbed soils should be reclaimed as quickly as possible or protective covers should be applied. Topsoil material should be segregated and not mixed or covered with subsurface material. Where cryptobiotic crust is present, the crust should be salvaged and reapplied to the surface of reclaimed soils as soon as possible.

7.2 Noxious Weeds Locations

Surveys for noxious weeds were based on a list of 82 species, as determined by the federal and state land and resource management agencies having jurisdiction over the LPP project area. Eighteen weed species were observed; 11 of the species were listed on a BLM, state, or county noxious weed list; six species were listed by USFWS, BLM, or Glen Canyon National Recreation Area (GCNRA) as invasive; and one species – *Salsola tragus* – was not listed as noxious or invasive by any agency, but is of concern to land managers. The weed species with the broadest distribution (occurring in the greatest number of ecological systems or anthropogenic lands) over the LPP survey area were, in descending order, *Bromus tectorum* (31 ecological systems and four anthropogenic lands), *Bromus rubens* and *Erodium cicutarium* (tied at 27 ecological systems and five anthropogenic lands), *Salsola tragus* (26 ecological systems and six anthropogenic lands) and *Tamarix* spp. (16 ecological systems and five anthropogenic lands). Of these broadly distributed species, only *Tamarix* spp. is listed as noxious; *S. tragus* has no designation, and *B. rubens*, *B. tectorum*, and *E. cicutarium* are listed as invasive.

The ecological region with the greatest number of noxious and invasive weed occurrences was the Colorado Plateau, with the Colorado Plateau Big Sagebrush Shrubland and the Colorado Plateau Mixed Desert Scrub ecosystems containing the greatest diversity of weed species. Anthropogenic lands (lands impacted by humans) were classified separately from the ecosystems, which allowed for a more specific analysis of weed occurrences on those lands. The anthropogenic lands with the greatest abundance of noxious and invasive weeds were those classified as Invasive Upland Vegetation, Agricultural Land, and Ruderal Vegetation.

Much of the LPP alignment occurs in transportation corridors, where the disturbed conditions create an environment that is favorable for weed establishment and spread. In addition, large portions of the project area have been subject to human impacts, including agriculture and livestock grazing. These factors, which have contributed to the current status of noxious and invasive weed occurrence, will continue to impact the project area. The additional impact created by construction of the LPP can be mitigated through the development of a weed management plan, once a preferred corridor is established that specifies best management practices for weed occurrences through the survey area. The results of the noxious weed survey provide a sound basis from which a weed management plan can be developed, which will assist land managers responsible for the lands impacted by the LPP project.

A listing of special status and noxious weed species by the reach in which they occurred is provided below. Reaches are presented in alphabetical order followed by special status plants (if present) and then noxious weeds (quantities of noxious weeds are not given due to high densities of occurrences). No special status or noxious weed species were encountered in four of the MWH reaches: Buckskin Substation, Dixie Springs Substation, Hurricane West Substation, and Sand Hollow Hydro Station.

Afterbay
Brassica tournefortii, *Bromus rubens*, *Bromus tectorum*, *Erodium cicutarium*, *Salsola tragus*, *Tamarix* spp.

Airport Road
Bromus rubens, *Centaurea solstitialis*, *Convolvulus arvensis*, *Eleagnus angustifolia*, *Erodium cicutarium*, *Salsola tragus*, *Sorghum halapense*, *Tamarix* spp.

BPS-2
Bromus tectorum, *Portulaca oleracea*

BPS-2 Transmission Line
Brassica tournefortii, *Bromus tectorum*, *Portulaca oleracea*, *Salsola tragus*

BPS-2 Transmission Line Alternative
Bromus rubens, *Bromus tectorum*, *Erodium cicutarium*, *Portulaca oleracea*, *Salsola tragus*, *Tribulus terrestris*

BPS-3
Tamarix spp.

BPS-3 Transmission Line South
Ascelpias subverticillata, *Brassica tournefortii*, *Bromus tectorum*, *Salsola tragus*, *Tribulus terrestris*

Buckskin to Paria Transmission Line
Lupinus caudatus var. *cutleri* 1 individual
Penstemon laevis 3 individuals
Buckskin to Paria Transmission Line
Bromus rubens, *Bromus tectorum*, *Erodium cicutarium*, *Salsola tragus*

CBPS-1 Transmission Line
Bromus tectorum, *Erodium cicutarium*, *Onopordum acanthium*, *Tamarix* spp.

CBPS-2 Transmission Line
Bromus tectorum, *Cardaria draba*

CBPS-3 Transmission Line
Bromus tectorum, *Convolvulus arvensis*, *Salsola tragus*

CVP WTF Transmission Line
Bromus tectorum

Cedar Valley Pipeline System
Ceanothus greggii var. *vestitus* 1,453 individuals
Eriogonum corymbosum var. *nilesii* 66 individuals
Eriogonum thompsoniae var. *atwoodii* 2 individuals

Asclepias subverticillata, *Brassica tournefortii*, *Bromus rubens*, *Bromus tectorum*, *Cardaria draba*, *Centaurea solsitialis*, *Convolvulus arvensis*, *Eleagnus angustifolia*, *Erodium cicutarium*, *Halogeton glomeratus*, *Onopordum acanthium*, *Salsola tragus*, *Tamarix* spp., *Ulmus pumila*

Cedar Valley Transmission Line
Ceanothus greggii var. *vestitus* 134 individuals

Eightmile Gap Road
*Camissonia exilis*111 individuals
Phacelia pulchella var. *atwoodii* 5 individuals

Bromus rubens, *Bromus tectorum*, *Eleagnus angustifolia*, *Erodium cicutarium*, *Onopordum acanthium*, *Salsola tragus*, *Tamarix* spp.

Forebay
Bromus rubens, *Bromus tectorum*, *Erodium cicutarium*, *Salsola tragus*, *Tamarix* spp.

Glen Canyon Substation
Eriogonum corymbosum var. *nilesii* 1,729individuals
Glen Canyon Substation
Erodium cicutarium, *Portulaca oleracea*, *Tribulus terrestris*

Glen Canyon to Buckskin Transmission Line
Asclepias subverticillata, *Brassica tournefortii*, *Bromus rubens*, *Bromus tectorum*, *Erodium cicutarium*, *Portulaca oleracea*, *Salsola tragus*, *Tamarix* spp., *Tribulus terrestris*, *Ulmus pumila*

Glen Canyon to Buckskin Transmission Line North
Lupinus caudatus var. *cutleri* 33 individuals
Penstemon laevis 12 individuals
Phacelia mammalariensis 1,688

Asclepias subverticillata, *Bromus tectorum*, *Erodium cicutarium*, *Salsola tragus*, *Tamarix* spp.

Henrieville Substation
Bromus tectorum, *Eleagnus angustifolia*, *Tamarix* spp.

Hurricane Cliffs Afterbay to Hurricane West Transmission Line
Bromus rubens, *Bromus tectorum*, *Convolvulus arvensis*, *Eleagnus angustifolia*, *Erodium cicutarium*, *Tamarix* spp., *Tribulus terrestris*

Hurricane Cliffs to Sand Hollow Transmission Line
Bromus rubens, *Bromus tectorum*, *Erodium cicutarium*, *Salsola tragus*

Hurricane West to Quail Creek Reservoir
Petalonyx parryii 15 individuals

Brassica tournefortii, *Bromus rubens*, *Bromus tectorum*, *Erodium cicutarium*, *Halogeton glomeratus*, *Onopordum acanthium*, *Salsola tragus*, *Tamarix* spp.

Hydro System
Eriogonum corymbosum var. *nilesii* 8 individuals
Pediocactus sileri 7 individuals
Penstemon laevis 2 individuals

Bromus rubens, *Bromus tectorum*, *Convolvulus arvensis*, *Eleagnus angustifolia*, *Erodium cicutarium*, *Halogeton glomeratus*, *Onopordum acanthium*, *Portulaca oleracea*, *Salsola tragus*, *Sorghum halapense*, *Tamarix* spp.

Hydro System and Hydro System High Point Alignment Alternative
*Camissonia exilis*3,890 individuals
Phacelia pulchella var. atwoodii 4,978,925 individuals

Asclepias subverticillata, *Bromus tectorum*, *Convolvulus arvensis*, *Erodium cicutarium*, *Salsola tragus*, *Tamarix* spp.

Hydro System Existing Highway Alternative
Cryptantha semiglabra 3,314 individuals
Eriogonum mortonianum 58,085 individuals
Eriogonum thompsoniae var. *atwoodii* 85,732 individuals
Pediocactus sileri 2,938 individuals
Pediomelum epipsilum 30 individuals
Penstemon laevis 90 individuals

Aegilops cylindrica, *Asclepias subverticillata*, *Brassica tournefortii*, *Bromus rubens*, *Bromus tectorum*, *Convolvulus arvensis*, *Eleagnus angustifolia*, *Erodium cicutarium*, *Halogeton glomeratus*, *Onopordum acanthium*, *Salsola tragus*, *Tamarix* spp., *Tribulus terrestris*

Hydro System Existing Highway Alternative and Hydro System South Alternative
Pediomelum epipsilum 8,489 individuals

Hydro System South Alternative
Camissonia exilis 571individuals
Echinocactus polycephalus var. *xeranthemoides* 9 individuals
Pediocactus sileri 1 individual
Pediomelum epipsilum 37 individuals
Phacelia pulchella var. atwoodii 1,346 individuals

Asclepias subverticillata, *Bromus rubens*, *Bromus tectorum*, *Convolvulus arvensis*, *Erodium cicutarium*, *Halogeton glomeratus*, *Onopordum acanthium*, *Portulaca oleracea*, *Salsola tragus*, *Tamarix* spp., *Tribulus terrestris*

Hydro System Southeast Corner Alternative
Bromus tectorum, *Erodium cicutarium*, *Salsola tragus*

Kane County Pipeline System
Asclepias subverticillata, *Bromus rubens*, *Bromus tectorum*, *Eleagnus angustifolia*, *Erodium cicutarium*, *Portulaca oleracea*, *Salsola tragus*, *Tribulus terrestris*

Mount Trumbull Road
Bromus tectorum, *Convolvulus arvensis*, *Salsola tragus*, *Tamarix* spp.

Paria Substation
Bromus tectorum, *Erodium cicutarium*, *Salsola tragus*

Penstock from Afterbay to Sand Hollow Hydro for Peaking Option
Brassica tournefortii, *Bromus rubens*, *Bromus tectorum*, *Erodium cicutarium*, *Salsola tragus*

Penstock from Afterbay to Sand Hollow Hydro for Pump Storage Option
Bromus rubens, *Bromus tectorum*, *Erodium cicutarium*, *Salsola tragus*

Sand Hollow to Dixie Springs Transmission Line
Bromus rubens, *Bromus tectorum*, *Erodium cicutarium*, *Salsola tragus*, *Tamarix* spp.

Water Conveyance System
Camissonia exilis 174individuals
Ceanothus greggii var. *vestitus* 3 individuals
Eriogonum corymbosum var. *nilesii* 12 individuals
Lupinus caudatus var. *cutleri* 20 individual
Pediomelum epipsilum 876 individuals

Asclepias subverticillata, *Bromus rubens*, *Bromus tectorum*, *Convolvulus arvensis*, *Erodium cicutarium*, *Halogeton glomeratus*, *Onopordum acanthium*, *Portulaca oleracea*, *Salsola tragus*, *Tamarix* spp., *Tribulus terrestris*

Water Conveyance System and Buckskin to Paria Transmission Line
Camissonia exilis 25 individuals

Water Conveyance System, Hydro System, and Hydro System High Point Alternative
Pediomelum epipsilum 13,609 individuals
Phacelia pulchella var. atwoodii 161,075 individuals

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Abbreviations and Acronyms

AGFD	Arizona Game and Fish Department
ARPC	Arizona Rare Plant Committee
ASTL	Arizona State Trust Land
BLM	Bureau of Land Management
BMP	Best Management Practice
BPS	Booster Pump Station
CICWCD	Central Iron County Water Conservancy District
DRG	Digital Raster Graphics
ESA	Endangered Species Act
FGDC	Federal Geographic Data Committee
GCNRA	Glen Canyon National Recreation Area
GIS	Geographic Information System
GOPB	Governor's Office of Planning and Budget
GPS	Global Positioning System
GSENM	Grand Staircase – Escalante National Monument
I-15	Interstate 15
KCWCD	Kane County Water Conservation District
LPP	Lake Powell Pipeline
LSD	Logan Simpson Design Inc.
M&I	Municipal and Industrial
NISC	National Invasive Species Council
MSL	Mean Sea Level
NMRPTC	New Mexico Rare Plant Technical Council
NNHP	Nevada Natural Heritage Program
NPIN	Native Plant Information Network
NPS	National Park Service
NRA	National Recreation Area
NRCS	Natural Resources Conservation Service
NVC	National Vegetation Classification
NVCS	National Vegetation Classification System
Reclamation	Bureau of Reclamation
RO	Reverse Osmosis
SITLA	School Institutional Trust Lands Administration
SR	State Route
TDS	Total Dissolved Solids
UAH	University of Arizona Herbarium
UDWR	Utah Division of Water Resources
UNPS	Utah Native Plant Society

U.S.	United States
USDA	United States Department of Agriculture
USGS	United States Geologic Survey
USFWS	United States Fish and Wildlife Service
USUE	Utah State University Extension
UTM	Universal Transverse Mercator
VRM	Visual Resource Management
WCWCD	Washington County Water Conservancy District

Glossary

Achene — a small, dry, seedlike fruit with a thin wall that does not open at maturity. The seed is readily separated from the fruit wall.

Anther — the part of the stamen that produces and releases pollen.

Auricle — an ear-shaped appendage.

Awn — a bristelike appendage of a plant, especially on the glumes of grasses.

Beak — a prolonged, usually narrowed tip of a thicker organ, as in some fruits and petals.

Bract — a modified or specialized leaf or leaflike part, usually situated at the base of a flower or inflorescence.

Calcareous — a sediment, sedimentary rock, or soil type which is formed from, or contains a high proportion of, calcium carbonate in the form of calcite or aragonite.

Calyx — the sepals of a flower, typically green and lie under the more conspicuous petals.

Capsule — a dry fruit that opens to release the seeds.

Caulescent — having an obvious stem rising above the ground.

Corm — a short, bulblike, underground stem, with only papery scale leaves.

Corymb — a form of inflorescence in which the flowers form a flat-topped or convex cluster, the outermost flowers being the first to open.

Cryptobiotic — biological soil crust that is a highly specialized community of cyanobacteria, mosses, and lichen. Commonly found in semiarid and arid environments.

Dolomite — a sedimentary carbonate rock and a mineral composed of calcium magnesium carbonate found in crystals.

Drupe — a fruit in which an outer fleshy part surrounds a shell with a seed inside.

Elliptic — in the form of a flattened circle, more than twice as long as broad, widest in the center and the two ends equal.

Eolian — processes pertaining to the activity of the winds and more specifically, to the winds' ability to shape the surface of the Earth and other planets.

Fluvial — the processes associated with rivers and streams and the deposits and landforms created by them.

Genus — the usual major subdivision of a family or subfamily in the classification of organisms, usually consisting of more than one species.

Genera — plural of genus.

Glabrous — without hairs.

Glume — a thin, dry basal bract of the inflorescence of grasses.

Gypsiferous — containing gypsum, a very common mineral.

Hypanthium — a cup-shaped or tubular body formed by the conjoined sepals, petals, and stamens.

Inflorescence — the flower cluster of a plant.

Invasive — a non-indigenous species that adversely affects the habitats it invades, economically, environmentally, or ecologically.

Involucre — a whorl of bracts that occurs beneath or close to a flower cluster.

Laminated — geologic term; a layered structure.

Lemma — a bract in a grass spikelet just below the male and female organs of the flower.

Ligule — a thin, membranous outgrowth from the base of the blad of most grasses; strap-shaped inner whorl of flower parts.

Microbiotic — see cryptogammic.

Node — the joint of a stem.

Noxious — a designation 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.

Nutlet — a small nut.

Oblong — much longer than broad, with nearly parallel sides.

Obovate — shaped like the longitudinal section of an egg, but with the broadest part toward the tip.

Ovate — broad and rounded at the base and tapering toward the end.

Pappus — a modified calyx, composed of scales, bristles, or featherlike hairs

Phyllary — one of the bracts forming the involucre or the head or inflorescence of a composite plant.

Pubescent — covered with short, soft hairs; downy.

Rachis — the axis of an inflorescence when somewhat elongated.

Raceme — a simple, elongated, indeterminate inflorescence with each flower on a short stalk.

Rhizome — a horizontal, usually underground stem that often sends out roots and shoots from the joints of its stems.

Samara — a dry, winged, often one-seeded fruit that does not split open at maturity.

Sheath — an enclosing or protective structure, such as a leaf base encasing the stem of a plant.

Silique — the long two-valved seed vessel or pod of plants belonging to the mustard family.

Spike — an elongated stem of stalkless flowers or spikelets.

Spikelet — a secondary spike, characteristic of grasses and sedges; the ultimate flower cluster in grasses, consisting of two thin, dry bracts and one or more florets.

Stamen — the male organ of the flower that bears pollen.

Stigma — the receptive part of the ovule-bearing organ of a flower on which the pollen germinates.

Taxa — plural of taxon.

Taxon — a taxanomic catefory or group, such as a phylum, order, family, genus, or species.

Tepal — a division of the envelope of a flower having a virtually indistinguishable calyx and corolla.

Umbel — a flat-topped or rounded flower cluster in which the individual flower stalks arise from about the same point.

Whorl — an arrangement of three or more leaves, petals, or other organs radiating from a single node.

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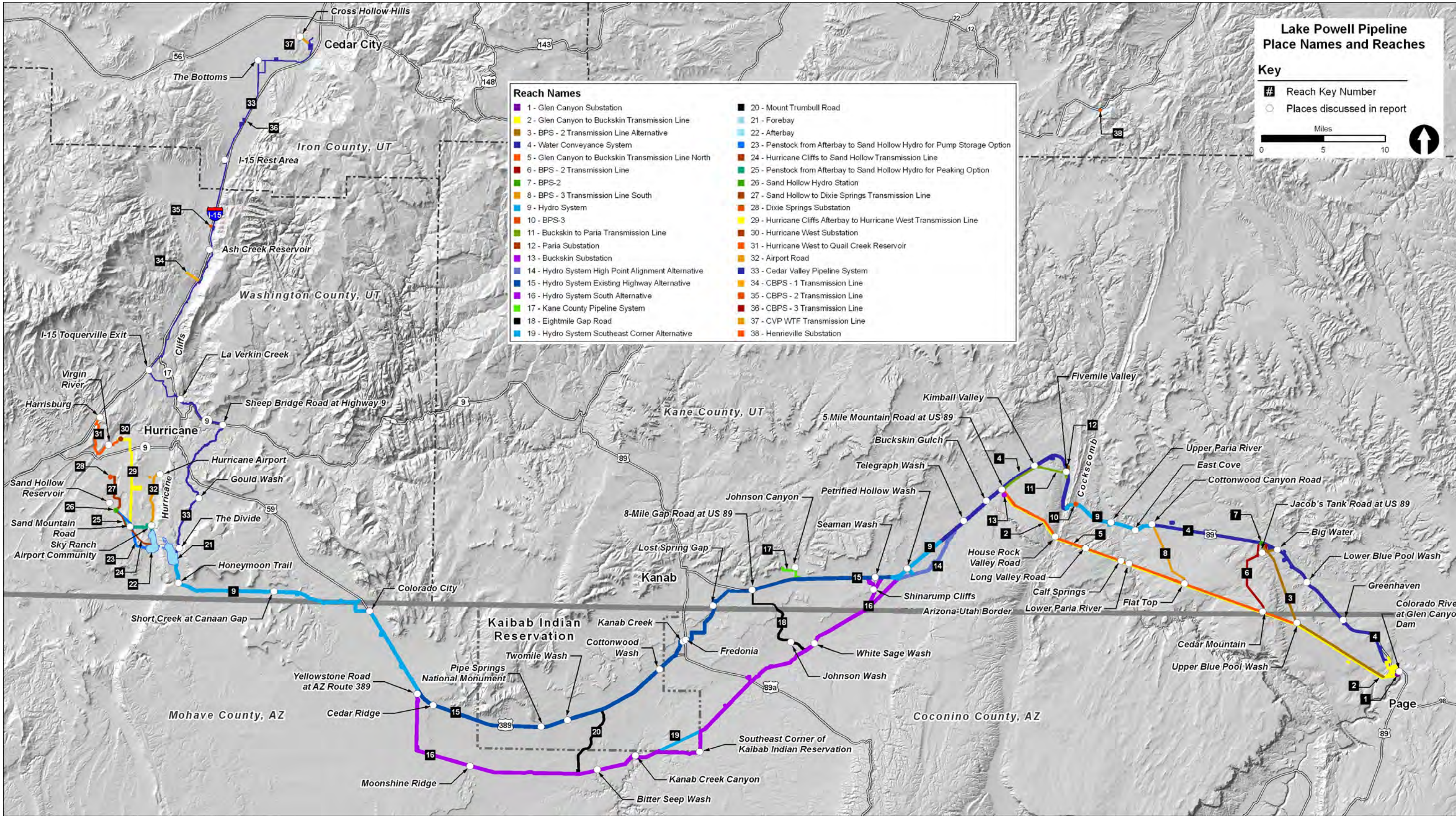
Appendix A
Introductory Figures (MWH Maps)

These Figures are incorporated into Chapter 1 of this report.

Appendix B
Lake Powell Pipeline Place Names and Reaches Map



Map B-1
LPP Place Names and Reaches

Appendix C
Data Sheet for Field Surveys

Field Data Sheet for Lake Powell Pipeline Rare Plant, Noxious Weed, and Veg. Community Surveys

Logan Simpson Design Project #065276 Page 1 of 2

General Information

Date: __________________ Beginning Time: ________________ Ending Time: ________________

Surveyor's Names:

☐ Team A ☐ Team B ☐ Team C

Recorder's Initials: _______

Location Information

State: __________ County: _______________ Location Description:______________________________

Corridor Width: ___________________ or Other Facility: _______________________________________

Topo Map Number(s) ________________ Aerial Map Number(s) _______________________________

GPS Information

File Name: ____________________________

Corner #	Direction (SW, SE, etc.)	Photo #	Easting	Northing	Elev.
1					
2					
3					
4					

Soils Information

Notes (soil type, geologic formation, cryptogamic crust, rock outcrops, sand dunes, lenses of different soils, exposed gypsum):

____

____

Vertebrates Sighted

-

Species: ____

Species: ____

Species: ____

Species: ____

Species: ____

Species: ____

Species: ____

Notes:

____

Field Data Sheet for Lake Powell Pipeline Rare Plant, Noxious Weed, and Veg. Community Surveys

Logan Simpson Design

Date: ____________________

GPS File Name: ________________________

Rare Plants (Record condition, blooming, fruiting, GPS pt. number, quantity, photo #)

Target Species:

Species sighted:

Notes: ______________________________

Noxious Weeds (gen. abundance, location, blooming, fruiting, GPS pt. number, quantity, photo #)

Species: ______________________________

Species: ______________________________

Species: ______________________________

Species: ______________________________

Species: ______________________________

Species: ______________________________

Species: ______________________________

Species: ______________________________

Notes: ______________________________

Vegetative Community Information

Vegetation Mapper:

Dominant Species:

Notes (include land use such as grazing, off-road vehicles, dumping):

Appendix D
Data Sheet for 50-m Transect Surveys

Field Data Sheet for Lake Powell Pipeline Vegetation Transects (50 m x 1 m)

Logan Simpson Design Project #065276 Page 1 of 2

General Information

Date: ____________ Beginning Time: ________________ Ending Time: ______________

Surveyor's Names (Recorder listed first): ____

Location Information

State: ________ County: _______________________

Transect Orientation (N-S, E-W): ________________ Notes: ______________________________

Corridor Width: __________________ or Other Facility: _________________________________

Topo Map Number(s): _______________ Aerial Map Number(s): ________________

GPS Information

File Name: ___________________________________

Point	Photo #	Easting	Northing	Elev.
Start				
End				

Soils & Topography Information

Geologic Formation per USGS: ____

Notes (cryptogamic crust, rock outcrops, sand dunes, lenses of different soils, exposed gypsum):

____

Aspect: _________________________

Slope: __________________________

Vegetation Community Information

Community Type: ____

Percent Cover: __________________

Hydrology (check one)

□ Upland (above and away from floodplains)

□ Riparian (along rivers or stream channels)

□ Wetland (saturated soil for majority of growing season)

□ Playa lakebed (poorly drained depressions)

Land Use

Apparent land use: ____

Distance from nearest road (two-track or larger): ______________________

Disturbance (check one)

□ No disturbance apparent

□ Light to moderate disturbance

□ Site heavily disturbed

If disturbed, cause: ____

Field Data Sheet for Lake Powell Pipeline Vegetation Transects (50 m x 1 m)

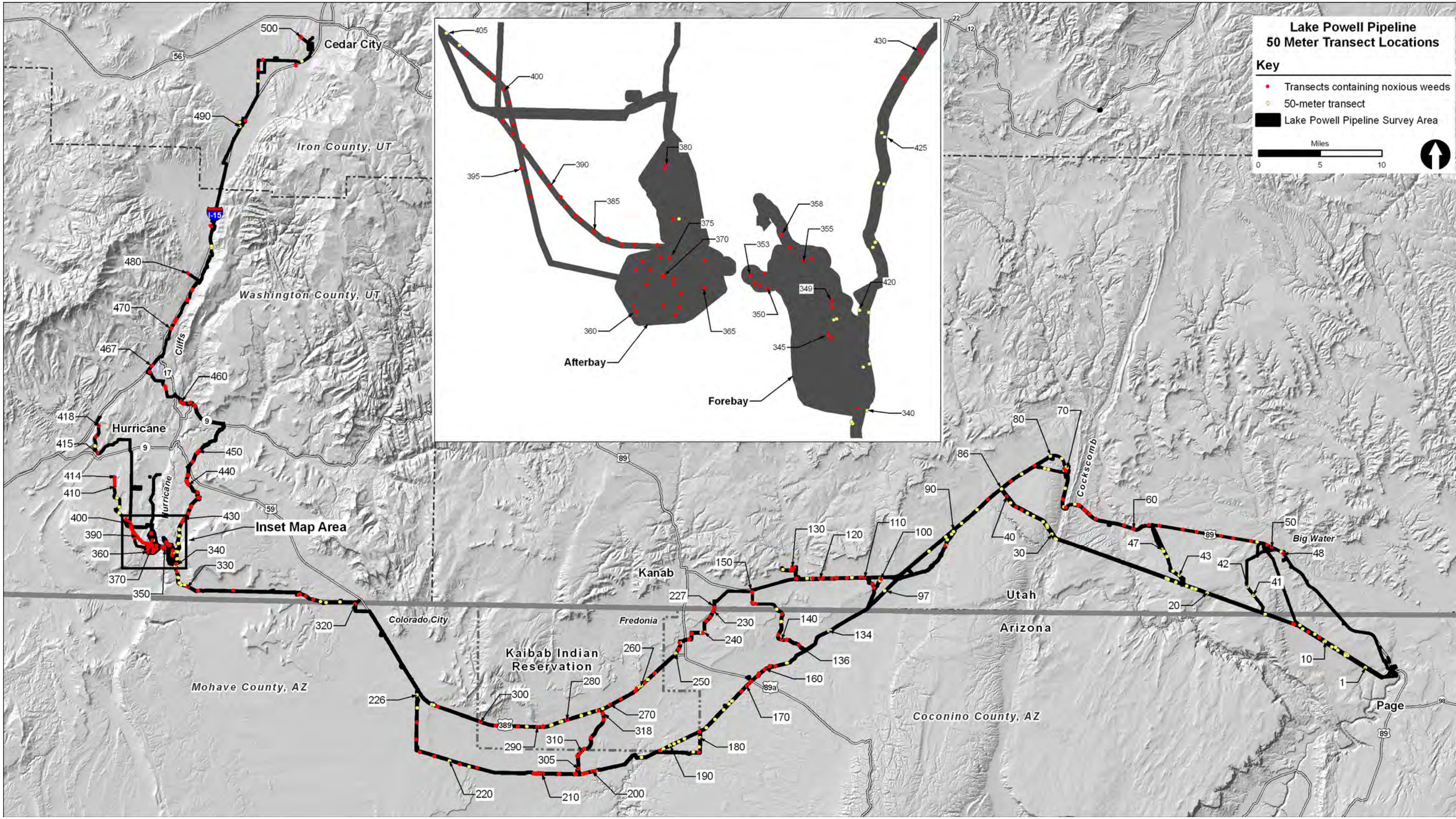
Logan Simpson Design Project #065276 Page 2 of 2

Date: ____________________

GPS File Name: ________________________

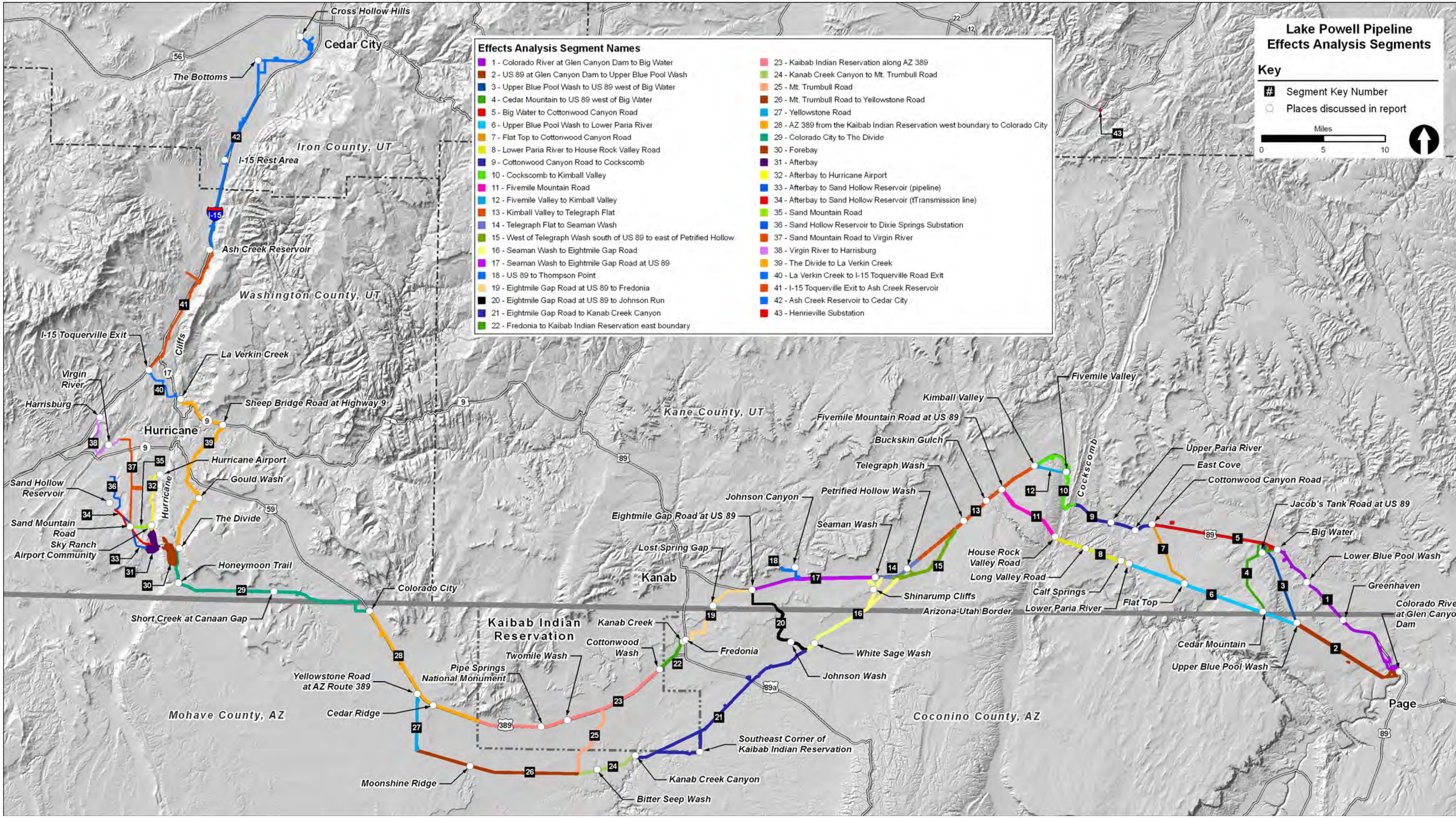
Species	Tabulation	Total		Species	Tabulation	Total
AGRO CRIS				KRAM EREC		
AMBR ACAN				KRAS LANA		
AMBR DUMO				LARR TRID		
AMEL UTAH				LEPI FREM		
ARCT PUNG				LYCI ANDE		
ARIS PURP				LYCI PALL		
ARTE BIGE				LYGO		
ARTE FILI				MAHO FREM		
ARTE LUDO				MENO SPIN		
ARTE NOVA				MIRA BIGE		
ARTE TRID				OPUN ERIN		
ASTR				OPUN POLY		
ATRI CANC				ORYZ HYME		
ATRI CONF				PINU EDUL		
BERB FREM				PINU MONO		
BOUT GRAC				PORT OLER		
BRAS TOUR				PRUN FASF		
BROM INER				PSOR FREM		
BROM RUBE				PURS GLAN		
CEAN GREG				PURS TRID		
CERC LEDI				QUER GAMB		
CHRY NAUS				QUER TURB		
CHRY VISC				RHUS TRIL		
CIRS				SALS TRAG		
COLE RAMO				SALV DORR		
COMA UMBE				SITA HYST		
CONV ARVE				SPHA AMBM		
CYLI WHIP				STAN PINN		
ECHI ENGE				STEP EXIG		
ECHI TRIG				TAMA CHIN		
ELAE ANGU				TETR AXIL		
ENCE VIRG				THAM MONT		
EPHE NEVA				TRIB TERR		
EPHE TORR				YUCC ANGU		
EPHE VIRI				YUCC BACC		
ERIO CORY						
ERIO INFL						
ERIO PULC						
ERIO UMBE						
FALL PARA						
GARR FLAV						
GUTI MICR						
GUTI SARO						
HAPL LINI						
HILA JAME						
HILA RIGI						
HYME SALS						
JUNI OSTE						

Appendix E
Lake Powell Pipeline 50 Meter Transect Locations



Map E-1
LPP 50-Meter Transect Locations Map

Appendix F
Lake Powell Pipeline Effects Analysis Map



Map F-1
LPP Effects Analysis Map