Chapter 5
Noxious Weeds and Invasive Species

5.1 Weed Occurrence within Survey Area

The survey for noxious weeds confirmed the presence of 16 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* spp. 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 cylindrica*, *Brassica tournefortii*, *Sorghum halepense*, and *Ulmus pumila*.

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 two Ecological Regions: Colorado Plateau and Mojave 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, 27 ecological systems were identified by the survey team, 15 within the Colorado Plateau and 12 within the Mojave 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 16 weed species observed within the survey area, while the lowest occurrence of weed species was documented for the Colorado Plateau Juniper Savanna Ecological System. Within the Mojave Desert Ecological Region, the Mojave Desert Lower Montane Riparian Woodland and Shrubland and the Mojave Desert Mixed Desert Scrub ecological systems each had seven noxious weed species. No noxious weed species were detected in the Mojave 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 2,581 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 Figure 5-1 through Figure 5-4, 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.

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

Species		USDA	USFWS[1]	State of Arizona[2]	State of Utah[3]	Iron Co., UT[4]	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		
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								
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] I = Invasive Species
[2] PNW = Prohibited Noxious Weed, RGNW = Regulated Noxious Weed, RNW = Restricted Noxious Weed (State of Arizona Department of Agriculture Noxious Weed List)
[3] NA = Noxious Class A (Early Detection Rapid Response), NB = Noxious Class B (Control), NC = Noxious Class C (Containment) (State of Utah Noxious Weed List)
[4] N = Noxious Weed Designation
[5] Not listed as noxious or invasive by any agencies, but of considerable concern to land managers

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

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	Acres*	*Aegilops cylindrica*	*Asclepias subverticillata*	*Brassica tournefortii*	*Bromus rubens*	*Bromus tectorum*	*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	615				x	x	x		x				x		x	x	x
Colorado Plateau Big Sagebrush Shrubland	3069	x	x	x	x	x	x	x	x	x	x	x	x		x		
Colorado Plateau Blackbrush-Mormon-tea Shrubland	1260				x	x			x	x		x	x		x	x	
Colorado Plateau Grassland	547				x	x			x				x			x	
Colorado Plateau Greasewood Flat	184					x		x	x	x		x	x		x		
Colorado Plateau Gypsum Badland	663				x	x	x		x	x			x		x		
Colorado Plateau Juniper Savanna	31			x		x							x				
Colorado Plateau Lower Montane Riparian Woodland and Shrubland	83		x		x	x	x	x	x	x	x	x	x		x		
Colorado Plateau Mixed Bedrock Canyon and Tableland	464				x	x			x				x		x	x	x
Colorado Plateau Mixed Desert Scrub	3671		x	x	x	x	x	x	x	x	x	x	x		x	x	
Colorado Plateau Mixed Low Sagebrush Shrubland	70				x	x			x				x		x		
Colorado Plateau Pinyon-Juniper Woodland	1774			x	x	x			x		x	x	x		x	x	
Colorado Plateau Shrub-Steppe	1859		x		x	x			x	x	x	x	x	x	x	x	x
Colorado Plateau Volcanic Rock and Cinder Land	37				x	x			x				x				
Colorado Plateau Wash	159		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***	***Convolvulus arvensis***	***Elaeagnus angustifolia***	***Erodium cicutarium***	***Halogeton glomeratus***	***Onopordum acanthium***	***Portulaca oleracea***	***Salsola tragus***	***Sorghum halepense***	***Tamarix* spp.**	***Tribulus terrestris***	***Ulmus pumila***
Mojave Desert Active and Stabilized Dune	106				x	x			x				x				
Mojave Desert Bedrock Cliff and Outcrop	26				x	x											
Mojave Desert Blackbrush-Mormon-tea Shrubland	81			x	x	x			x	x					x		
Mojave Desert Creosote bush-White Bursage Desert Scrub	307			x	x	x			x	x			x				
Mojave Desert Grassland	39				x	x			x				x				
Mojave Desert Lower Montane Riparian Woodland and Shrubland	3				x	x	x	x	x				x		x		
Mojave Desert Mixed Desert Scrub	250			x	x	x			x				x		x		
Mojave Desert Shrub-Steppe	201				x	x			x				x				
Mojave Desert Volcanic Rock and Cinder Land	139				x	x			x				x				
Mojave Desert Wash	11				x	x			x								
Anthropogenic Lands																	
Agricultural Land	192		x		x	x	x	x	x	x		x	x	x	x		
Developed – Road	469				x		x		x		x		x		x	x	x
Developed Land	248		x		x	x		x	x			x	x		x	x	
Invasive Upland Vegetation	971		x	x	x	x	x	x	x	x	x	x	x		x		
Quarry	2												x				
Reservoir	2																
Ruderal Vegetation	698		x	x	x	x	x	x	x	x		x	x	x	x	x	

Note:
*Total acres for each ecological system in the survey area

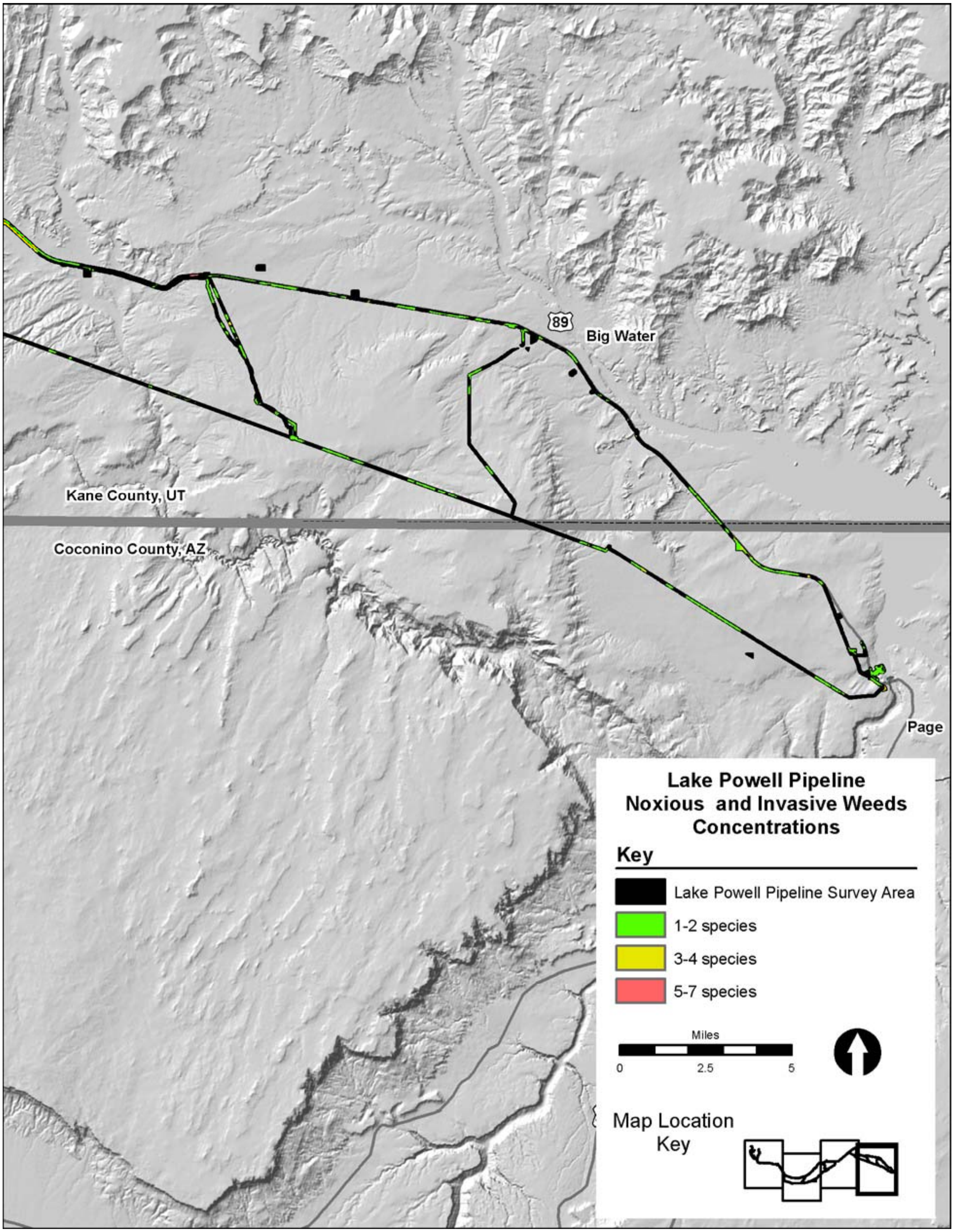

Figure 5-1
Noxious Weeds Concentration Map 1

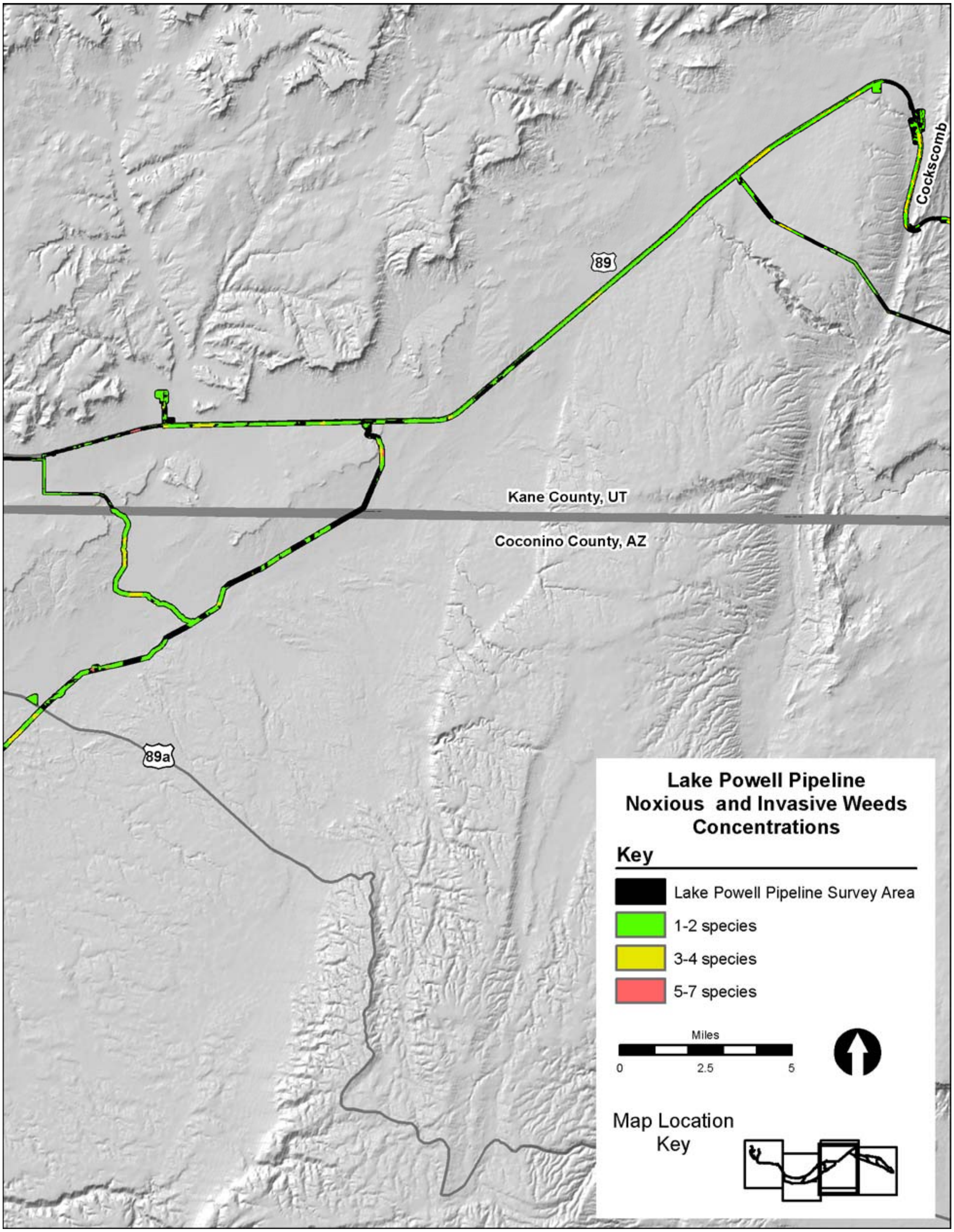

Figure 5-2
Noxious Weeds Concentration Map 2

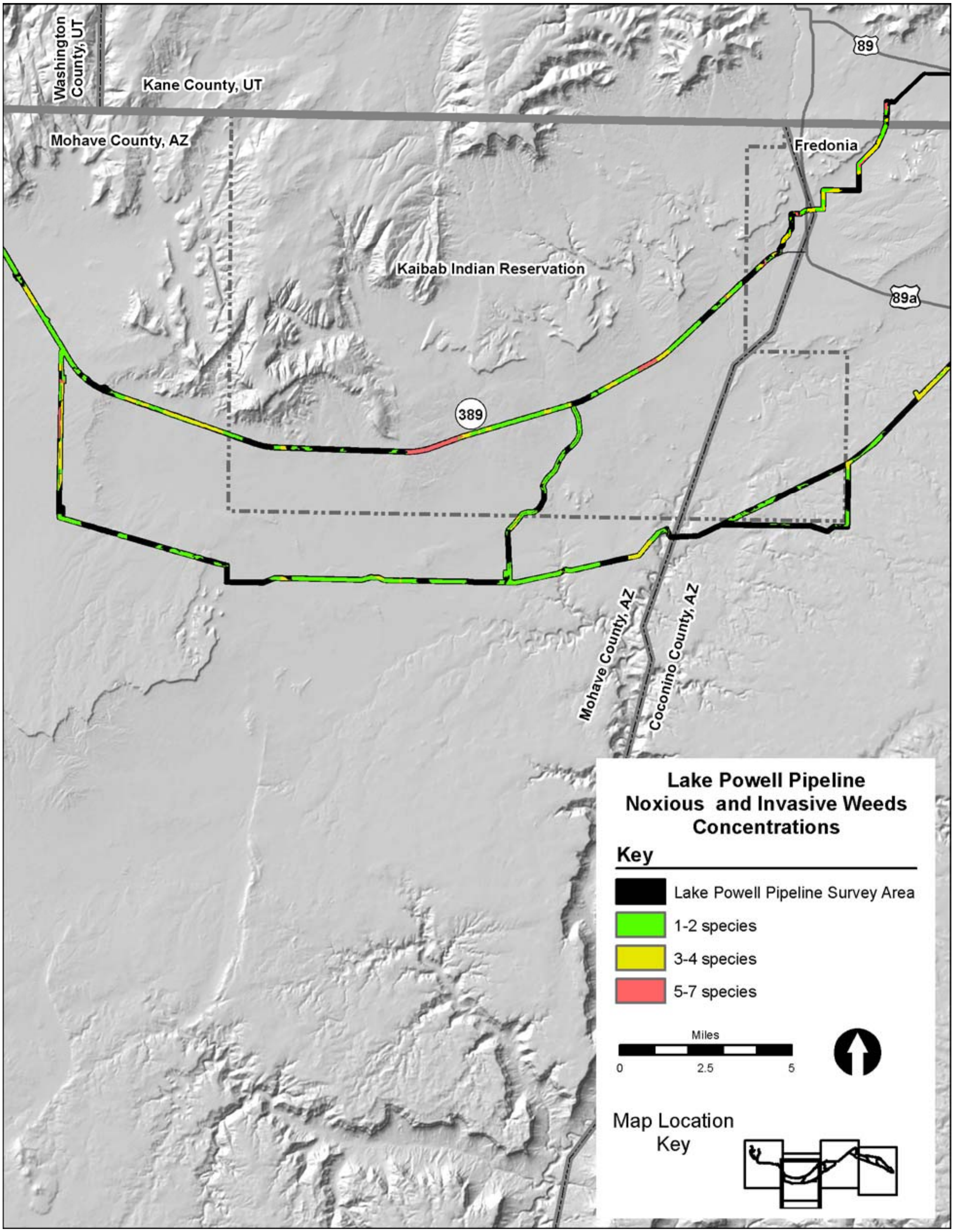

Figure 5-3
Noxious Weeds Concentration Map 3

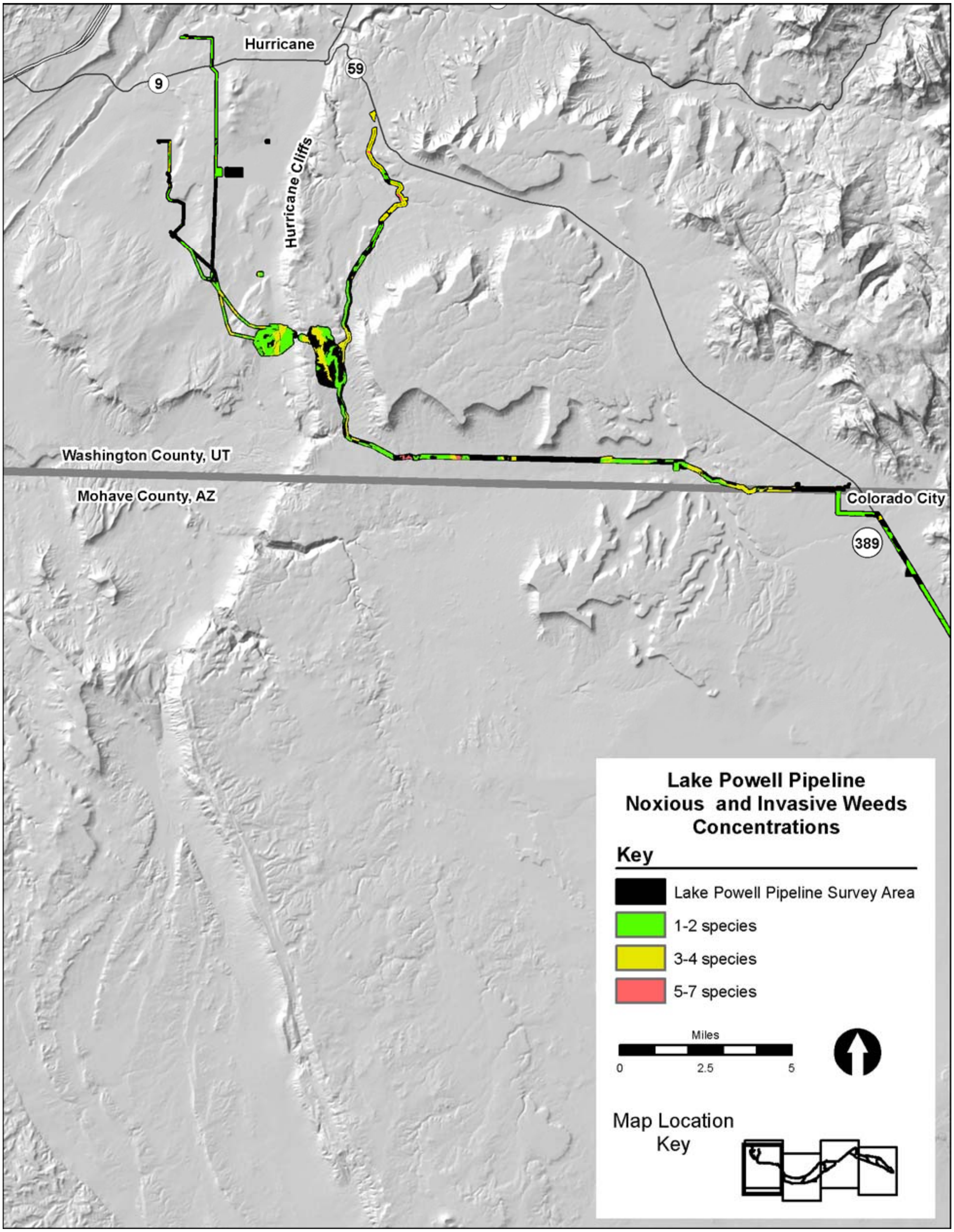

Figure 5-4
Noxious Weeds Concentration Map 4

5.3 50-meter Transects

5.3.1 Weed Species Occurrences

Three hundred and ninety-two transects, measuring 50 meters by 1 meter, were established throughout the LPP survey area (Appendix D). 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 259 of the 392 transects. The most occurrences of noxious weeds within the transects were recorded for *Salsola tragus* (193). Other weed species that occurred in numerous transects were: *Bromus tectorum* (80), *Bromus rubens* (65), and *Erodium cicutarium* (73). Occurring in a limited number of transects were *Aegilops cylindrica* (2), *Asclepias subverticillata* (1), *Elaeagnus angustifolia* (1), *Halogeton glomeratus* (3), *Sorghum halepense* (2), *Tamarix* spp. (10), and *Tribulus terrestris* (1). Five of the 16 weed species recorded as occurring in the LPP survey area were not found in the 50-meter transects. Those species included *Brassica tournefortii*, *Convolvulus arvensis*, *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. 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*, *Convolvulus arvensis*, *Elaeagnus 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 plant species.

Table 5-3
Belt Transect Data

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Transect Number	LPP Code	Ecological System	*Aegilops cylindrica*	*Asclepias subverticillata*	*Bromus rubens*	*Bromus tectorum*	*Convolvulus arvensis*	*Elaeagnus angustifolia*	*Erodium cicutarium*	*Halogeton glomeratus*	*Salsola tragus*	*Sorghum halepense*	*Tamarix* spp.	*Tribulus terrestris*
2	LPP082709TMB4	C.P. Shrub-Steppe												
3	LPP082709TMC3E	C.P. Blackbrush-Mormon-tea Shrubland												
4	LPP082709TMA3	C.P. Blackbrush-Mormon-tea Shrubland												
7	LPP082709TMC2E	C.P. Mixed Desert Scrub												
9	LPP082709TMC1E	C.P. Active and Stabilized Dune												
12	LPP082709TMC5E	C.P. Blackbrush-Mormon-tea Shrubland									2			
13	LPP082709TMA4	C.P. Blackbrush-Mormon-tea Shrubland												
16	LPP082709TMC7E	C.P. Blackbrush-Mormon-tea Shrubland												
32	LPP061910TMB2	C.P. Pinyon-Juniper Woodland												
33	LPP061910TMB1	C.P. Pinyon-Juniper Woodland												
41	LPP082809TMC14S	C.P. Pinyon-Juniper Woodland												
42	LPP082809TMC12S	C.P. Pinyon-Juniper Woodland												
43	LPP082809TMC6	C.P. Blackbrush-Mormon-tea Shrubland												
44	LPP082809TMC5	C.P. Shrub-Steppe												
45	LPP082809TMC3	C.P. Pinyon-Juniper Woodland												
46	LPP082809TMC2	C.P. Shrub-Steppe												
47	LPP082809TMC1	C.P. Shrub-Steppe												
48	LPP082709TMC8S	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*	*Convolvulus arvensis*	*Elaeagnus angustifolia*	*Erodium cicutarium*	*Halogeton glomeratus*	*Salsola tragus*	*Sorghum halepense*	*Tamarix* spp.	*Tribulus terrestris*
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	LPP082709TMC14E	C.P. Wash[b]											10	
61	LPP082709TMA13	C.P. Greasewood Flat									3			
62	LPP082709TMC15S	C.P. Blackbrush-Mormon-tea Shrubland									104			
63	LPP082709TMA14	C.P. Mixed Desert Scrub									90			
64	LPP082709TMC16E	C.P. Greasewood Flat									42			
65	LPP082709TMA15	C.P. Wash						3			52	P		
66	LPP082709TMC17E	C.P. Blackbrush-Mormon-tea Shrubland				P								

Table 5-3
Belt Transect Data

Transect Number	LPP Code	Ecological System	*Aegilops cylindrica*	*Asclepias subverticillata*	*Bromus rubens*	*Bromus tectorum*	*Convolvulus arvensis*	*Elaeagnus angustifolia*	*Erodium cicutarium*	*Halogeton glomeratus*	*Salsola tragus*	*Sorghum halepense*	*Tamarix* spp.	*Tribulus terrestris*
67	LPP082809TMA1	C.P. Shrub-Steppe									39	2		
68	LPP082809TMA2	C.P. Shrub-Steppe									21			
69	LPP082809TMA3	C.P. Pinyon-Juniper Woodland												
70	LPP060710TME2	C.P. Active and Stabilized Dune												
71	LPP060710TMB2	C.P. Mixed Bedrock Canyon and Tableland												
72	LPP082809TMA4	C.P. Active and Stabilized Dune				C					5			
73	LPP082809TMA8	C.P. Pinyon-Juniper Woodland				C					C			
74	LPP082809TMA7	C.P. Big Sagebrush Shrubland												
75	LPP060710TMB1	C.P. Wash				5					2			
76	LPP060710TME1	C.P. Pinyon-Juniper Woodland												
77	LPP082809TMA5	C.P. Pinyon-Juniper Woodland												
78	LPP082809TMA6	Invasive Upland Vegetation				A					A			
79	LPP082809TMA9	C.P. Pinyon-Juniper Woodland												
80	LPP082809TMA10	C.P. Big Sagebrush Shrubland												
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												

Table 5-3
Belt Transect Data

Transect Number	LPP Code	Ecological System	*Aegilops cylindrica*	*Asclepias subverticillata*	*Bromus rubens*	*Bromus tectorum*	*Convolvulus arvensis*	*Elaeagnus angustifolia*	*Erodium cicutarium*	*Halogeton glomeratus*	*Salsola tragus*	*Sorghum halepense*	*Tamarix* spp.	*Tribulus terrestris*
87	LPP082809TMA19	C.P. Big Sagebrush Shrubland							C		13			
88	LPP082809TMA20	C.P. Big Sagebrush Shrubland												
89	LPP082809TMA21	C.P. Big Sagebrush Shrubland												
94	LPP082809TMA22	C.P. Pinyon-Juniper Woodland												
96	LPP082809TMA23	C.P. Pinyon-Juniper Woodland												
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	LPP082909TMB1	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			
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			

Table 5-3
Belt Transect Data

Transect Number	LPP Code	Ecological System	*Aegilops cylindrica*	*Asclepias subverticillata*	*Bromus rubens*	*Bromus tectorum*	*Convolvulus arvensis*	*Elaeagnus angustifolia*	*Erodium cicutarium*	*Halogeton glomeratus*	*Salsola tragus*	*Sorghum halepense*	*Tamarix* spp.	*Tribulus terrestris*
121	LPP082909TMc4E	C.P. Pinyon-Juniper Woodland				C			A		A			
122	LPP082909TMB4	C.P. Pinyon-Juniper Woodland												
123	LPP082909TMA17	C.P. Pinyon-Juniper Woodland												
124	LPP082909TMc6S	C.P. Pinyon-Juniper Woodland												
125	LPP082909TMB6	C.P. Pinyon-Juniper Woodland												
126	LPP082909TMc5S	C.P. Big Sagebrush Shrubland	6								A			
127	LPP082909TMB5	Ruderal Vegetation									A			5
128	LPP061810TMB1	C.P. Mixed Desert Scrub				4			2		55			
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	LPP082909TMB15	C.P. Mixed Desert Scrub									A			
139	LPP082909TMB11	C.P. Gypsum Badlands									5			
140	LPP082909TMc14E	C.P. Greasewood Flat									2			
141	LPP082909TMB14	C.P. Greasewood Flat												
142	LPP082909TMC12S	C.P. Gypsum Badlands												

Table 5-3
Belt Transect Data

Transect Number	LPP Code	Ecological System	*Aegilops cylindrica*	*Asclepias subverticillata*	*Bromus rubens*	*Bromus tectorum*	*Convolvulus arvensis*	*Elaeagnus angustifolia*	*Erodium cicutarium*	*Halogeton glomeratus*	*Salsola tragus*	*Sorghum halepense*	*Tamarix* spp.	*Tribulus terrestris*
143	LPP082909TMB12	C.P. Big Sagebrush Shrubland												
144	LPP082909TMc13E	C.P. Shrub-Steppe									2			
145	LPP082909TMB13	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	C.P. Mixed Desert Scrub									350			
159	LPP061710TMC1	Invasive Upland Vegetation									8000			
160	LPP083009TMA4	Invasive Upland Vegetation									A			

Table 5-3
Belt Transect Data

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Transect Number	LPP Code	Ecological System	*Aegilops cylindrica*	*Asclepias subverticillata*	*Bromus rubens*	*Bromus tectorum*	*Convolvulus arvensis*	*Elaeagnus angustifolia*	*Erodium cicutarium*	*Halogeton glomeratus*	*Salsola tragus*	*Sorghum halepense*	*Tamarix* spp.	*Tribulus terrestris*
161	LPP083009TMc4S	Invasive Upland Vegetation									C			
162	LPP083009TMA5	C.P. Mixed Desert Scrub									87		2	
163	LPP083009TMc5S	C.P. Mixed Desert Scrub									C		8	
164	LPP061710TMB1	Invasive Upland Vegetation									1450			
165	LPP083109TMA1	C.P. Big Sagebrush Shrubland									5			
166	LPP083109TMc1E	C.P. Big Sagebrush Shrubland												
167	LPP083109TMA2	C.P. Mixed Desert Scrub									A			
168	LPP083109TMc2S	C.P. Mixed Desert Scrub									A			
169	LPP083109TMc3S	C.P. Shrub-Steppe									O			
170	LPP083109TMA3	C.P. Shrub-Steppe									O			
171	LPP083109TMA4	C.P. Shrub-Steppe									C			
172	LPP083109TMc4E	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												
180	LPP083009TMB10	C.P. Mixed Desert Scrub												

Table 5-3
Belt Transect Data

Transect Number	LPP Code	Ecological System	*Aegilops cylindrica*	*Asclepias subverticillata*	*Bromus rubens*	*Bromus tectorum*	*Convolvulus arvensis*	*Elaeagnus angustifolia*	*Erodium cicutarium*	*Halogeton glomeratus*	*Salsola tragus*	*Sorghum halepense*	*Tamarix* spp.	*Tribulus terrestris*
181	LPP083009TMB9	C.P. Mixed Desert Scrub									A			
185	LPP091009TMA5	C.P. Shrub-Steppe												
186	LPP091009TMc5E	C.P. Shrub-Steppe												
187	LPP091009TMB2	C.P. Shrub-Steppe												
188	LPP091009TMA4	C.P. Shrub-Steppe												
189	LPP091009TMc4S	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	LPP083109TMc11E	C.P. Shrub-Steppe												
198	LPP083109TMA11	C.P. Shrub-Steppe									C			
199	LPP083109TMA12	C.P. Grassland									C			
200	LPP083109TMc12S	C.P. Grassland									A			
201	LPP083109TMA13	C.P. Grassland									A			

Table 5-3
Belt Transect Data

Transect Number	LPP Code	Ecological System	*Aegilops cylindrica*	*Asclepias subverticillata*	*Bromus rubens*	*Bromus tectorum*	*Convolvulus arvensis*	*Elaeagnus angustifolia*	*Erodium cicutarium*	*Halogeton glomeratus*	*Salsola tragus*	*Sorghum halepense*	*Tamarix* spp.	*Tribulus terrestris*
202	LPP083109TMc13E	C.P. Grassland									C			
203	LPP083109TMA14	C.P. Grassland									O			
204	LPP083109TMc14E	C.P. Grassland												
205	LPP083109TMA20	C.P. Grassland									A			
206	LPP083109TMc20E	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	LPP083109TMA17	C.P. Greasewood Flat								42	83			
212	LPP083109TMc17S	C.P. Greasewood Flat									C			
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	LPP083109TMB13	C.P. Shrub-Steppe							P		C-A			
223	LPP083109TMB5	C.P. Mixed Desert Scrub												
224	LPP083109TMB4	C.P. Mixed Desert Scrub												

Table 5-3
Belt Transect Data

Transect Number	LPP Code	Ecological System	*Aegilops cylindrica*	*Asclepias subverticillata*	*Bromus rubens*	*Bromus tectorum*	*Convolvulus arvensis*	*Elaeagnus angustifolia*	*Erodium cicutarium*	*Halogeton glomeratus*	*Salsola tragus*	*Sorghum halepense*	*Tamarix* spp.	*Tribulus terrestris*
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	LPP083009TMA10	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			
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	C.P. Gypsum Badlands				36								
242	LPP062210TMG1	C.P. Gypsum Badlands												

Table 5-3
Belt Transect Data

Transect Number	LPP Code	Ecological System	*Aegilops cylindrica*	*Asclepias subverticillata*	*Bromus rubens*	*Bromus tectorum*	*Convolvulus arvensis*	*Elaeagnus angustifolia*	*Erodium cicutarium*	*Halogeton glomeratus*	*Salsola tragus*	*Sorghum halepense*	*Tamarix* spp.	*Tribulus terrestris*
243	LPP083009TMc7E	C.P. Mixed Desert Scrub				6					A			
244	LPP083009TMA7	C.P. Greasewood Flat									C-A			
245	LPP083009TMc6E	C.P. Greasewood Flat									C			
246	LPP083009TMA6	C.P. Greasewood Flat									3			
247	LPP091009TMc11E	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	LPP091009TMC6S	Ruderal Vegetation				12					A			
253	LPP091009TMA6	Invasive Upland Vegetation									O			
254	LPP091009TMB4	C.P. Gypsum Badlands												
255	LPP091009TMB3	C.P. Gypsum Badlands												
256	LPP090909TMB6	C.P. Shrub-Steppe				13					75			
257	LPP090809TMA3	C.P. Gypsum Badlands												
258	LPP090809TMA2	C.P. Gypsum Badlands												
259	LPP090809TMc2E	C.P. Gypsum Badlands												
260	LPP090809TMA1	C.P. Gypsum Badlands												

Table 5-3
Belt Transect Data

Transect Number	LPP Code	Ecological System	*Aegilops cylindrica*	*Asclepias subverticillata*	*Bromus rubens*	*Bromus tectorum*	*Convolvulus arvensis*	*Elaeagnus angustifolia*	*Erodium cicutarium*	*Halogeton glomeratus*	*Salsola tragus*	*Sorghum halepense*	*Tamarix* spp.	*Tribulus terrestris*
261	LPP090809TMc1	C.P. Gypsum Badlands												
262	LPP090809TMc3S	C.P. Gypsum Badlands												
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	LPP090809TMA7	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	LPP090909TMA5	C.P. Lower Montane Riparian Woodland and Shrubland				14					2		9	
280	LPP90909TMc5E	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*	*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	LPP090909TMc9S	C.P. Shrub-Steppe		1										
291	LPP090909TMc10E	C.P. Pinyon-Juniper Woodland												
292	LPP090909TMA10	C.P. Pinyon-Juniper Woodland												
293	LPP090909TMA11	C.P. Pinyon-Juniper Woodland									3			
294	LPP090909TMC11	Ruderal Vegetation				2					38			
295	LPP090909TMA12	C.P. Pinyon-Juniper Woodland												
296	LPP090909Tmc12S	C.P. Pinyon-Juniper Woodland				A					26			
297	LPP090909Tmc13E	C.P. Mixed Desert Scrub				1					A			
298	LPP090909TMA13	C.P. Shrub-Steppe									38			

Table 5-3
Belt Transect Data

Transect Number	LPP Code	Ecological System	*Aegilops cylindrica*	*Asclepias subverticillata*	*Bromus rubens*	*Bromus tectorum*	*Convolvulus arvensis*	*Elaeagnus angustifolia*	*Erodium cicutarium*	*Halogeton glomeratus*	*Salsola tragus*	*Sorghum halepense*	*Tamarix* spp.	*Tribulus terrestris*
299	LPP090909TMA14	C.P. Shrub-Steppe									A			
300	LPP090909Tmc14S	C.P. Shrub-Steppe				A					A			
301	LPP083109TMB1	C.P. Shrub-Steppe									2			
302	LPP083109TMB3	C.P. Pinyon-Juniper Woodland												
303	LPP083109TMB2	C.P. Blackbrush-Mormon-tea Shrubland												
304	LPP083109TMc10E	C.P. Shrub-Steppe				P					C			
305	LPP083109TMA10	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			

Table 5-3
Belt Transect Data

Transect Number	LPP Code	Ecological System	*Aegilops cylindrica*	*Asclepias subverticillata*	*Bromus rubens*	*Bromus tectorum*	*Convolvulus arvensis*	*Elaeagnus angustifolia*	*Erodium cicutarium*	*Halogeton glomeratus*	*Salsola tragus*	*Sorghum halepense*	*Tamarix* spp.	*Tribulus terrestris*
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	LPP083109TMB15	C.P. Mixed Desert Scrub												
322	LPP083109TMB14	C.P. Pinyon-Juniper Woodland												
323	LPP083109TMB19	C.P. Pinyon-Juniper Woodland												
324	LPP083109TMB18	Developed-Road							A		A			
325	LPP083109TMB17	C.P. Mixed Desert Scrub			O				A		A			
326	LPP062210TMB2	C.P. Mixed Desert Scrub				1250			53		20			
327	LPP062210TMB1	C.P. Mixed Desert Scrub				700			25		50			
328	LPP091109TMB2	C.P. Mixed Desert Scrub				22					7			
329	LPP091109TMB1	C.P. Shrub-Steppe									3			
330	LPP082509TMB20	C.P. Shrub-Steppe									3			
331	LPP082509TMA21	C.P. Pinyon-Juniper Woodland												
332	LPP082509TMB19	C.P. Mixed Desert Scrub												
333	LPP082509TMA20	C.P. Mixed Desert Scrub												
334	LPP082509TMA19	C.P. Mixed Desert Scrub												

Table 5-3
Belt Transect Data

Transect Number	LPP Code	Ecological System	*Aegilops cylindrica*	*Asclepias subverticillata*	*Bromus rubens*	*Bromus tectorum*	*Convolvulus arvensis*	*Elaeagnus angustifolia*	*Erodium cicutarium*	*Halogeton glomeratus*	*Salsola tragus*	*Sorghum halepense*	*Tamarix* spp.	*Tribulus terrestris*
335	LPP082509TMB18	C.P. Mixed Desert Scrub												
337	LPP082509TMB17	C.P. Pinyon-Juniper Woodland				P								
338	LPP090109TMc6E	C.P. Pinyon-Juniper Woodland												
341	LPP082509TMB16	C.P. Pinyon-Juniper Woodland									1			
342	LPP082509TMB15	C.P. Pinyon-Juniper Woodland												
343	LPP082509TMA16	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	LPP090109TMA3	C.P. Shrub-Steppe				6								
349	LPP090109TMc3E	C.P. Shrub-Steppe			P	20								
351	LPP052410TMC2	C.P. Mixed Desert Scrub				134			967		29			
352	LPP052410TMC3	C.P. Mixed Desert Scrub				1534			3984		1734			
353	LPP052410TMB2	C.P. Mixed Desert Scrub			1600	350			7000		102			
354	LPP052410TMB1	C.P. Mixed Desert Scrub			150	600			1450		33			
355	LPP090109TMc2S	C.P. Shrub-Steppe				18			C		O			
356	LPP090109TMA2	C.P. Shrub-Steppe			C	C					O			

Table 5-3
Belt Transect Data

Transect Number	LPP Code	Ecological System	*Aegilops cylindrica*	*Asclepias subverticillata*	*Bromus rubens*	*Bromus tectorum*	*Convolvulus arvensis*	*Elaeagnus angustifolia*	*Erodium cicutarium*	*Halogeton glomeratus*	*Salsola tragus*	*Sorghum halepense*	*Tamarix* spp.	*Tribulus terrestris*
357	LPP090109TMA1	C.P. Volcanic Rock and Cinder Land			C						A			
359	LPP052210TMA3	Mojave Desert (M.D.) Mixed Desert Scrub			2700	2			1003					
360	LPP052210TMA5	M.D. Blackbrush-Mormon-tea Shrubland			163				3					
361	LPP052310TMA6	M.D. Mixed Desert Scrub			1450				1600					
362	LPP052210TMA4	M.D. Mixed Desert Scrub			6500	177			1443					
363	LPP052210TMA6	M.D. Blackbrush-Mormon-tea Shrubland			287				26					
364	LPP052310TMA10	M.D. Mixed Desert Scrub			1600				2688					
365	LPP052210TMA2	M.D. Creosote bush-White Bursage Desert Scrub			1500				3876					
366	LPP052210TMA7	M.D. Mixed Desert Scrub			1800				5000					
367	LPP052310TMA9	M.D. Creosote bush-White Bursage Desert Scrub			506	6			612		1			
368	LPP052310TMA7	M.D. Mixed Desert Scrub			3743	1523			282					
369	LPP052310TMA8	M.D. Mixed Desert Scrub			500				4250					
370	LPP052210TMA8	M.D. Mixed Desert Scrub			952				5400					
371	LPP052310TMA5	M.D. Mixed Desert Scrub			850				1100					
372	LPP052310TMA4	M.D. Volcanic Rock and Cinder Land			5550				2750					
373	LPP052310TMA3	M.D. Volcanic Rock and Cinder Land			6250				2650					
374	LPP052210TMA1	M.D. Creosote bush-White Bursage Desert Scrub			5500				753					

Table 5-3
Belt Transect Data

Transect Number	**LPP Code**	**Ecological System**	***Aegilops cylindrica***	***Asclepias subverticillata***	***Bromus rubens***	***Bromus tectorum***	***Convolvulus arvensis***	***Elaeagnus angustifolia***	***Erodium cicutarium***	***Halogeton glomeratus***	***Salsola tragus***	***Sorghum halepense***	***Tamarix* spp.**	***Tribulus terrestris***
375	LPP052310TMA1	M.D. Blackbrush-Mormon-tea Shrubland			4250				614					
376	LPP052310TMA2	M.D. Blackbrush-Mormon-tea Shrubland			1750				557					
381	LPP052410TMA1	M.D. Volcanic Rock and Cinder Land			5500				267					
382	LPP052410TMA2	M.D. Volcanic Rock and Cinder Land			1150				4600					
383	LPP052410TMA3	M.D. Volcanic Rock and Cinder Land			1700				352					
384	LPP052210TMB7	M.D. Volcanic Rock and Cinder Land			1650	125			2750					
385	LPP052210TMB6	M.D. Volcanic Rock and Cinder Land			1075	2875			1450					
386	LPP052210TMB5	M.D. Blackbrush-Mormon-tea Shrubland			2550				2600					
387	LPP052210TMB4	M.D. Creosote bush-White Bursage Desert Scrub			1355	15			3125					
388	LPP052210TMB3	M.D. Volcanic Rock and Cinder Land			3213	1056			850		32			
389	LPP052210TMB2	M.D. Grassland			50	75			25		225			
390	LPP052210TMB1	M.D. Active and Stabilized Dune			465	267					45			
391	LPP042210TMA250M	M.D. Shrub-Steppe			1300				5000					
392	LPP042210TMB250M	M.D. Grassland			2317				5066					
393	LPP042210TMB350M	M.D. Creosote bush-White Bursage Desert Scrub			1983				2033					
394	LPP052210TMB10	M.D. Creosote bush-White Bursage Desert Scrub			3350				1600					

Table 5-3
Belt Transect Data

Transect Number	LPP Code	Ecological System	*Aegilops cylindrica*	*Asclepias subverticillata*	*Bromus rubens*	*Bromus tectorum*	*Convolvulus arvensis*	*Elaeagnus angustifolia*	*Erodium cicutarium*	*Halogeton glomeratus*	*Salsola tragus*	*Sorghum halepense*	*Tamarix* spp.	*Tribulus terrestris*
395	LPP042210TMA350M	M.D. Shrub-Steppe			1884	5			2052					
396	LPP042210TMA150M	M.D. Grassland			432				461		1			
397	LPP042210TMB150M	M.D. Grassland			2467				6716					
398	LPP052210TMB8	M.D. Creosote bush-White Bursage Desert Scrub			1350	100			2775					
399	LPP052210TMB9	M.D. Shrub-Steppe			2850				1450		2			
400	LPP052210TMC1	M.D. Shrub-Steppe			4550				9800					
401	LPP052210TMC2	M.D. Shrub-Steppe			269	74			1500					
402	LPP052210TMC3	M.D. Shrub-Steppe			1450	200			1300					
403	LPP052210TMC4	M.D. Shrub-Steppe			800				1850					
404	LPP052210TMC5	M.D. Active and Stabilized Dune												
405	LPP052210TMC6	M.D. 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	LPP090109TMB4	M.D. Creosote-White Bursage Desert Scrub (outside of survey area)												
410	LPP052210TMC7	M.D. Creosote-White Bursage Desert Scrub			1400				2850					
411	LPP052210TMC8	M.D. Shrub-Steppe			5350				1950					

Table 5-3
Belt Transect Data

Transect Number	LPP Code	Ecological System	*Aegilops cylindrica*	*Asclepias subverticillata*	*Bromus rubens*	*Bromus tectorum*	*Convolvulus arvensis*	*Elaeagnus angustifolia*	*Erodium cicutarium*	*Halogeton glomeratus*	*Salsola tragus*	*Sorghum halepense*	*Tamarix* spp.	*Tribulus terrestris*
412	LPP052210TMC9	M.D. Creosote bush-White Bursage Desert Scrub			800				1050					
413	LPP052210TMC10	Ruderal Vegetation			2200				850		350			
414	LPP052210TMC11	M.D. Creosote bush-White Bursage Desert Scrub			1300				1300					
419	LPP082509TMA15	C.P. Gypsum Badlands												
420	LPP082509TMB14	C.P. Pinyon-Juniper Woodland												
421	LPP082509TMB13	C.P. Gypsum Badlands												
422	LPP082509TMA14	C.P. Gypsum Badlands												
423	LPP082509TMA13	C.P. Gypsum Badlands												
424	LPP082509TMB12	C.P. Pinyon-Juniper Woodland												
425	LPP082509TMA12	C.P. Pinyon-Juniper Woodland												
426	LPP082509TMB11	C.P. Blackbrush-Mormon-tea Shrubland												
427	LPP082509TMA11	C.P. Mixed Bedrock Canyon and Tableland				P								
428	LPP082509TMB10.	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	LPP082509TMA9	C.P. Lower Montane Riparian Woodland and Shrubland (and some outside of survey area)											10	

Table 5-3
Belt Transect Data

Transect Number	LPP Code	Ecological System	*Aegilops cylindrica*	*Asclepias subverticillata*	*Bromus rubens*	*Bromus tectorum*	*Convolvulus arvensis*	*Elaeagnus angustifolia*	*Erodium cicutarium*	*Halogeton glomeratus*	*Salsola tragus*	*Sorghum halepense*	*Tamarix* spp.	*Tribulus terrestris*
432	LPP082509TMA8	C.P. Big Sagebrush Shrubland									19			
433	LPP082509TMB7	C.P. Big Sagebrush Shrubland				P								
434	LPP082509TMA7	C.P. Big Sagebrush Shrubland									2			
435	LPP082509TMA6	C.P. Lower Montane Riparian Woodland and Shrubland											18	
436	LPP082509TMB6	C.P. Lower Montane Riparian Woodland and Shrubland and small part in C.P. Mixed Desert Scrub			P						12		5	
437	LPP082509TMB5	C.P. Shrub-Steppe				P					1			
438	LPP082509TMA5	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	LPP082509TMA2	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			

Notes:
A = Abundant, C = Common, O = Occasional, P = Present, R = Rare

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 5-5). 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 (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 5-5
Close-up View of *Aegilops cylindrica*

A. cylindrica has an appearance similar to winter wheat. *A. cylindrica* can be distinguished from winter wheat, though, as the spikelets of winter wheat do not separate into joints, as they do in *A. cylindrica* (Figure 5-6). The two taxa are closely related, and can cross to form hybrids which are intermediate in form, and often sterile.

A. 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 (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).

Figure 5-6
Aegilops cylindrica

A. 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). *A. 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 (Sonoran Institute 2008).

5.5.1.2 Survey Results

A. cylindrica was encountered at two locations within the survey area (Figure 5-7), 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 U.S. Highway 89 (U.S. 89) and the turn-off to Johnson Canyon (Transects # 119 and 126).

A. 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*. *A. cylindrica* was a co-dominant species in the vegetation community where the larger population occurred. The areas were lightly to moderately disturb from agricultural activities, primarily from grazing. Both occurrences were located in proximity to U.S. 89 (Figure 5-8 and Figure 5-9).

5.5.1.3 Discussion

The survey identified only two occurrences of *A. 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.

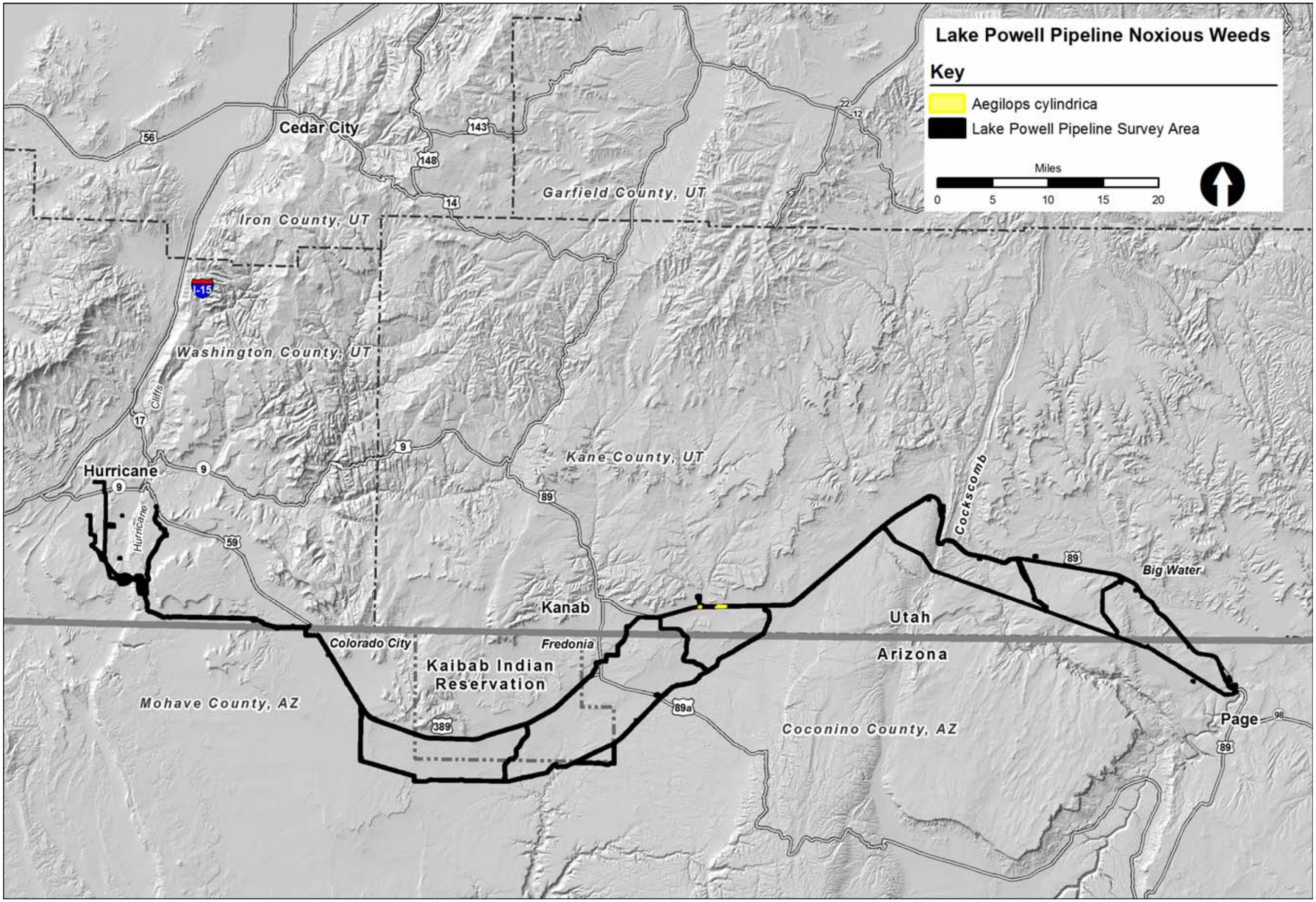

Figure 5-7
***Aegilops cylindrica* Overview Map**

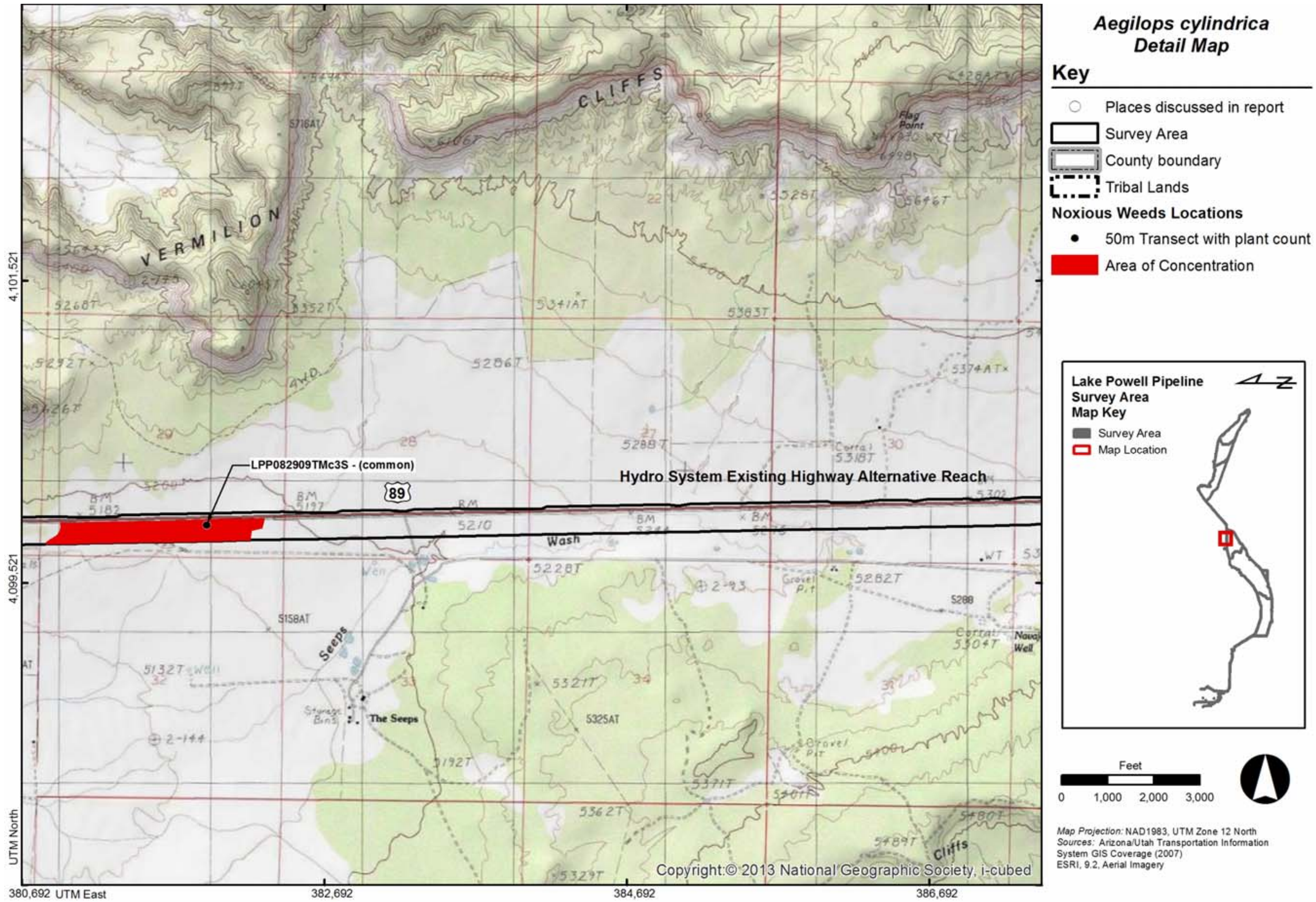

Figure 5-8
***Aegilops cylindrica* Detail Map 1**

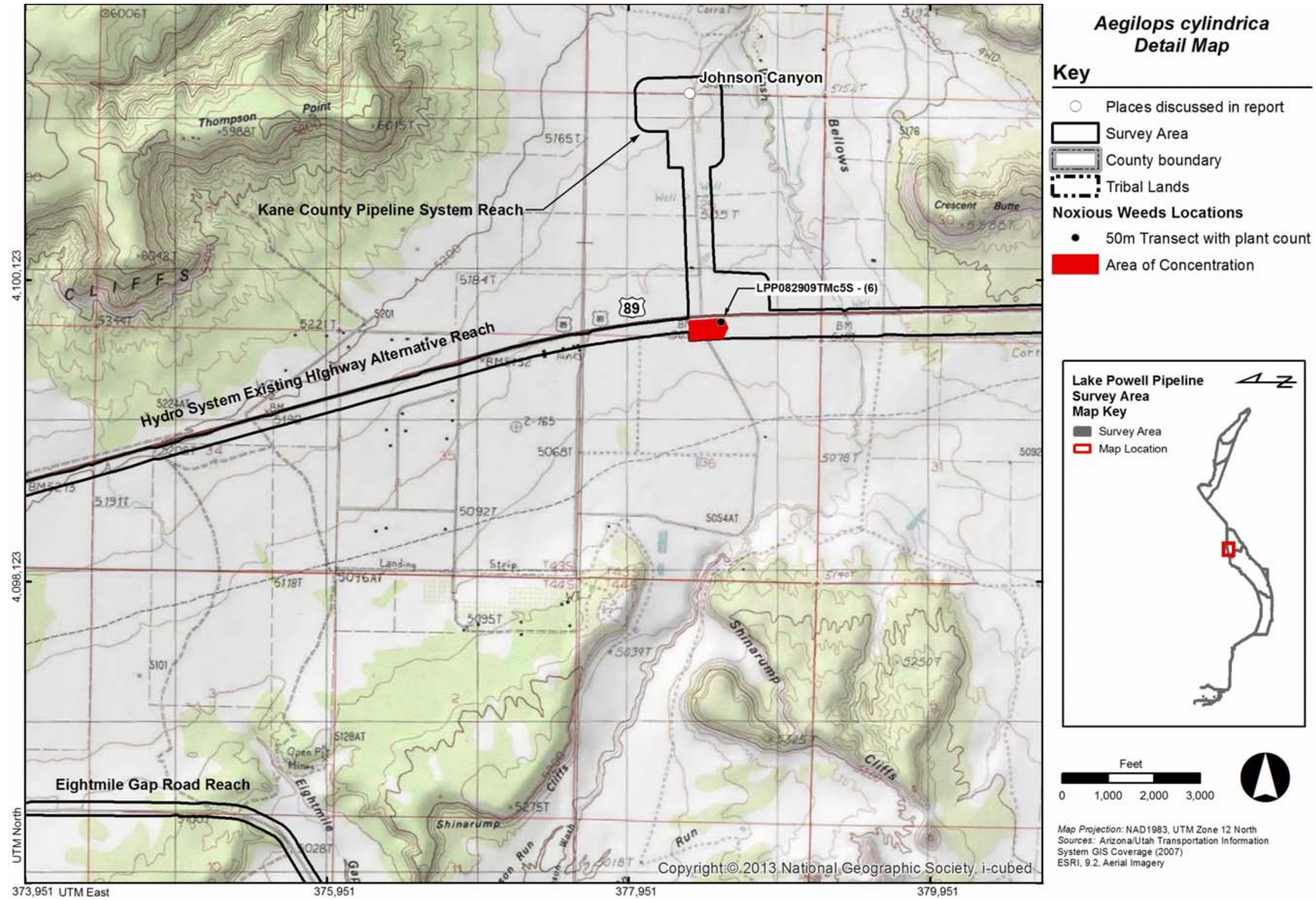

Figure 5-9
***Aegilops cylindrica* Detail Map 2**

5.5.2 *Asclepias subverticillata* (Poison milkweed)

5.5.2.1 Natural History

Asclepias subverticillata is an herbaceous perennial in the Asclepiadaceae (Milkweed Family). *A. subverticillata* can have a shrubby appearance due to the development of many slender, un-branched stems (Figure 5-10), 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).

Figure 5-10
Close-up View of *Asclepias subverticillata*
within the Survey Area

A. 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*.

A. 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 at elevations from 2,700 to 7,200 feet along roadsides and other disturbed sites within a variety of native vegetation types, including creosote bush, 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, *A. subverticillata* is invasive in disturbed areas, where its wind-born seeds are able to establish easily. *A. 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 *A. subverticillata* occasionally throughout the survey area (Figure 5-12). Individuals were located in eight reaches of the survey area (Figure 5-13 to Figure 5-26). 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 U.S. 89. *A. 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 U.S. 89. In the Hydro System Existing Highway Alternative Reach the species was encountered between Seaman Wash and the intersection of U.S. 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. *A. 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. 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).

A. subverticillata was found in the Colorado Plateau Ecological Region, in five 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. *A. 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.

5.5.2.3 Discussion

The survey identified the presence of *A. subverticillata* at various locations throughout the survey area. Individuals were encountered in habitats that ranged from minimally to heavily disturbed (Figure 5-11), 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 5-11
***Asclepias subverticillata* Growing in**
Disturbed Habitat within the Survey Area

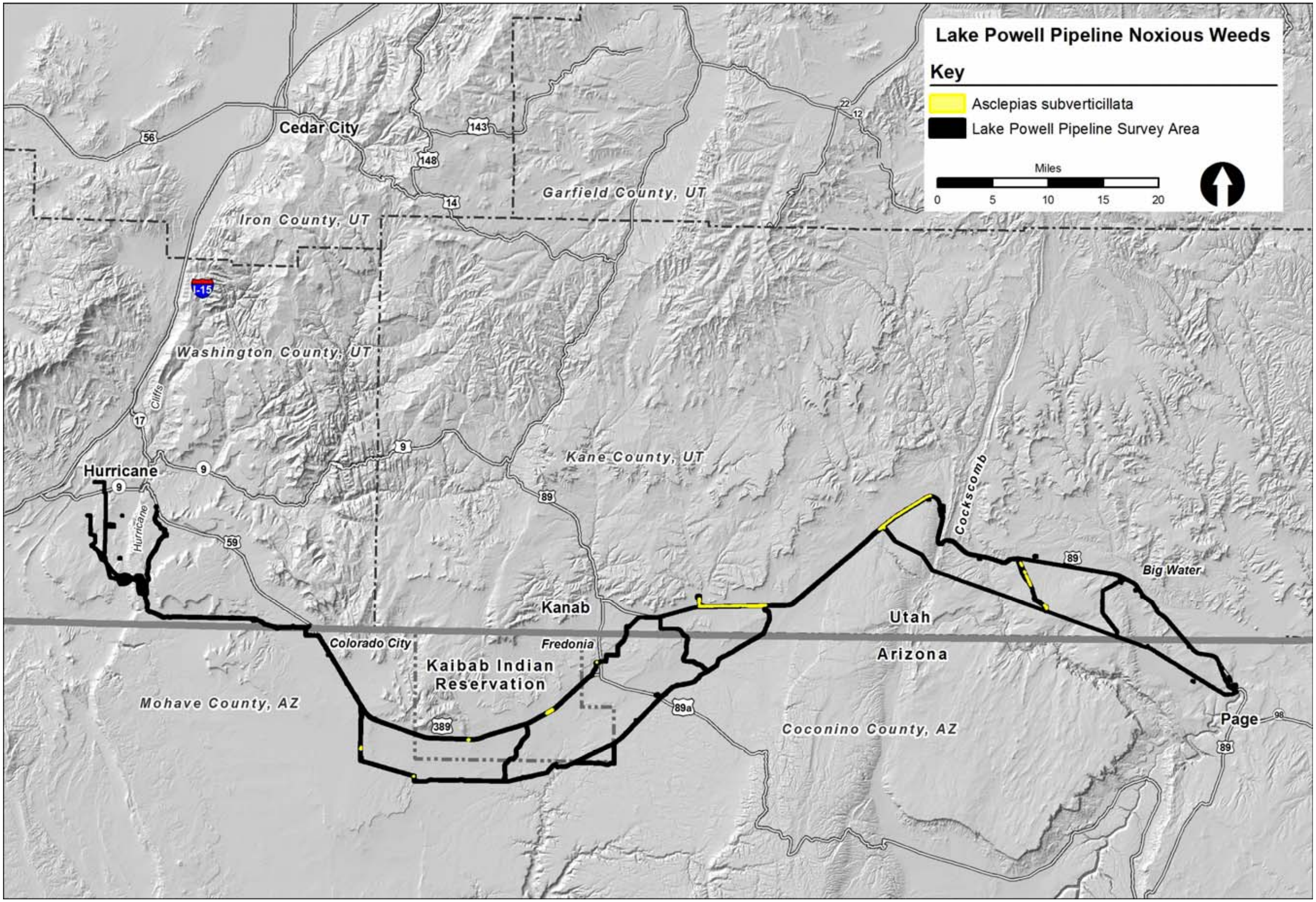

Figure 5-12
***Asclepias subverticillata* Overview Map**

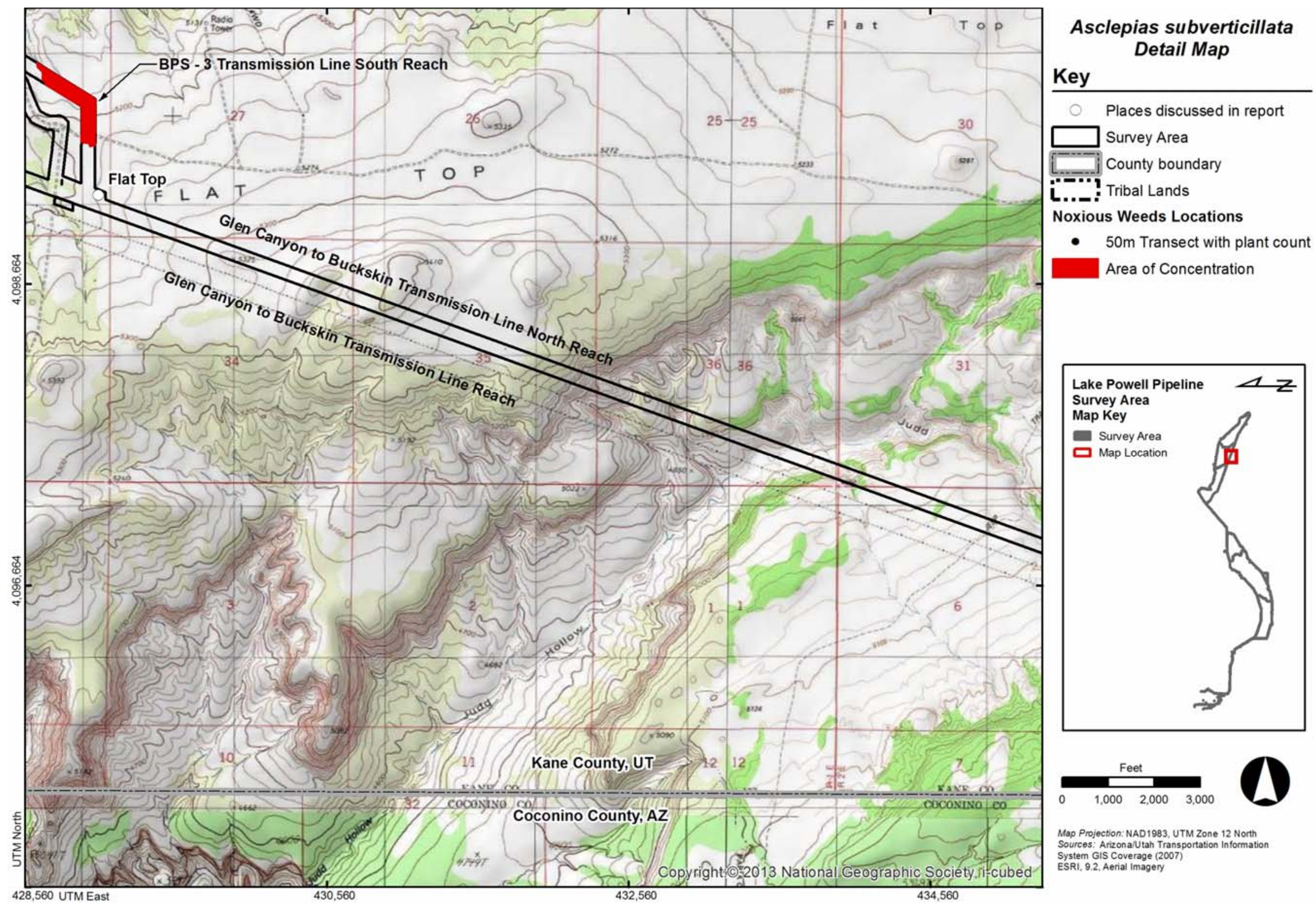

Figure 5-13
***Asclepias subverticillata* Detail Map 1**

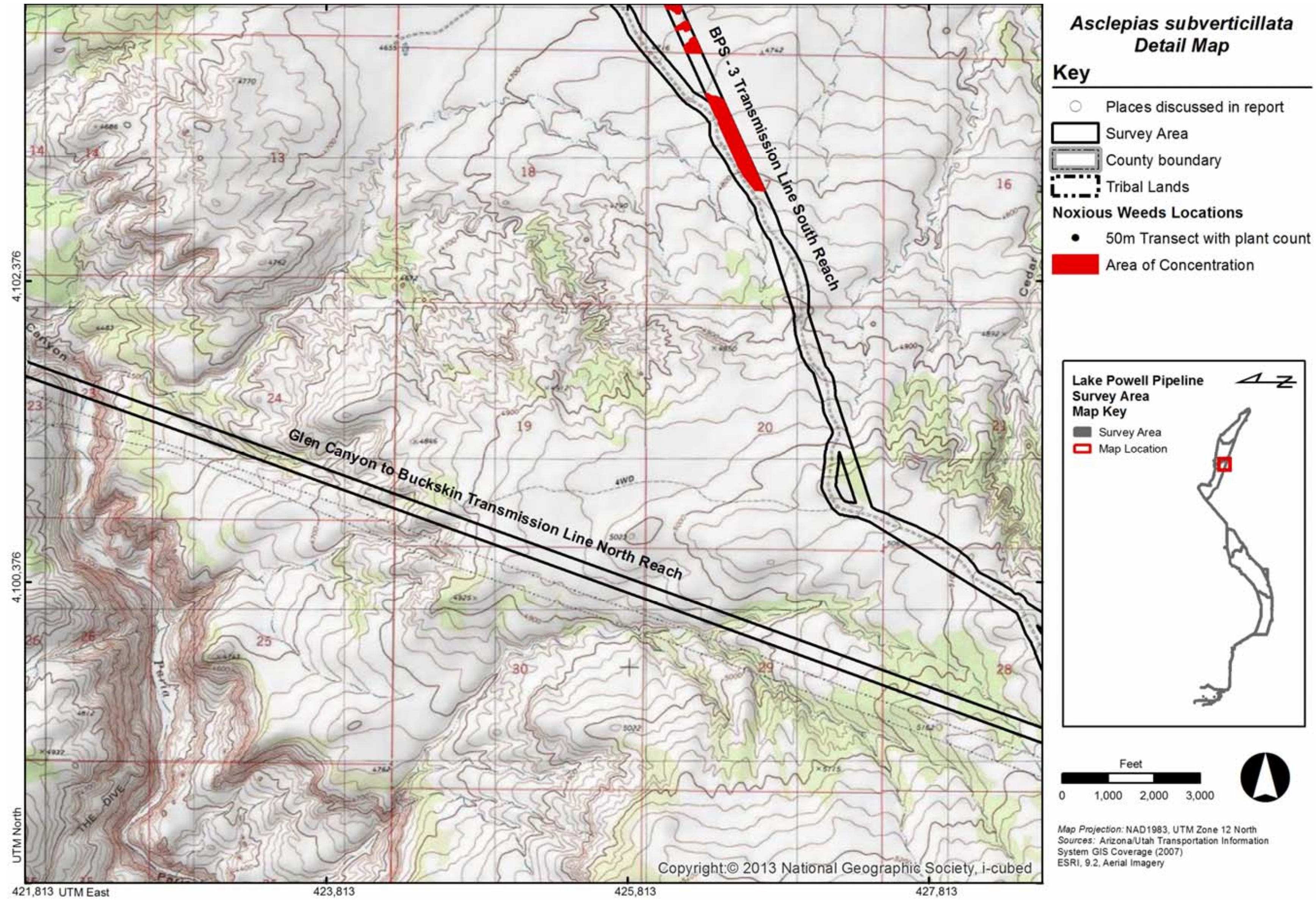

Figure 5-14
***Asclepias subverticillata* Detail Map 2**

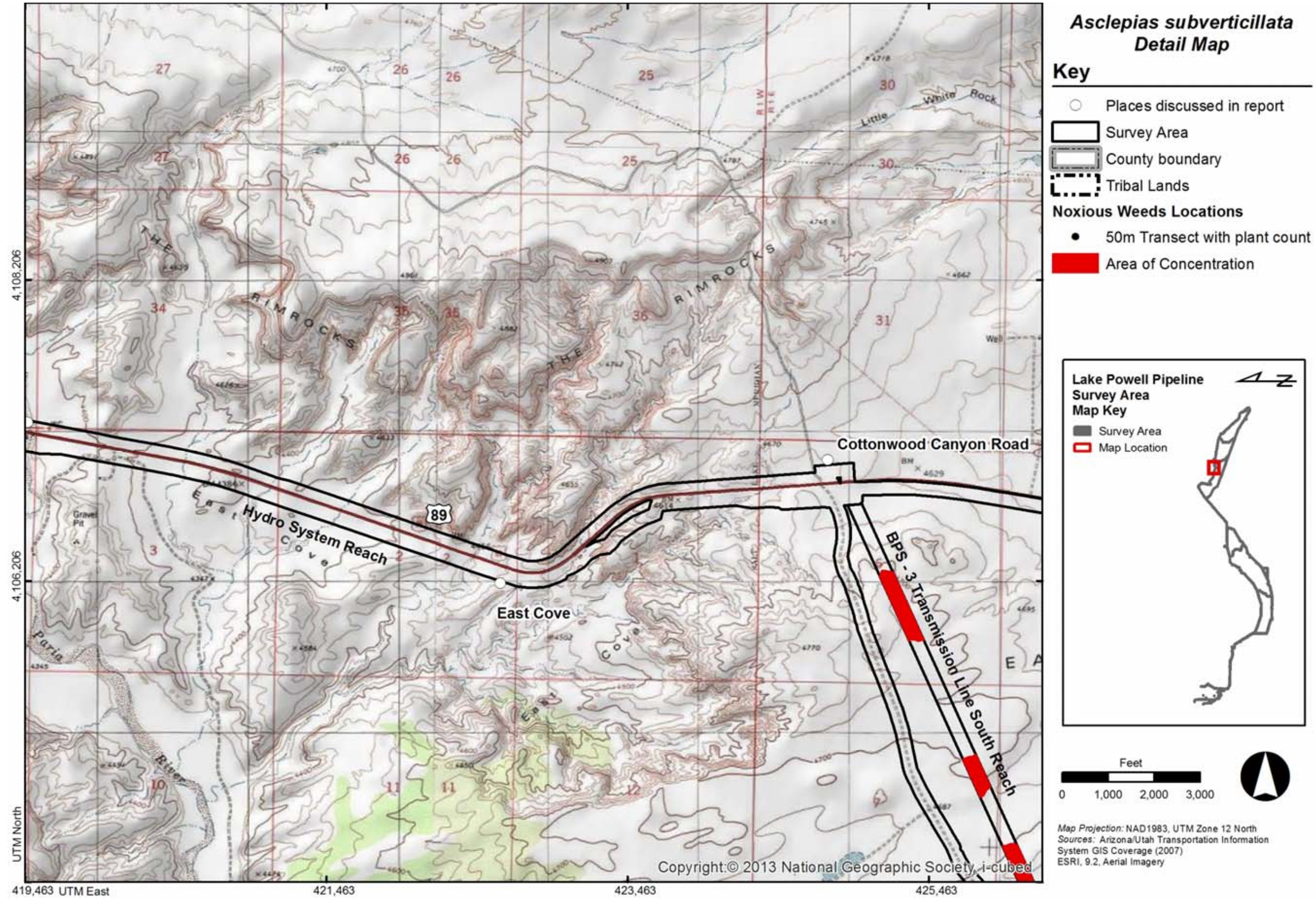

Figure 5-15
Asclepias subverticillata **Detail Map 3**

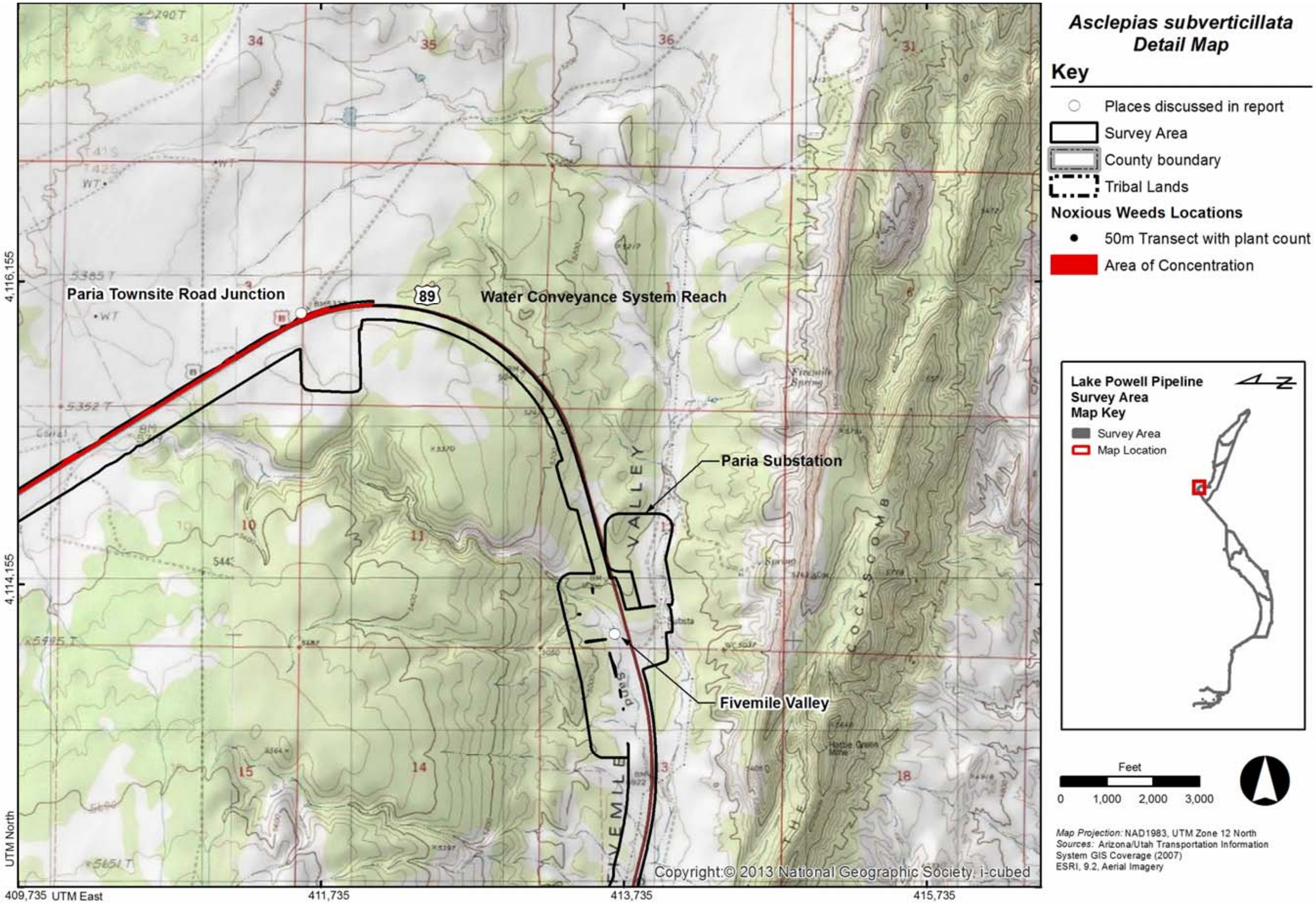

Figure 5-16
***Asclepias subverticillata* Detail Map 4**

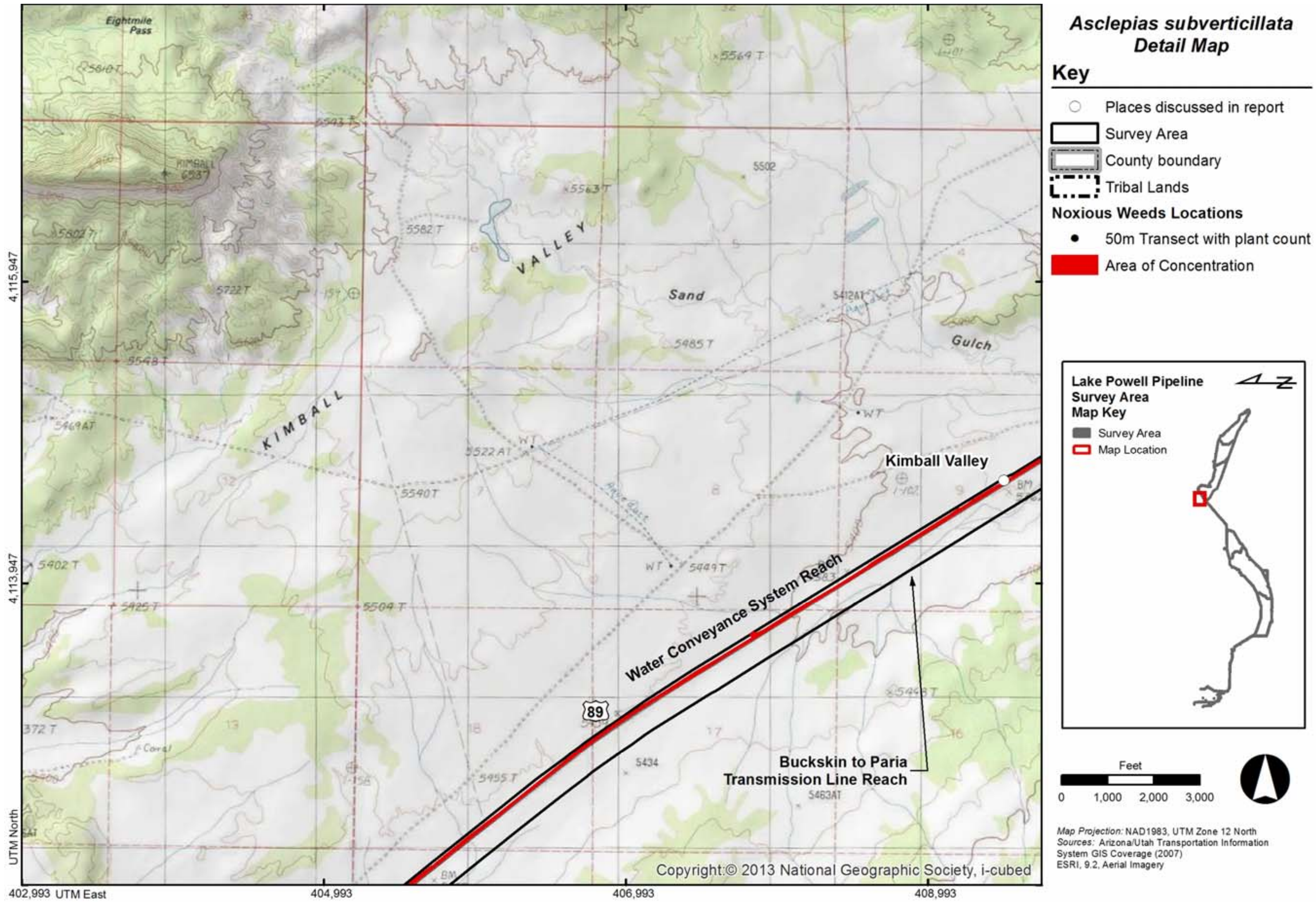

Figure 5-17
***Asclepias subverticillata* Detail Map 5**

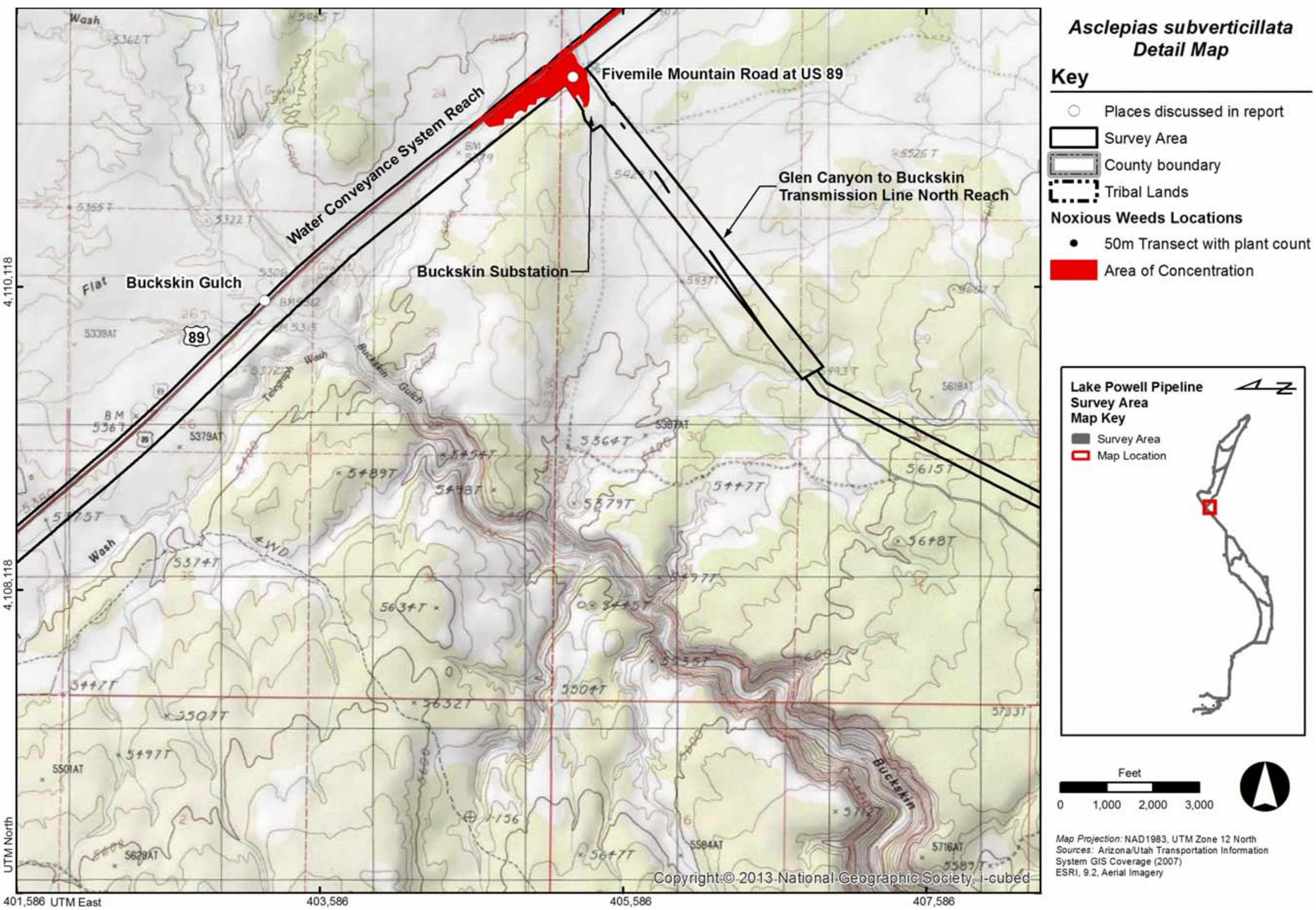

Figure 5-18
***Asclepias subverticillata* Detail Map 6**

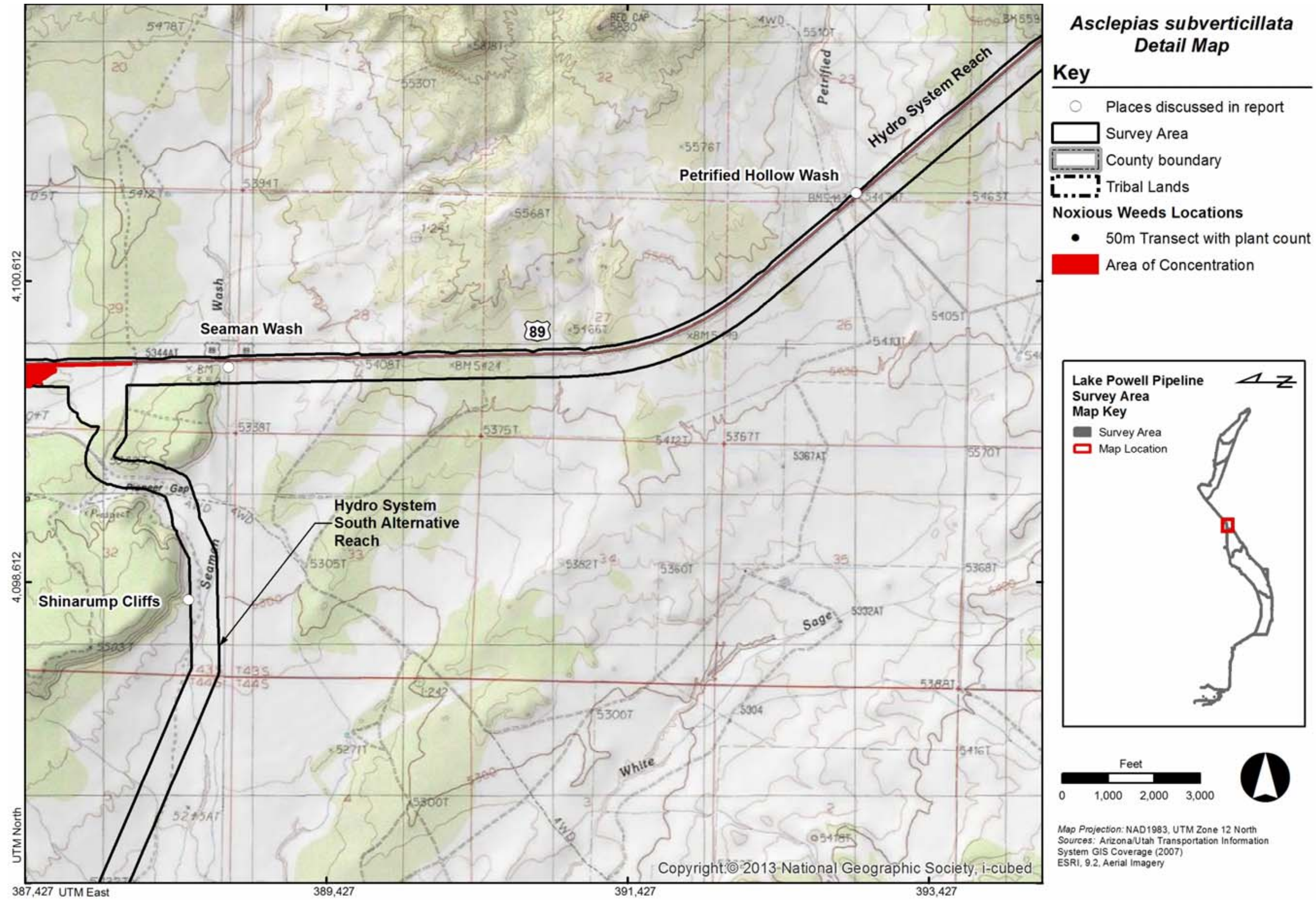

Figure 5-19
***Asclepias subverticillata* Detail Map 7**

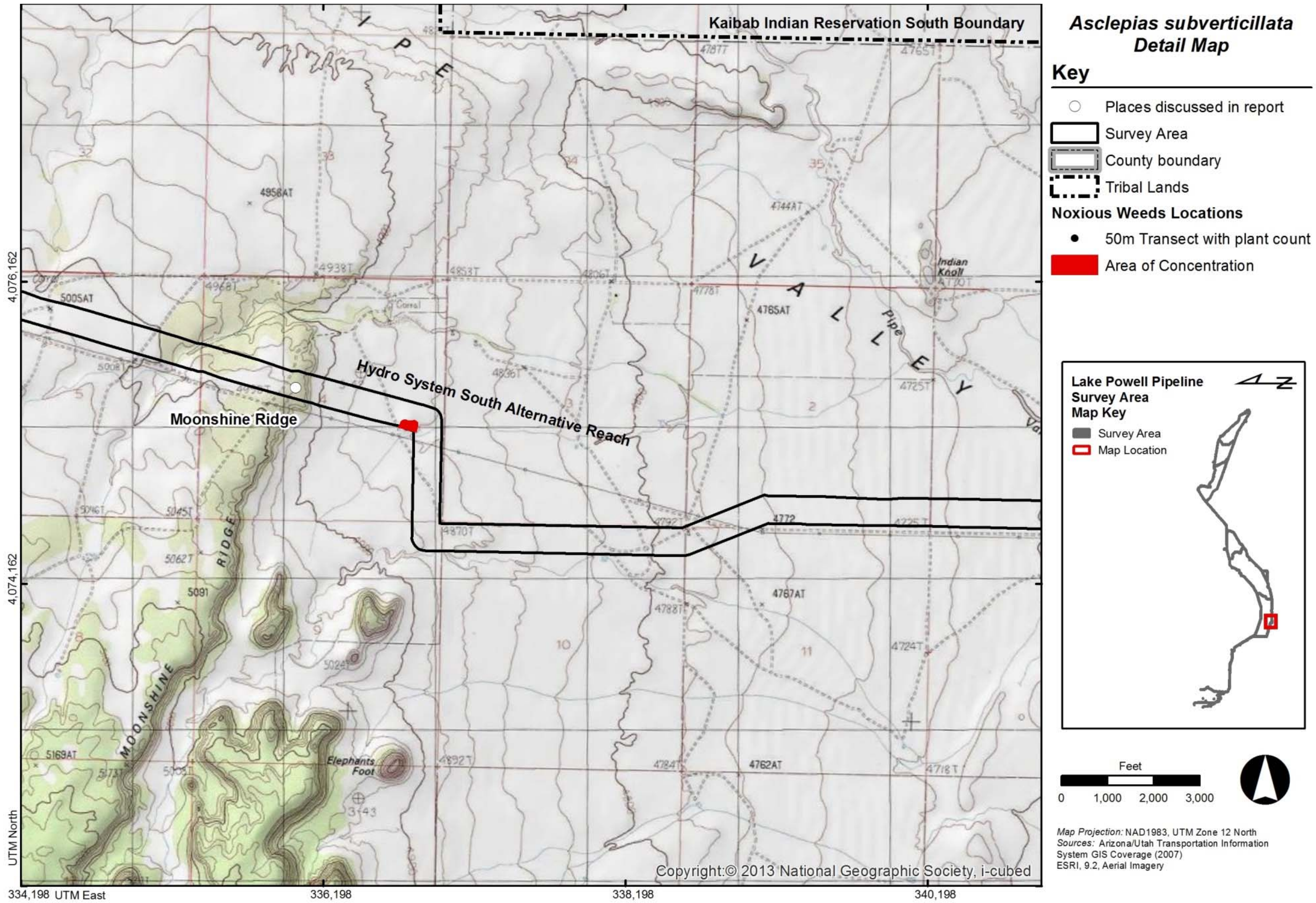

Figure 5-20
***Asclepias subverticillata* Detail Map 8**

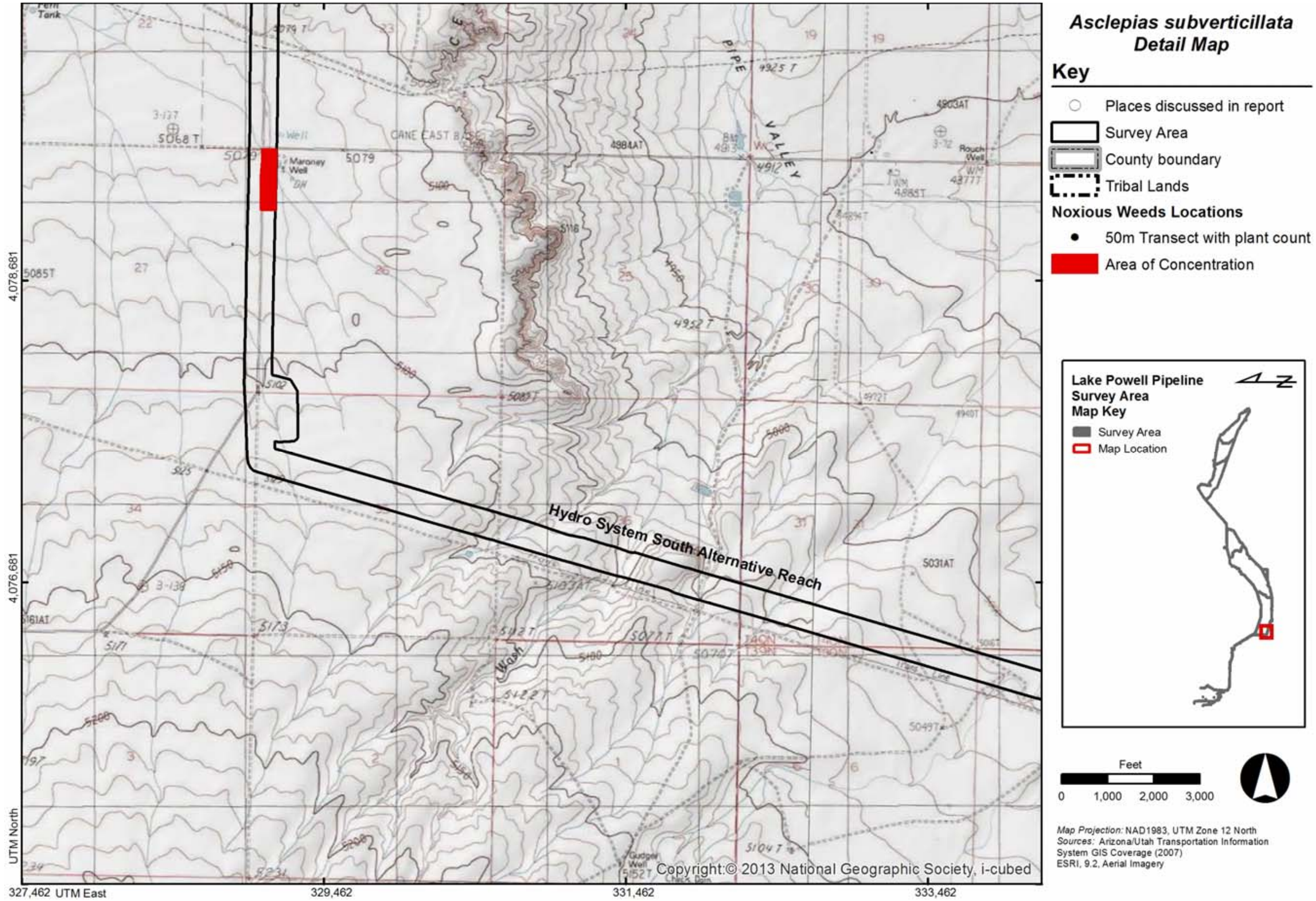

Figure 5-21
***Asclepias subverticillata* Detail Map 9**

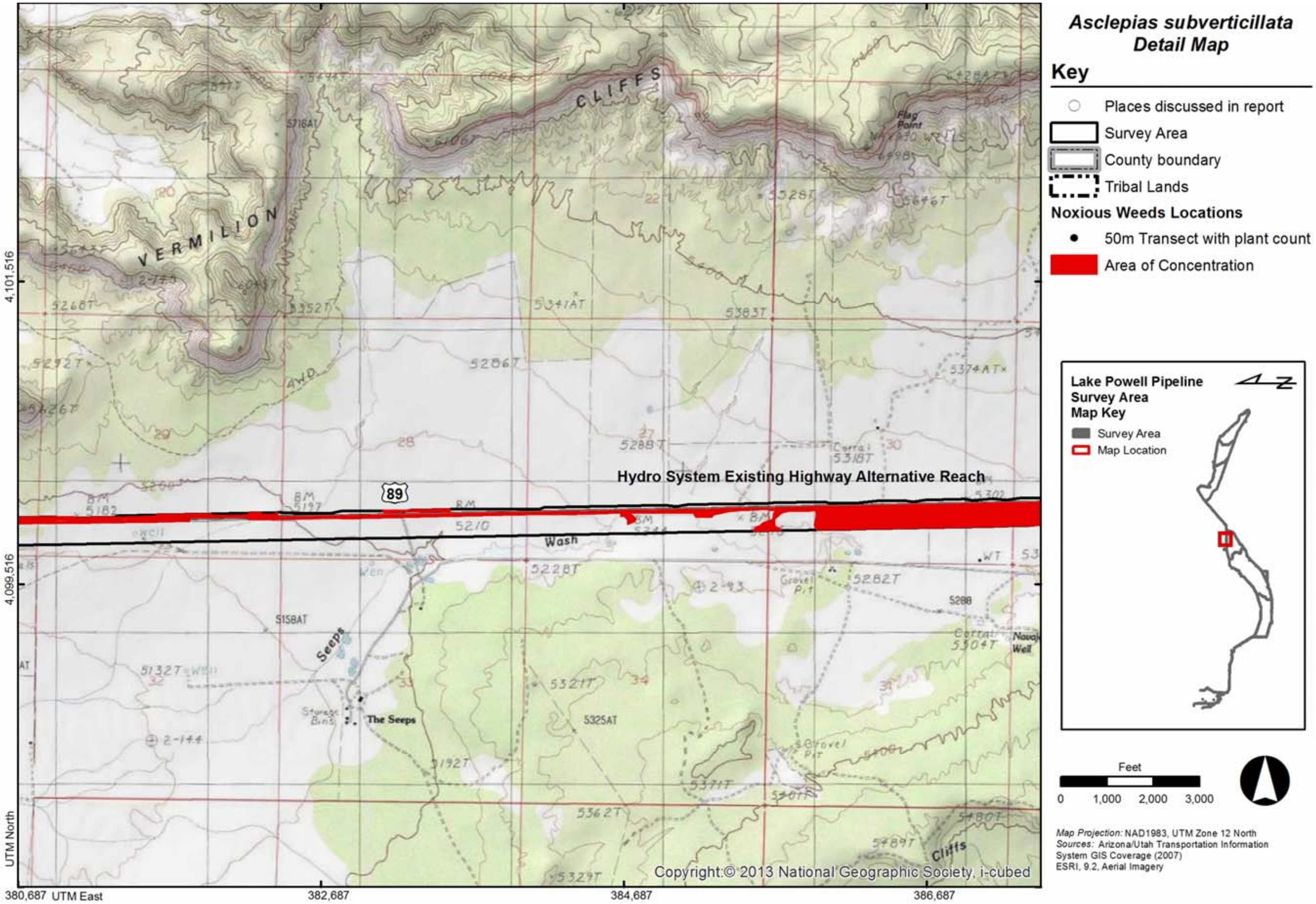

Figure 5-22
***Asclepias subverticillata* Detail Map 10**

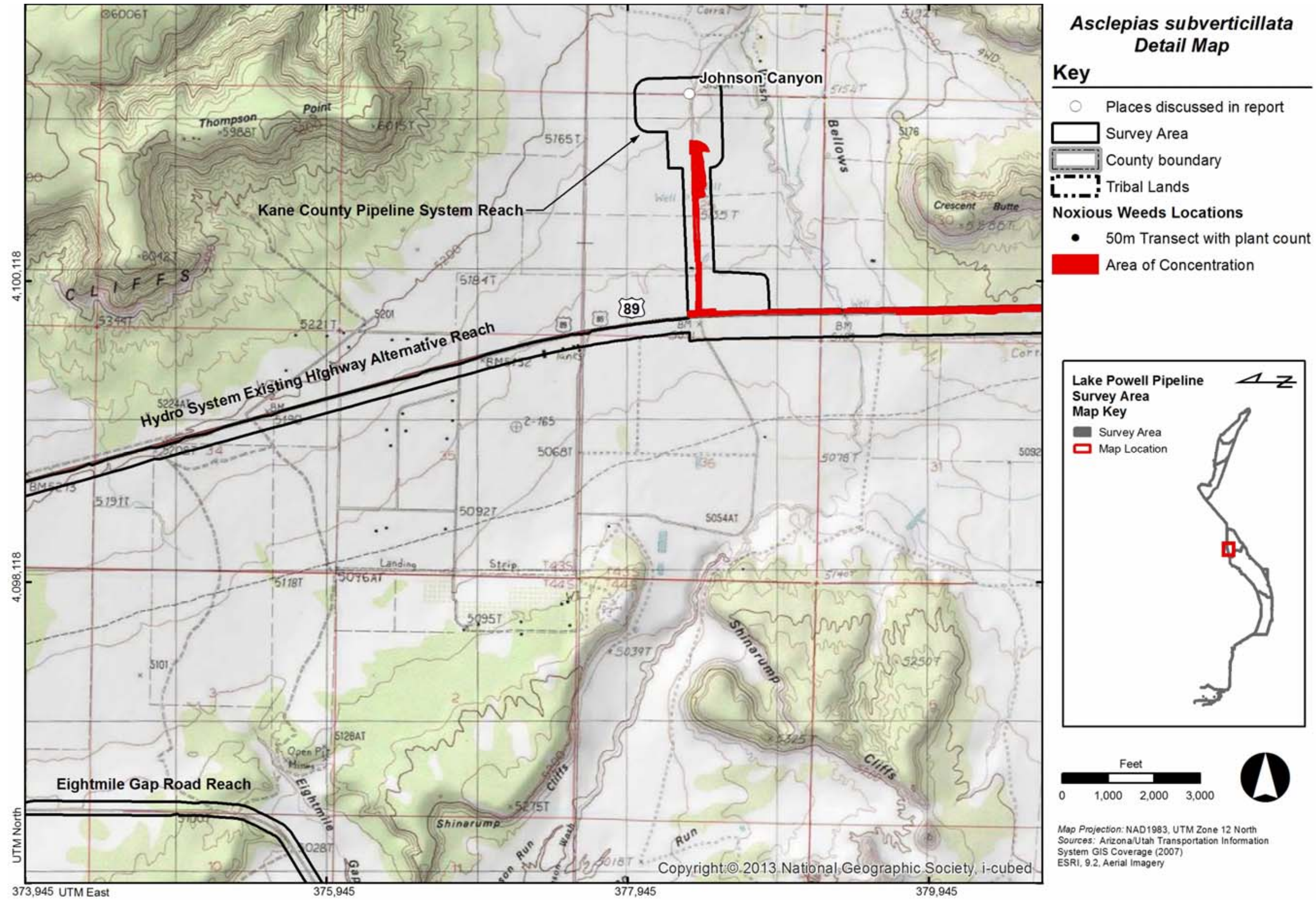

Figure 5-23
***Asclepias subverticillata* Detail Map 11**

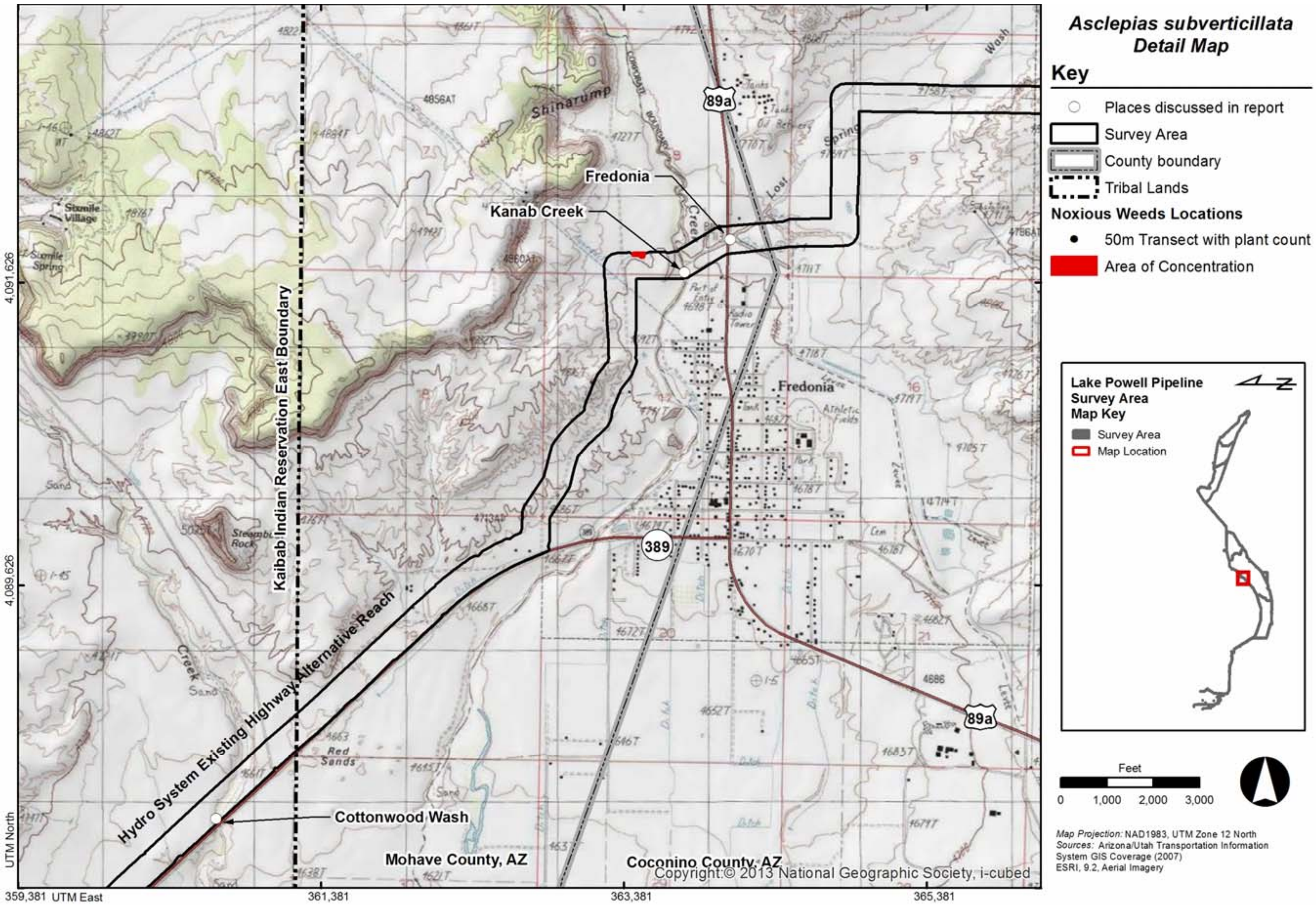

Figure 5-24
***Asclepias subverticillata* Detail Map 12**

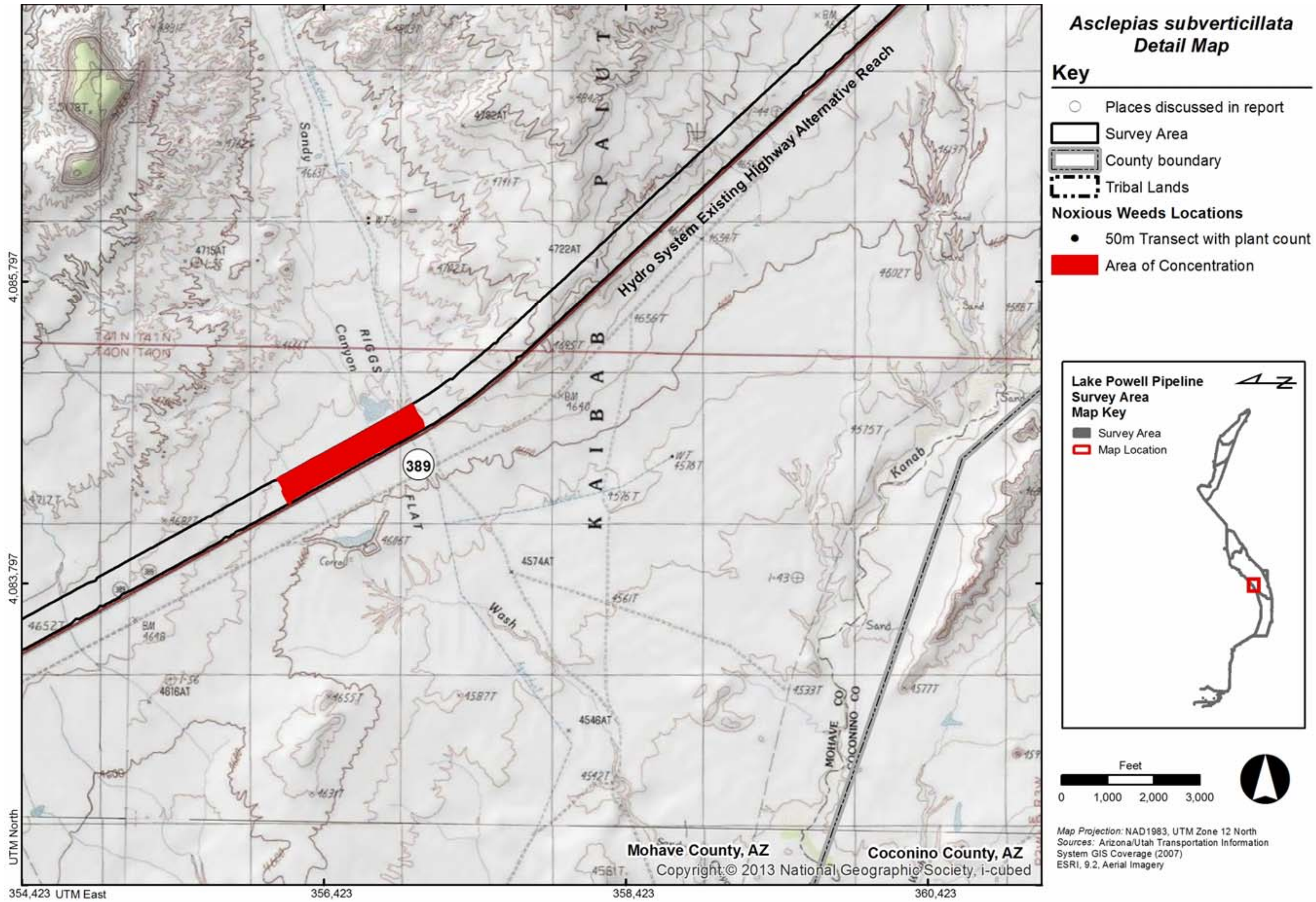

Figure 5-25
Asclepias subverticillata **Detail Map 13**

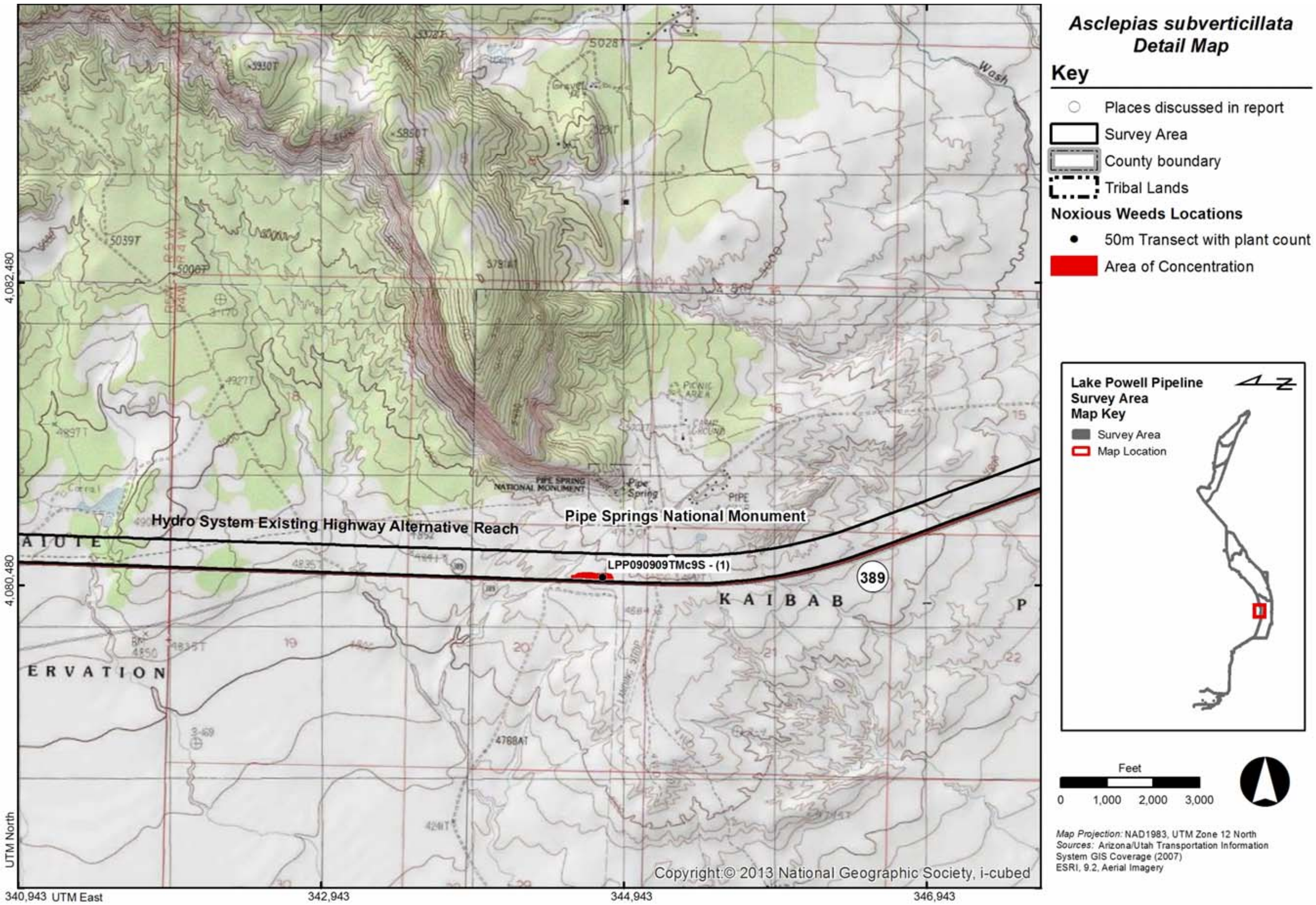

Figure 5-26
***Asclepias subverticillata* Detail Map 14**

5.5.3 *Brassica tournefortii* (Sahara mustard)

5.5.3.1 Natural History

Brassica tournefortii is an annual in the Brassicaceae (Mustard Family). *B. 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 5-27). 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).

B. tournefortii appears similar to other yellow-flowered mustards, including other *Brassica* species and *Sinapsis* species. *B. 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).

Figure 5-27
Close-up View of *Brassica tournefortii*
within the Survey Area

B. tournefortii is native to North Africa, the Middle East, and the Mediterranean portions of southern Europe. *B. 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. *B. 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 (Sonoran Institute 2008).

B. 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. *B. 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). *B. 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

B. tournefortii occurred occasionally throughout the survey area (Figure 5-28). The survey identified *B. tournefortii* in a total of four reaches within the survey area (Figure 5-29 to Figure 5-33). 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; 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. *B. tournefortii* was not detected in any 50-meter belt transects; all encounters occurred while conducting special status species and noxious weed surveys.

B. tournefortii was encountered in the Colorado Plateau and Mojave Desert Ecological Regions, where it occurred in four ecological systems and one anthropogenic land. On the Colorado Plateau *B. tournefortii* was identified in Juniper Savanna, Mixed Desert Scrub, and Pinyon-Juniper Woodland. In the Mojave Desert it was encountered in Creosote-White Bursage Desert Scrub. Anthropogenic land that provided habitat for *B. tournefortii* is classified as Invasive Upland 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 *B. 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 corridors 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.

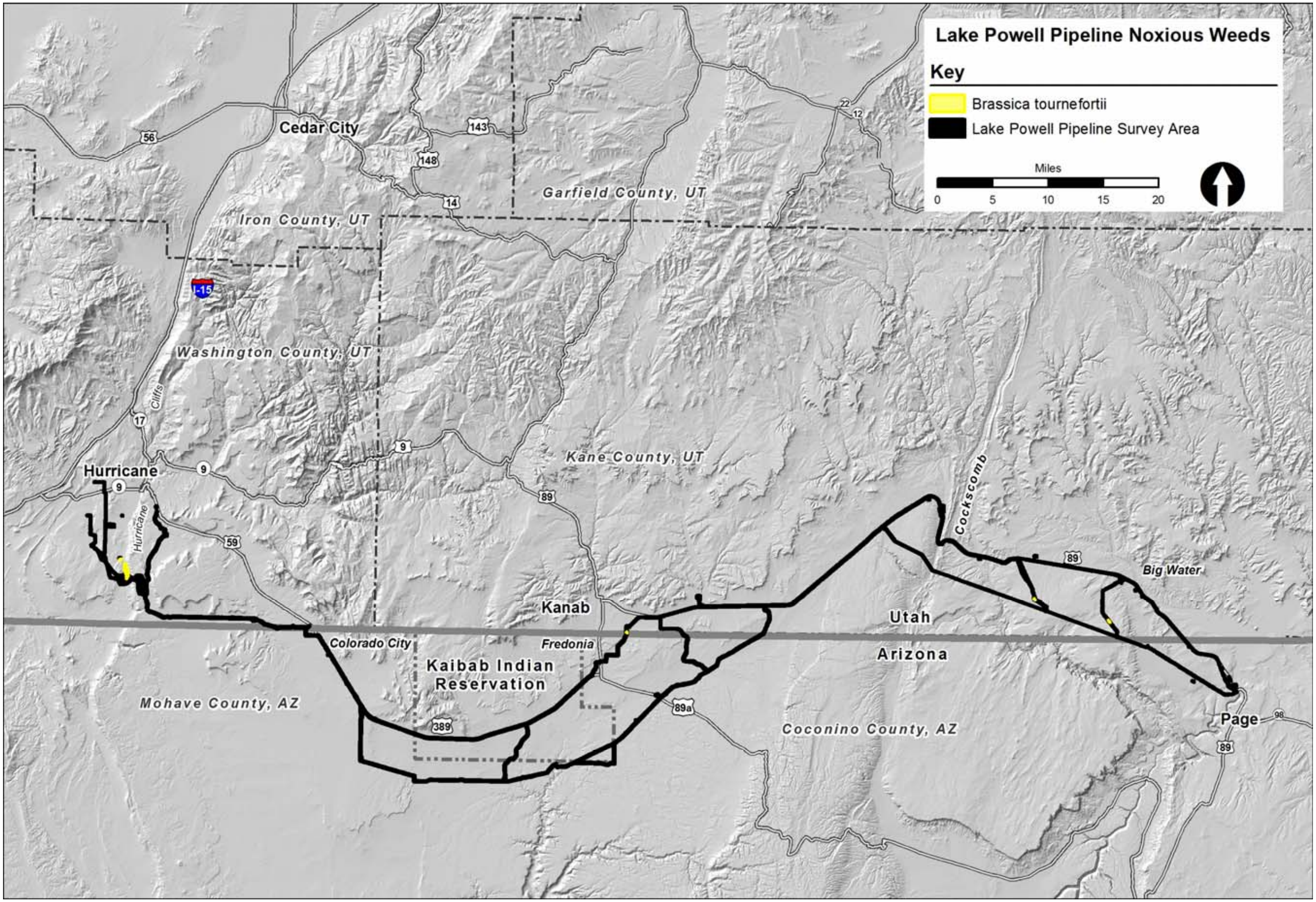

Figure 5-28
***Brassica tournefourtii* Overview Map**

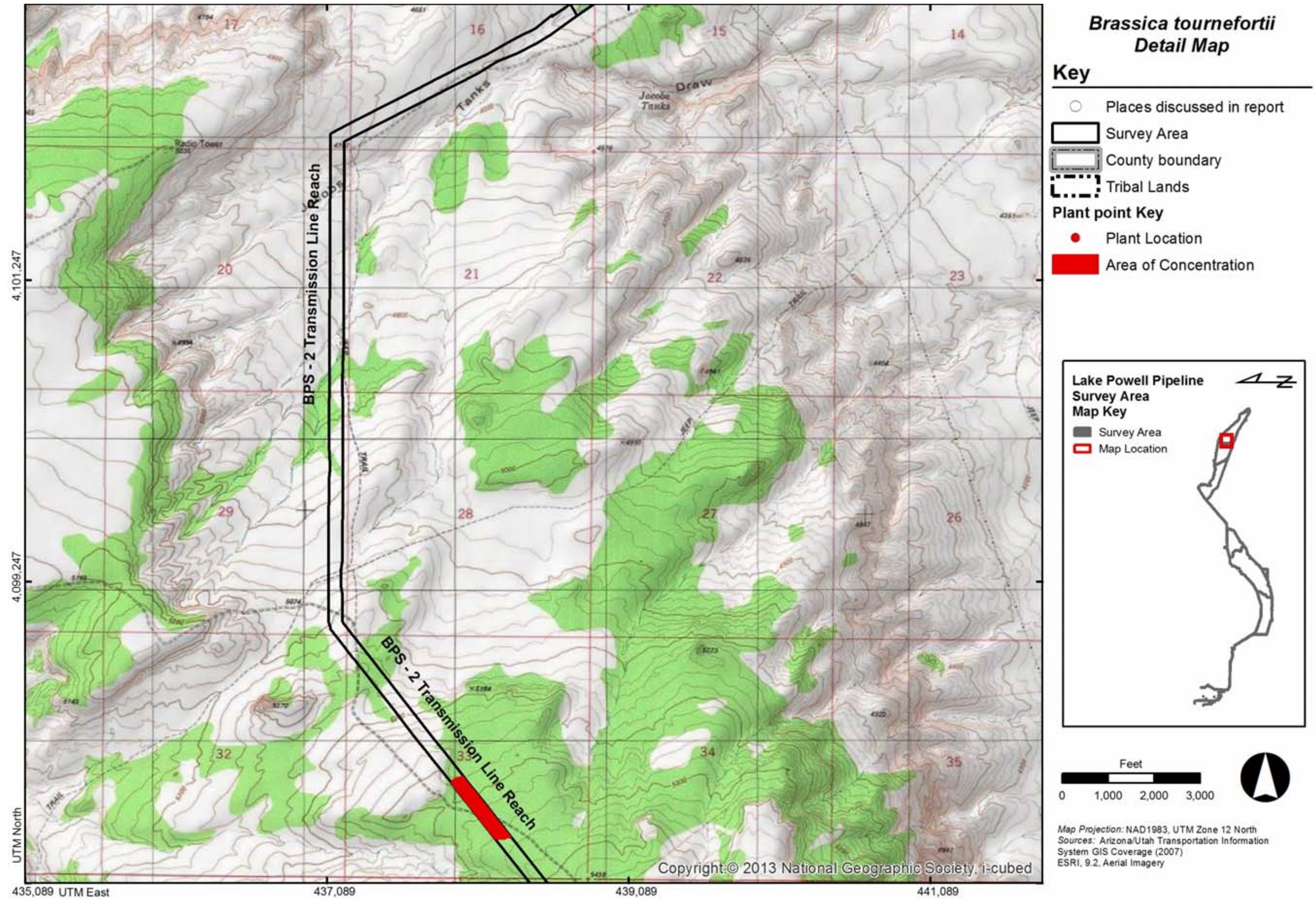

Figure 5-29
***Brassica tournefourtii* Detail Map 1**

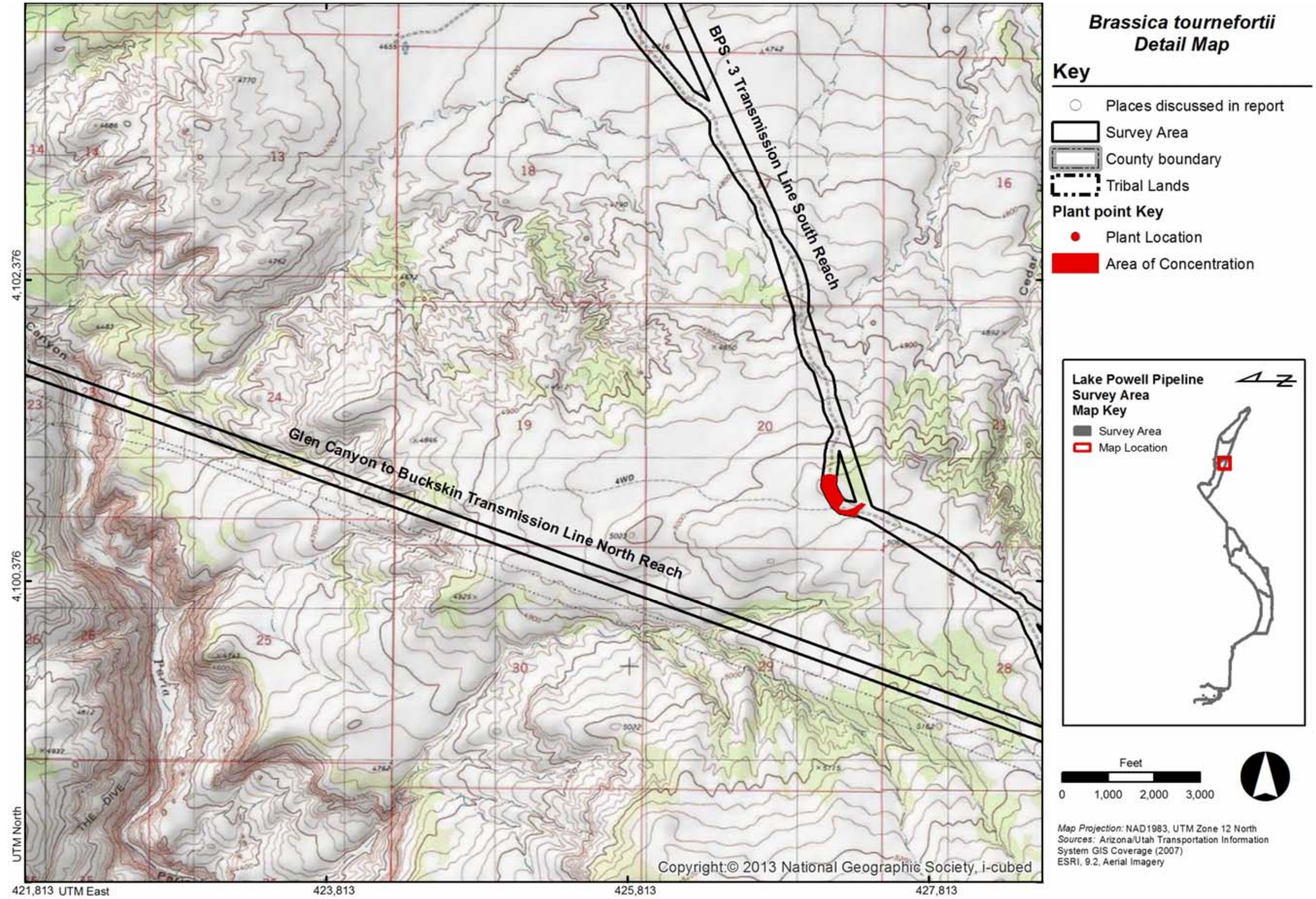

Figure 5-30
***Brassica tournefourtii* Detail Map 2**

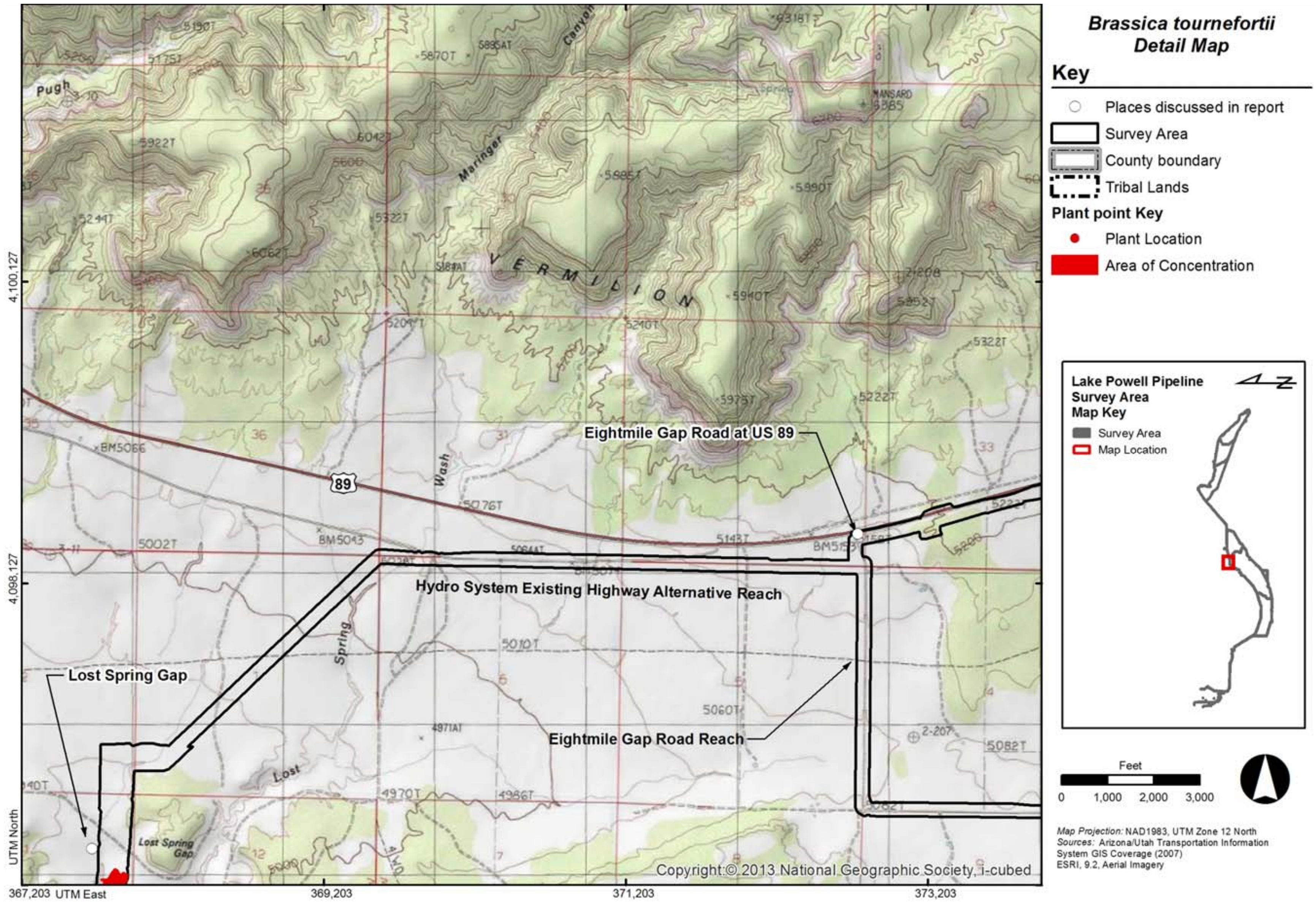

Figure 5-31
***Brassica tournefourtii* Detail Map 3**

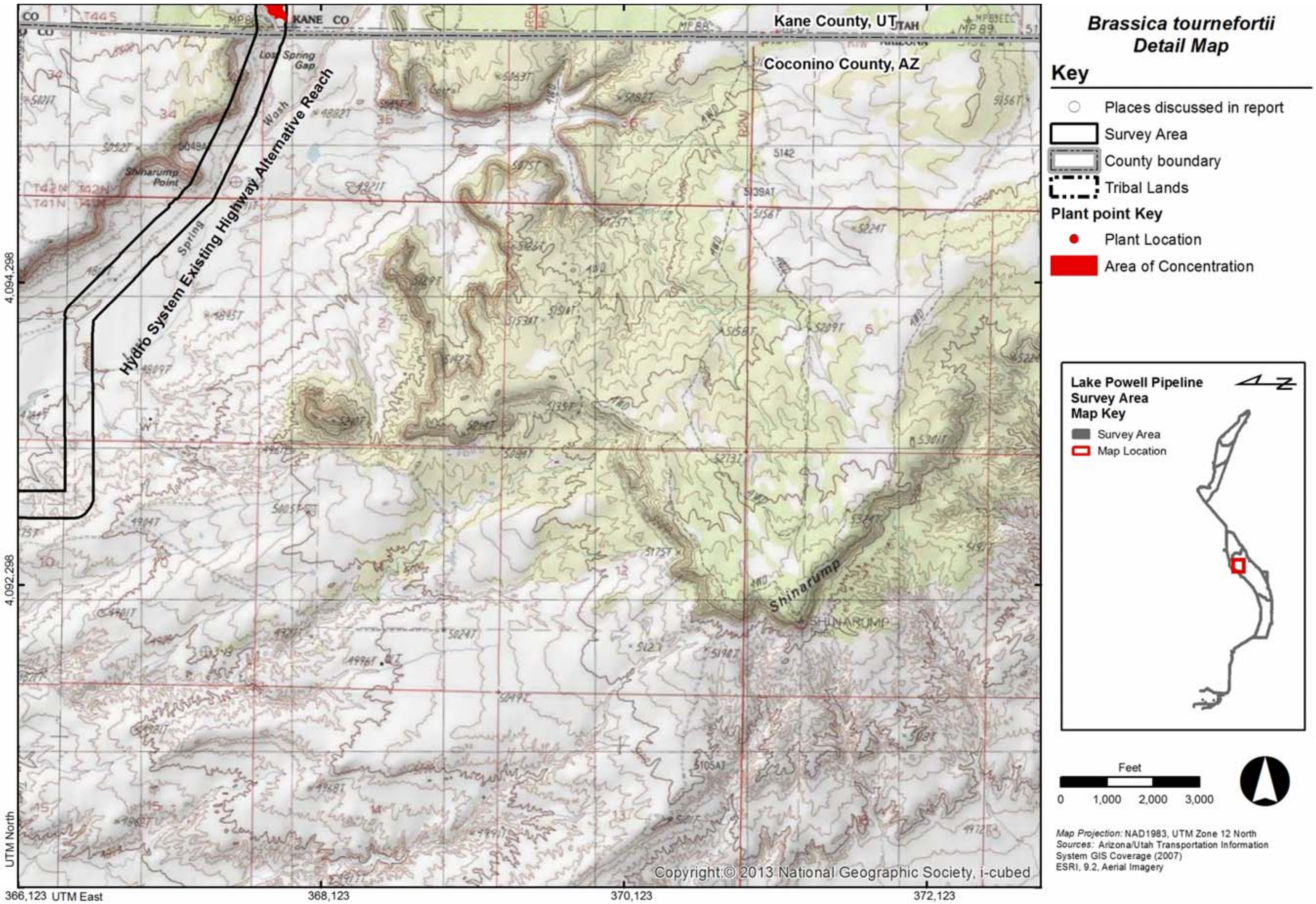

Figure 5-32
***Brassica tournefourtii* Detail Map 4**

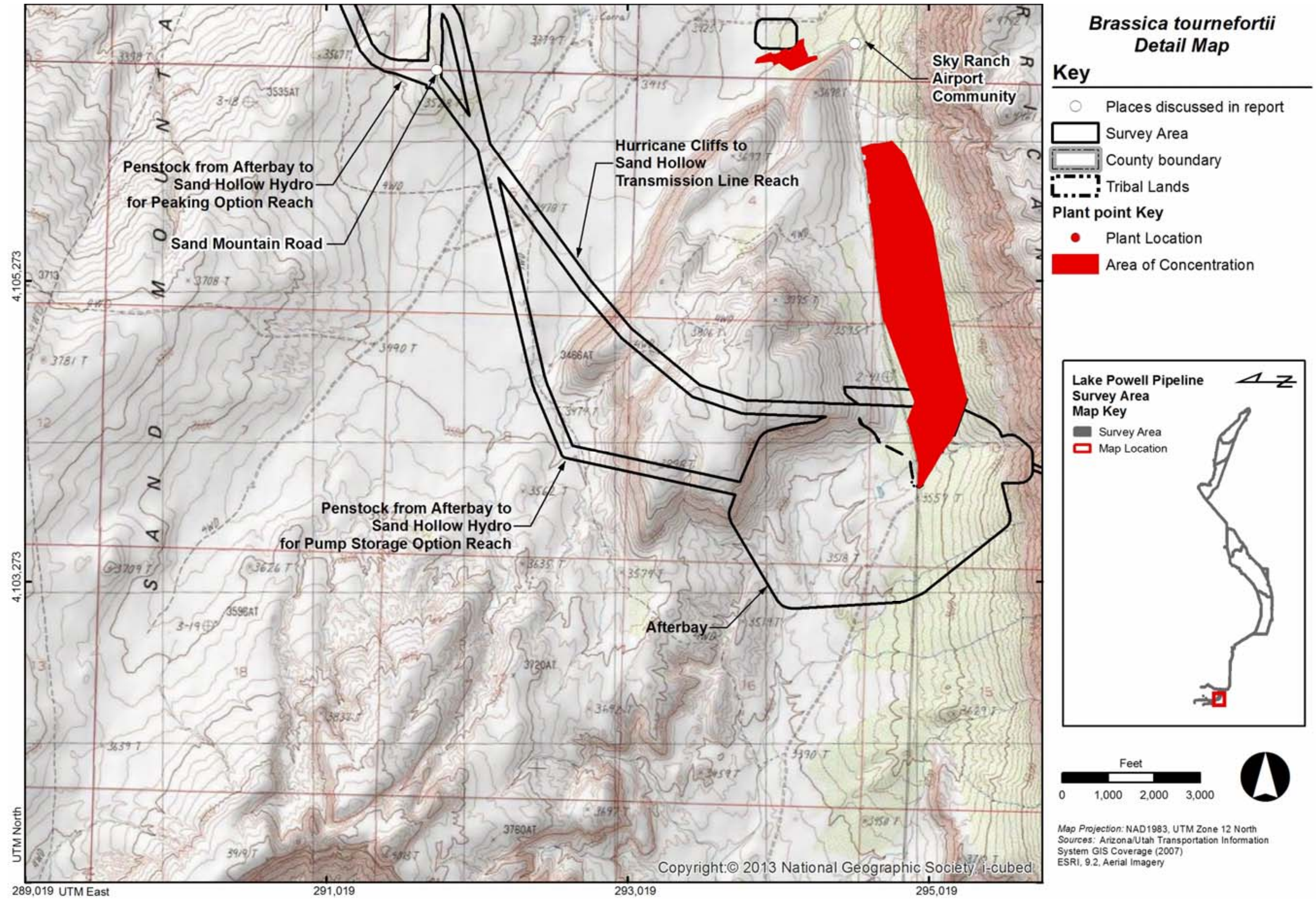

Figure 5-33
***Brassica tournefourtii* Detail Map 5**

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 5-34). 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. *B. 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 5-35), 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).

B. 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*.

B. 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). *B. rubens* was reported in Utah in 1935, and occurs in blackbrush, creosote bush, 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 (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).

Figure 5-34
***Bromus rubens* within the Survey Area**

Figure 5-35
View of *Bromus rubens* and Its Habitat
within the Survey Area

B. 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

The survey identified *B. rubens* throughout the survey area, from the Colorado River at Glen Canyon Dam to the city of Hurricane, Utah (Figure 5-36). *B. 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 29 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 Alternative 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 to just east of the Cockscomb, 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 just west of Big Water to East Cove and between Kimball Valley and Buckskin Gulch. *B. 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. *B. 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 and near the Sand Hollow Reservoir in the Sand Hollow to Dixie Springs Transmission Line Reach. 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 65.

B. rubens was encountered in both Ecological Regions, in a total of 23 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 Mojave Desert, *B. rubens* was identified in 10 ecological systems: Active and Stabilized Dune, Bedrock Cliff and Outcrop, 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 Mojave 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

B. 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*.

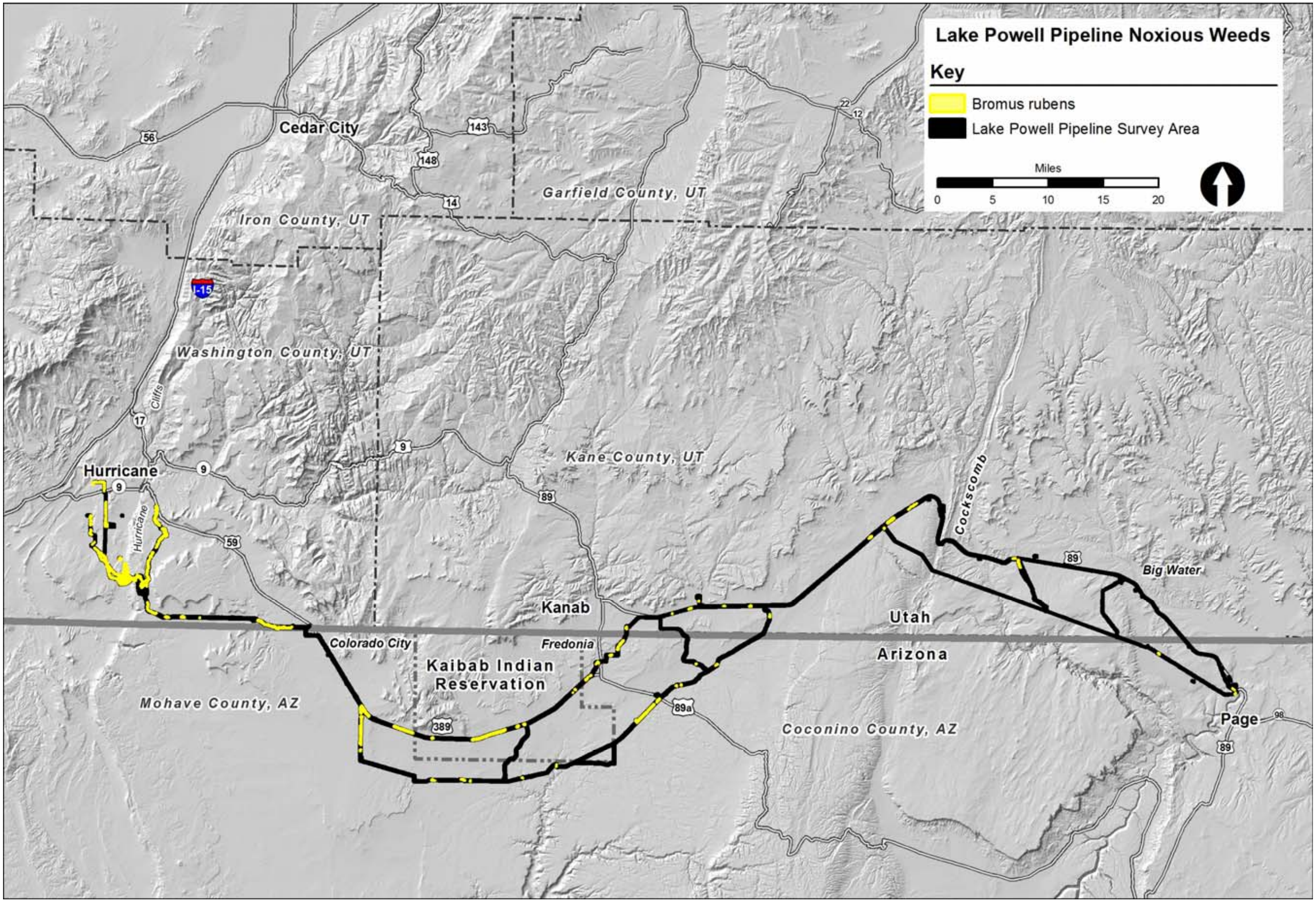

Figure 5-36
***Bromus rubens* Overview Map**

5.5.5 *Bromus tectorum* (Cheatgrass)

5.5.5.1 Natural History

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 5-37). 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). *B. tectorum* produces open, loose panicles between 2 and 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).

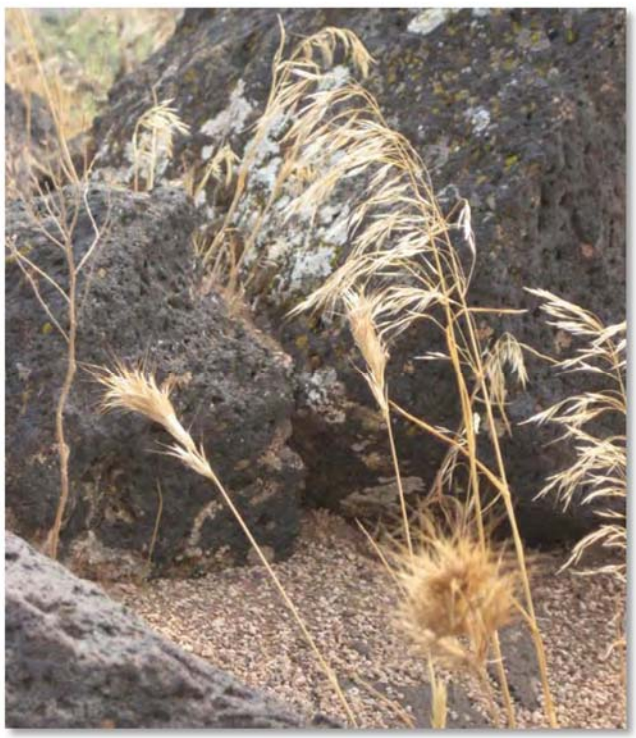

Figure 5-37
Close-up View of *Bromus tectorum* (with *B. rubens*)

B. tectorum may be distinguished from other similar-looking brome grasses, including *B. rubens*, *B. diandrus*, and *B. sterilis*. *B. 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*. *B. 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.

B. 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). *B. 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 shrub steppe, and desert grasslands. *B. 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 (Sonoran Institute 2008).

B. 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 *B. tectorum* throughout much of the survey area, from the vicinity of Upper Blue Pool Wash to the city of Hurricane, Utah (Figure 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 23 reaches. The species was found in the Water Conveyance System Reach near Jacob's Tank Road at U.S. 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. *B. 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. *B. tectorum* was identified in the area north of Sand Hollow Reservoir in the Sand Hollow to Dixie Springs Transmission Line Reach.

B. tectorum was encountered in both ecological regions, in a total of 23 ecological systems and five 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 Mojave Desert, *B. tectorum* was identified in eight ecological systems: Active and Stabilized Dune, Bedrock Cliff and Outcrop, Creosote bush-White Bursage Desert Scrub, Grassland, Mixed Desert Scrub, Shrub-Steppe, Volcanic Rock and Cinder Land, and Mojave Desert Wash. Anthropogenic lands which supported *B. tectorum* included Agricultural Land, Developed Land, Developed Roads, 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

B. 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*.

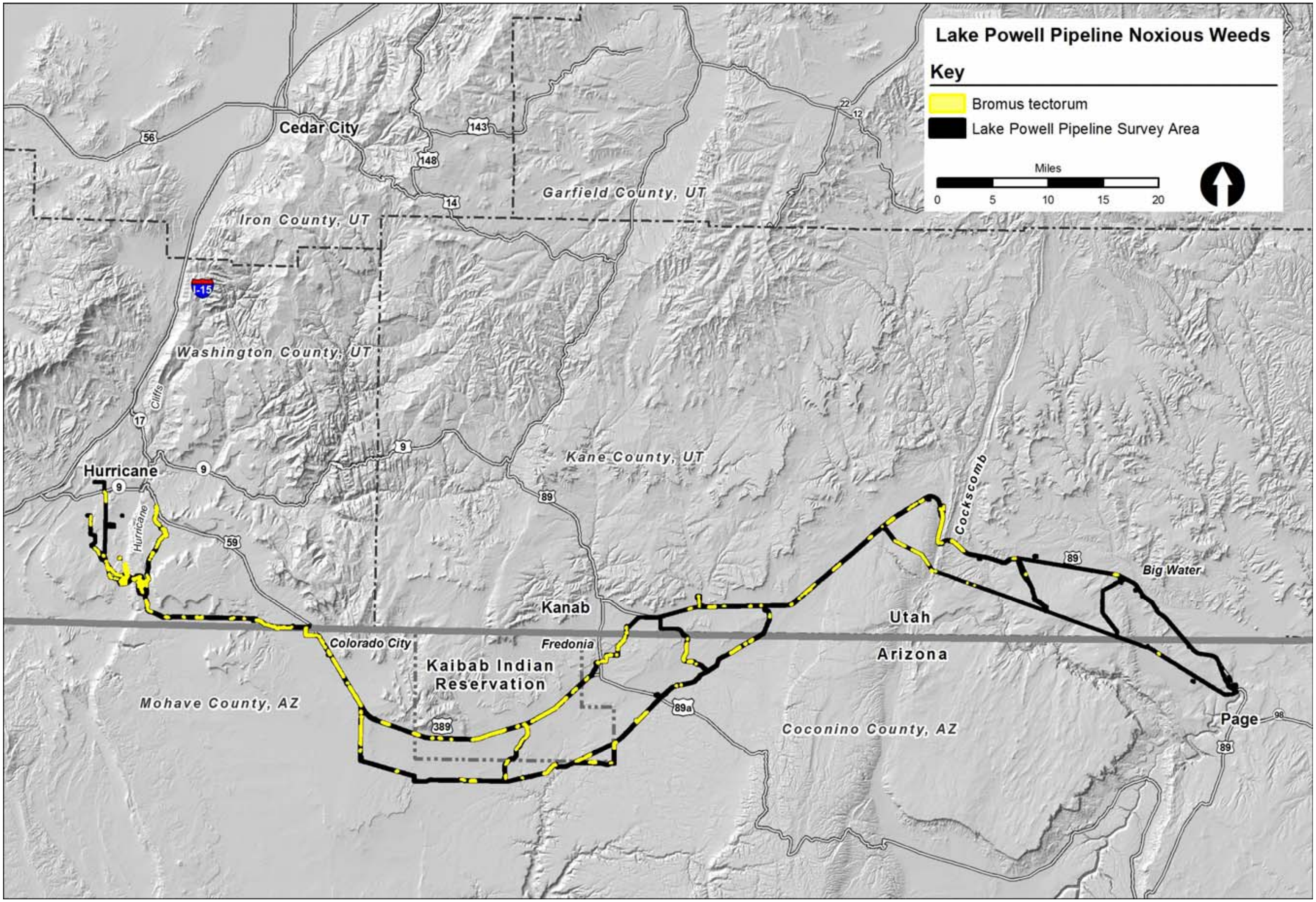

Figure 5-38
***Bromus tectorum* Overview Map**

5.5.6 *Convolvulus arvensis* (Field bindweed)

5.5.6.1 Natural History

Convolvulus arvensis is an herbaceous perennial vine in the Convolvulaceae (Morningglory Family; Figure 5-39). 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 5-40), 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).

C. 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 at elevations from 100 to 8,500 feet (Sonoran Institute 2008).

Figure 5-39
View of *Convolvulus arvensis* and Its Habitat within the Survey Area

Figure 5-40
Close-up View of *Convovulus arvensis*
within the Survey Area

C. arvensis is considered to be highly noxious in agricultural fields throughout the world. The species is remarkably adaptable to a range of environmental conditions (Sonoran Institute 2008). Encroachment into wildlands follows disturbances such as road construction, ditch digging, mining, and mechanical fire suppression. *C. 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). *C. 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).

5.5.6.2 Survey Results

The survey encountered *C. arvensis* occasionally within the survey area, ranging from the area of the Cockscomb to Hurricane (Figure 5-41). *C. arvensis* was identified in a total of six reaches (Figure 5-42 to Figure 5-52). In the Water Conveyance System Reach, individuals were encountered near the Cockscomb and at Telegraph Wash. *C. 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. The species was identified northeast of Sand Hollow Reservoir in the Hurricane Cliffs Afterbay to Hurricane West Transmission Line Reach.

C. arvensis was encountered in both Ecological Regions, in a total of seven 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 Mojave 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*.

C. 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.

5.5.6.3 Discussion

C. 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. *C. 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, soil that likely contains active rhizomes could be disposed as trench backfill above the pipeline rather than re-used on site as topsoil for revegetation.

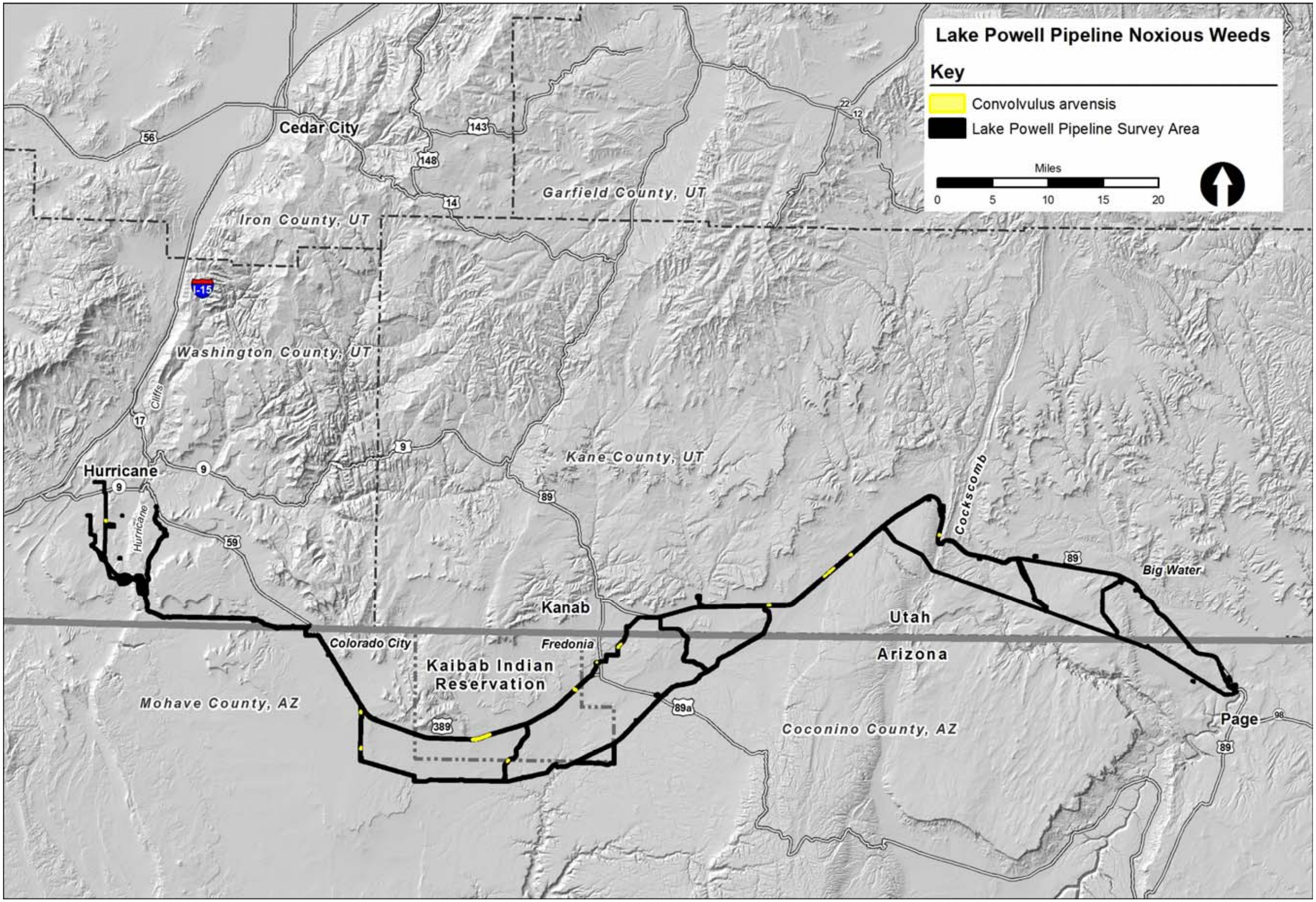

Figure 5-41
***Convolvulus arvensis* Overview Map**

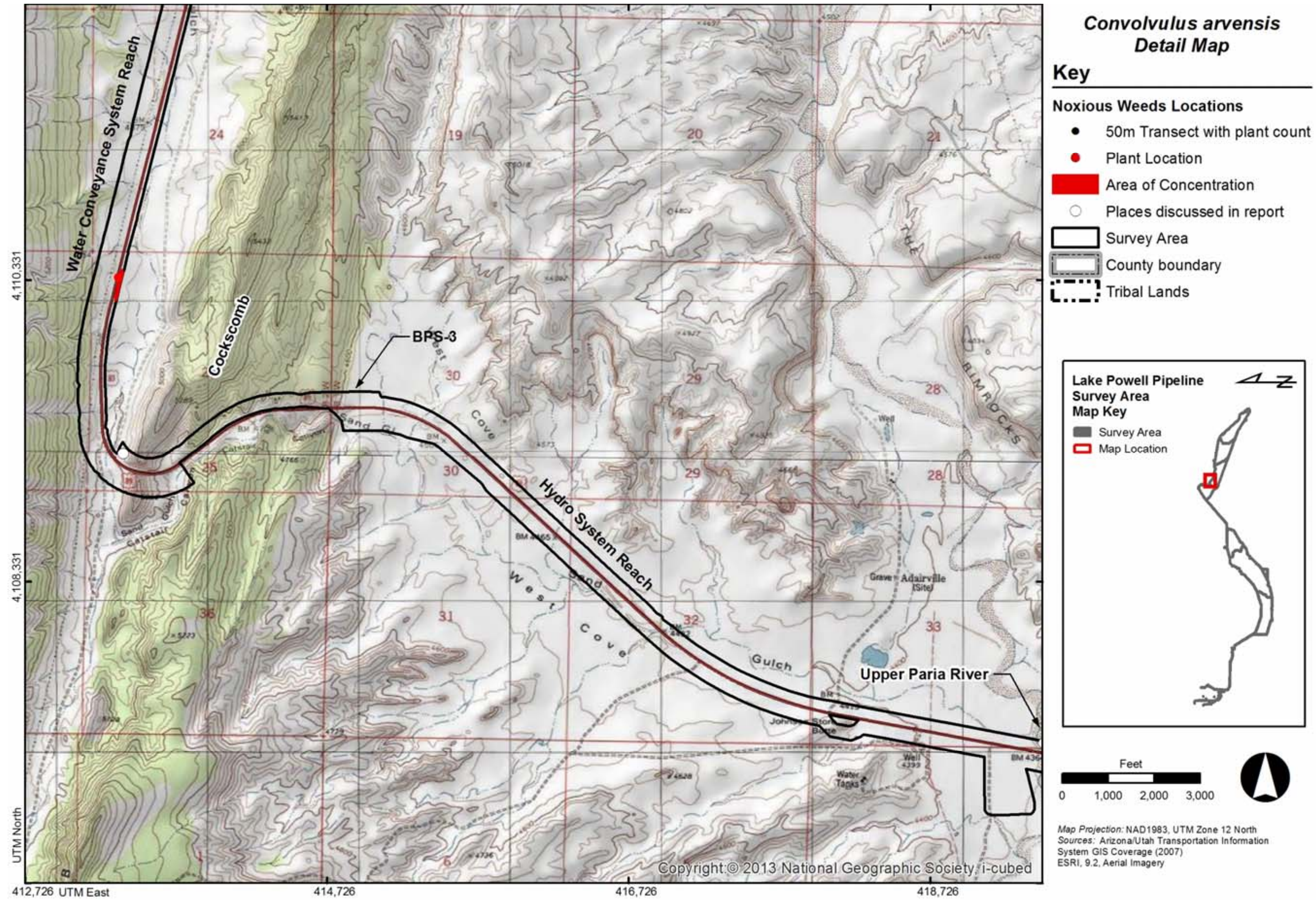

Figure 5-42
***Convolvulus arvensis* Detail Map 1**

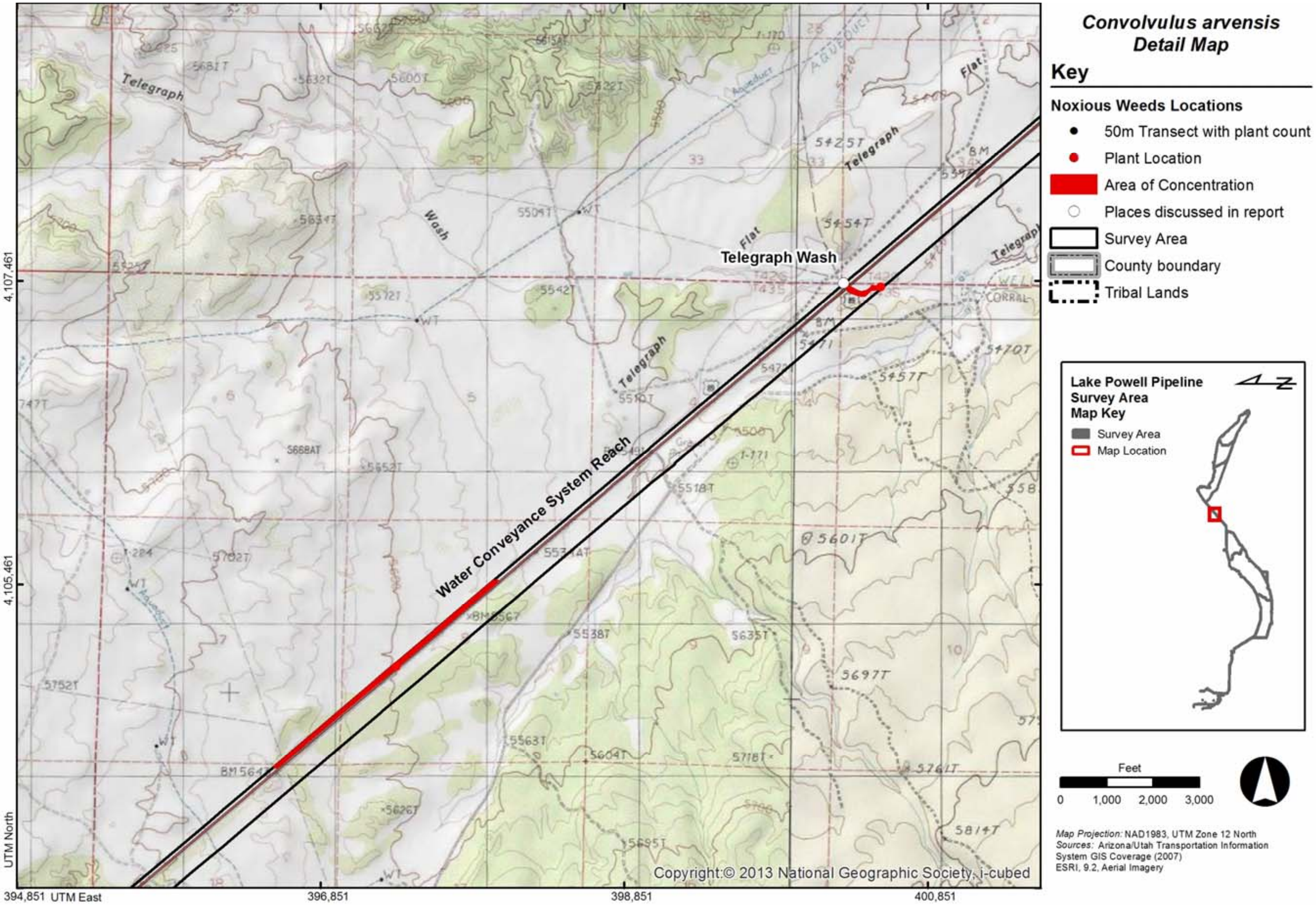

Figure 5-43
***Convolvulus arvensis* Detail Map 2**

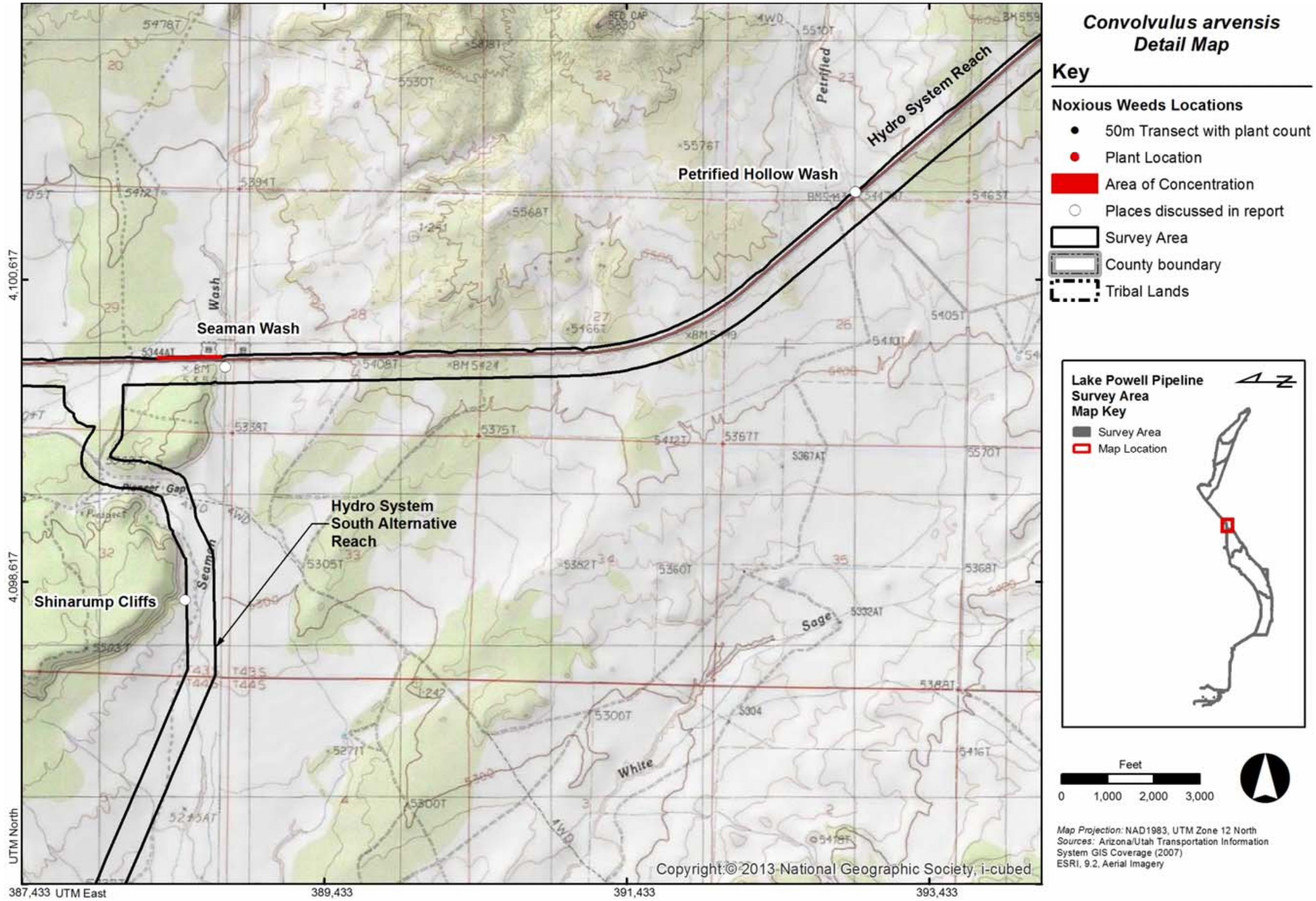

Figure 5-44
***Convolvulus arvensis* Detail Map 3**

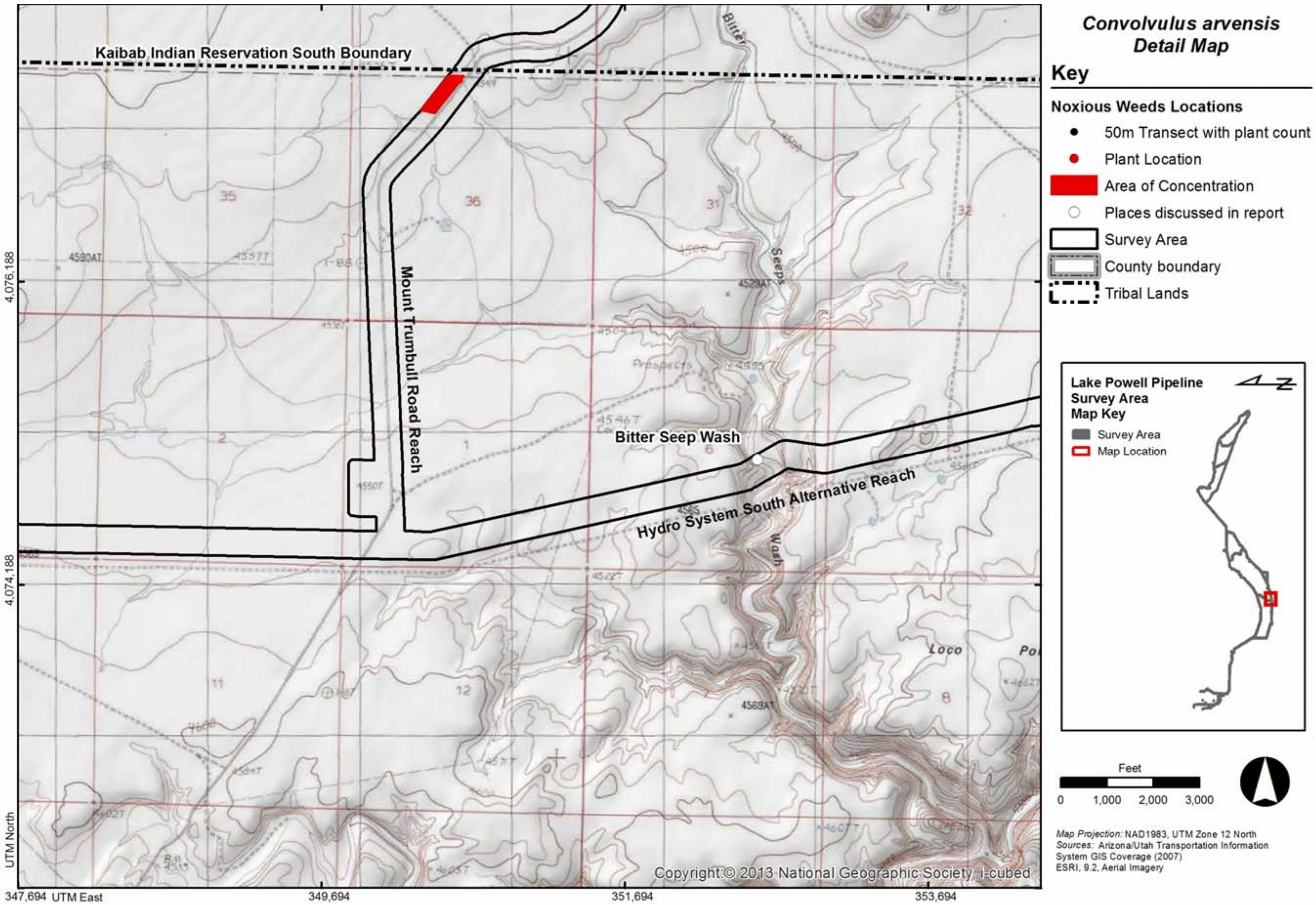

Figure 5-45
***Convolvulus arvensis* Detail Map 4**

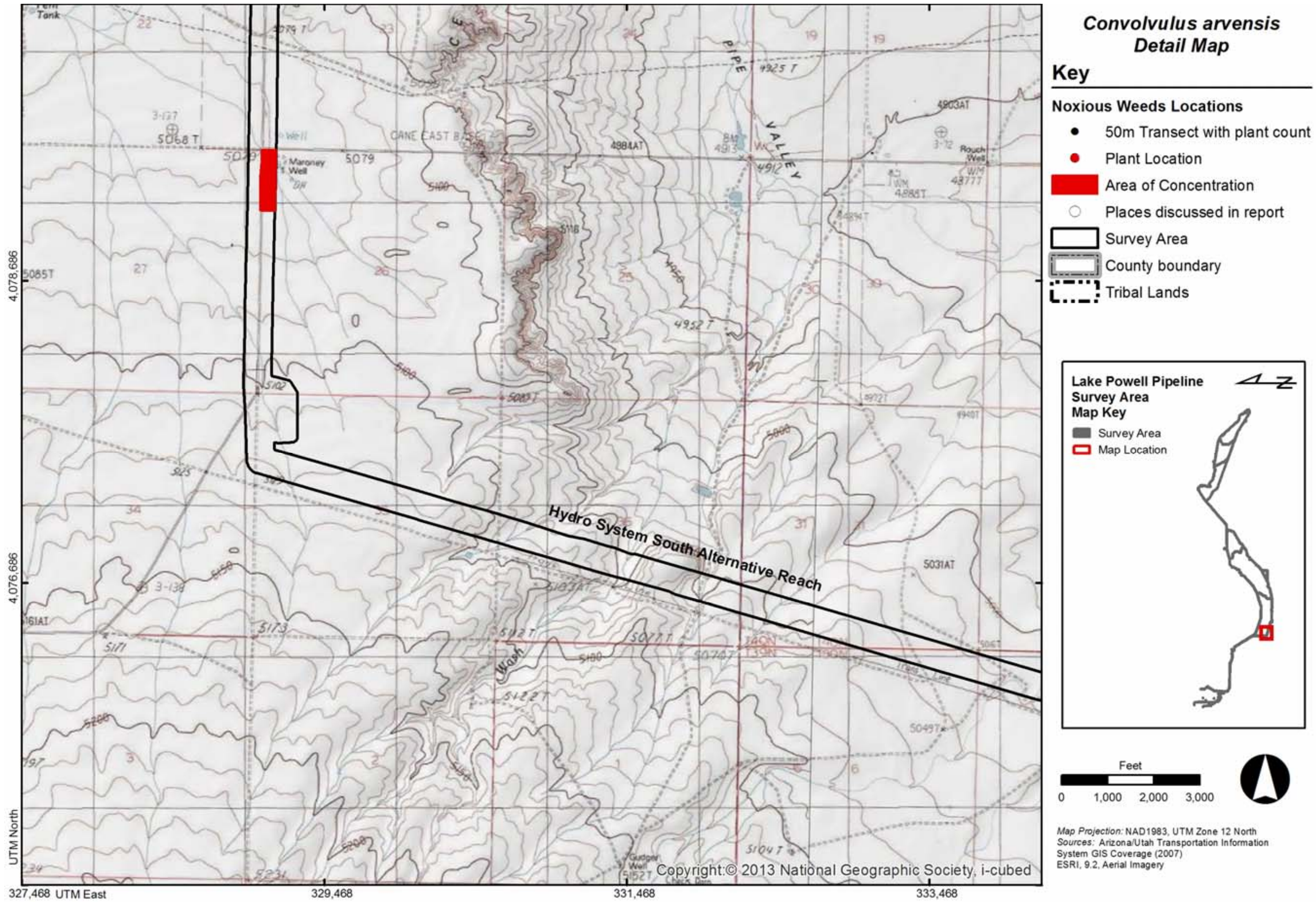

Figure 5-46
***Convolvulus arvensis* Detail Map 5**

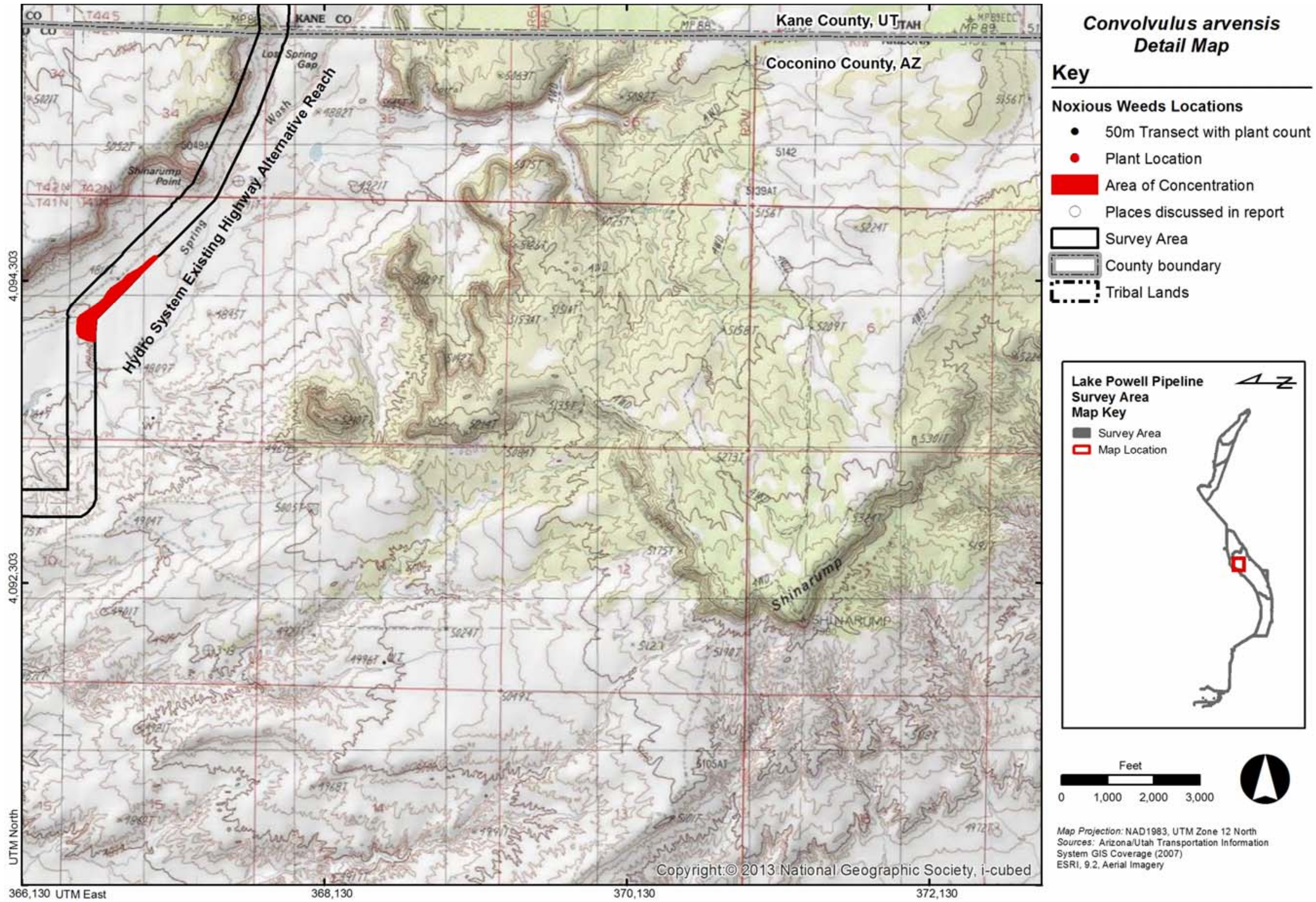

Figure 5-47
***Convolvulus arvensis* Detail Map 6**

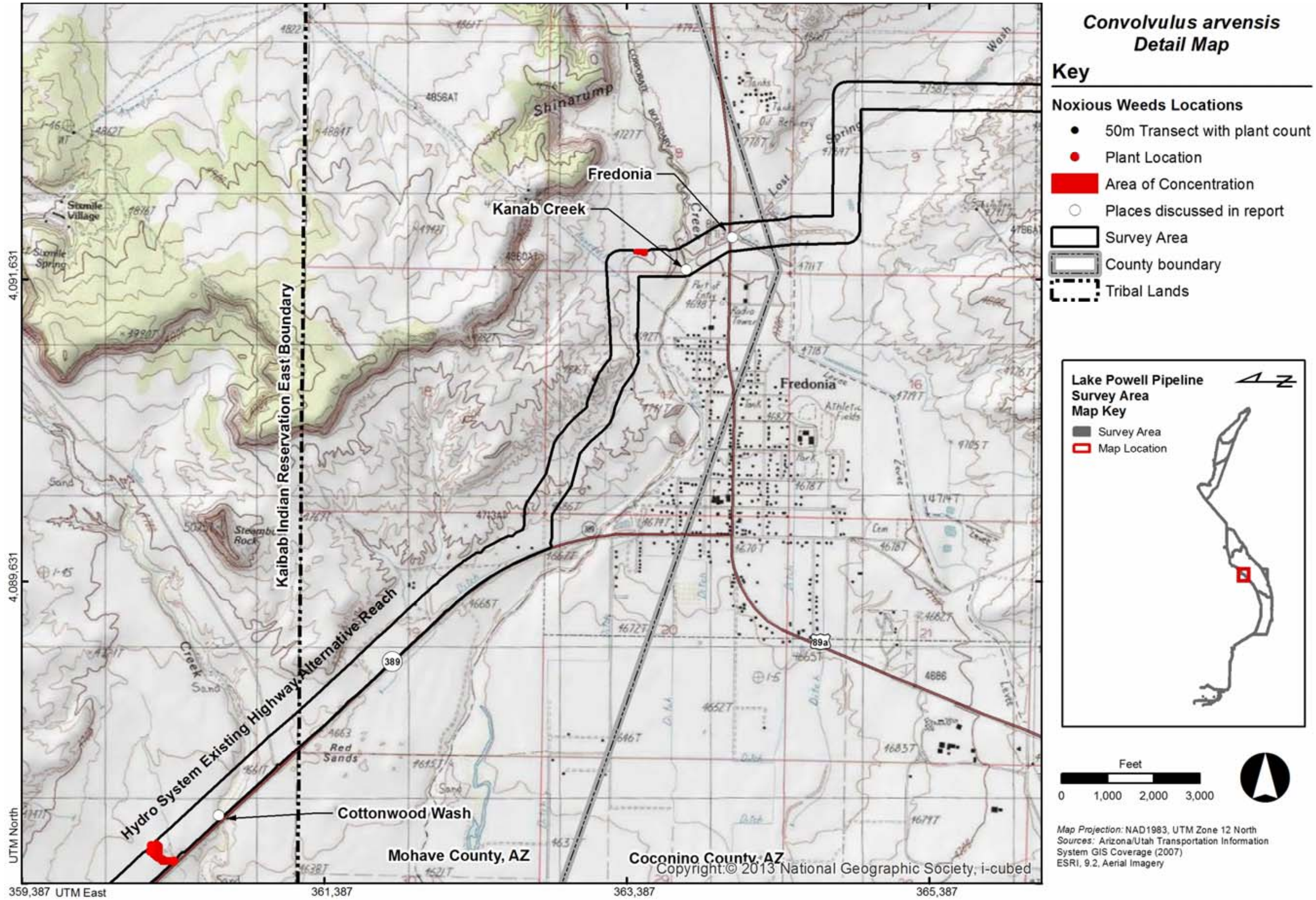

Figure 5-48
***Convolvulus arvensis* Detail Map 7**

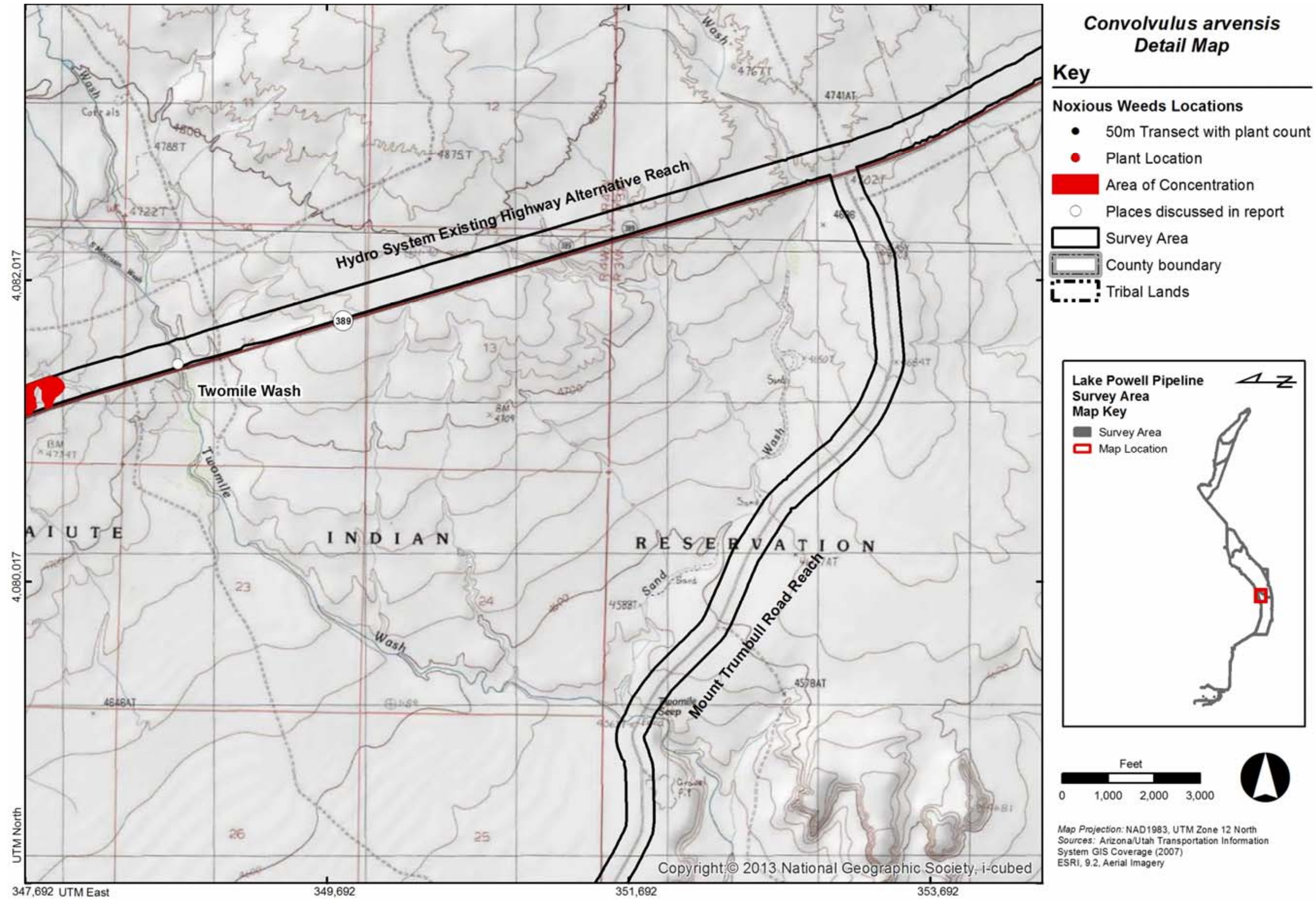

Figure 5-49
***Convolvulus arvensis* Detail Map 8**

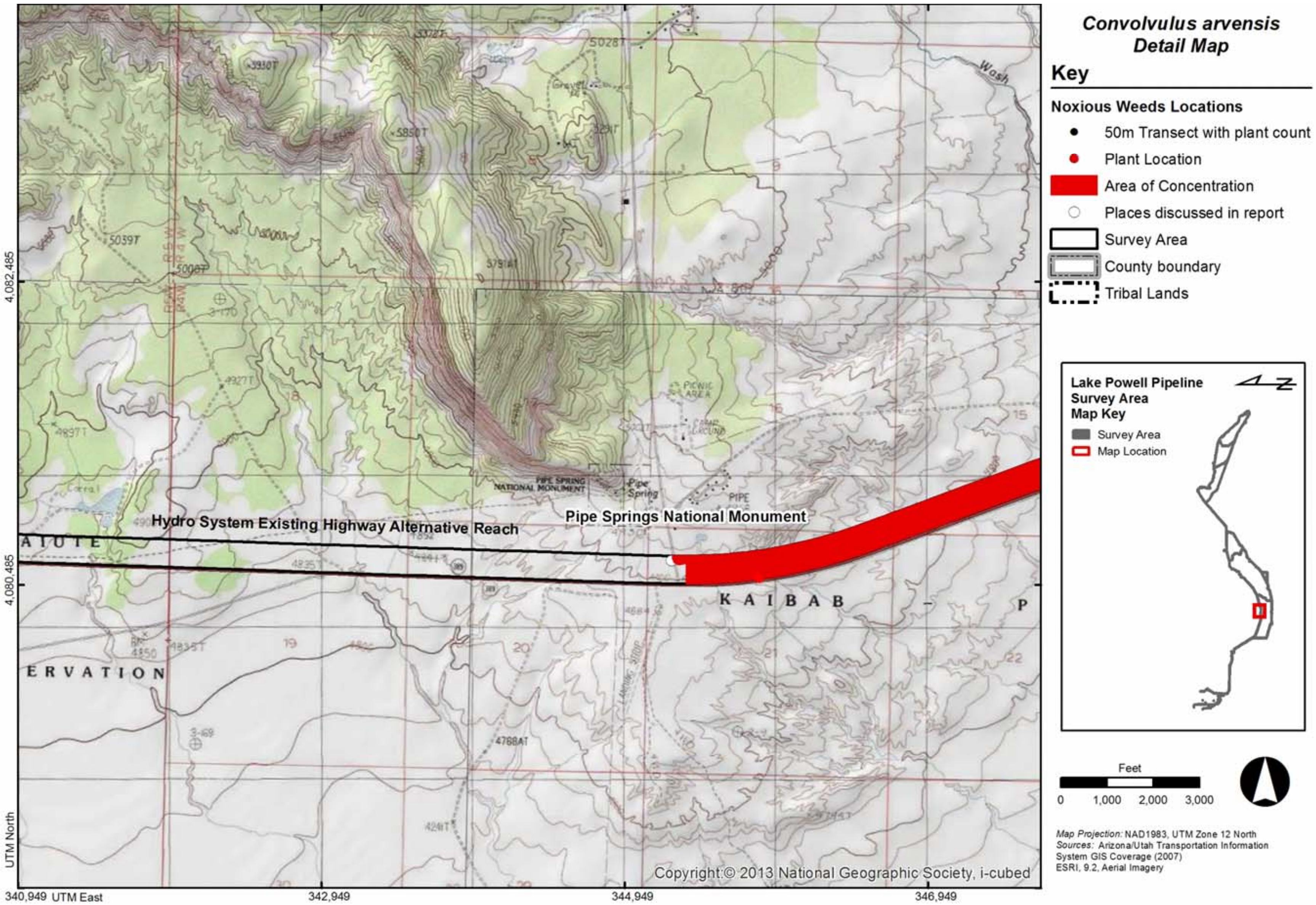

Figure 5-50
***Convolvulus arvensis* Detail Map 9**

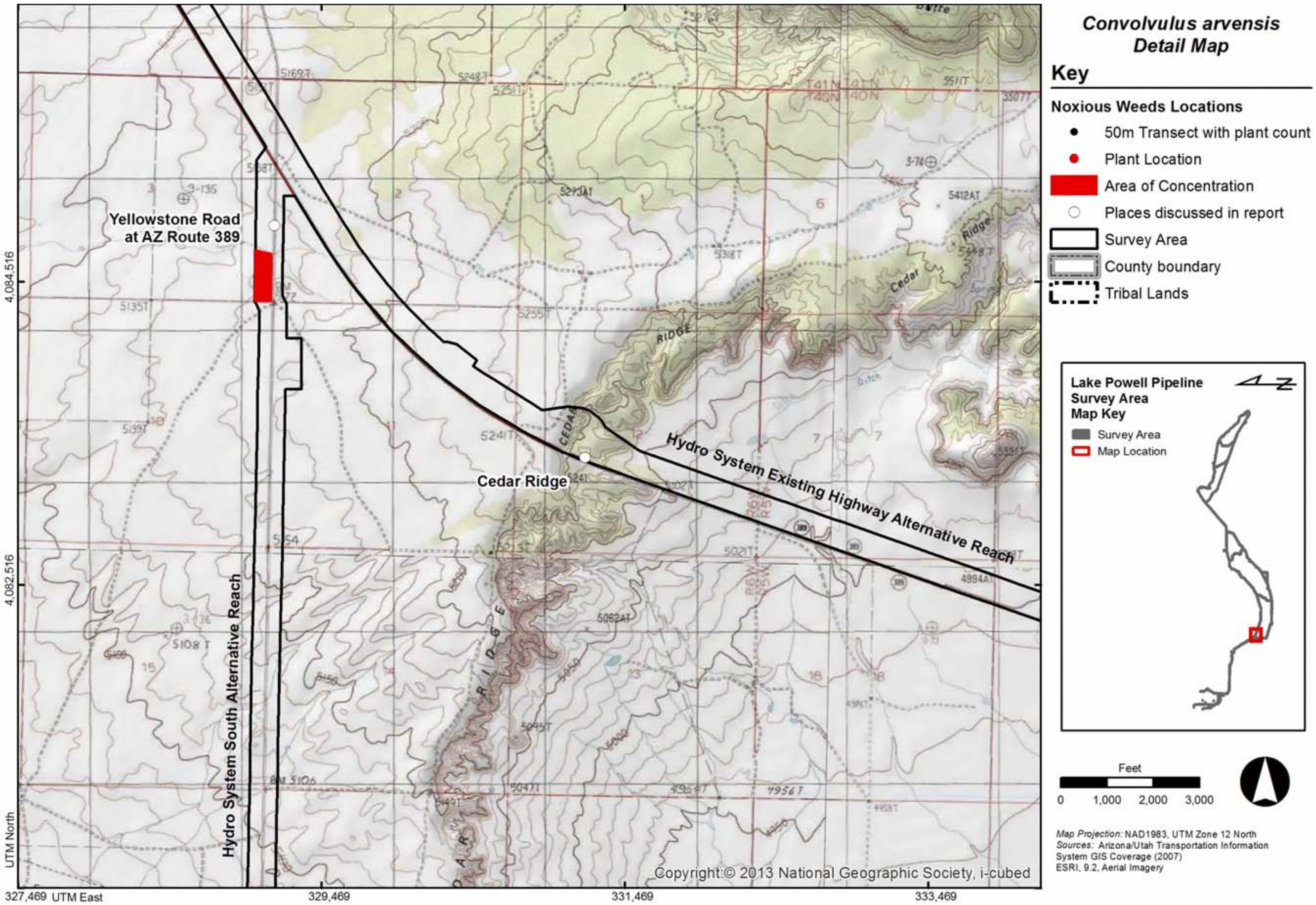

Figure 5-51
***Convolvulus arvensis* Detail Map 10**

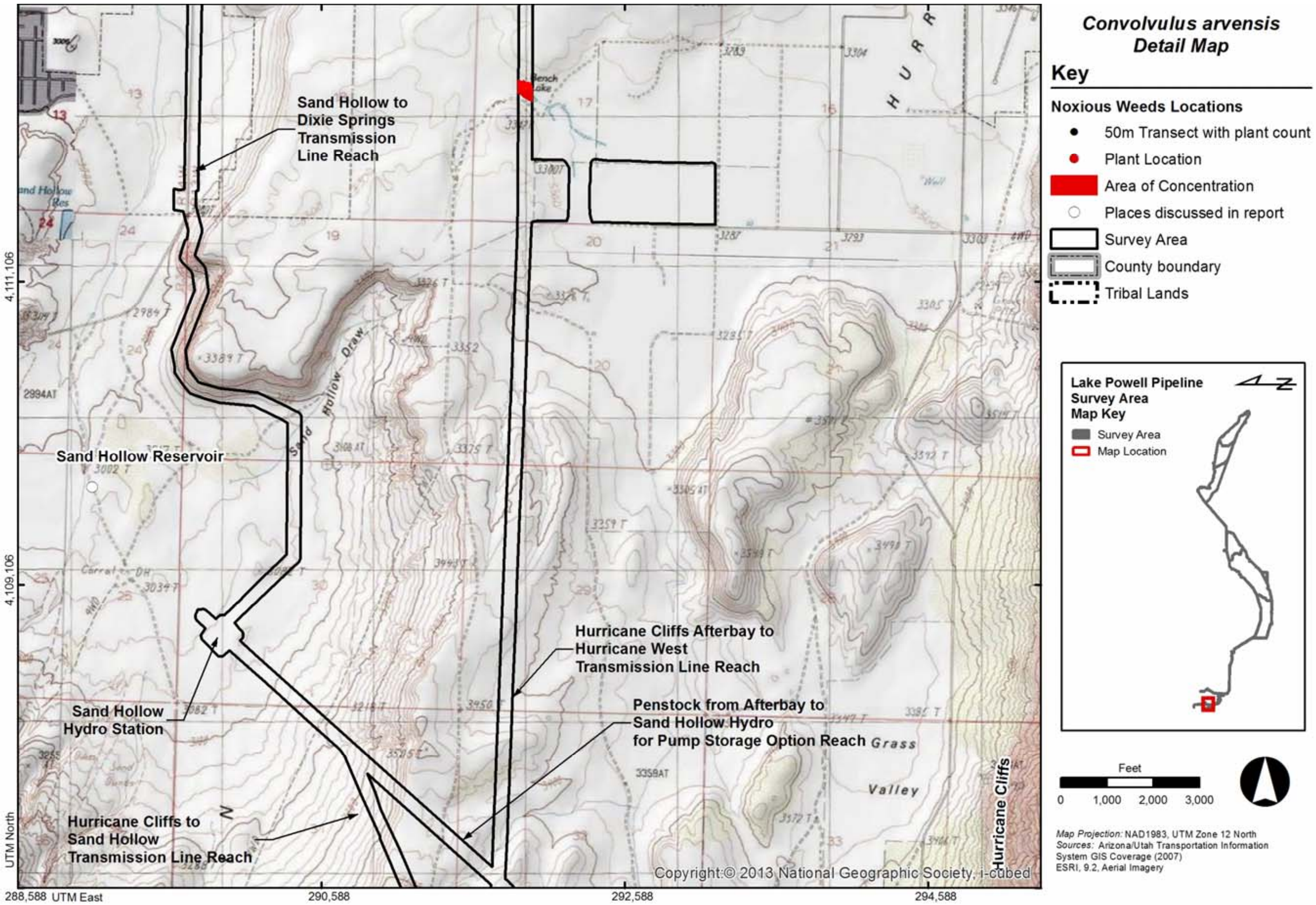

Figure 5-52
***Convolvulus arvensis* Detail Map 11**

5.5.7 *Elaeagnus angustifolia* (Russian olive)

5.5.7.1 Natural History

Elaeagnus angustifolia is a deciduous tree in the Elaeagnaceae (Oleaster Family; Figure 5-53), 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).

E. angustifolia may be confused with either *Ligustrum lucidum* or *Olea europaea*, two other olive species that can also escape cultivation on occasion. *E. 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.

Figure 5-53
View of *Elaeagnus angustifolia*
within the Survey Area

E. 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 at elevations from 5,500 to 7,000 feet (Sonoran Institute 2008).

E. 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 (Sonoran Institute 2008). *E. angustifolia* can withstand flooding, silting and drought, and is shade tolerant (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.

5.5.7.2 Survey Results

E. angustifolia was encountered occasionally along the survey area, ranging from the vicinity of the Upper Paria River to Hurricane (Figure 5-54). *E. angustifolia* was identified in six reaches (Figure 5-55 to Figure 5-65), 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. *E. angustifolia* was also encountered northeast of Sand Hollow Reservoir in the Hurricane Cliffs Afterbay to Hurricane West Transmission Line Reach. *E. angustifolia* was not detected in any 50-meter belt transects; all encounters occurred while conducting special status species and noxious weed surveys.

E. angustifolia was identified in both Ecological Regions, in six 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 Mojave 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.

5.5.7.3 Discussion

E. 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.

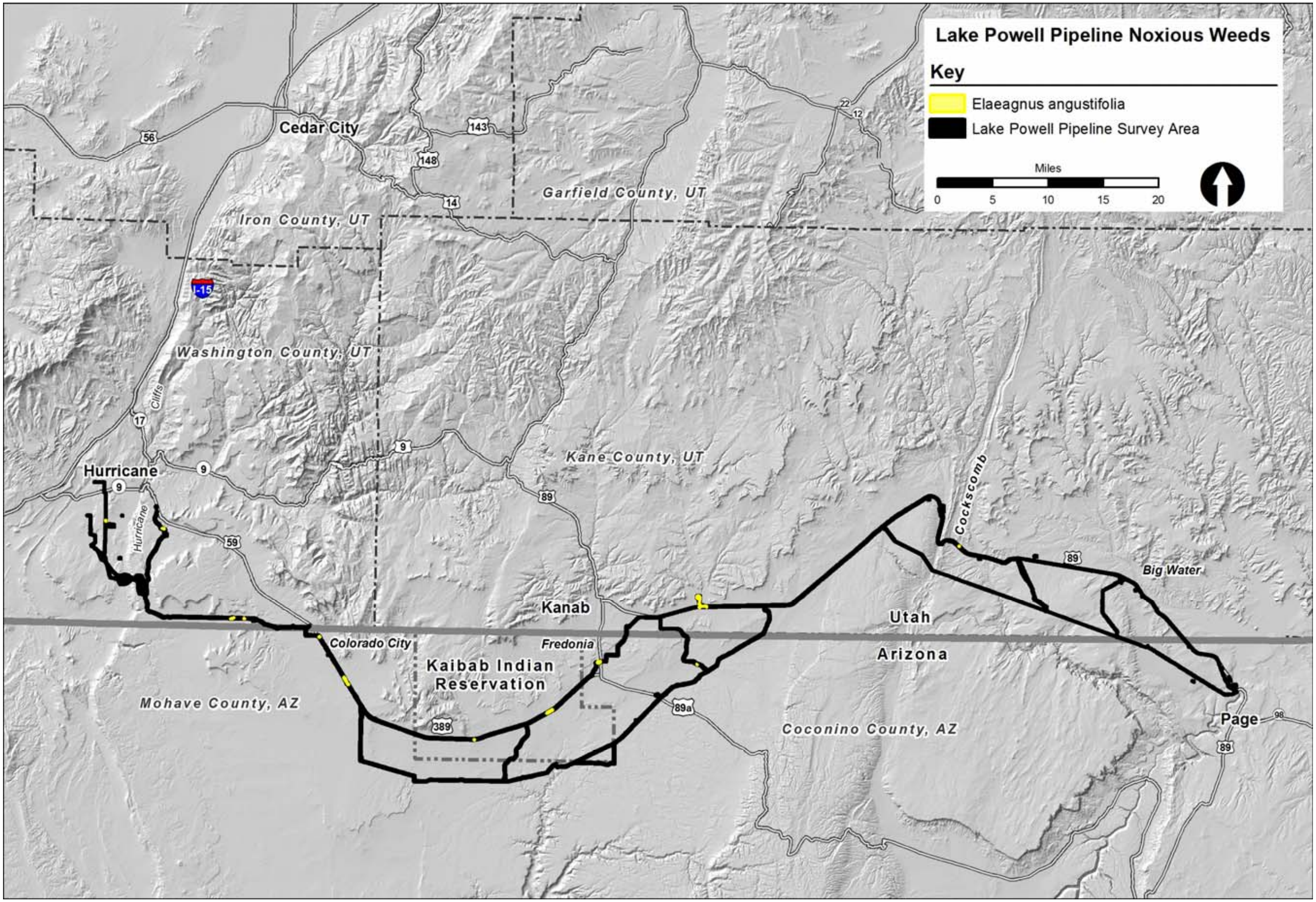

Figure 5-54
***Elaeagnus angustifolia* Overview Map**

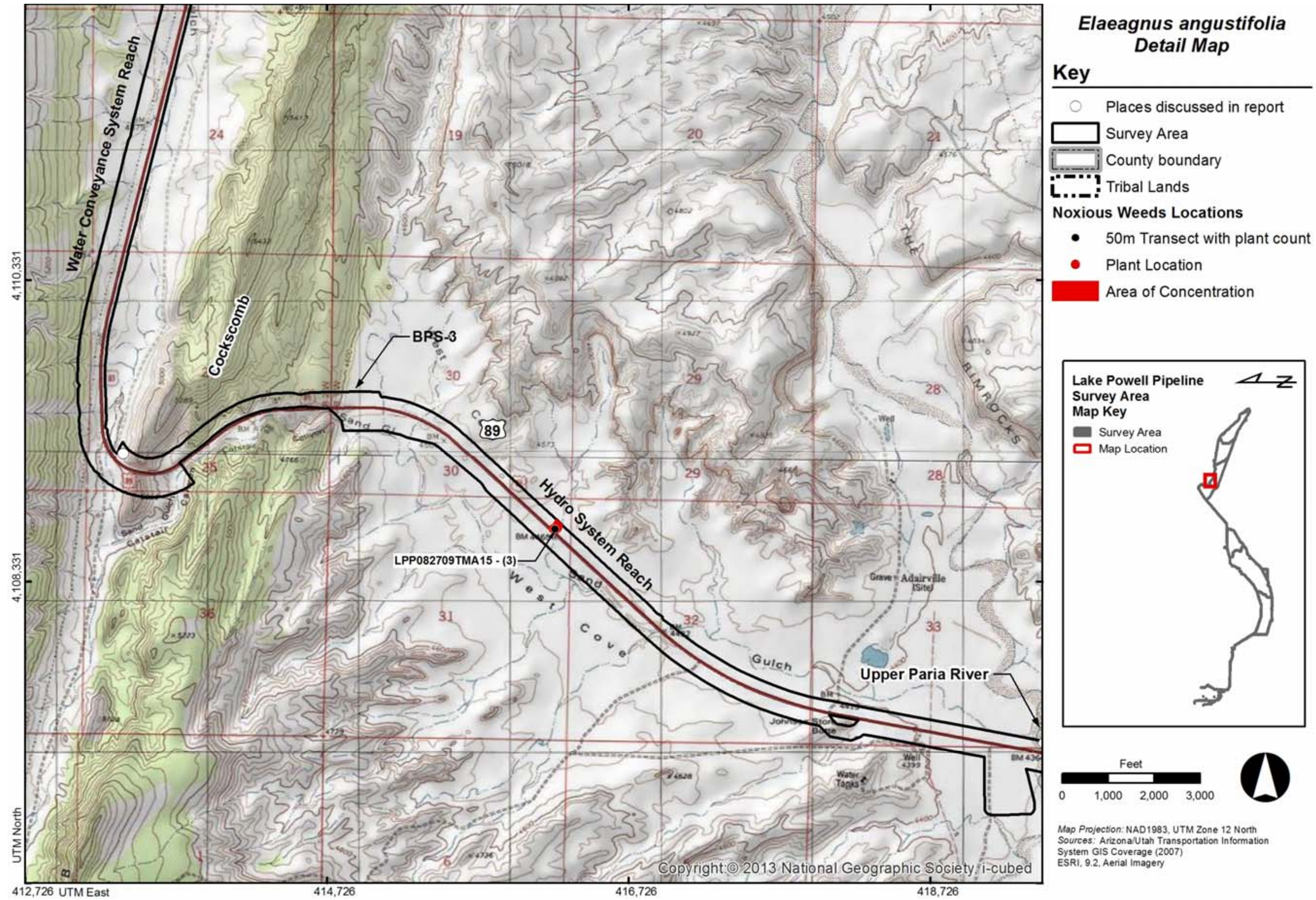

Figure 5-55
***Elaeagnus angustifolia* Detail Map 1**

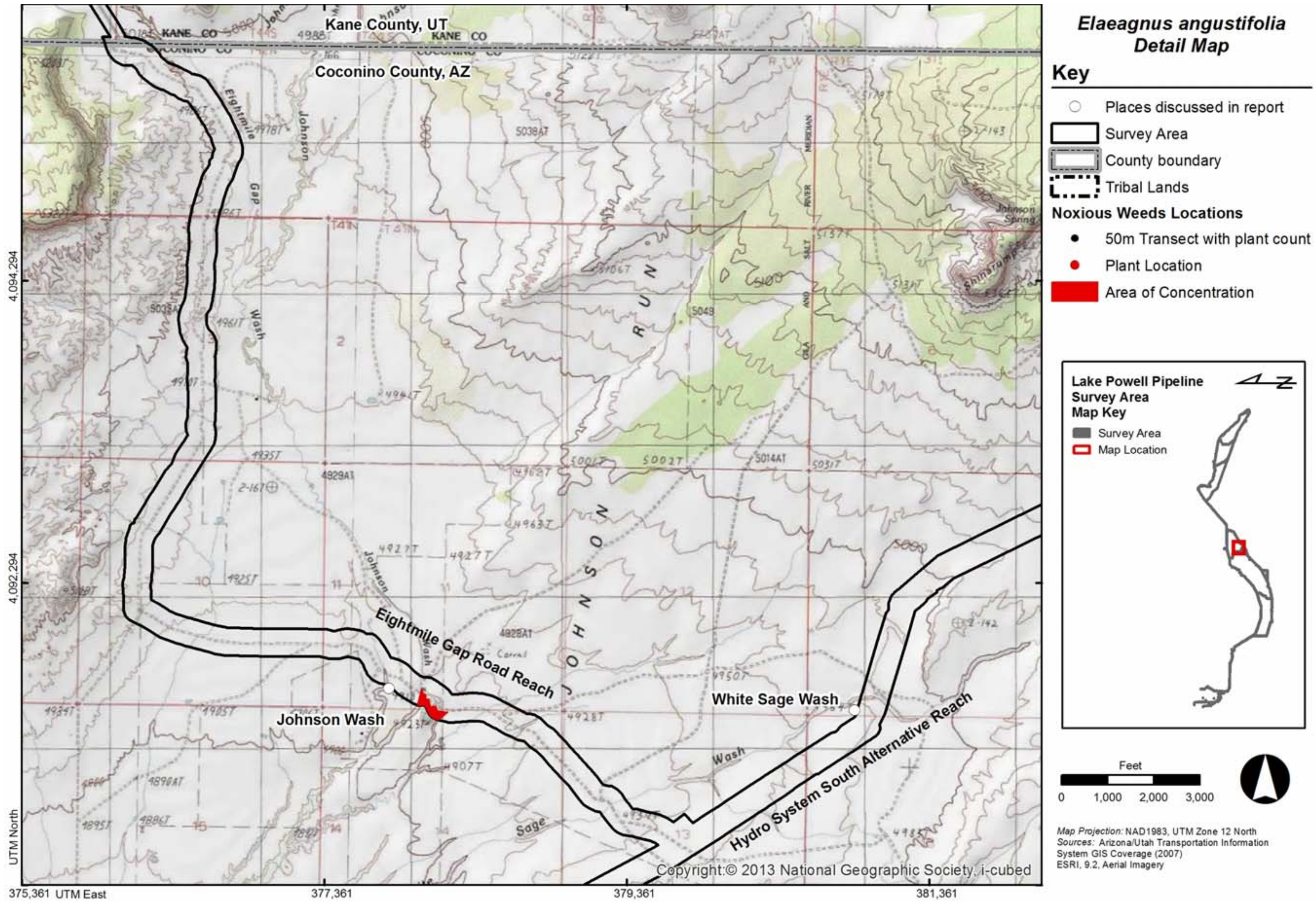

Figure 5-56
***Elaeagnus angustifolia* Detail Map 2**

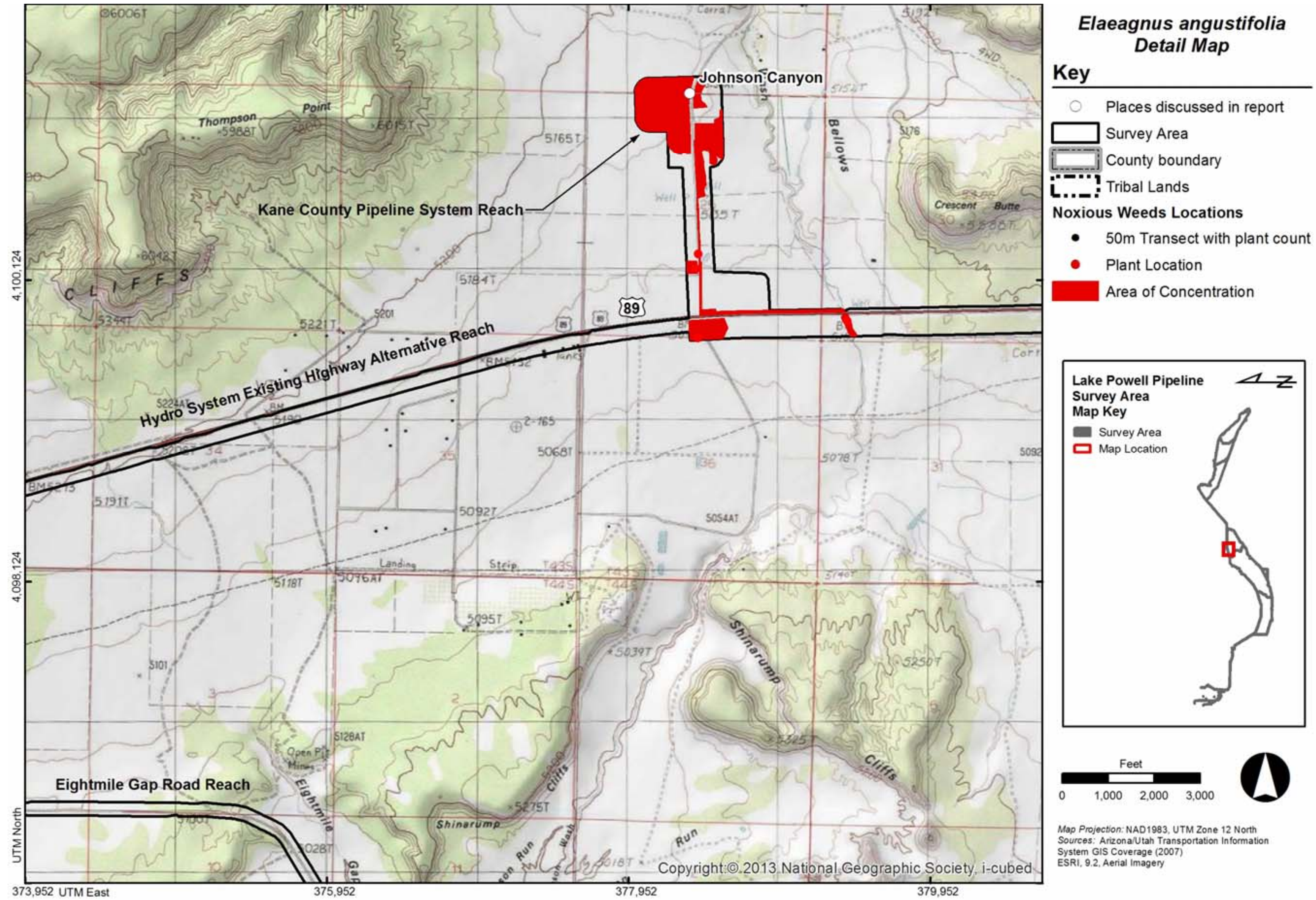

Figure 5-57
***Elaeagnus angustifolia* Detail Map 3**

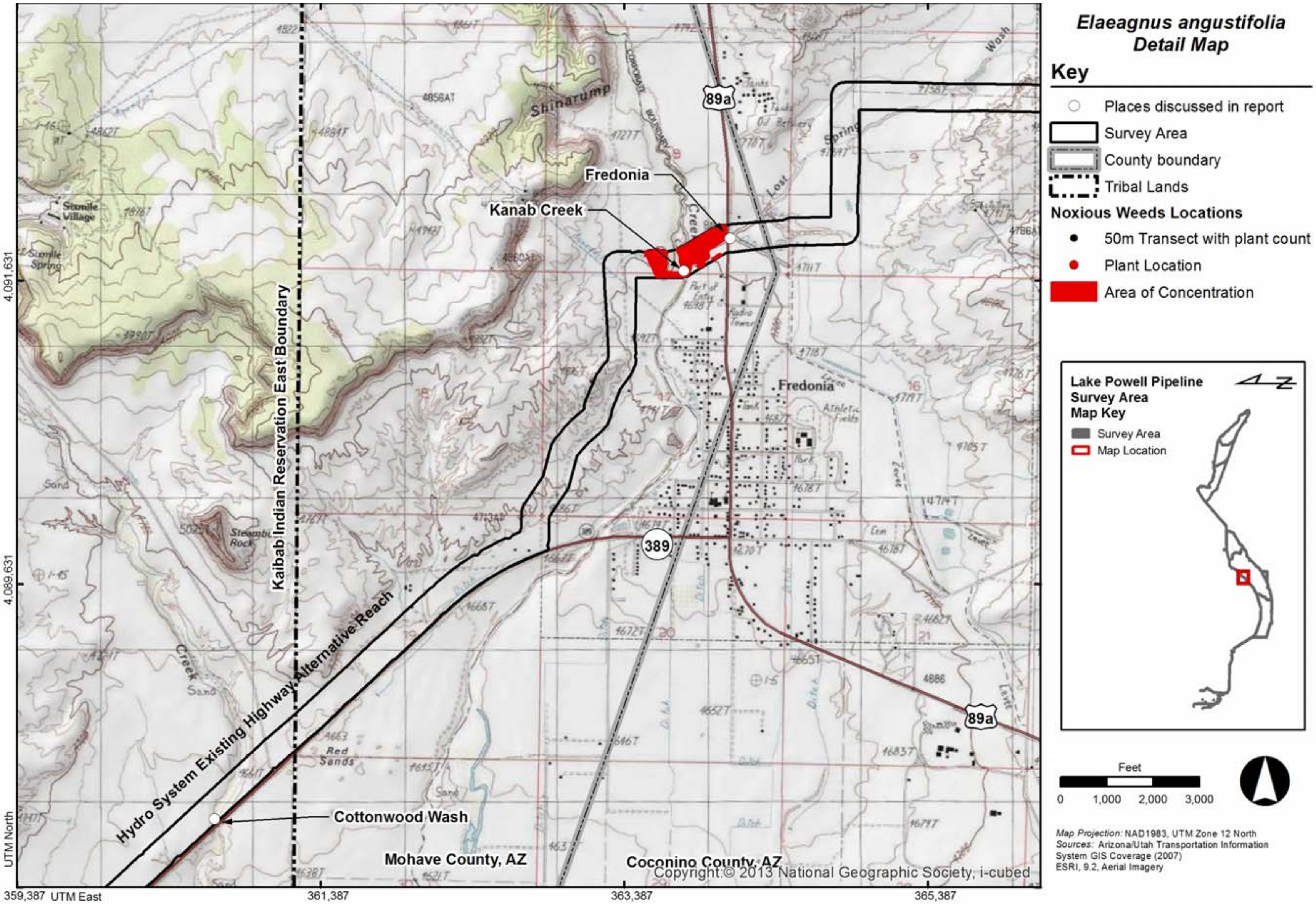

Figure 5-58
***Elaeagnus angustifolia* Detail Map 4**

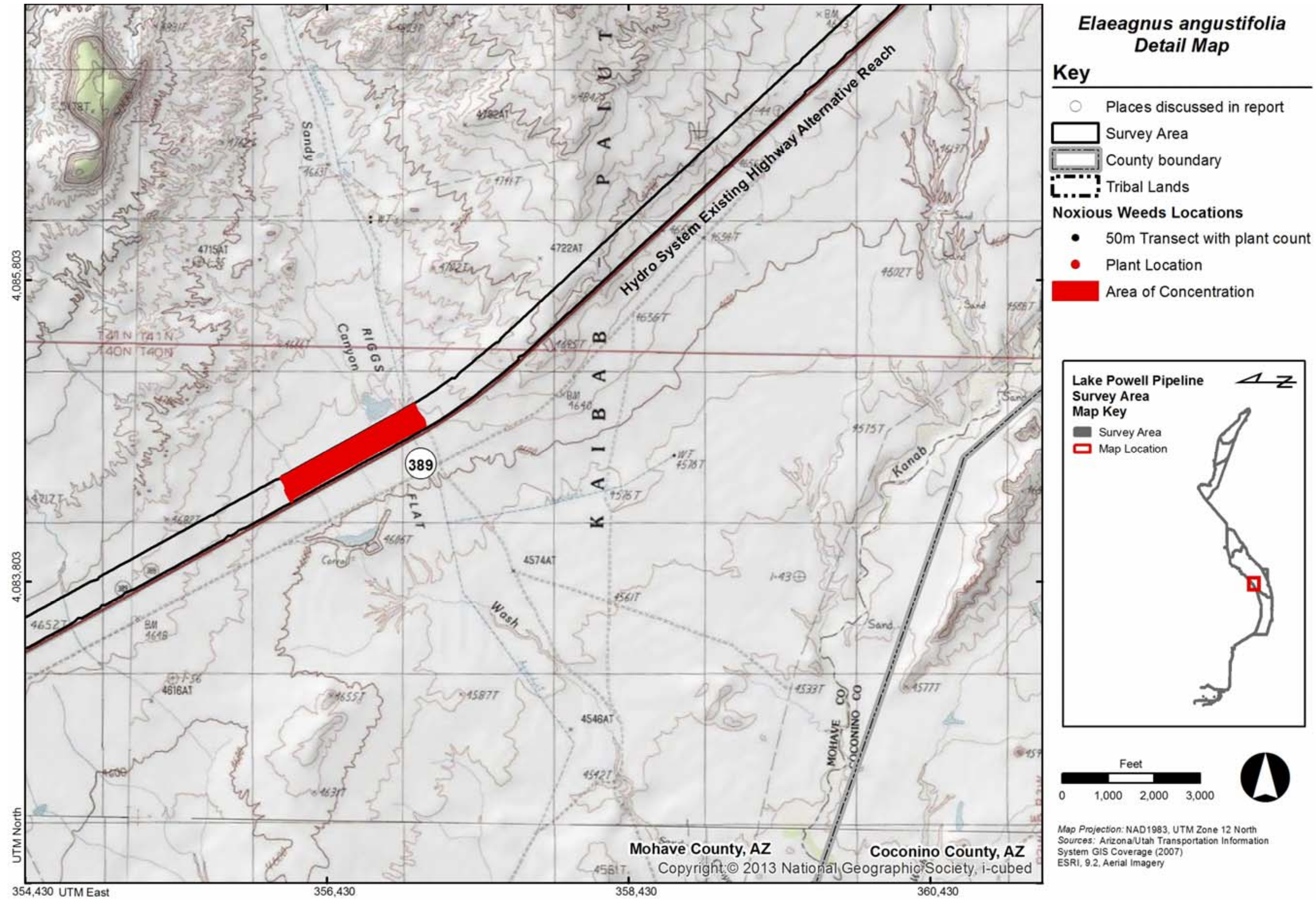

Figure 5-59
***Elaeagnus angustifolia* Detail Map 5**

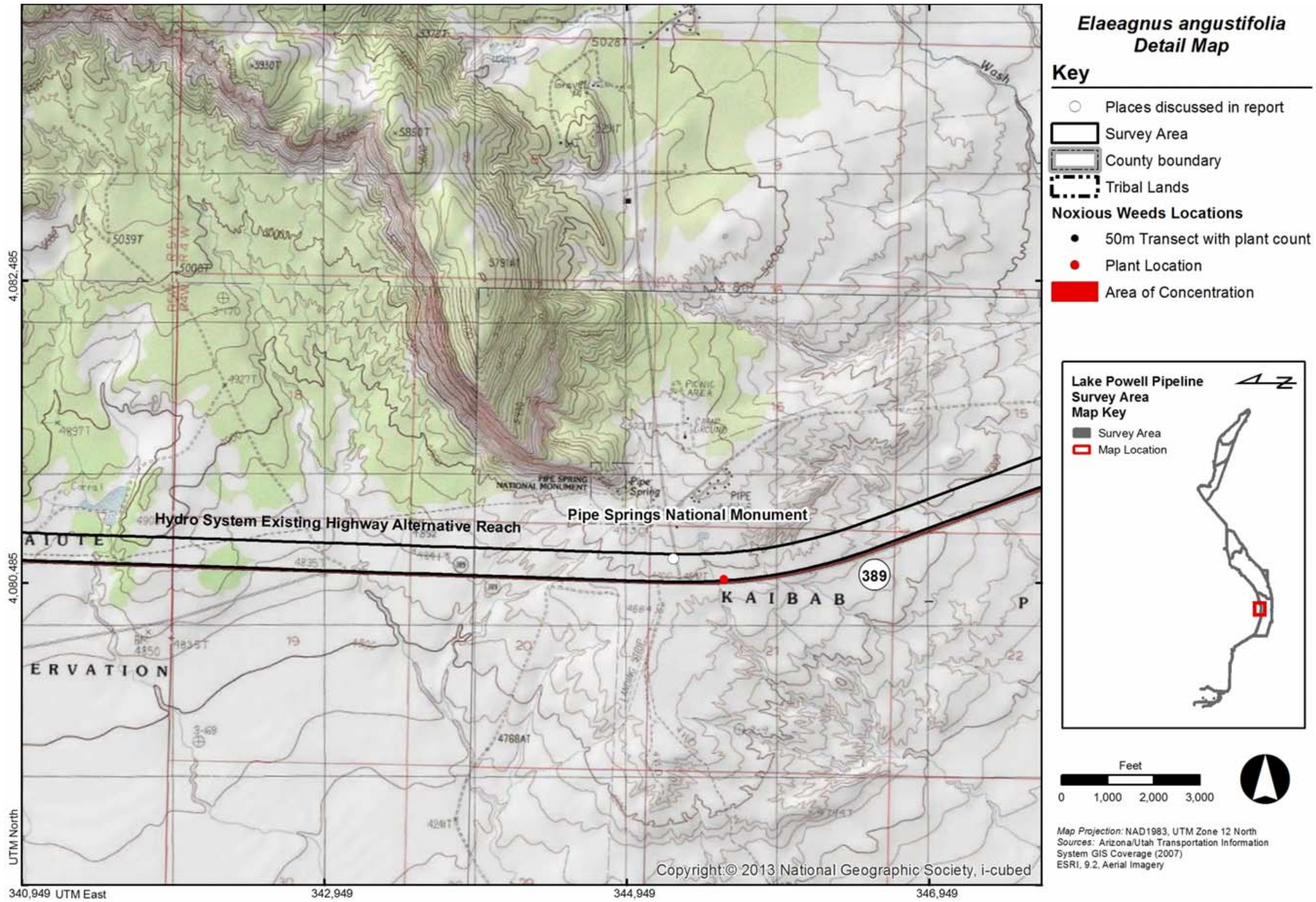

Figure 5-60
***Elaeagnus angustifolia* Detail Map 6**

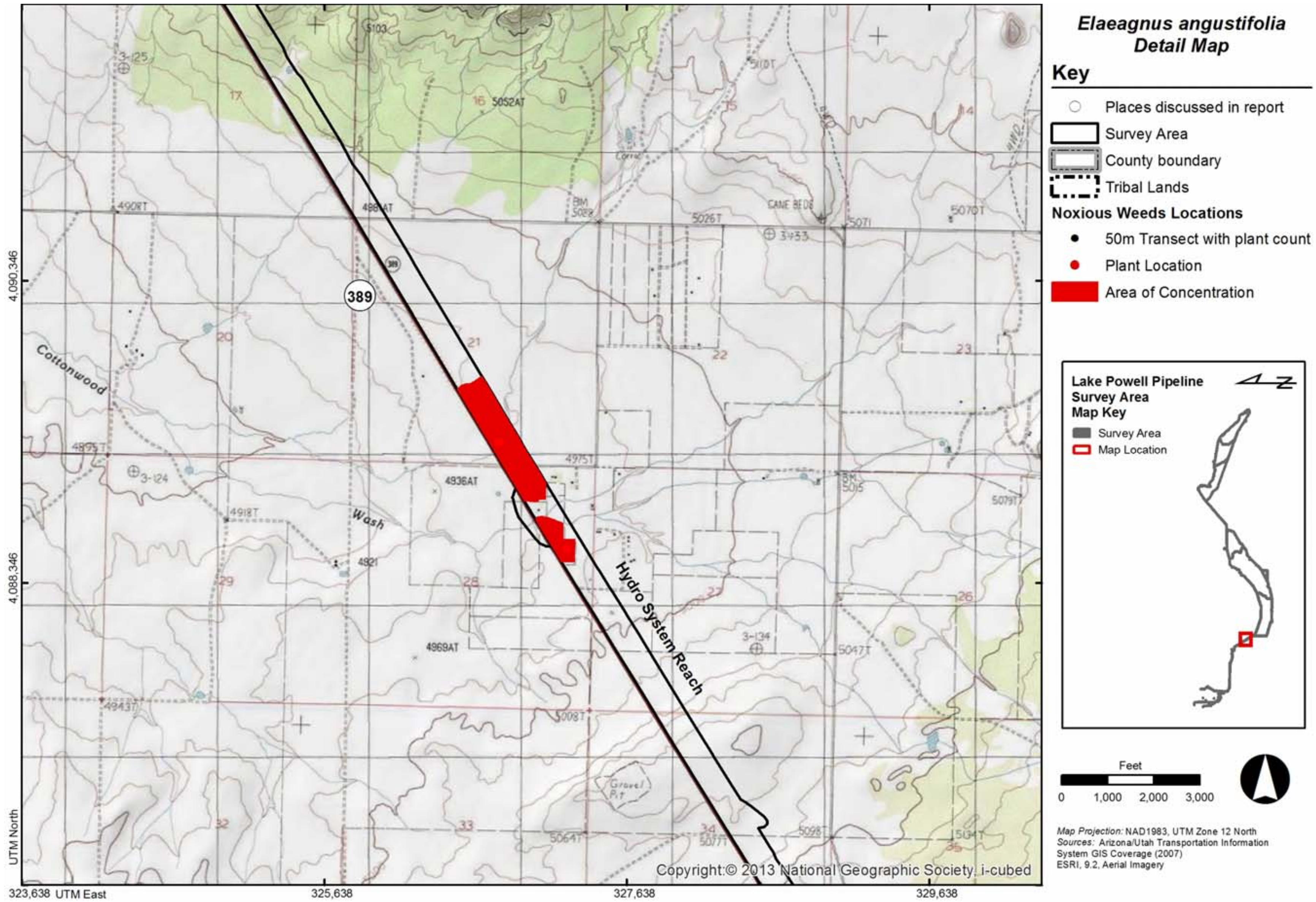

Figure 5-61
***Elaeagnus angustifolia* Detail Map 7**

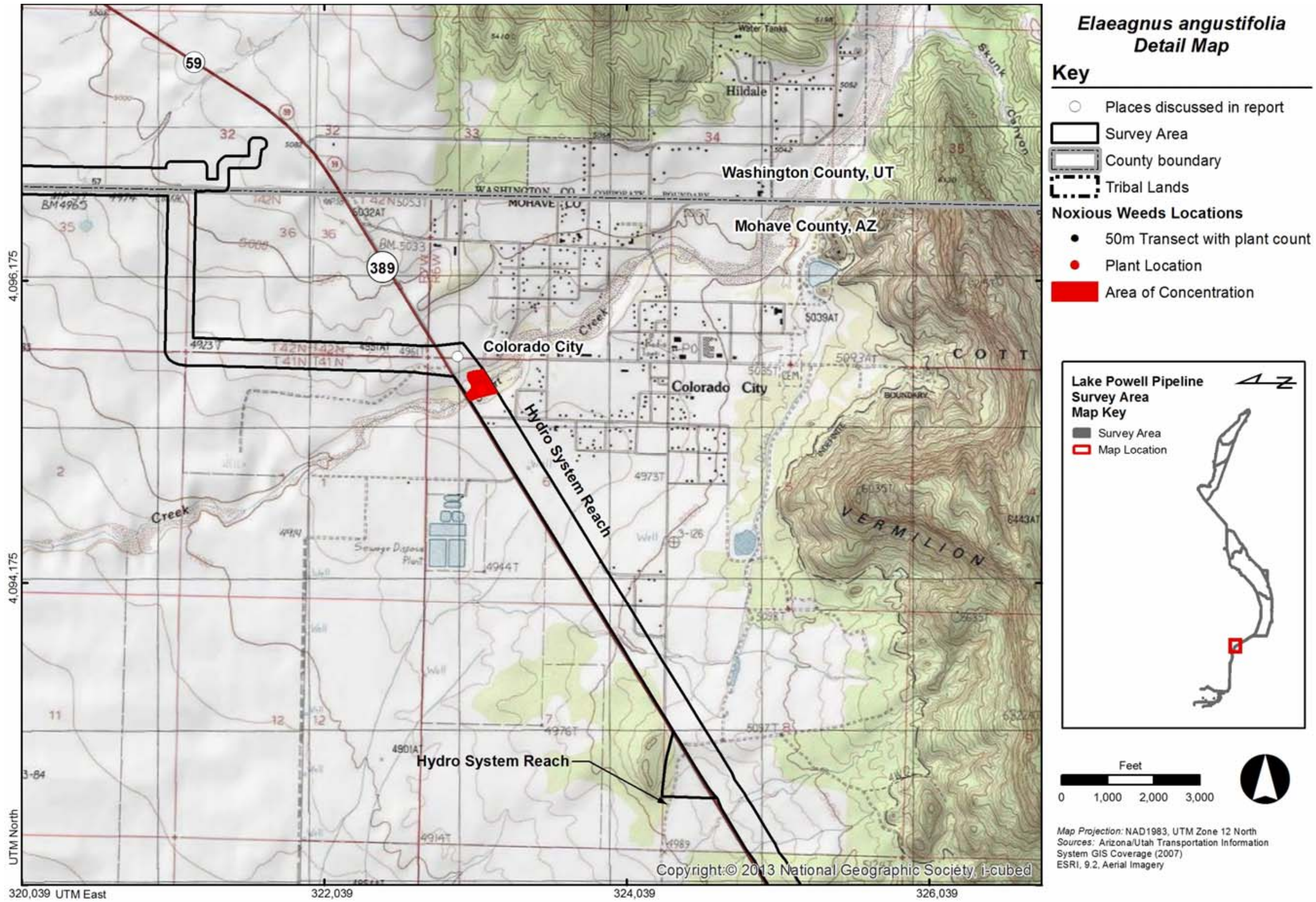

Figure 5-62
***Elaeagnus angustifolia* Detail Map 8**

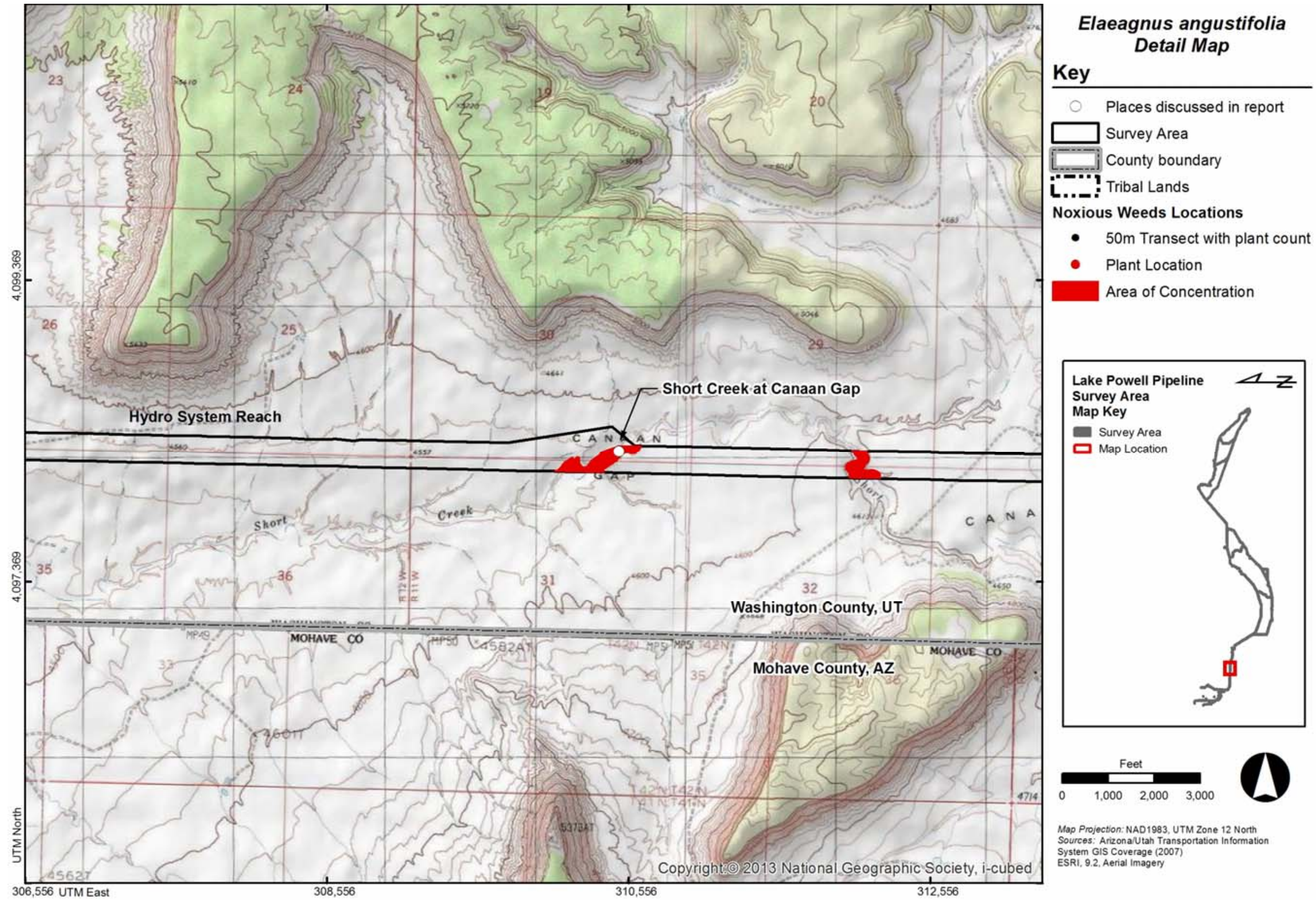

Figure 5-63
***Elaeagnus angustifolia* Detail Map 9**

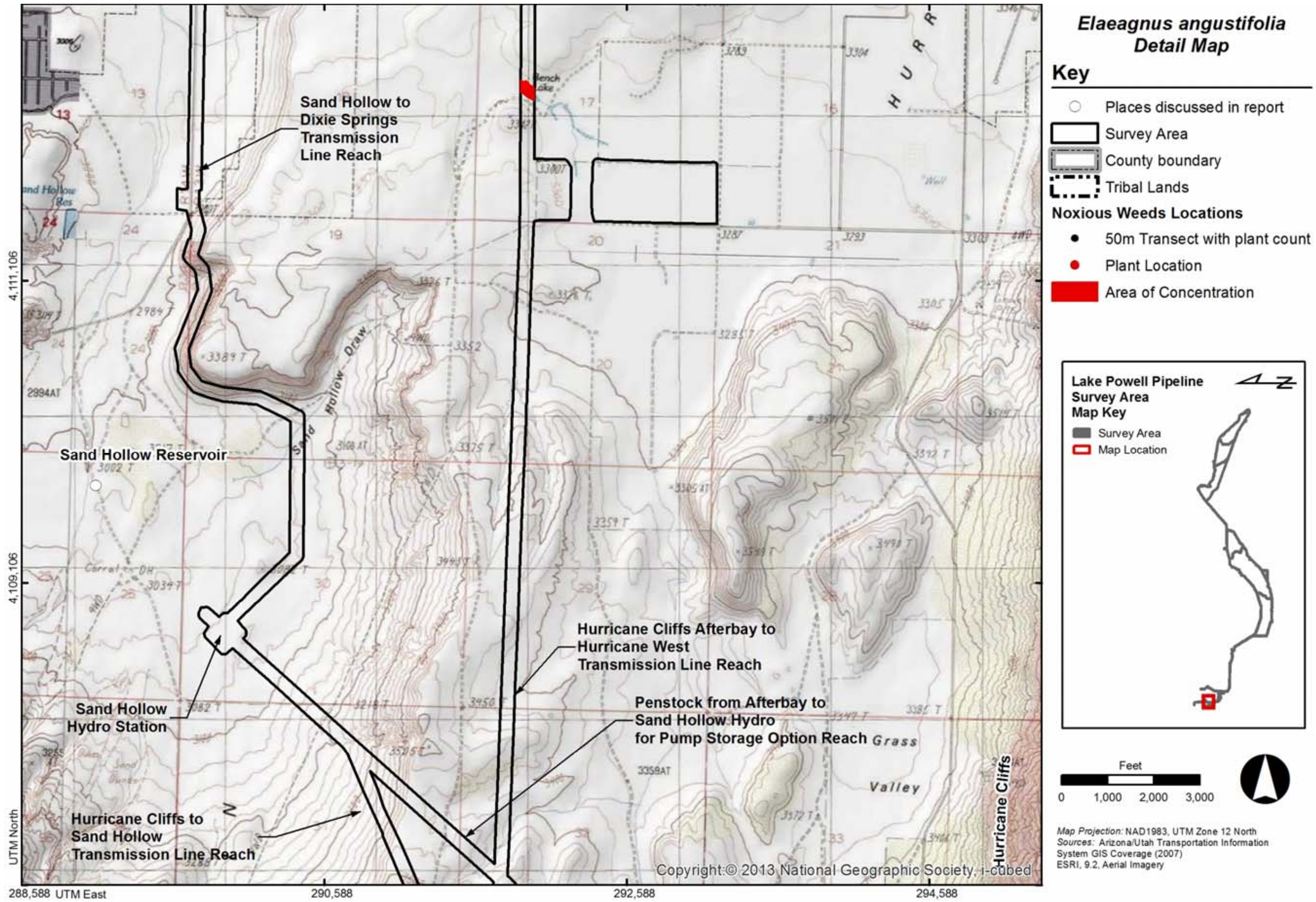

Figure 5-64
***Elaeagnus angustifolia* Detail Map 10**

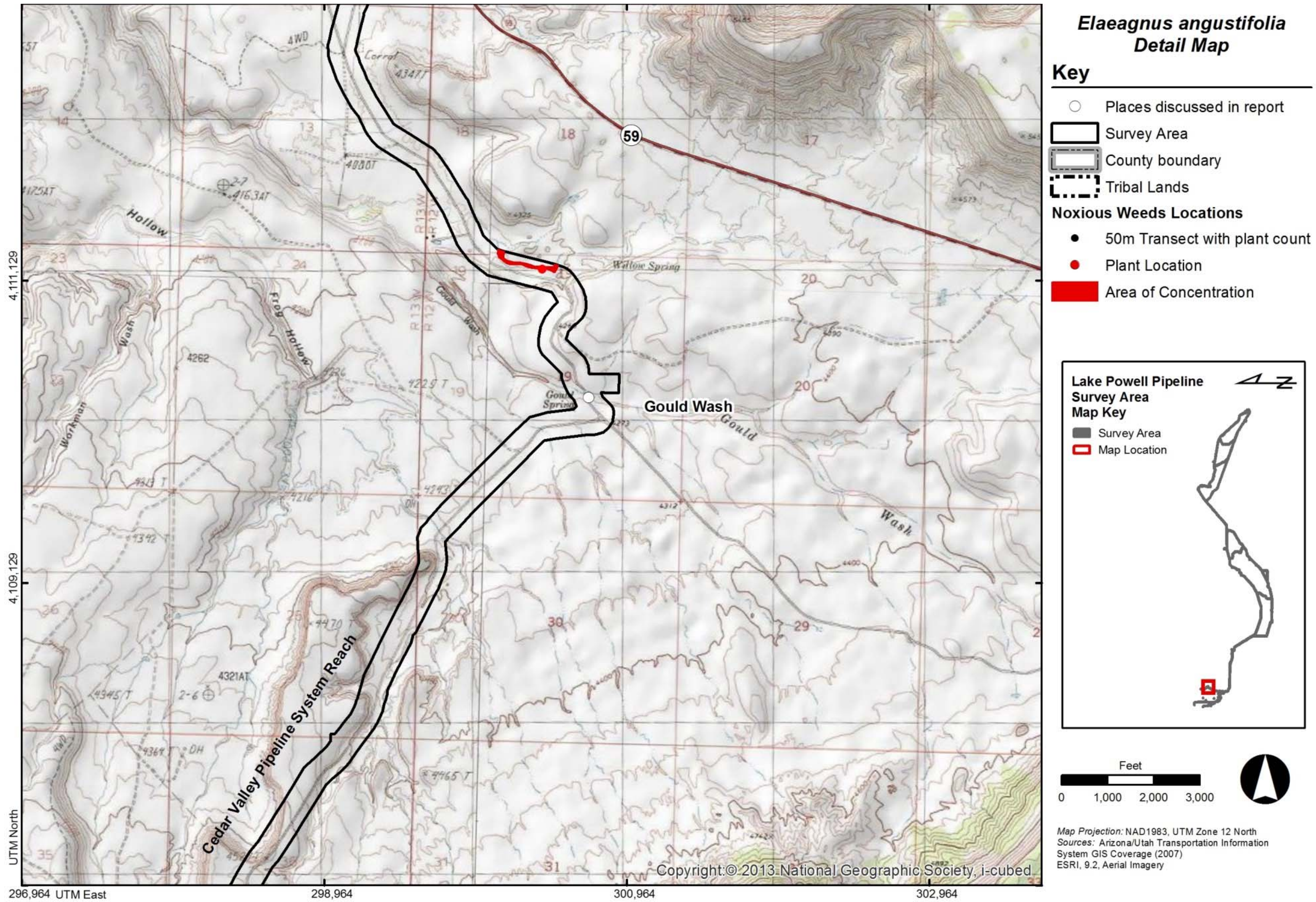

Figure 5-65
***Elaeagnus angustifolia* Detail Map 11**

5.5.8 *Erodium cicutarium* (Stork's bill)

5.5.8.1 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 5-66). 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).

Figure 5-66
Close-up View of *Erodium cicutarium*
within the Survey Area

E. 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).

E. 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, desert lands, 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 (Sonoran Institute 2008).

E. cicutarium can invade natural Ecological Systems following disturbance. *E. 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.

5.5.8.2 Survey Results

E. cicutarium was one of the most abundant noxious weeds encountered during the survey (Figure 5-67). In general, the frequency of occurrences was highest from between the area of the Cockscomb and Hurricane, while the species was encountered less frequently in the easternmost extent of the survey area, from the Cockscomb east to the Colorado River at Glen Canyon Dam. *E. cicutarium* was identified in a total of 21 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. In the Water Conveyance System Reach, *E. cicutarium* was encountered around Greenehaven, 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 Fivemile Mountain Road at U.S. 89. 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, *E. cicutarium* was identified in the area from Johnson Canyon to U.S. 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 Eightmile Gap Road at U.S. 89.

E. cicutarium was also found in the Forebay and throughout much of the Afterbay Reach. 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, and the Hurricane Cliffs Afterbay to Hurricane West Transmission Line Reach. Individuals were also found at several locations around Sand Hollow Reservoir, in the Sand Hollow to Dixie Springs Transmission Line Reach. *E. cicutarium* was encountered while conducting surveys for special status species and noxious weeds, and was detected in a total of 73 transects.

E. cicutarium was encountered in both Ecological Regions, in a total of 24 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 Mojave 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 Mojave Desert Wash. Anthropogenic lands which supported *E. cicutarium* included Agricultural Land, Developed Road, Developed Land, Invasive Upland Vegetation, and Ruderal Vegetation. *E. 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., *Gutierrizia sarothrae*, or by *Juniperus osteosperma* and *Pinus edulis*. *E. 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*.

5.5.8.3 Discussion

E. 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.

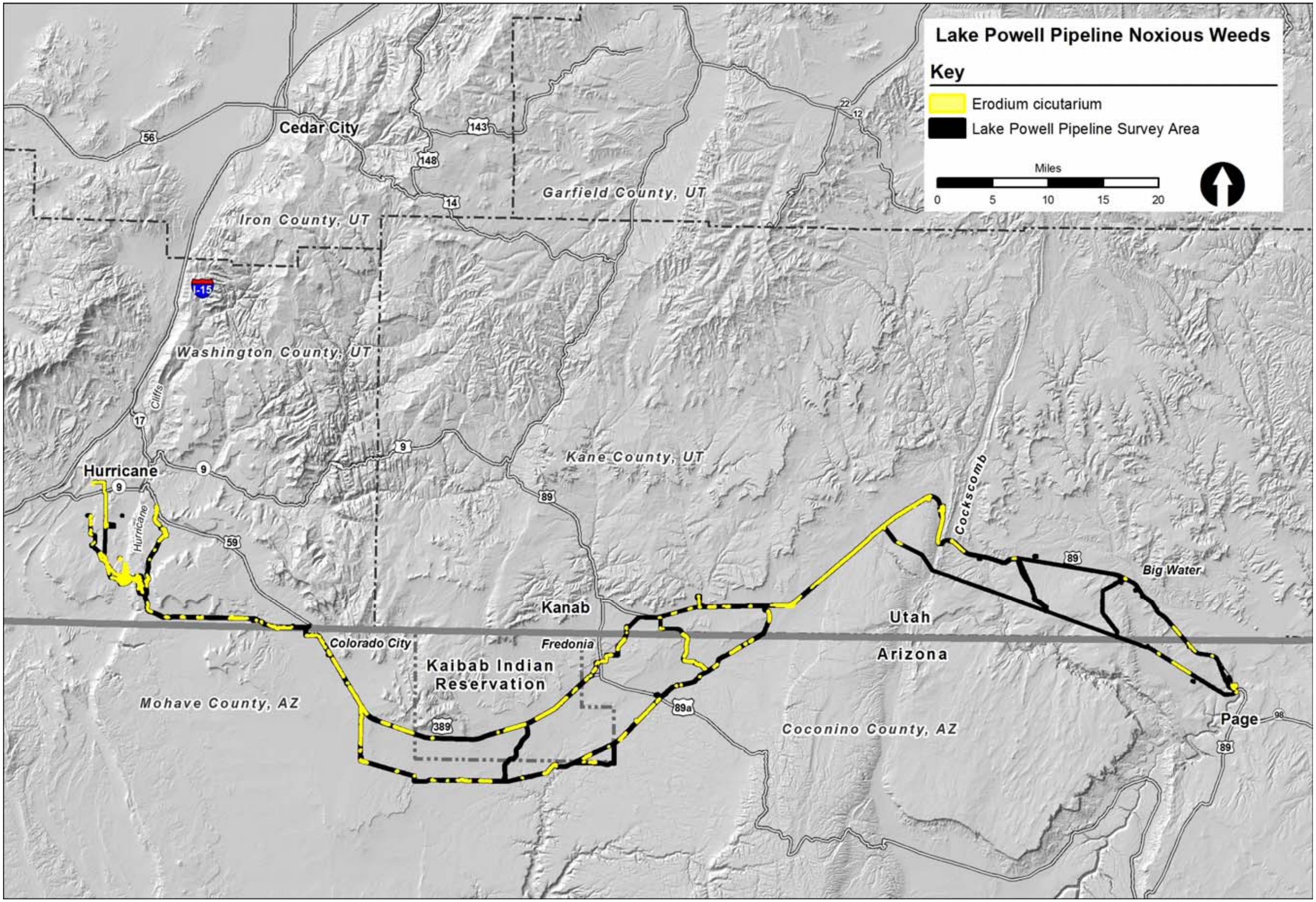

Figure 5-67
***Erodium cicutarium* Overview Map**

5.5.9 *Halogeton glomeratus* (Halogeton)

5.5.9.1 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 5-68). 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. *H. 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. *H. 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, *H. glomeratus* may resemble *Salsola* spp. or *Kochia scoparia*; however, immature *Salsola* spp. have linear leaves rather than cylindrical leaves. *H. glomeratus* can also be differentiated from *K. scoparia*, which has pubescent leaves that lack the terminal bristles found on *H. glomeratus*.

Figure 5-68
Close-up View of *Halogeton glomeratus*
within the Survey Area

H. 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.

H. 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).

H. 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 5-69). Spread of the species is particularly enhanced by fire disturbance, which encourages seed germination and the development of dense stands of individuals. *H. 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. *H. 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).

Figure 5-69
View of *Halogeton glomeratus* and Its Habitat
within the Survey Area

5.5.9.2 Survey Results

The distribution of *H. glomeratus* was sporadic within the survey area (Figure 5-70). *H. glomeratus* occurred as far east as the vicinity of Cottonwood Canyon Road and as far west as Hurricane. The species was found in five reaches (Figure 5-71 to Figure 5-87). 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. *H. glomeratus* was encountered sporadically along the Hydro System South Alternative Reach. *H. 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).

H. glomeratus was encountered in the Colorado Plateau Ecological Region, in eight ecological systems, and in three anthropogenic lands. *H. glomeratus* was identified in Big Sagebrush Shrubland, Blackbrush-Mormon-tea Shrubland, Greasewood Flat, Gypsum Badland, Mixed Desert Scrub, Pinyon-Juniper Woodland, Shrub-Steppe, and Colorado Plateau Wash. Anthropogenic lands supporting *H. glomeratus* included Agricultural Land, Invasive Upland Vegetation, and Ruderal Vegetation. *H. 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.

5.5.9.3 Discussion

H. glomeratus was encountered sporadically throughout the survey area and in a variety of ecological systems. *H. 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.

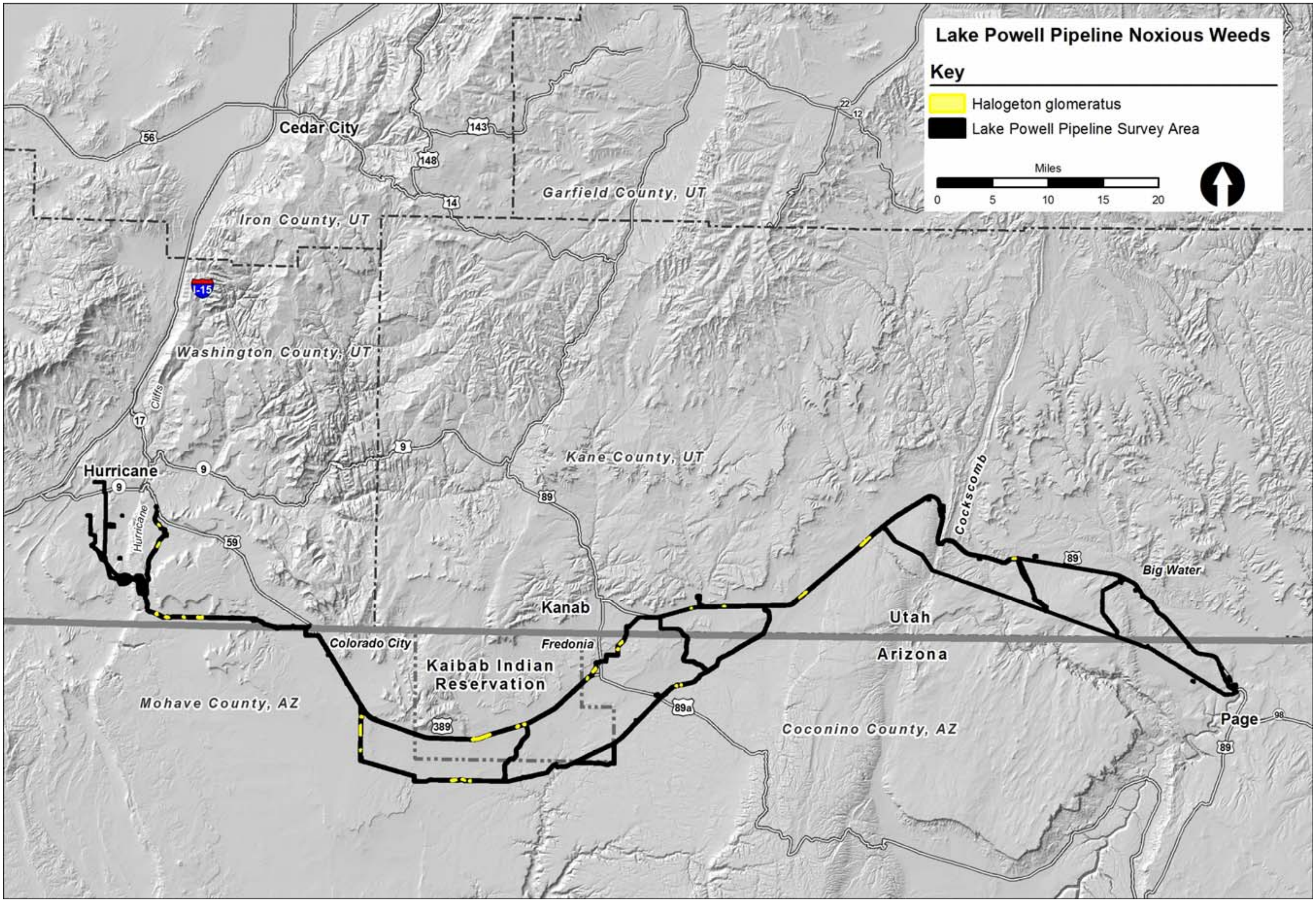

Figure 5-70
***Halogeton glomeratus* Overview Map**

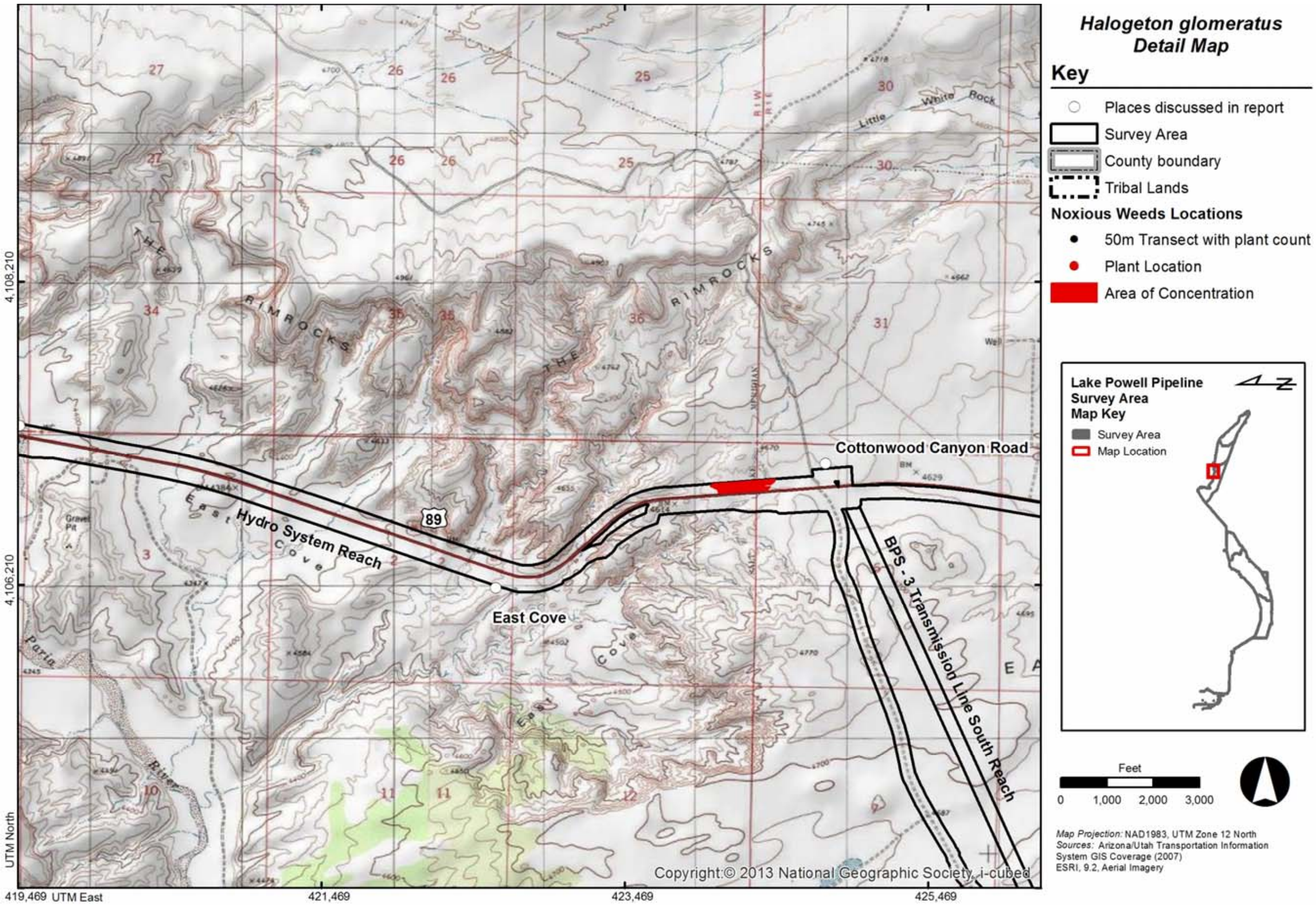

Figure 5-71
***Halogeton glomeratus* Detail Map 1**

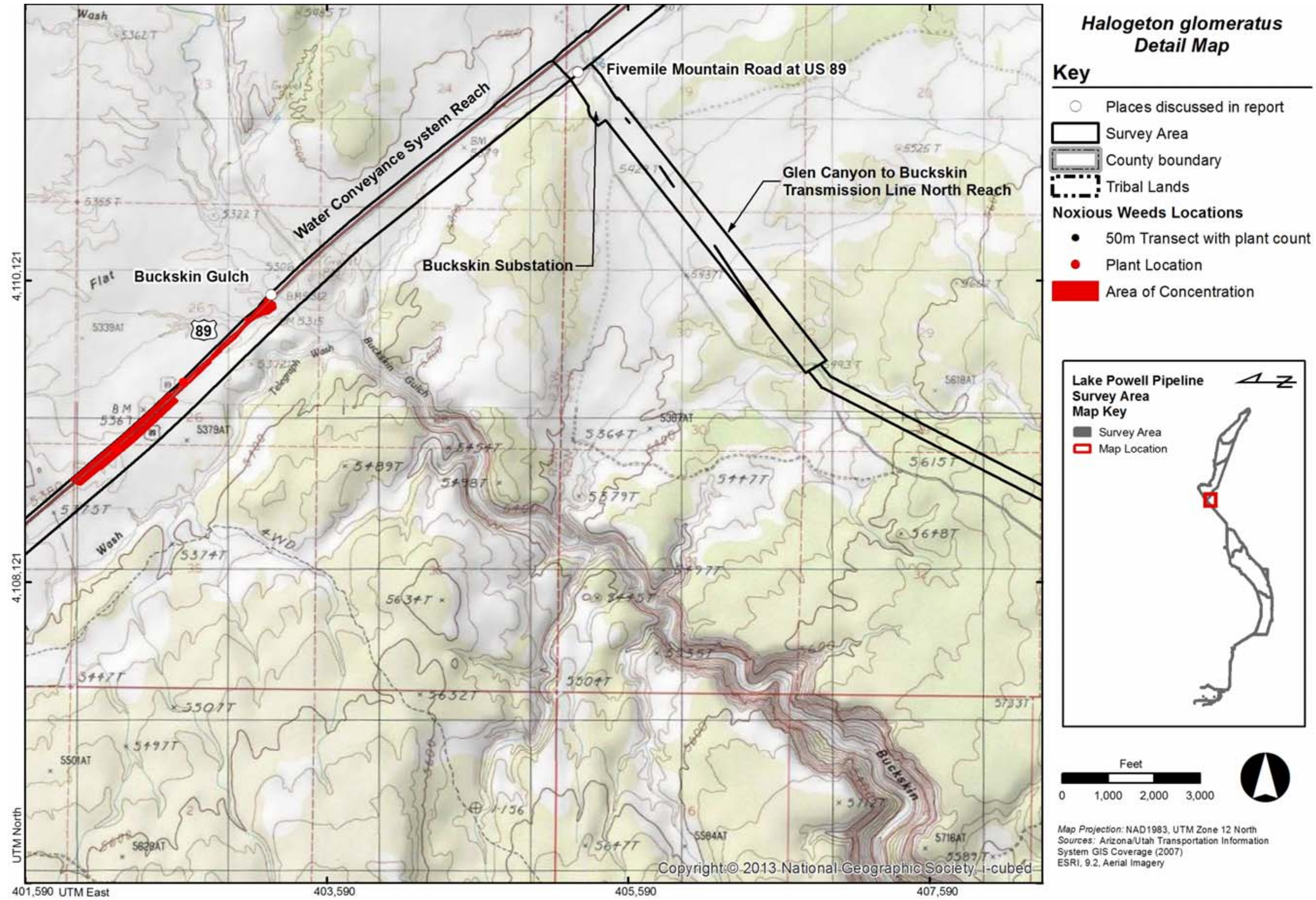

Figure 5-72
***Halogeton glomeratus* Detail Map 2**

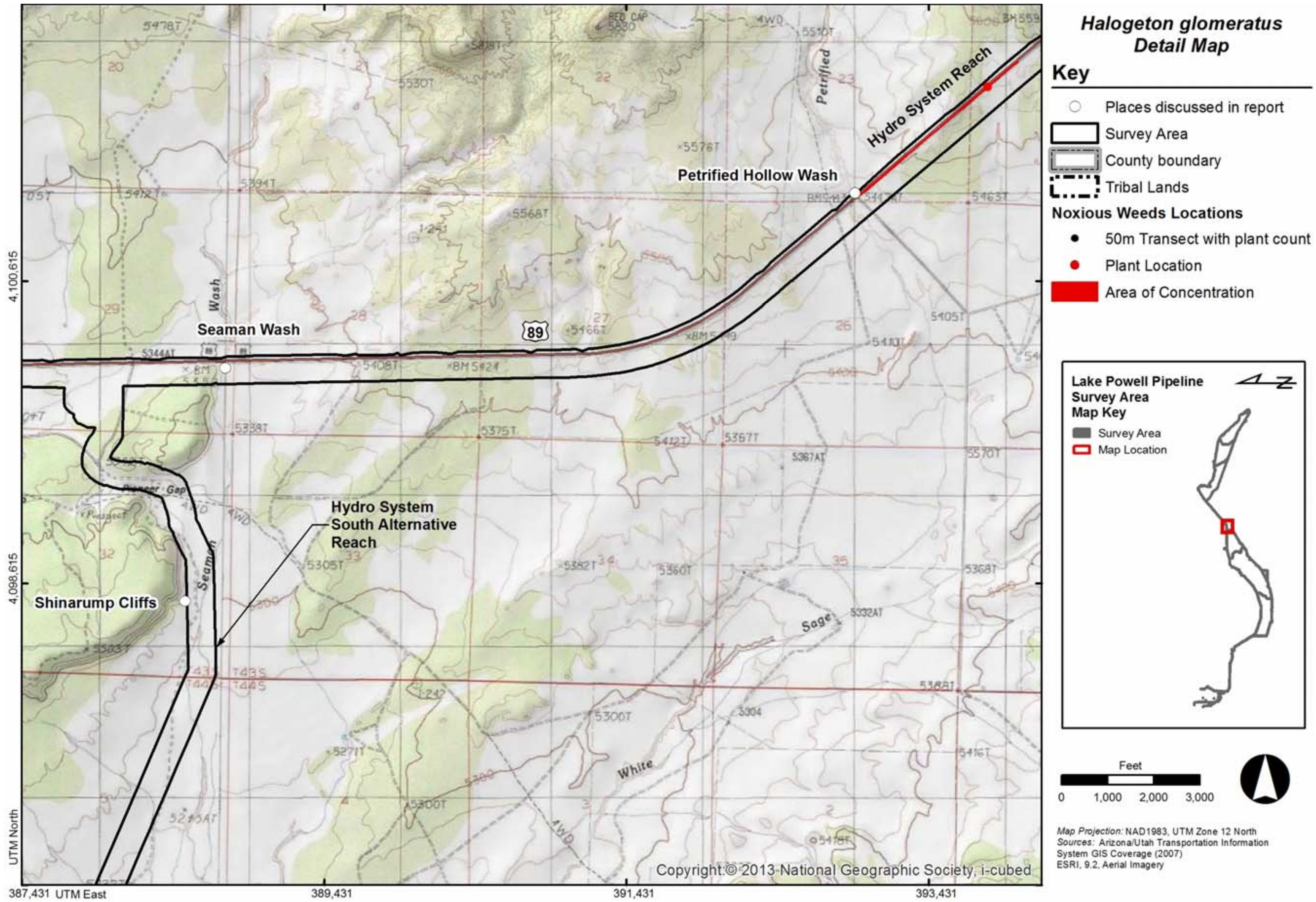

Figure 5-73
***Halogeton glomeratus* Detail Map 3**

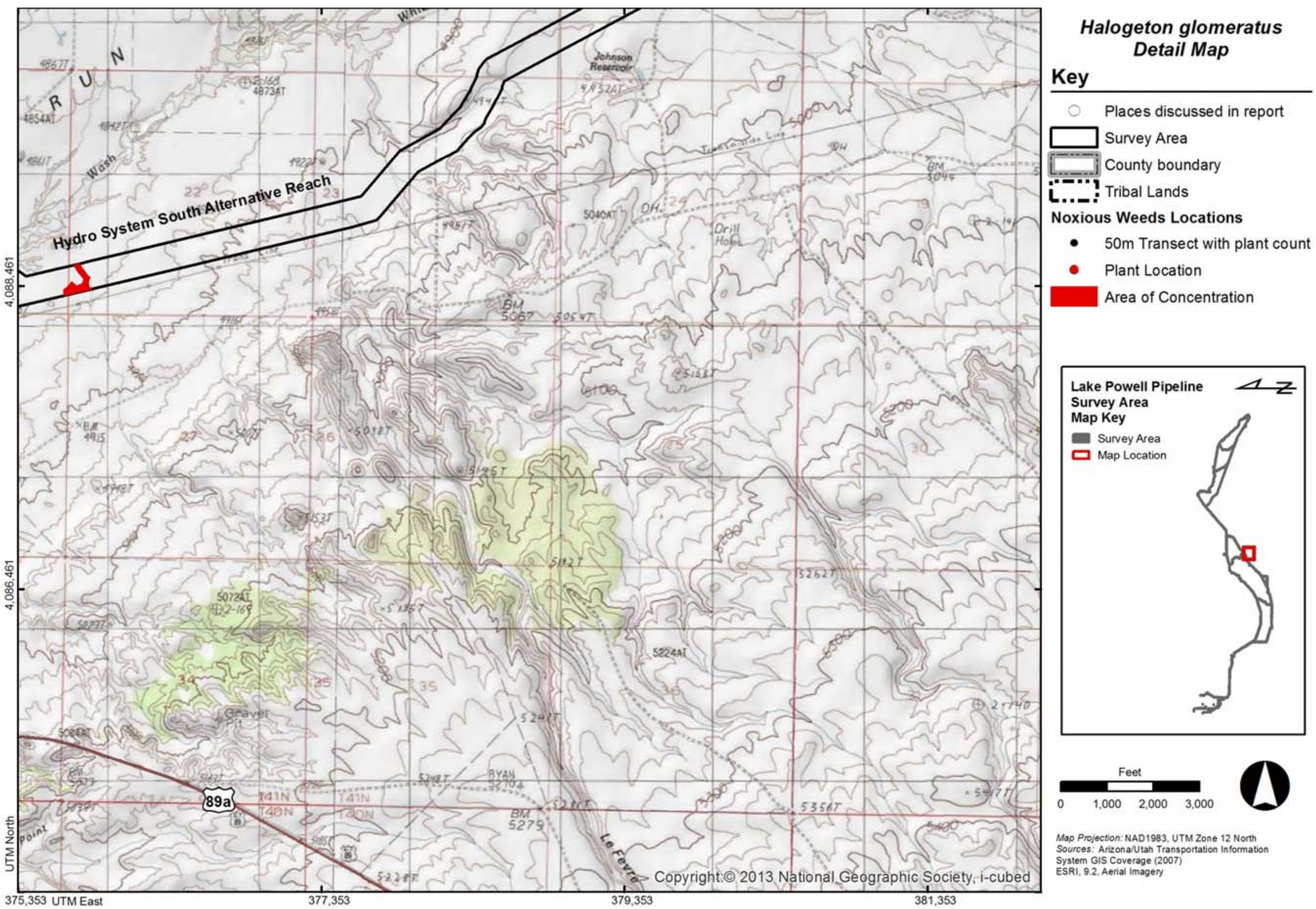

Figure 5-74
***Halogeton glomeratus* Detail Map 4**

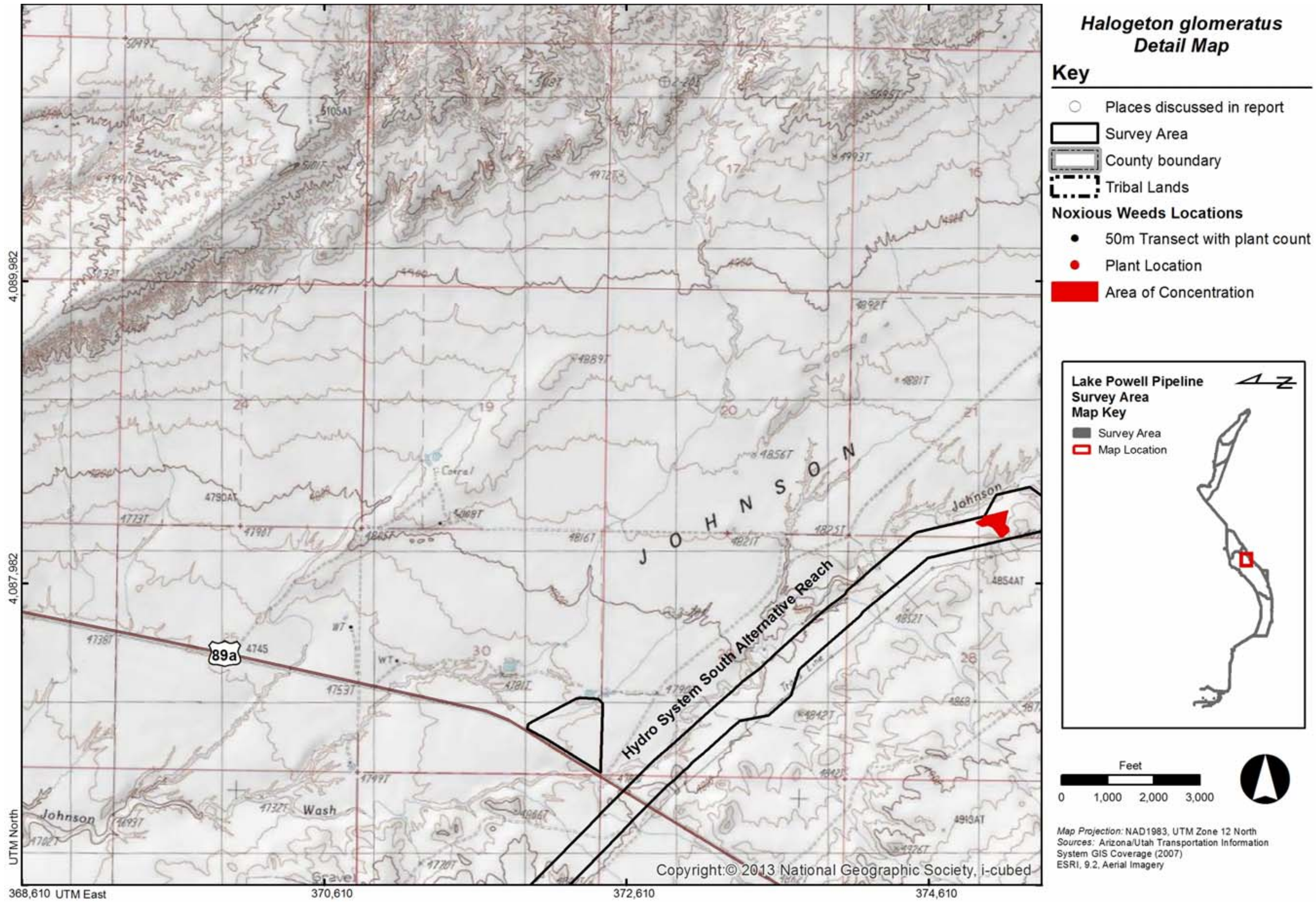

Figure 5-75
***Halogeton glomeratus* Detail Map 5**

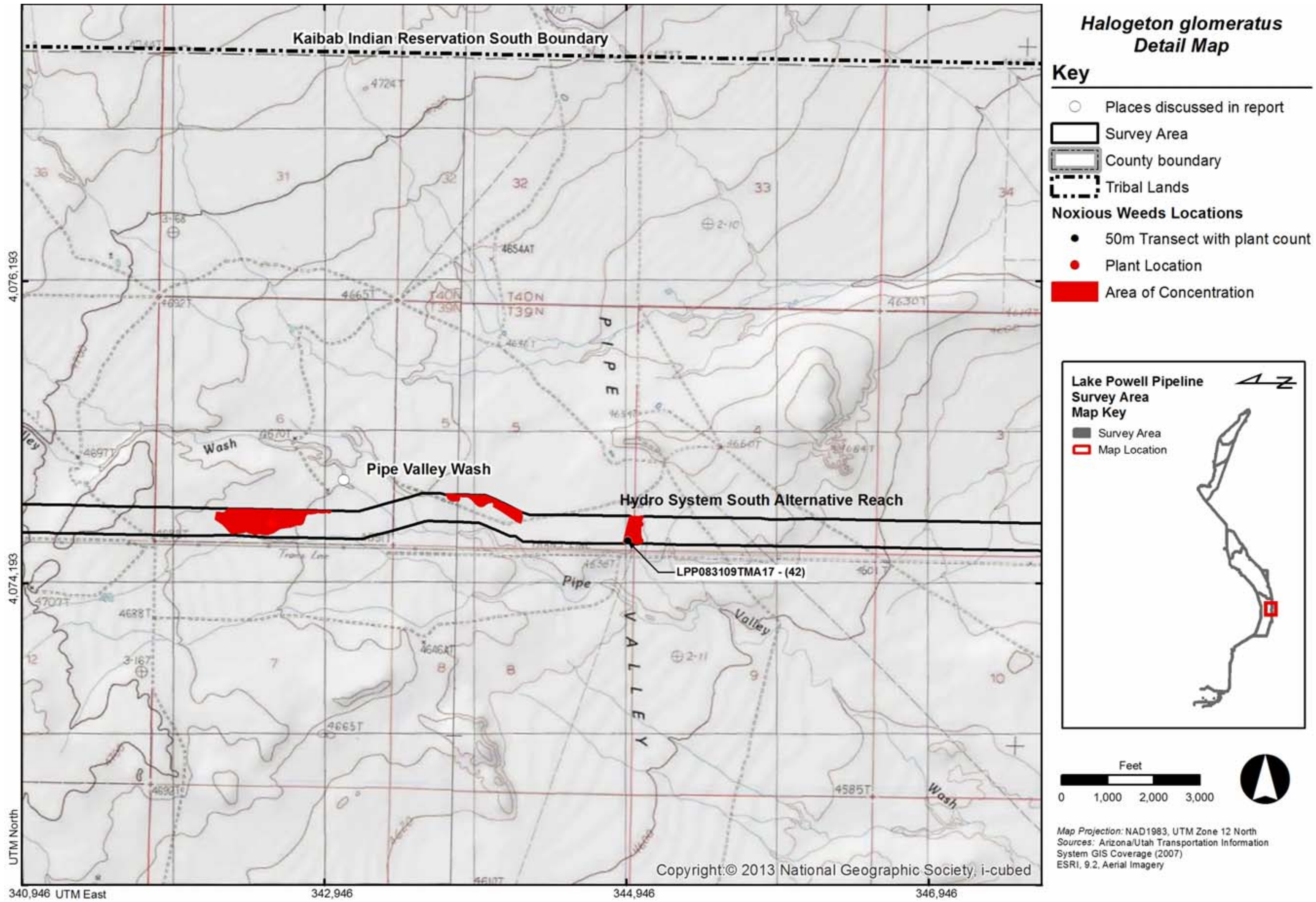

Figure 5-76
***Halogeton glomeratus* Detail Map 6**

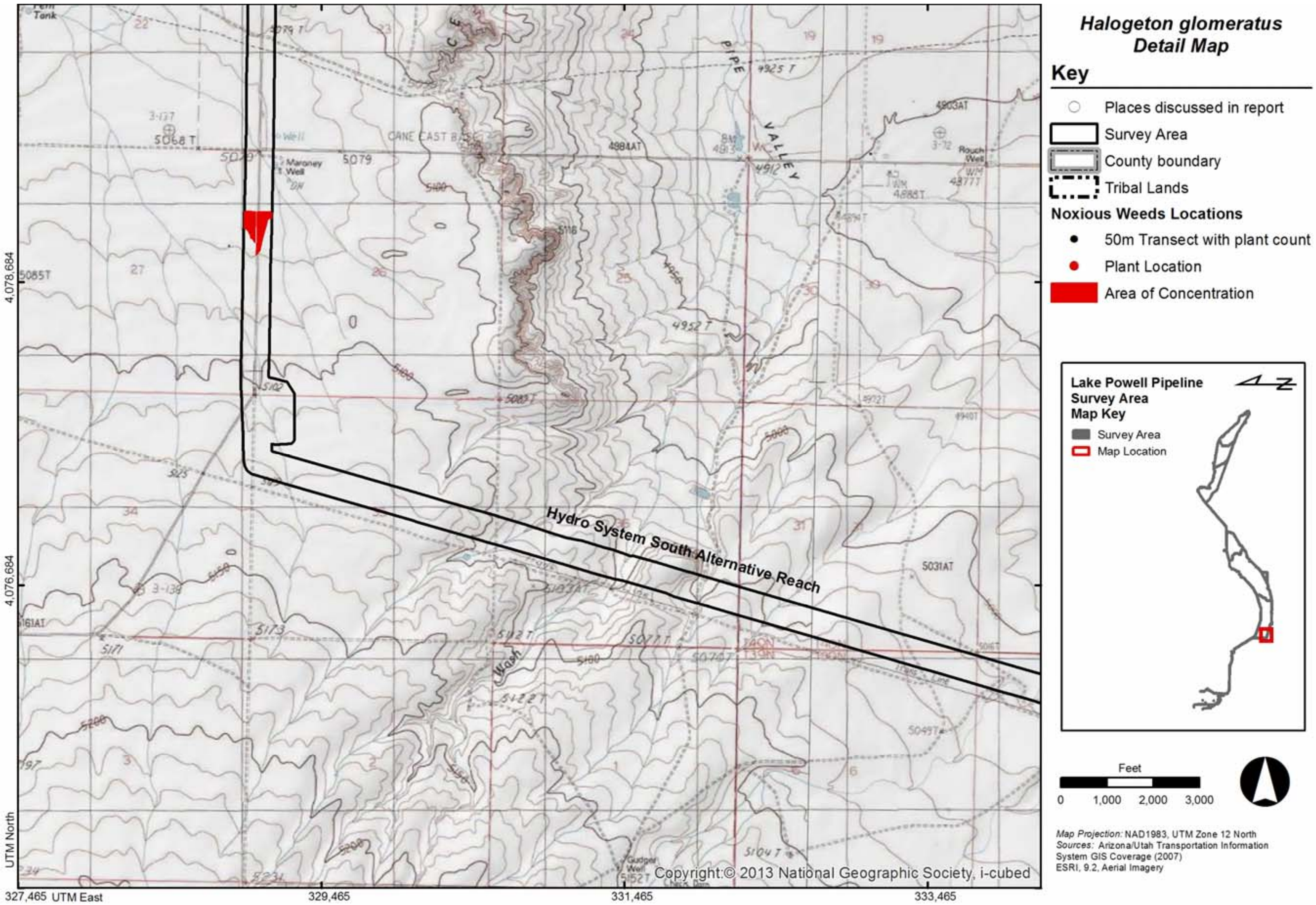

Figure 5-77
***Halogeton glomeratus* Detail Map 7**

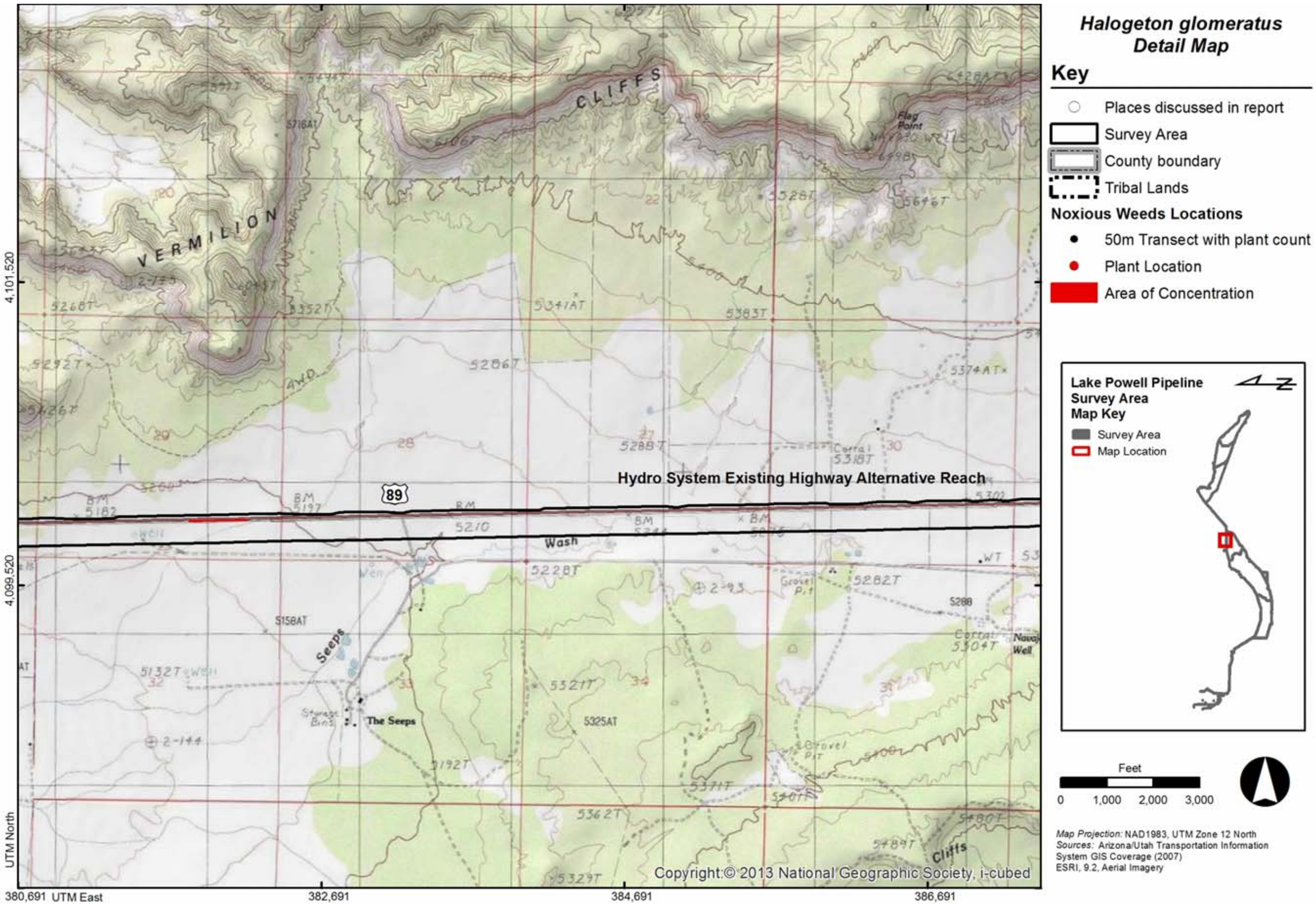

Figure 5-78
***Halogeton glomeratus* Detail Map 8**

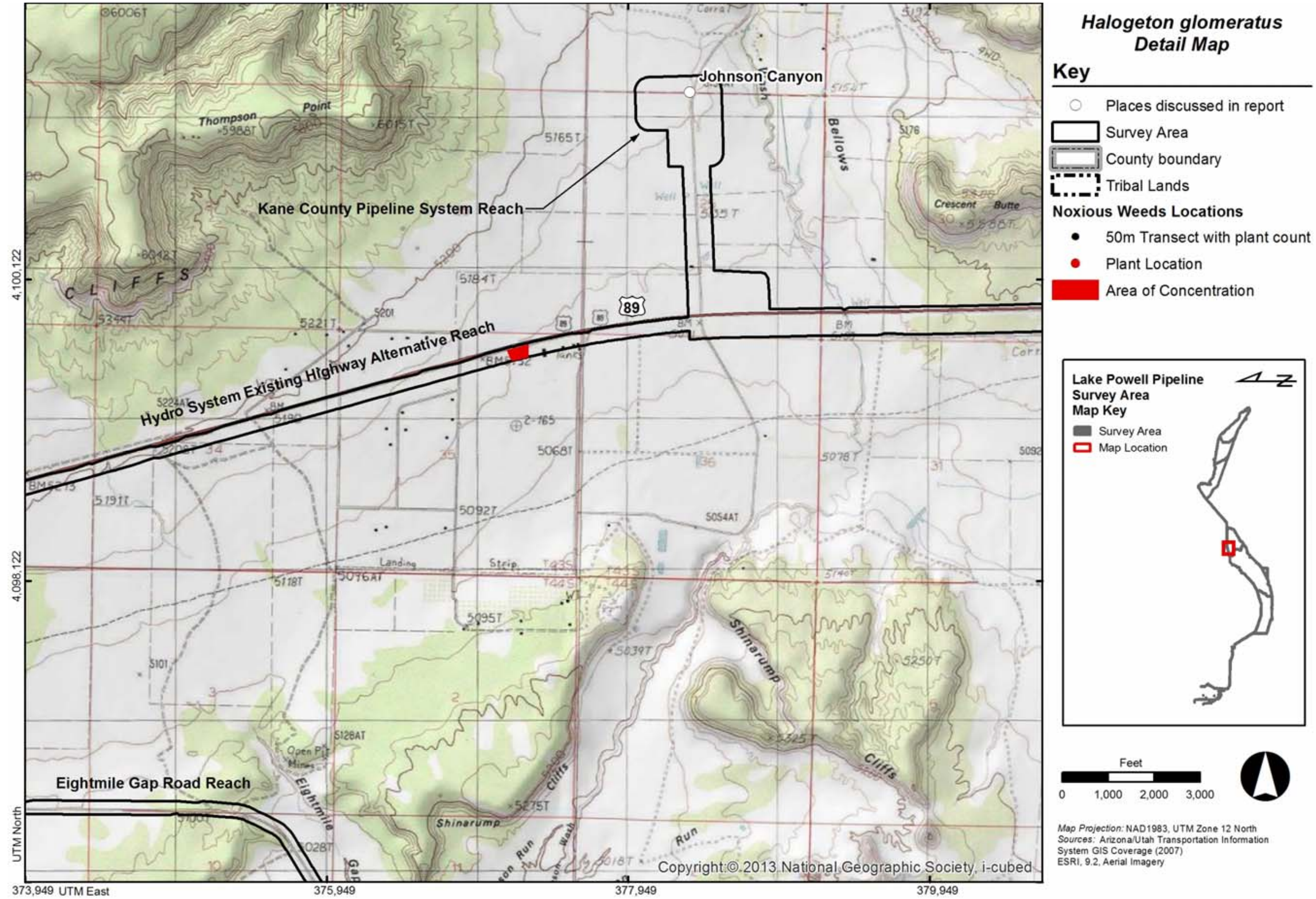

Figure 5-79
***Halogeton glomeratus* Detail Map 9**

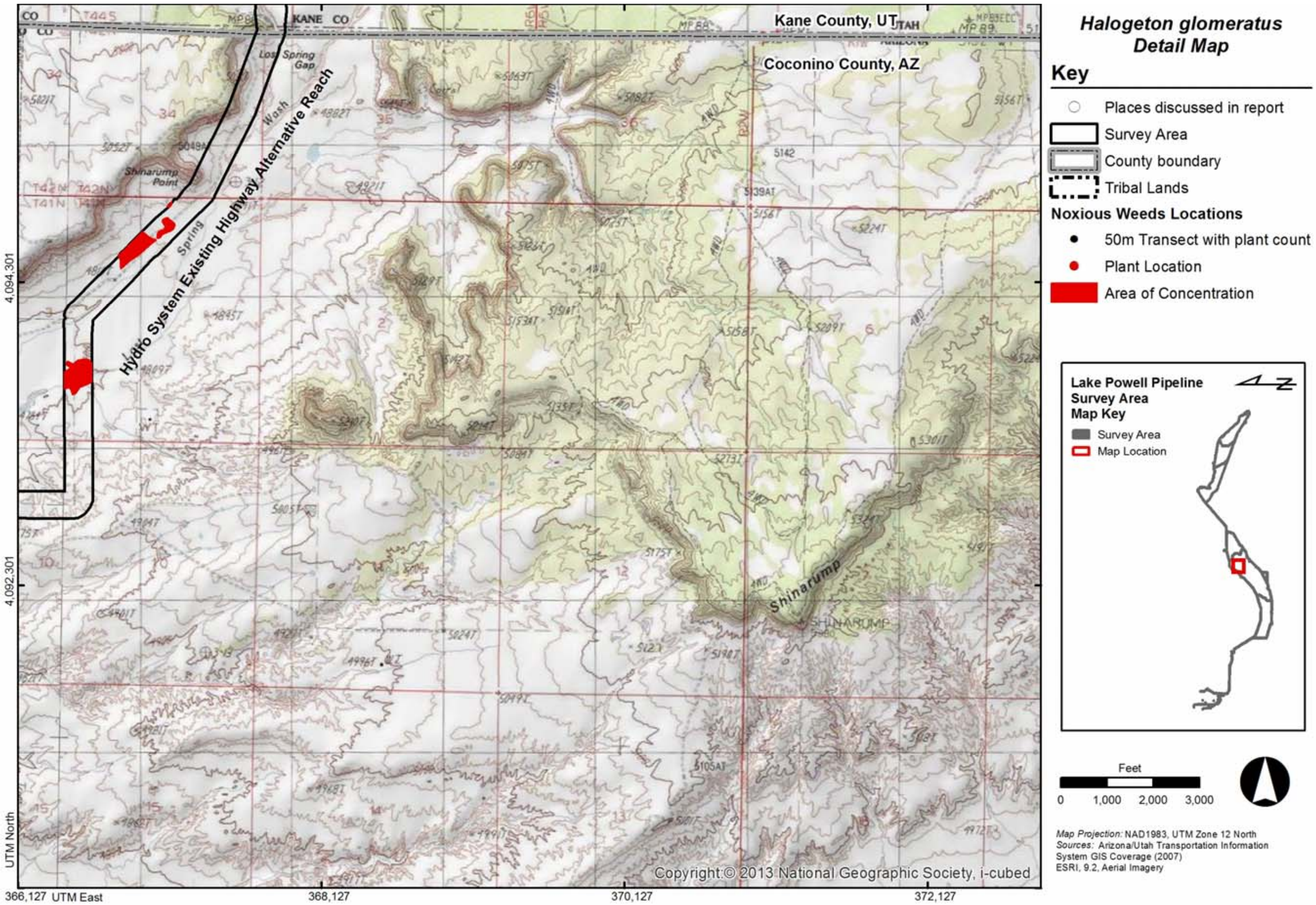

Figure 5-80
***Halogeton glomeratus* Detail Map 10**

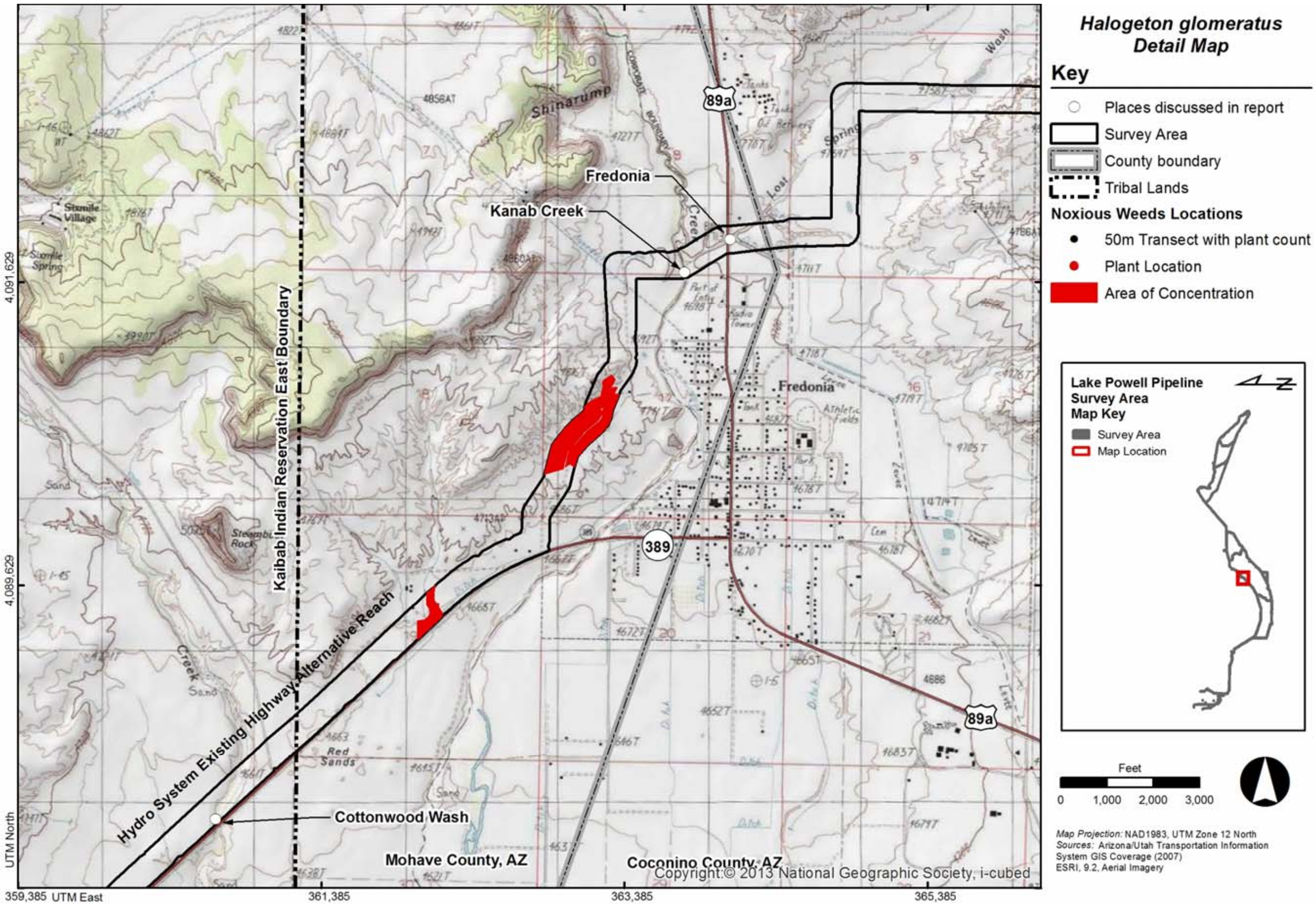

Figure 5-81
***Halogeton glomeratus* Detail Map 11**

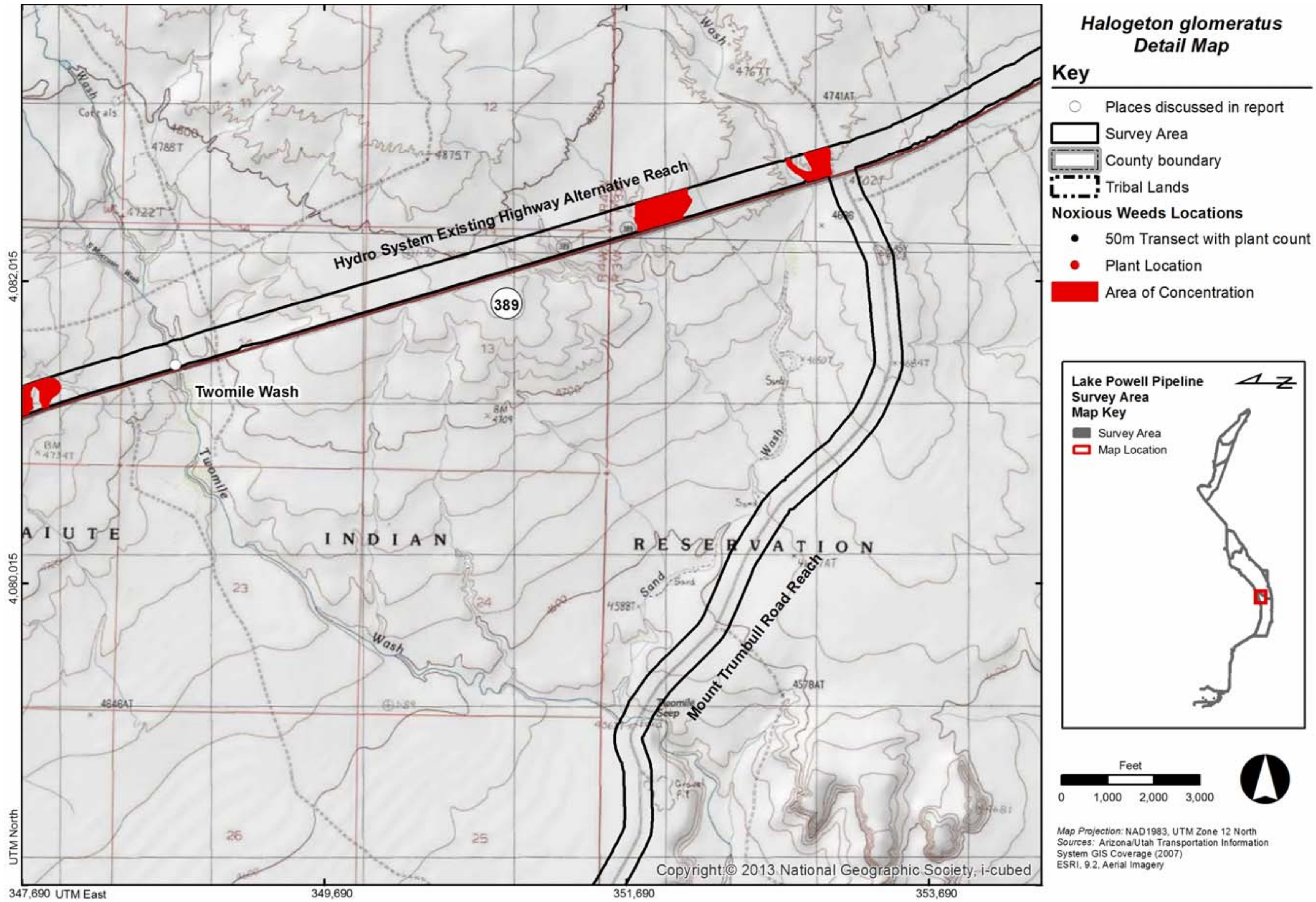

Figure 5-82
***Halogeton glomeratus* Detail Map 12**

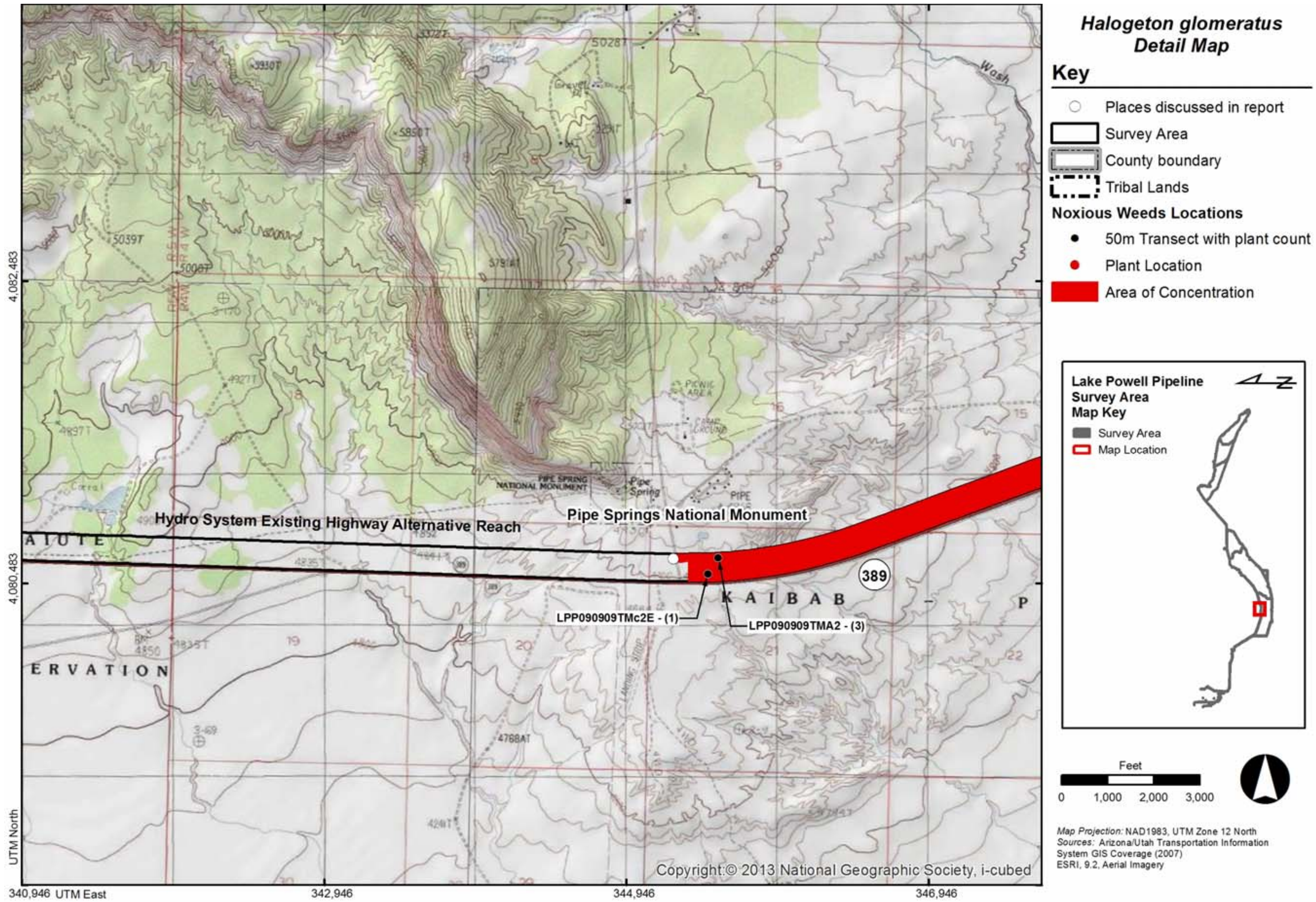

Figure 5-83
***Halogeton glomeratus* Detail Map 13**

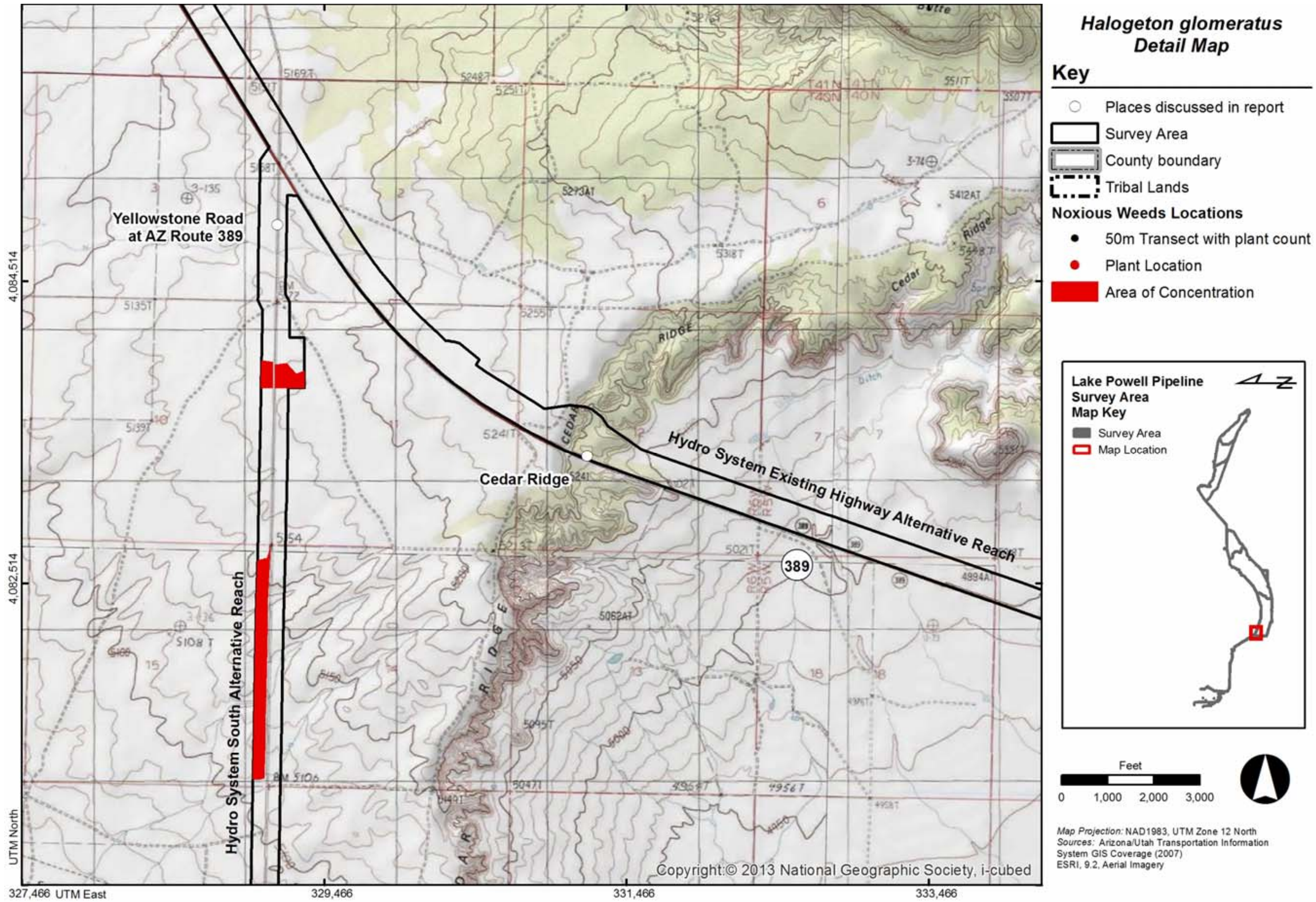

Figure 5-84
***Halogeton glomeratus* Detail Map 14**

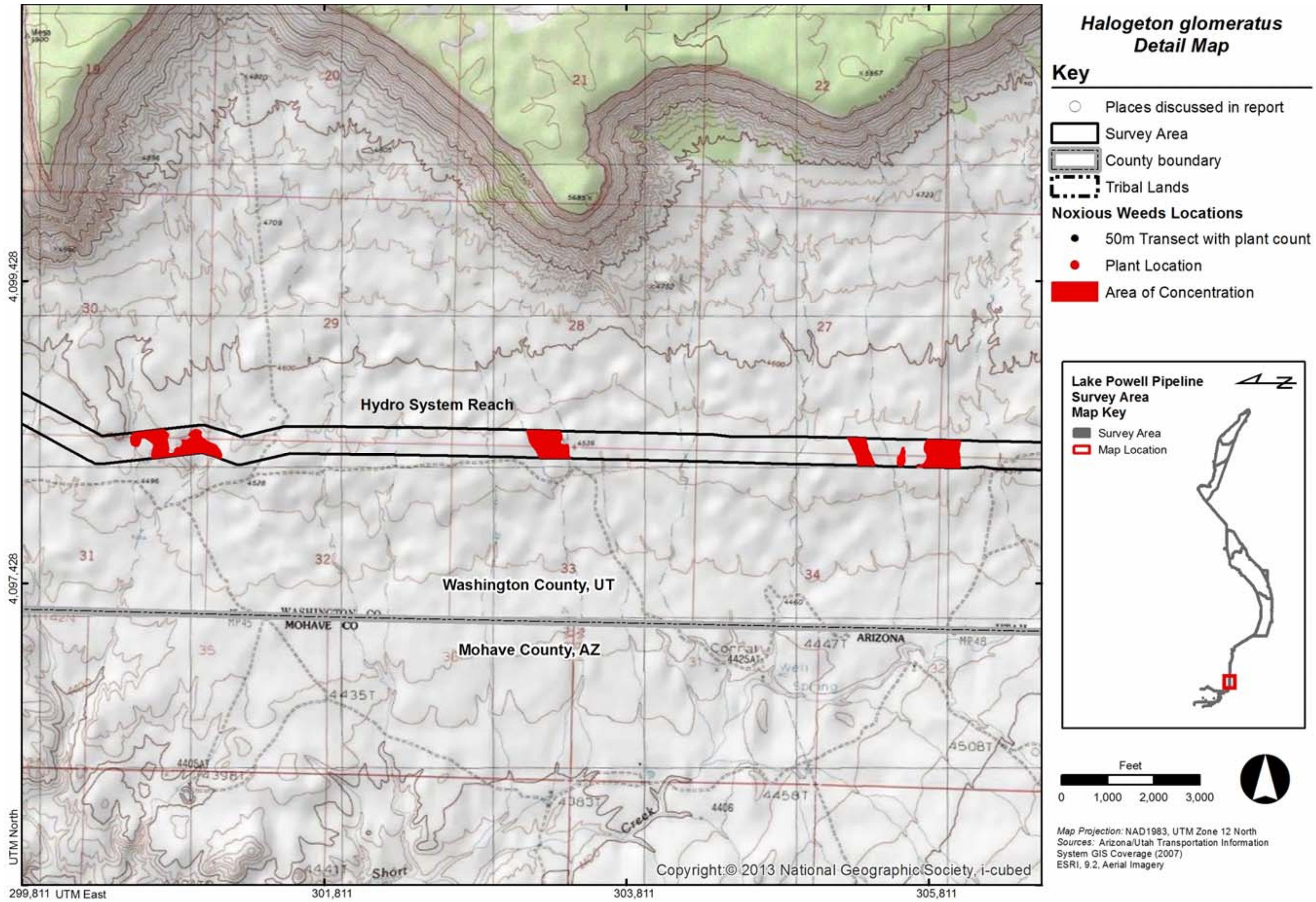

Figure 5-85
***Halogeton glomeratus* Detail Map 15**

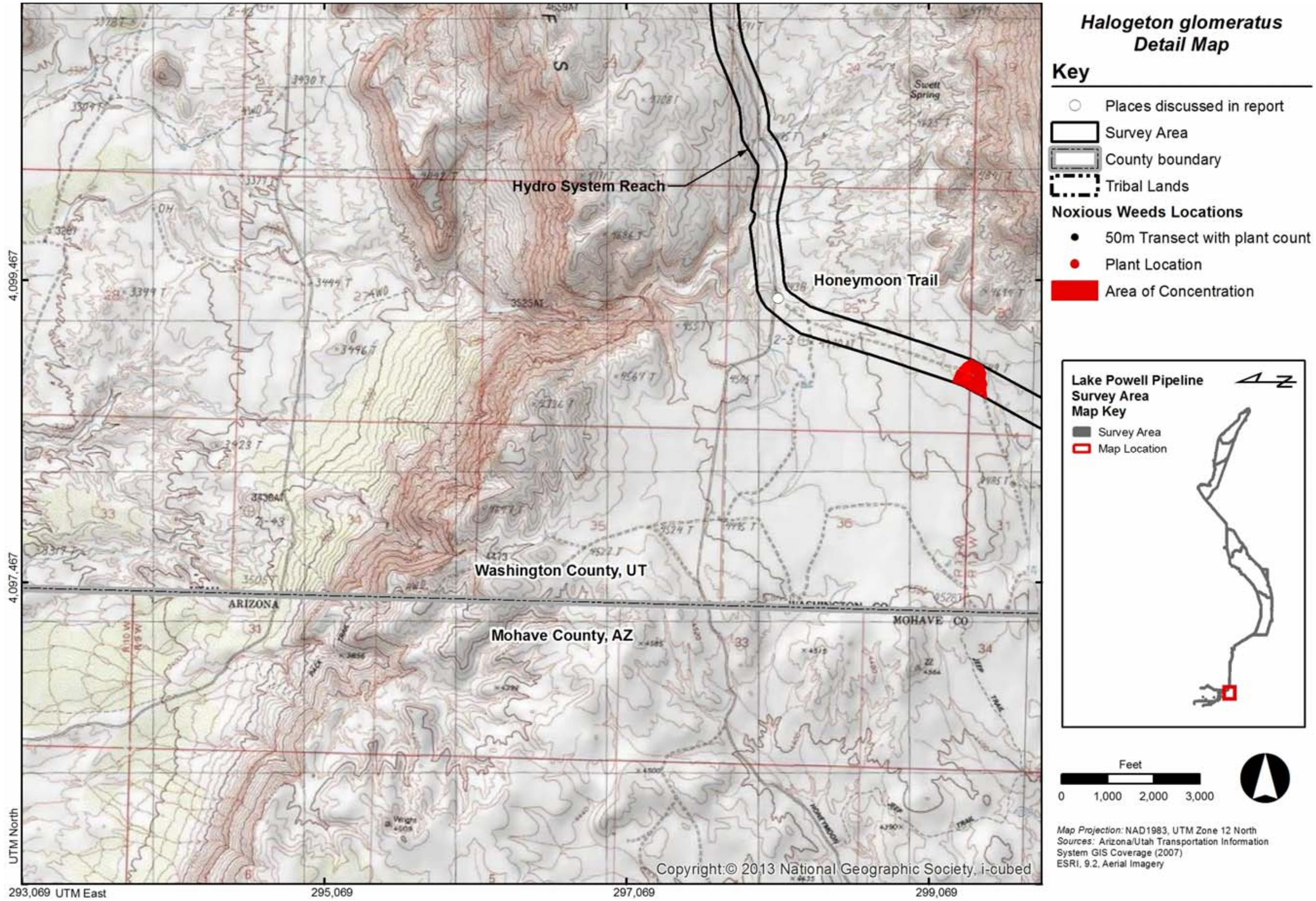

Figure 5-86
***Halogeton glomeratus* Detail Map 16**

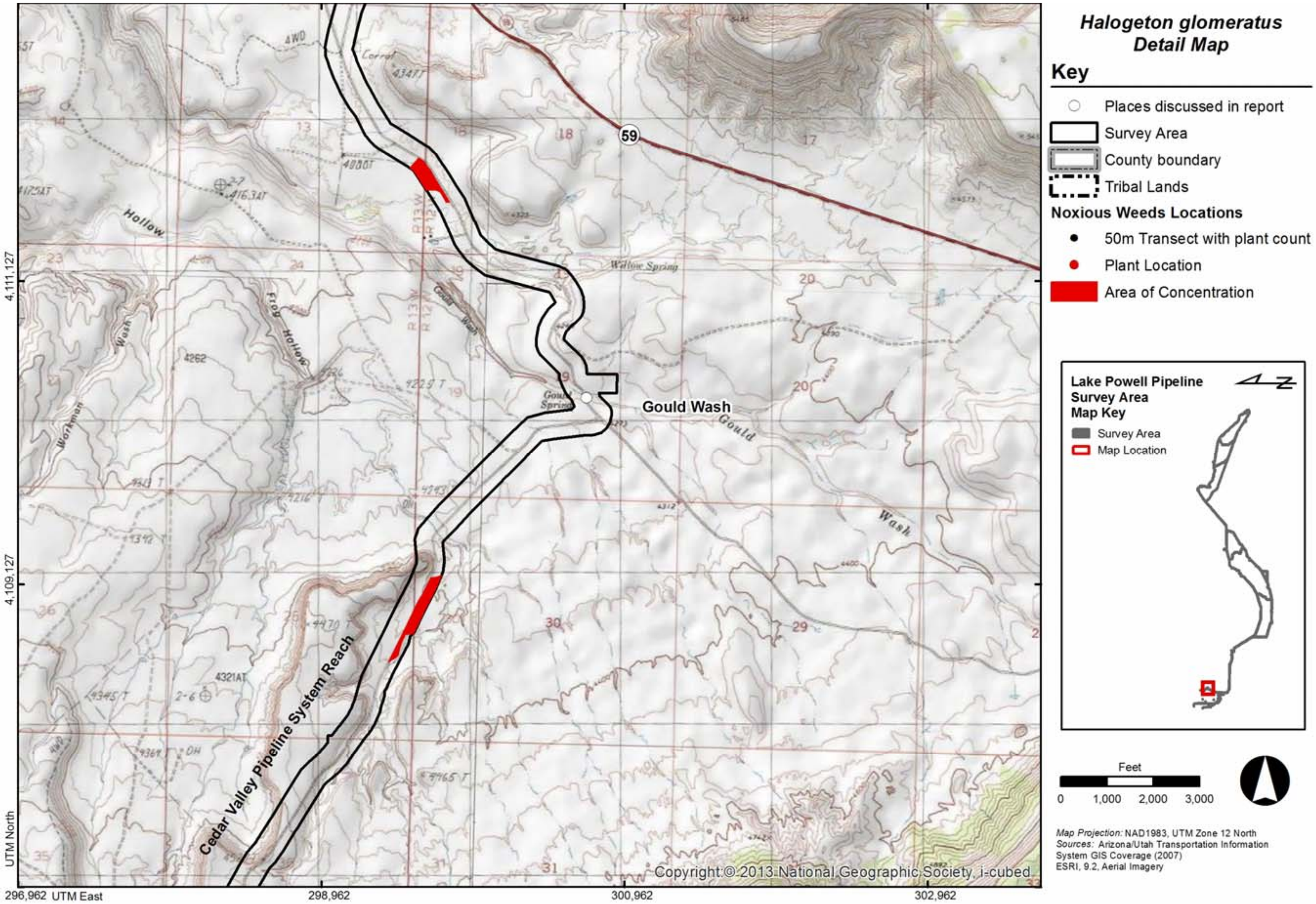

Figure 5-87
***Halogeton glomeratus* Detail Map 17**

5.5.10 *Onopordum acanthium* (Scotch thistle)

5.5.10.1 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 5-88). 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.

Figure 5-88
View of *Onopordum acanthium* and It's Habitat within the Survey Area

O. 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). *O. 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.

O. 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).

5.5.10.2 Survey Results

O. acanthium was encountered occasionally within the survey area, between the vicinity of Johnson Canyon and Short Creek at Canaan Gap (Figure 5-89). *O. acanthium* was encountered in five reaches of the survey area (Figure 5-90 to Figure 5-100). 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 U.S. 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 Mojave County (east of Short Creek at Canaan Gap) and in the vicinity of Short Creek at Canaan Gap. *O. acanthium* was not detected in any 50-meter belt transects; all encounters occurred while conducting special status species and noxious weed surveys.

O. acanthium was found in the Colorado Plateau Ecological Region, in seven ecological systems, and in three 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. Anthropogenic lands which supported individuals included Developed Road and Invasive Upland Vegetation. *O. acanthium* 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.

5.5.10.3 Discussion

O. 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 pre-construction spraying within the right-of-way be performed to control seed production. Additionally, topsoil from infested areas could be disposed as trench backfill above the pipeline, rather than re-used on-site as topsoil for revegetation.

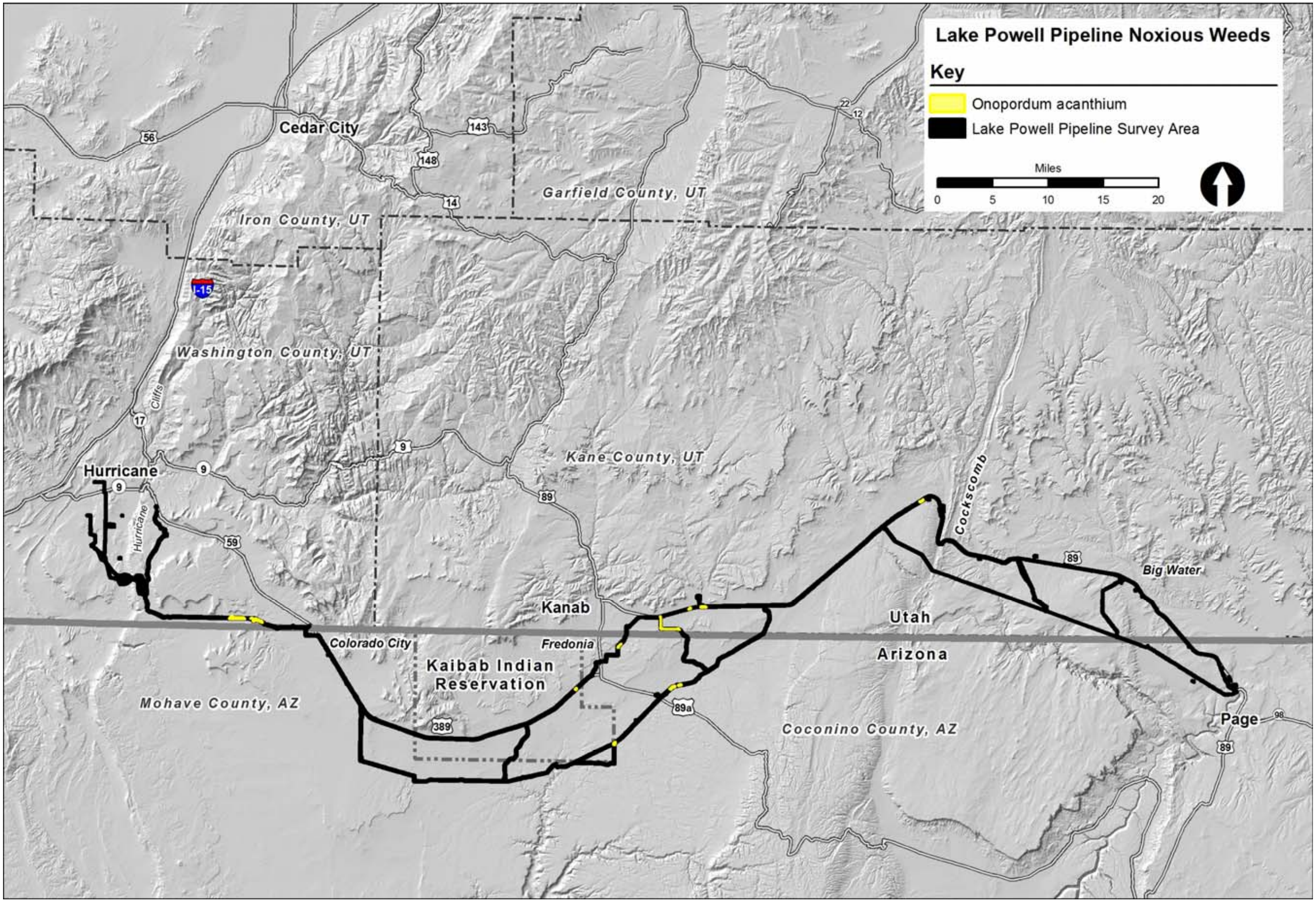

Figure 5-89
***Onopordum acanthium* Overview Map**

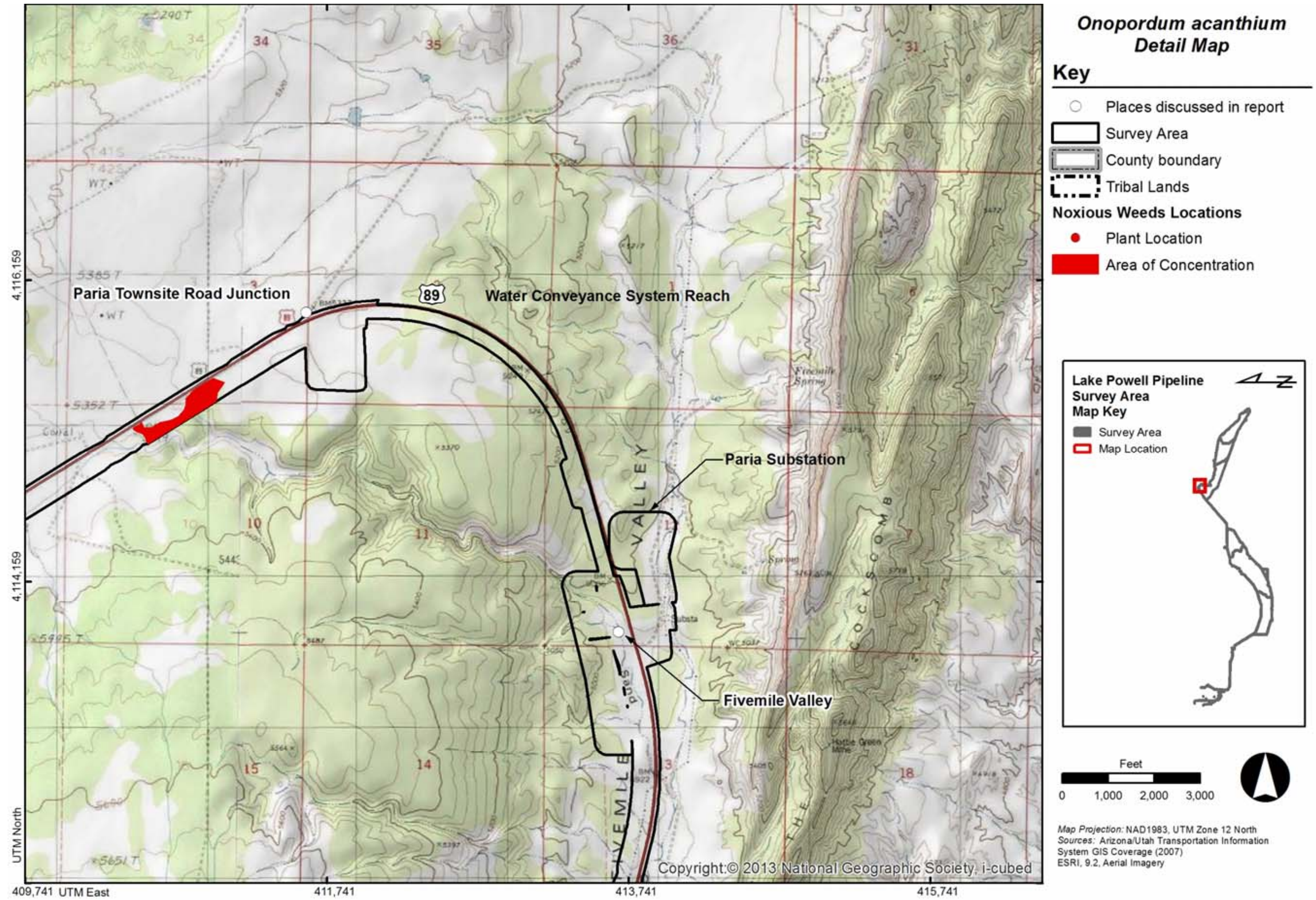

Figure 5-90
***Onopordum acanthium* Detail Map 1**

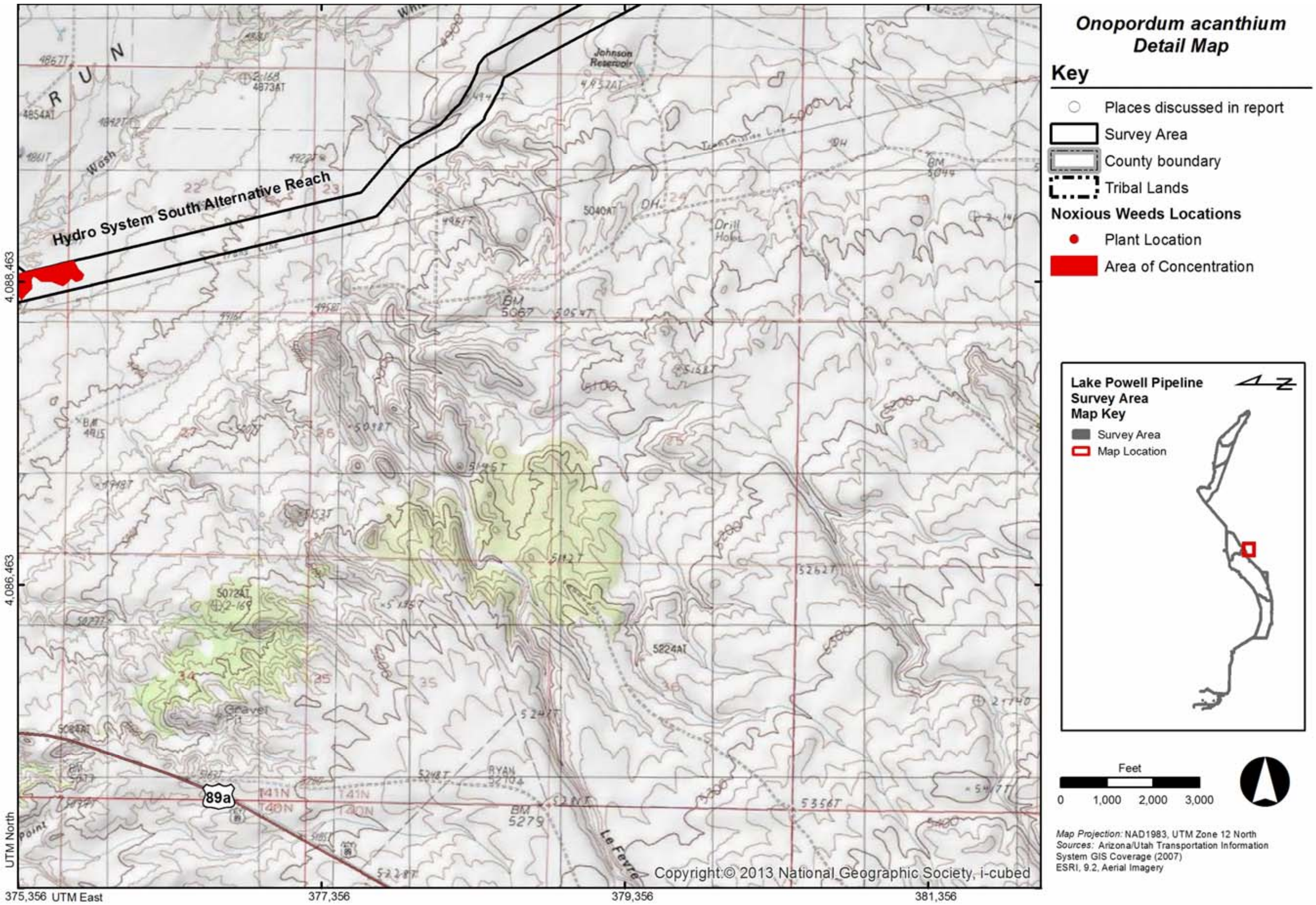

Figure 5-91
***Onopordum acanthium* Detail Map 2**

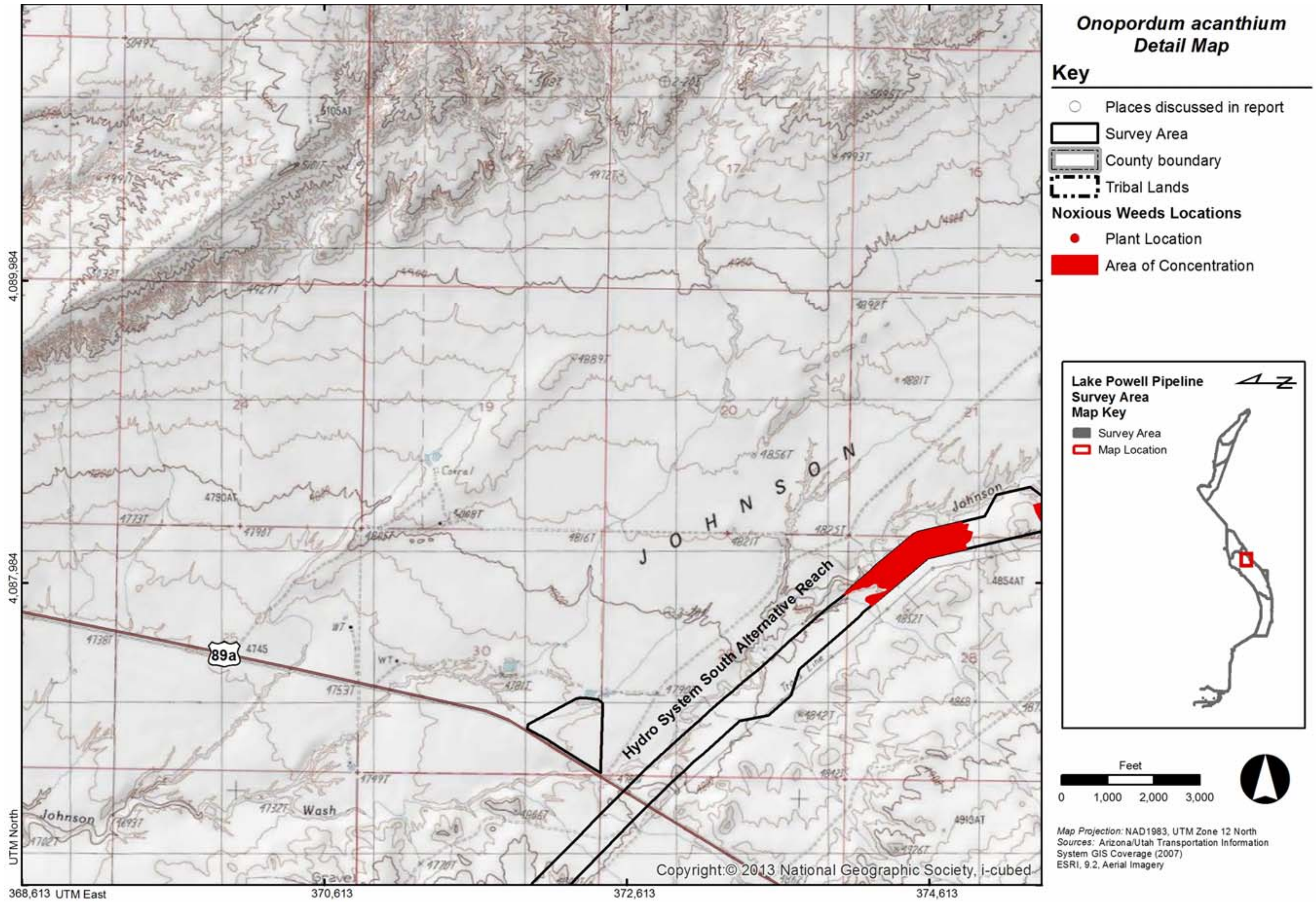

Figure 5-92
***Onopordum acanthium* Detail Map 3**

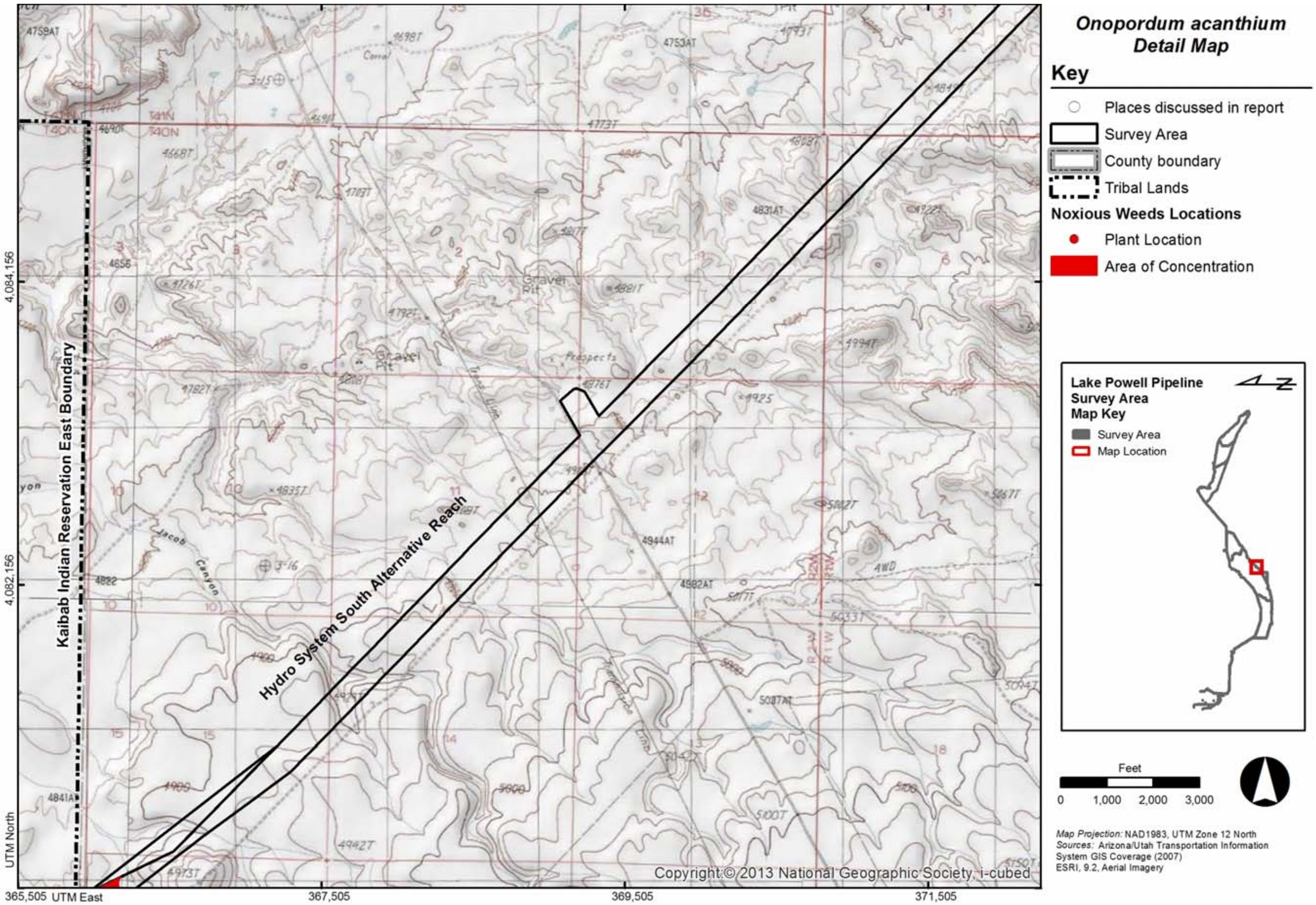

Figure 5-93
***Onopordum acanthium* Detail Map 4**

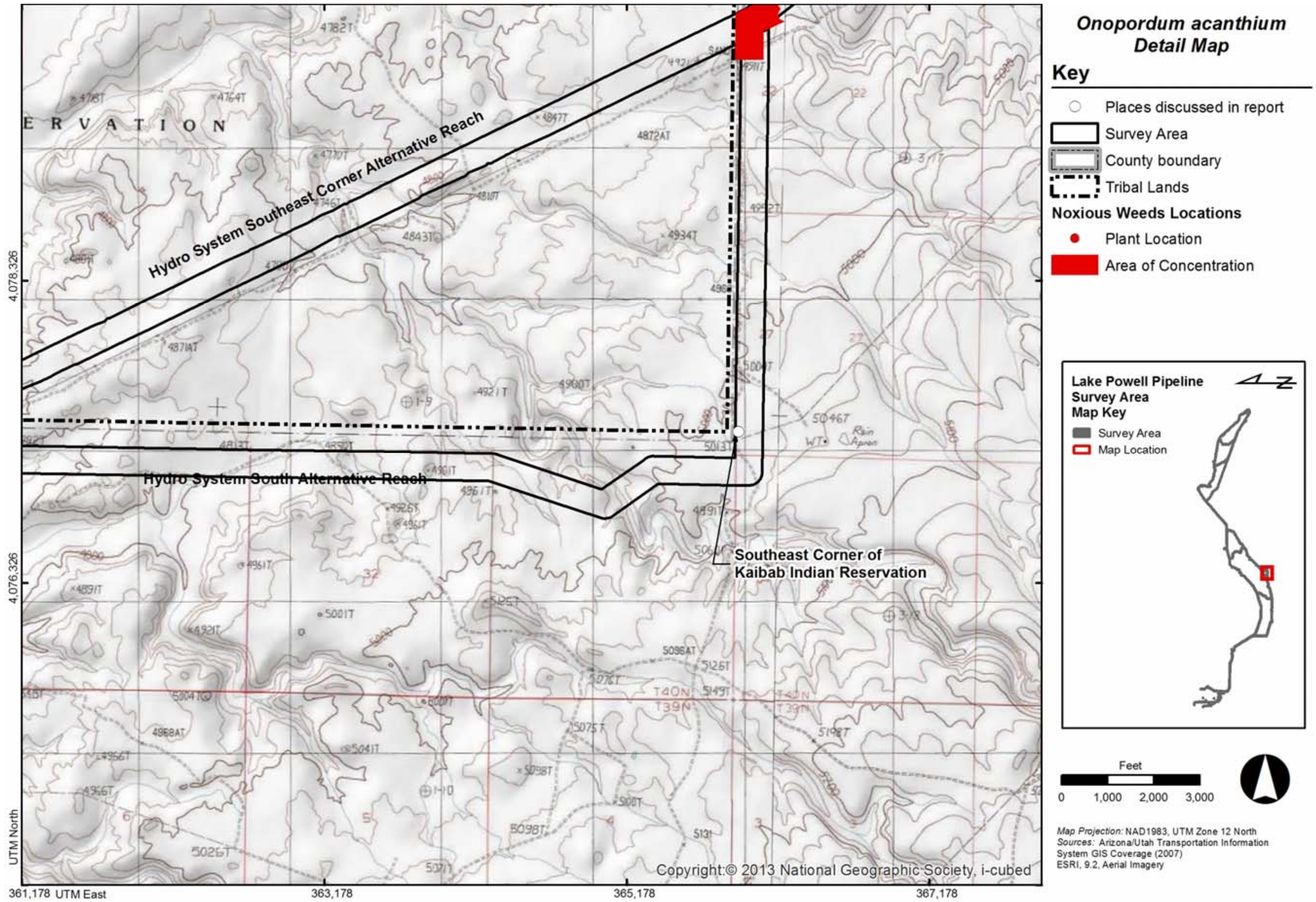

Figure 5-94

***Onopordum acanthium* Detail Map 5**

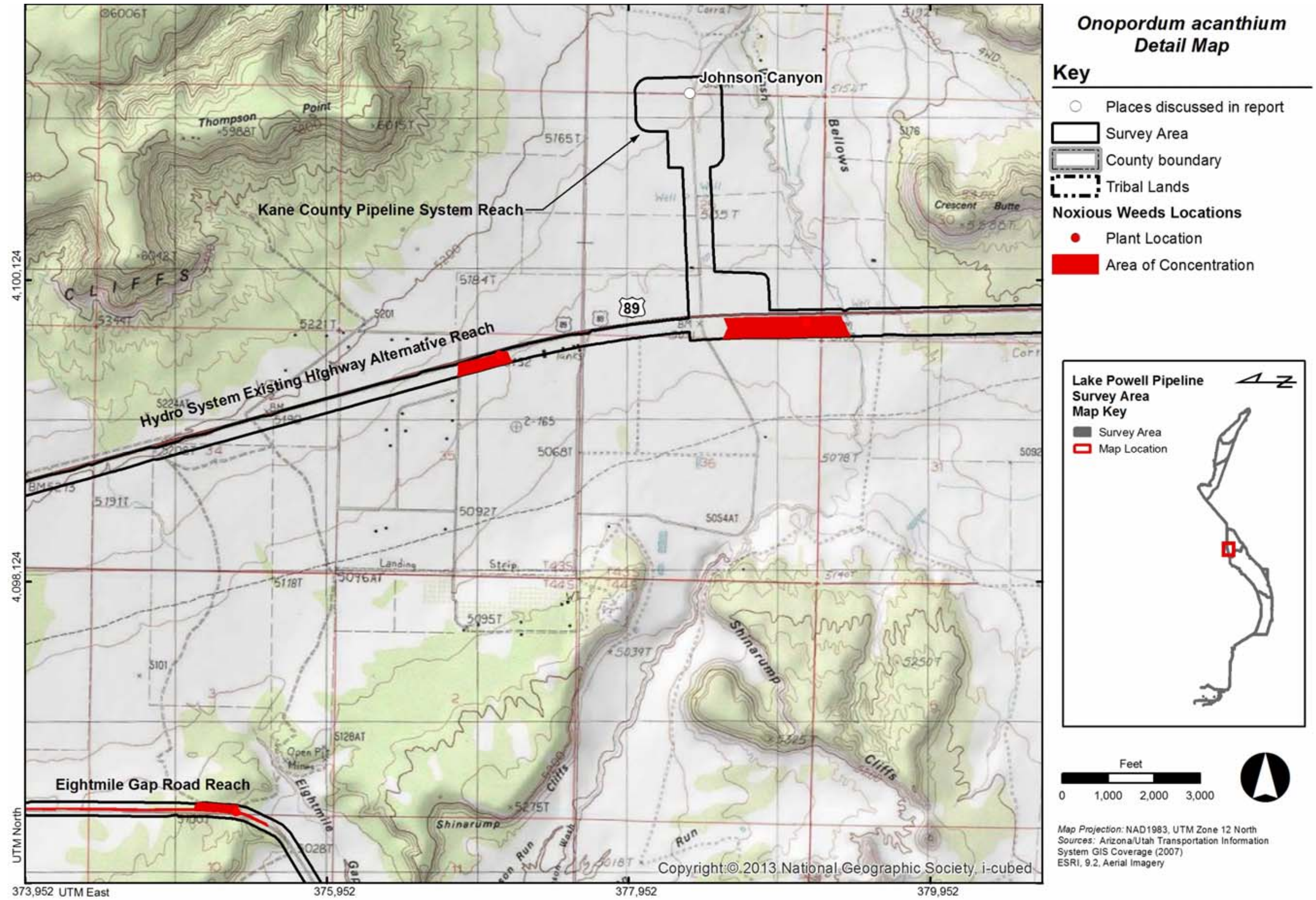

Figure 5-95
***Onopordum acanthium* Detail Map 6**

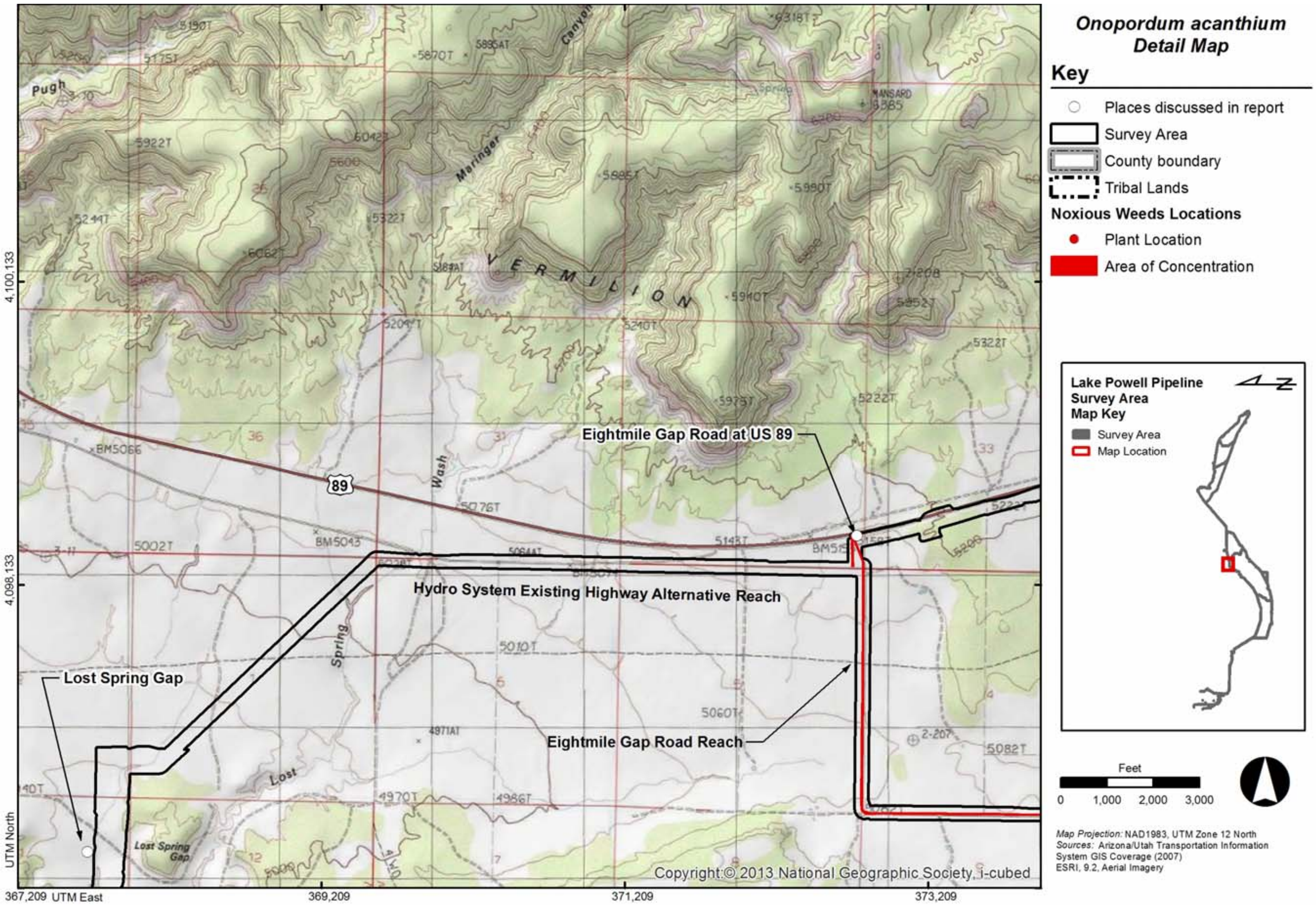

Figure 5-96
***Onopordum acanthium* Detail Map 7**

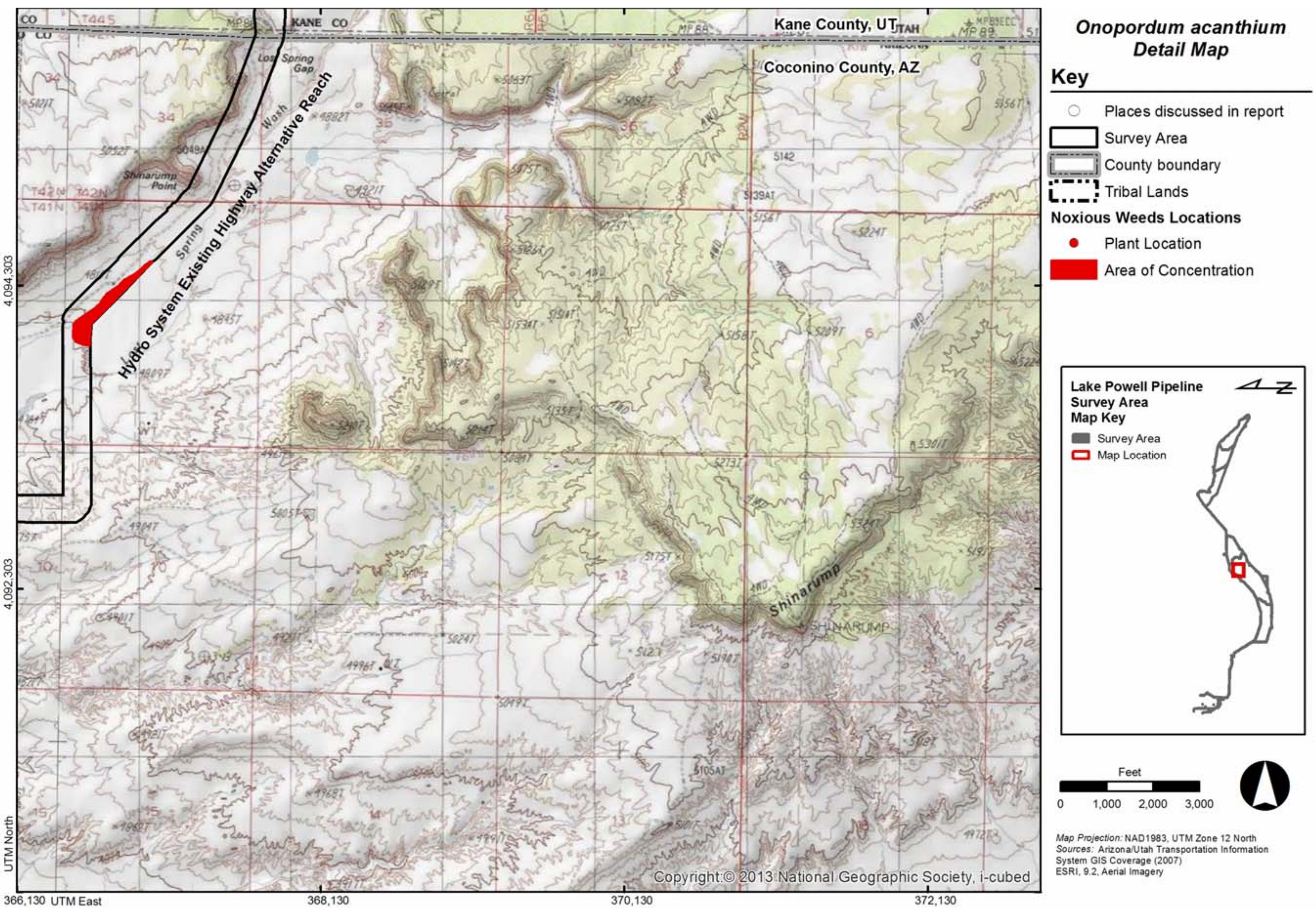

Figure 5-97
***Onopordum acanthium* Detail Map 8**

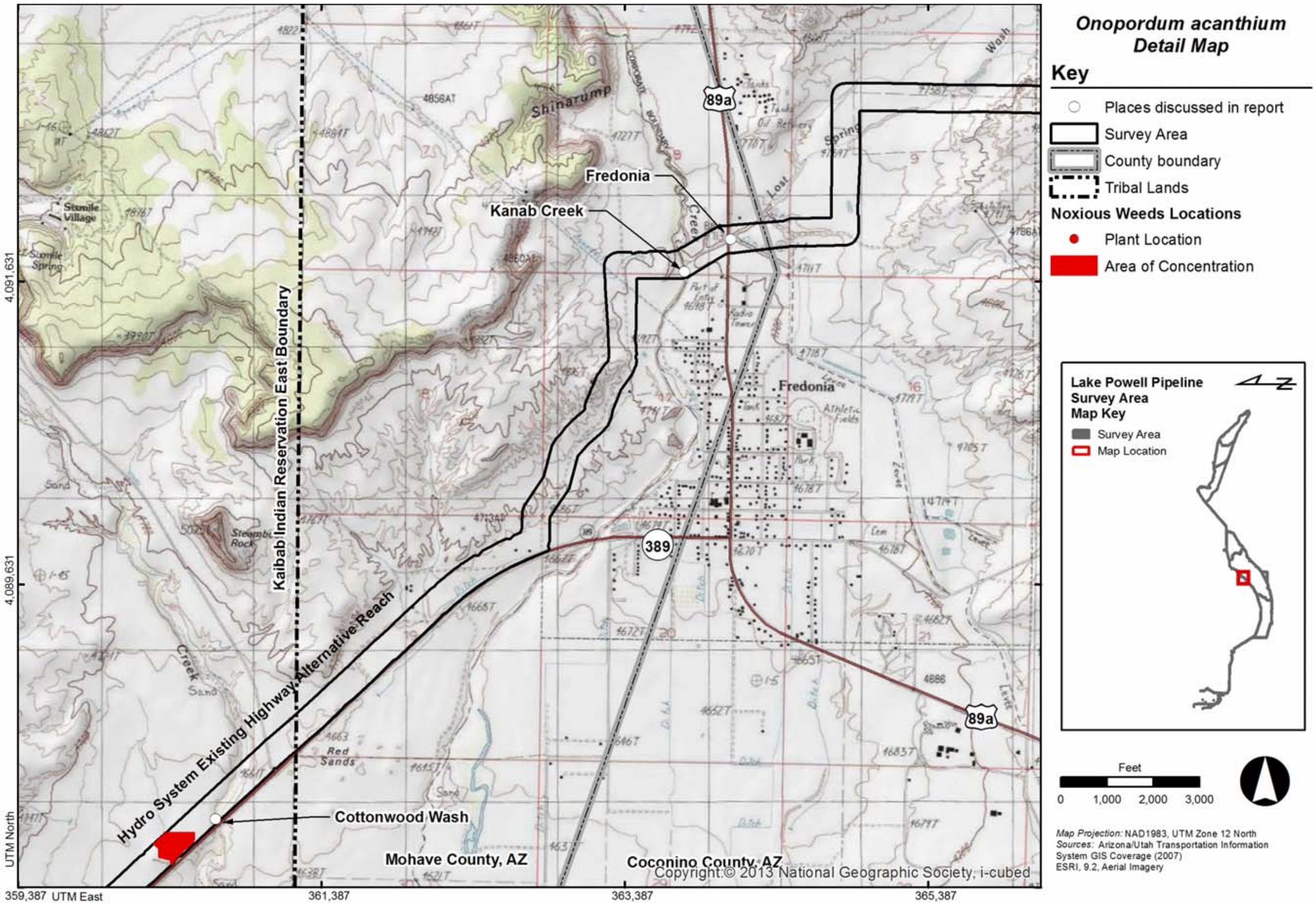

Figure 5-98
***Onopordum acanthium* Detail Map 9**

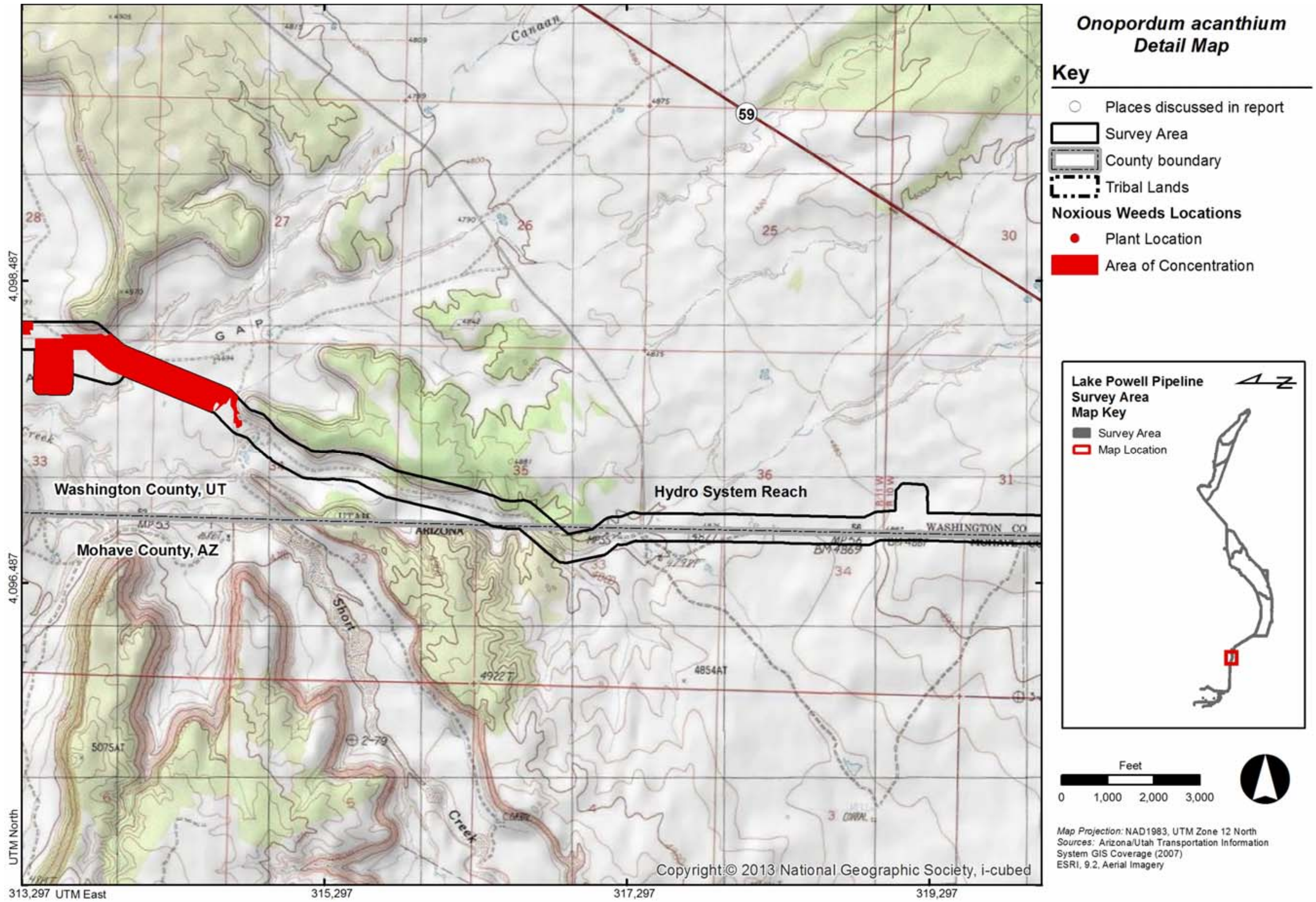

Figure 5-99
***Onopordum acanthium* Detail Map 10**

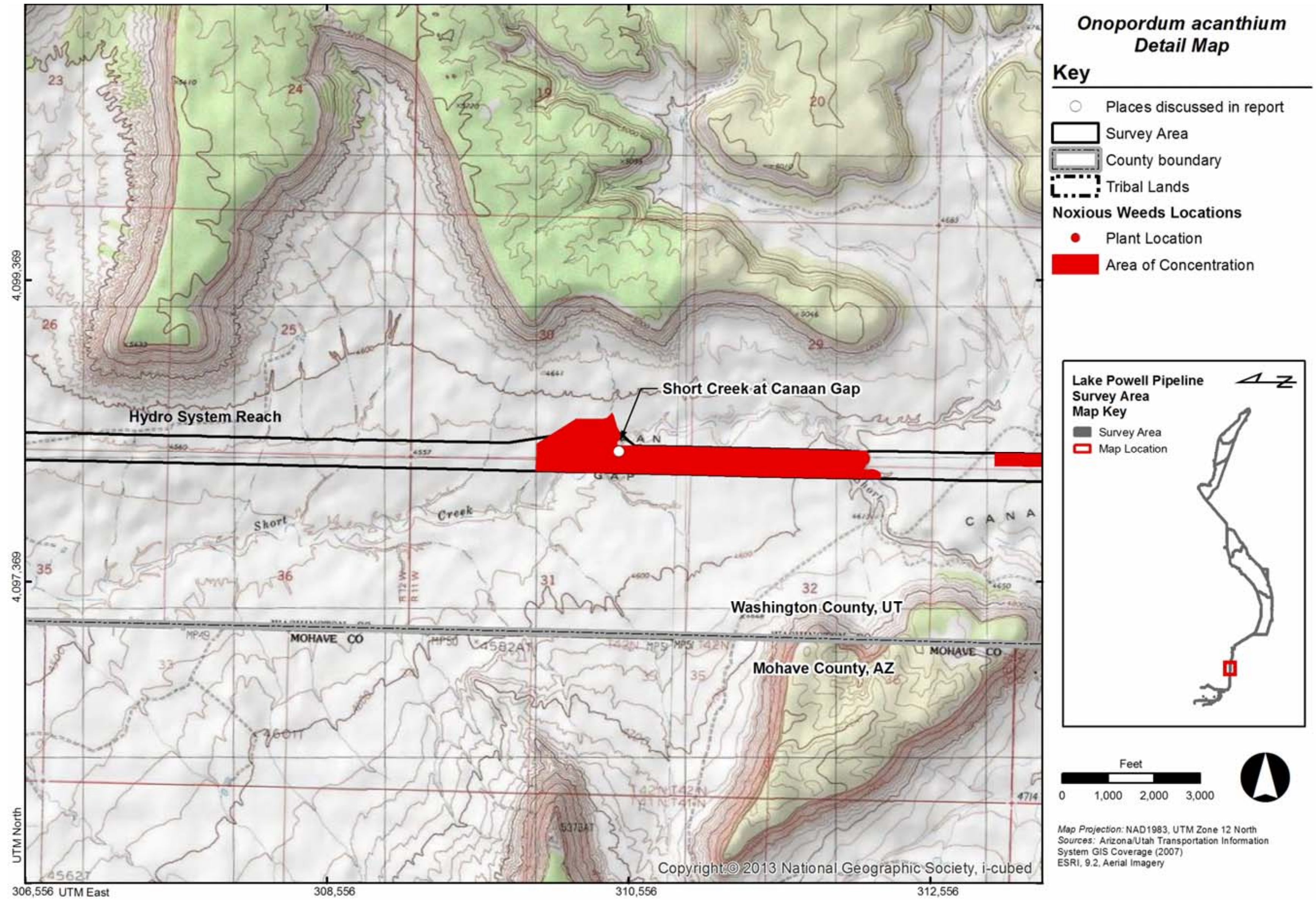

Figure 5-100
***Onopordum acanthium* Detail Map 11**

5.5.11 *Portulaca oleracea* (Common purslane)

5.5.11.1 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 5-101). 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.

Figure 5-101
Close-up View of *Portulaca oleracea*
within the Survey Area

P. 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, *P. 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).

P. 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 5-102), 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).

Figure 5-102
View of *Portulaca oleracea* and It's Habitat
within the Survey Area

5.5.11.2 Survey Results

The survey identified *P. oleracea* infrequently, in only a handful of locations within the survey area (Figure 5-103). *P. oleracea* was encountered primarily in the eastern and central portions of the survey area, and found within five reaches (Figure 5-104 to Figure 5-113). *P. oleracea* was identified at the Glen Canyon Substation. In the Water Conveyance System Reach it was found in the vicinity of Greenehaven, near Big Water, and north of Jacob's Tank Road at U.S. 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. *P. oleracea* was not detected in any 50 meter belt transects; all encounters occurred while conducting special status species and noxious weed surveys.

P. 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.

5.5.11.3 Discussion

P. 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.

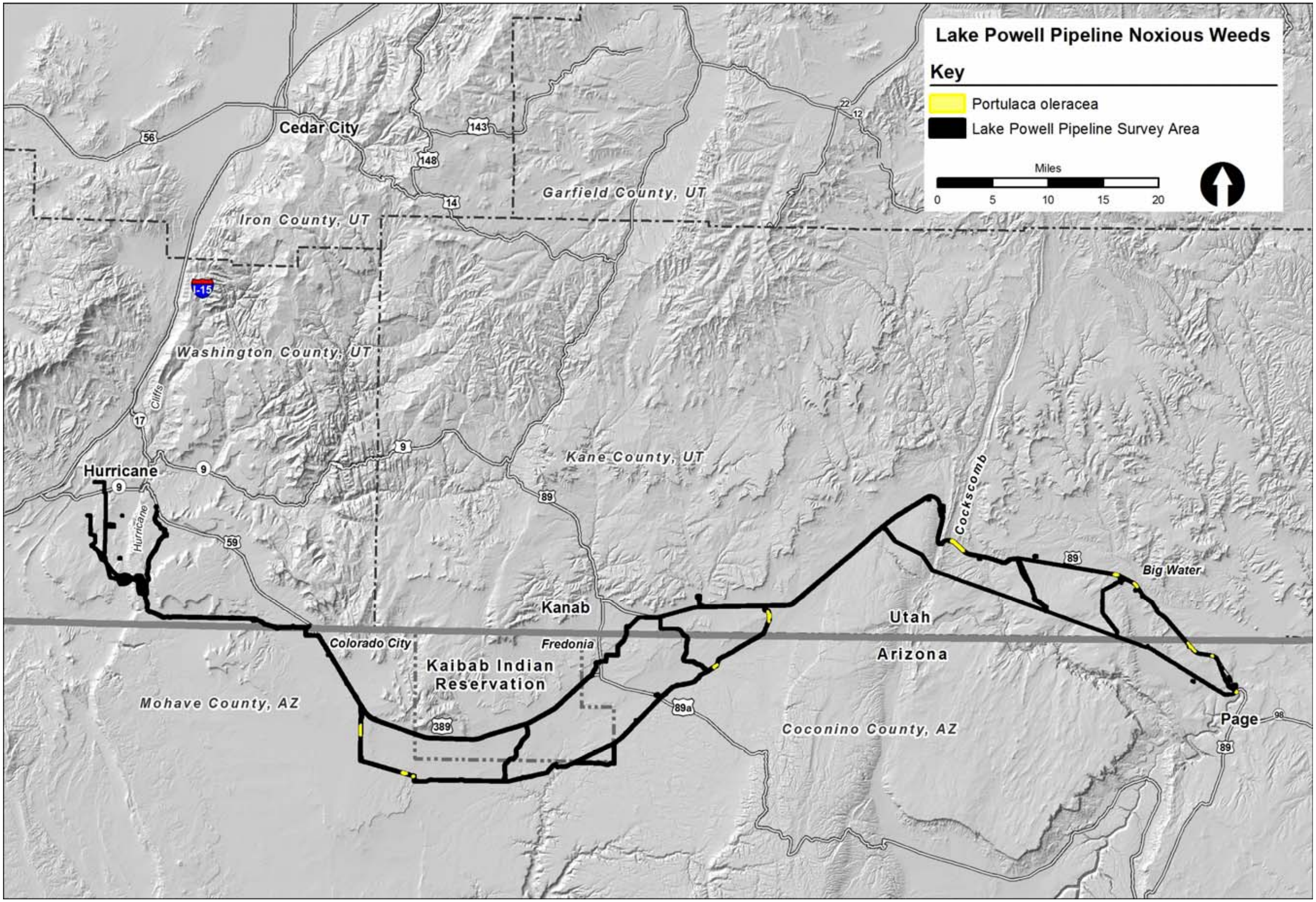

Figure 5-103
***Portulaca oleracea* Overview Map**

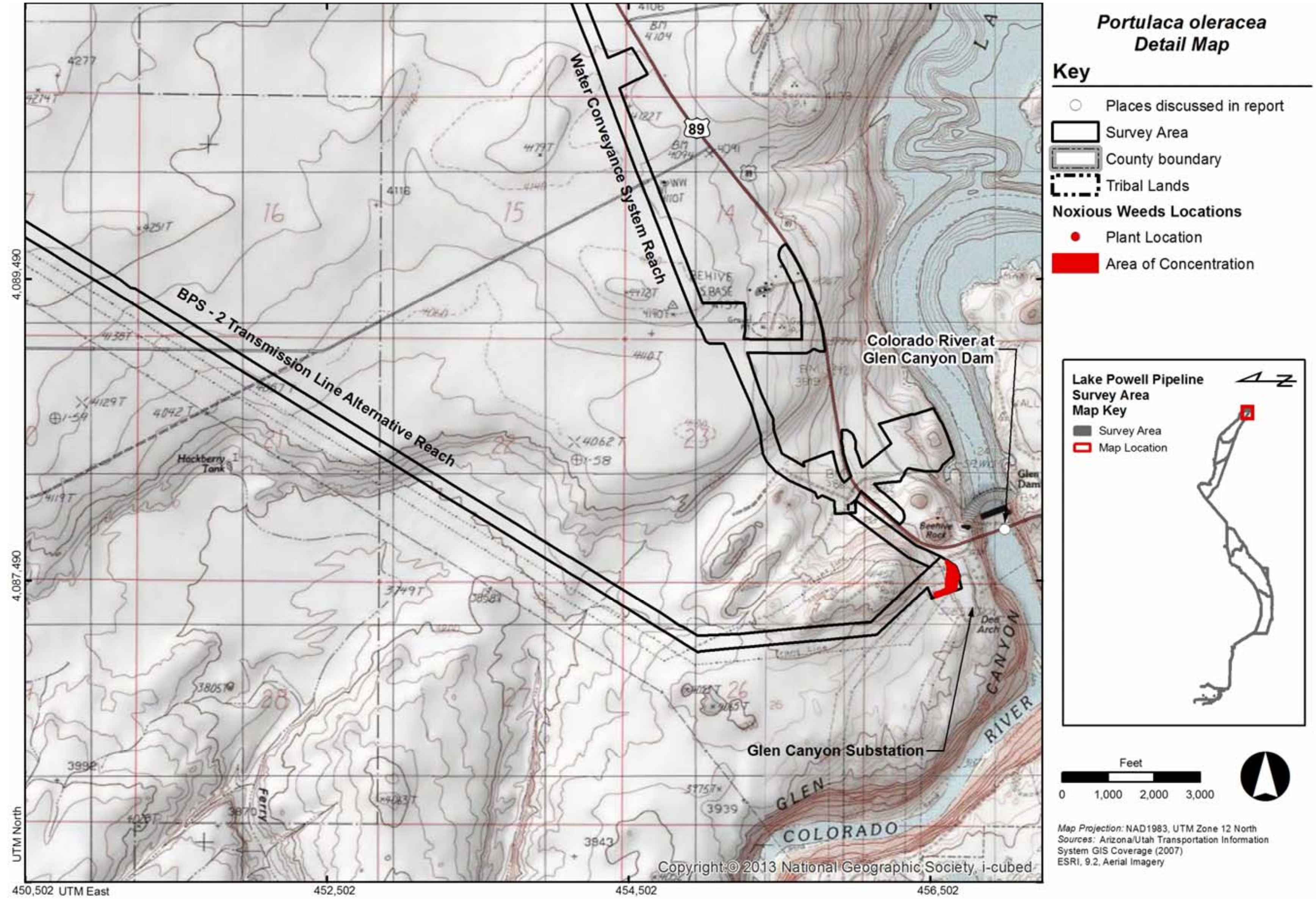

Figure 5-104
***Portulaca oleracea* Detail Map 1**

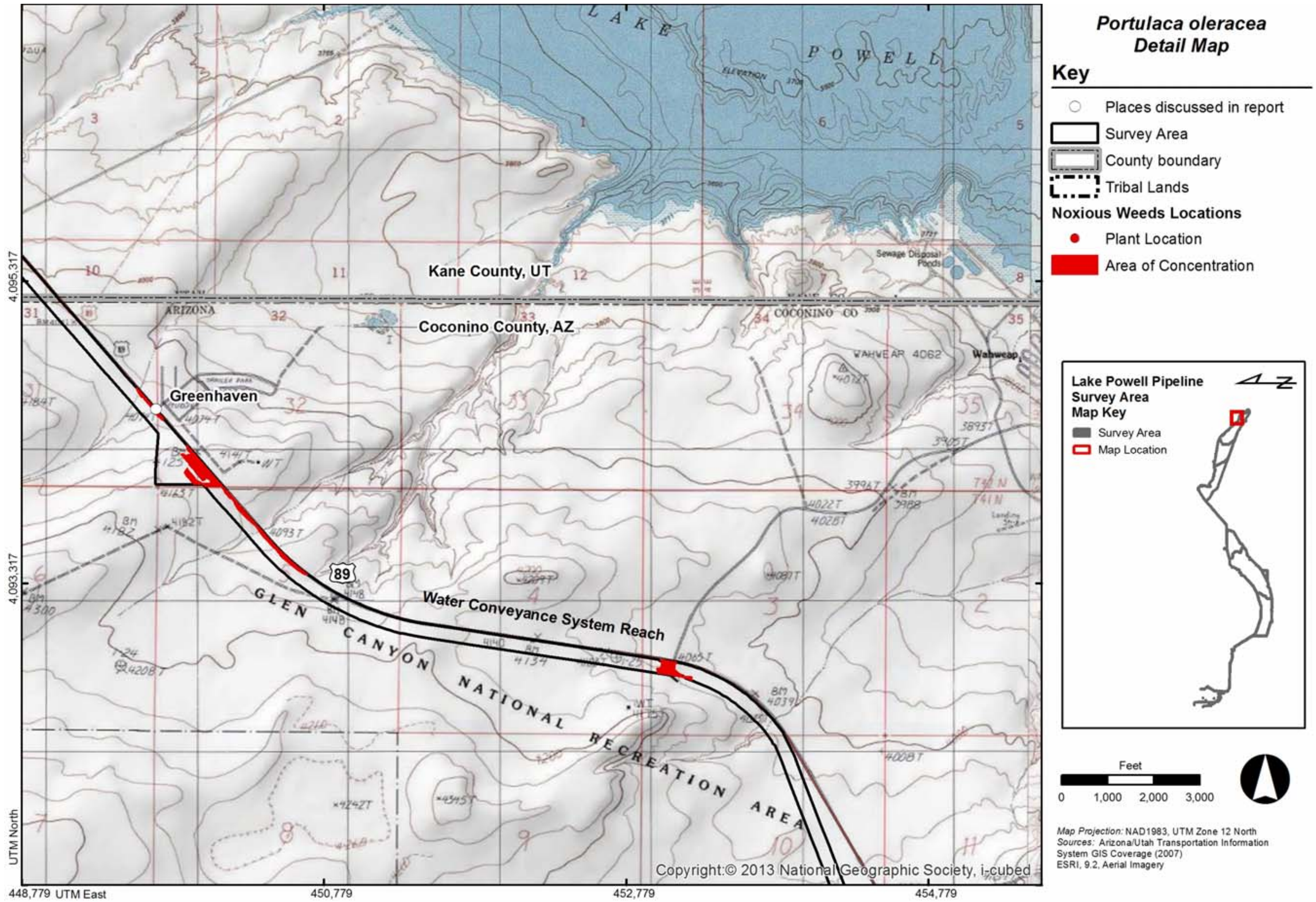

Figure 5-105
***Portulaca oleracea* Detail Map 2**

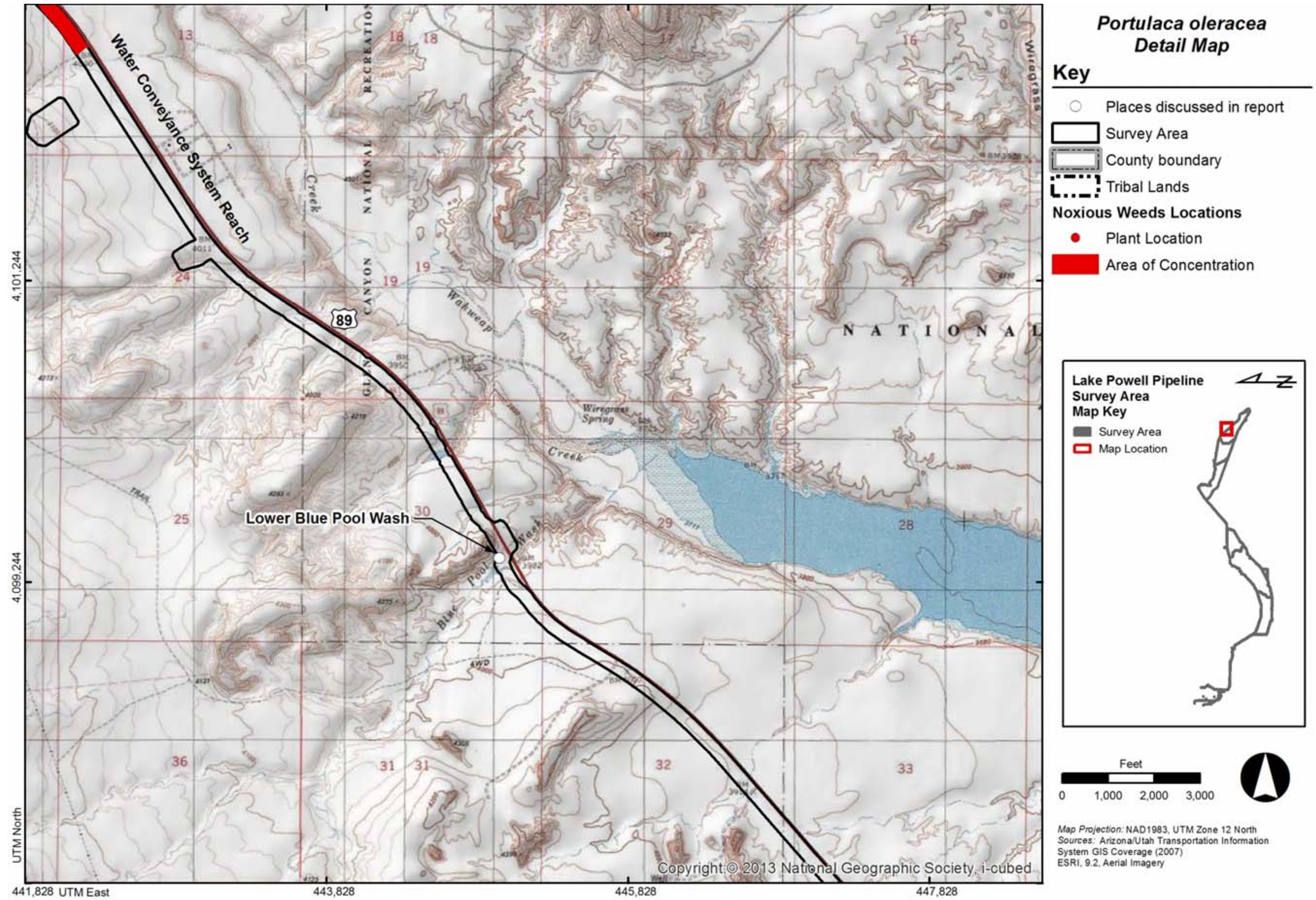

Figure 5-106
***Portulaca oleracea* Detail Map 3**

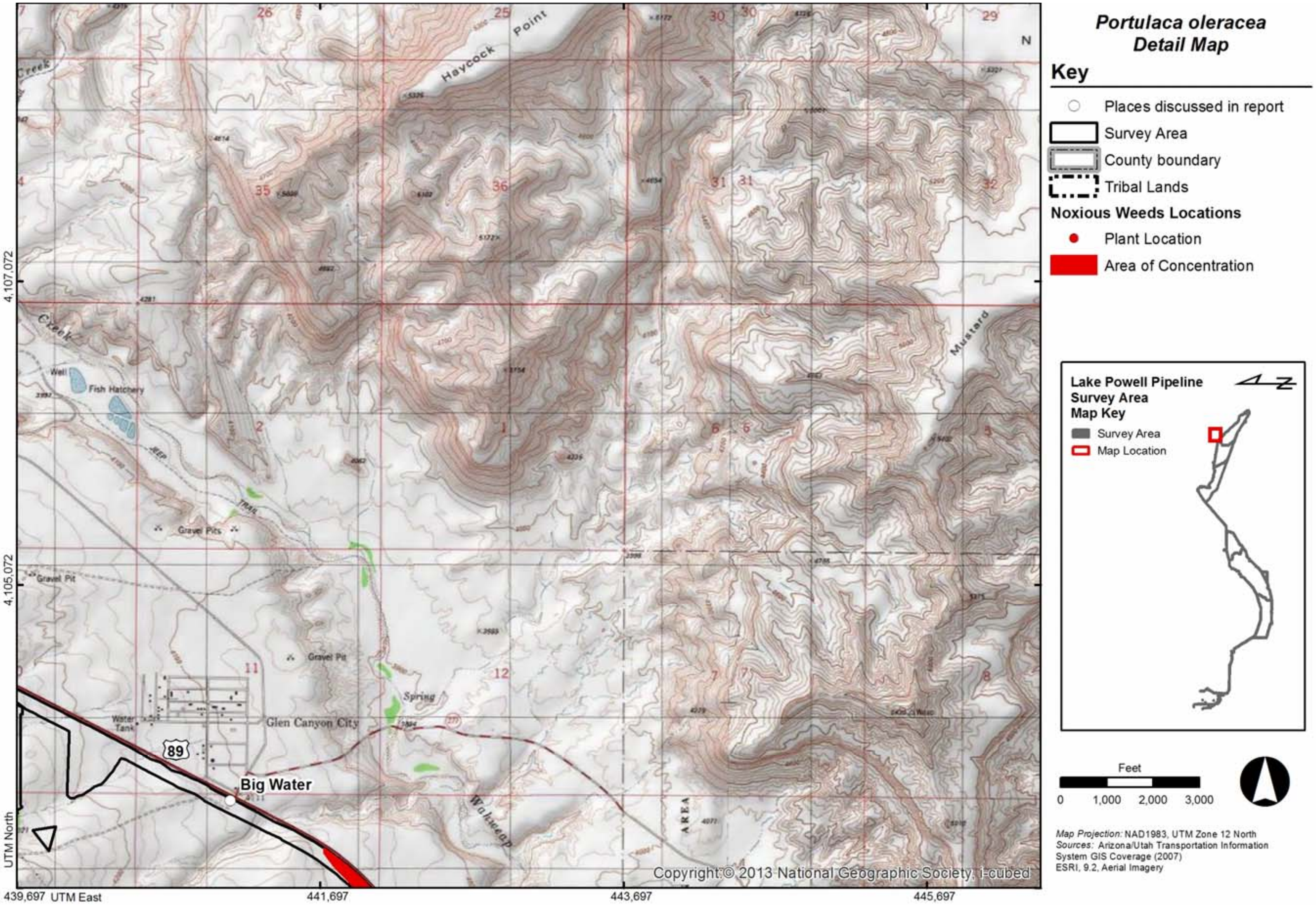

Figure 5-107
***Portulaca oleracea* Detail Map 4**

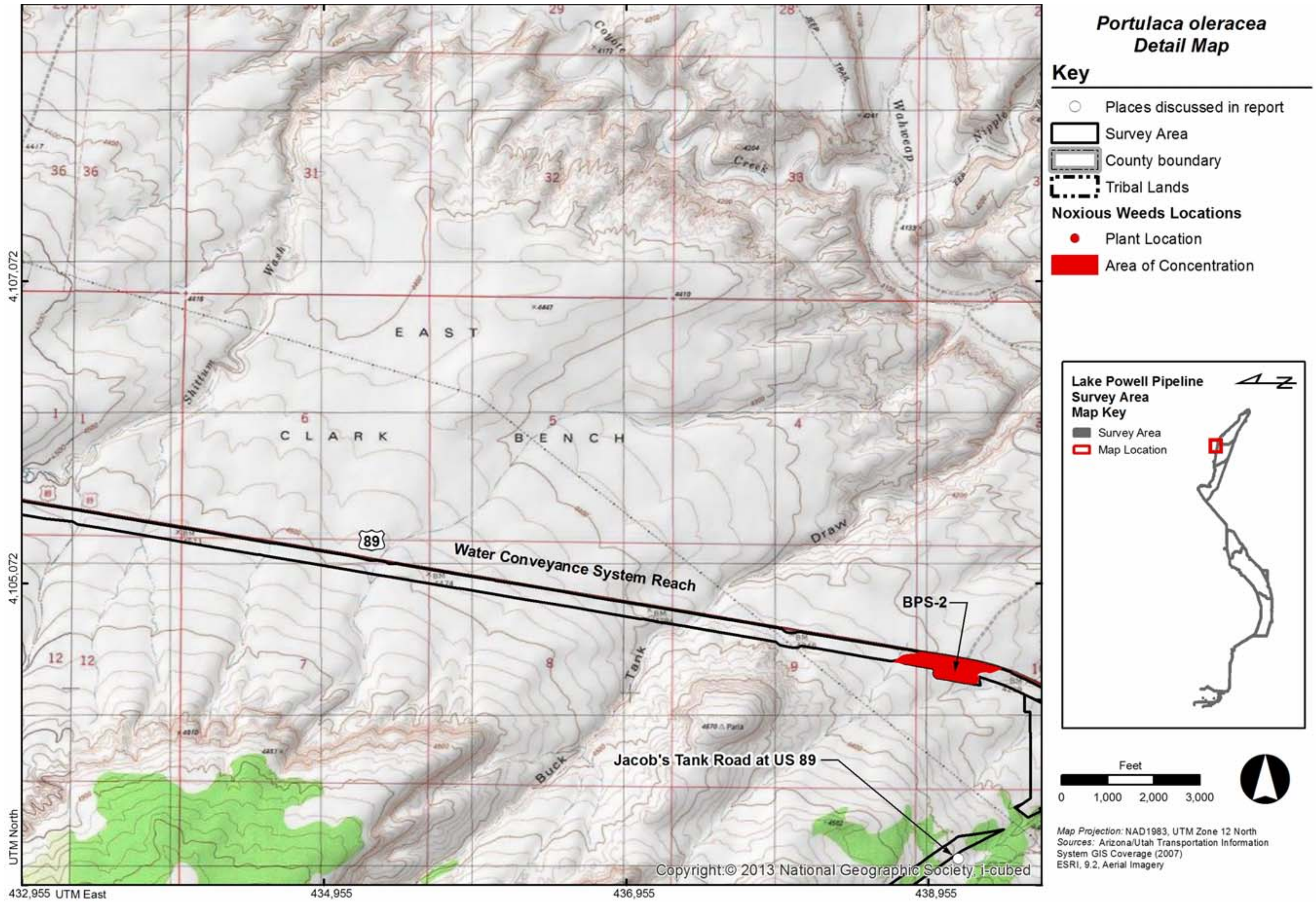

Figure 5-108
***Portulaca oleracea* Detail Map 5**

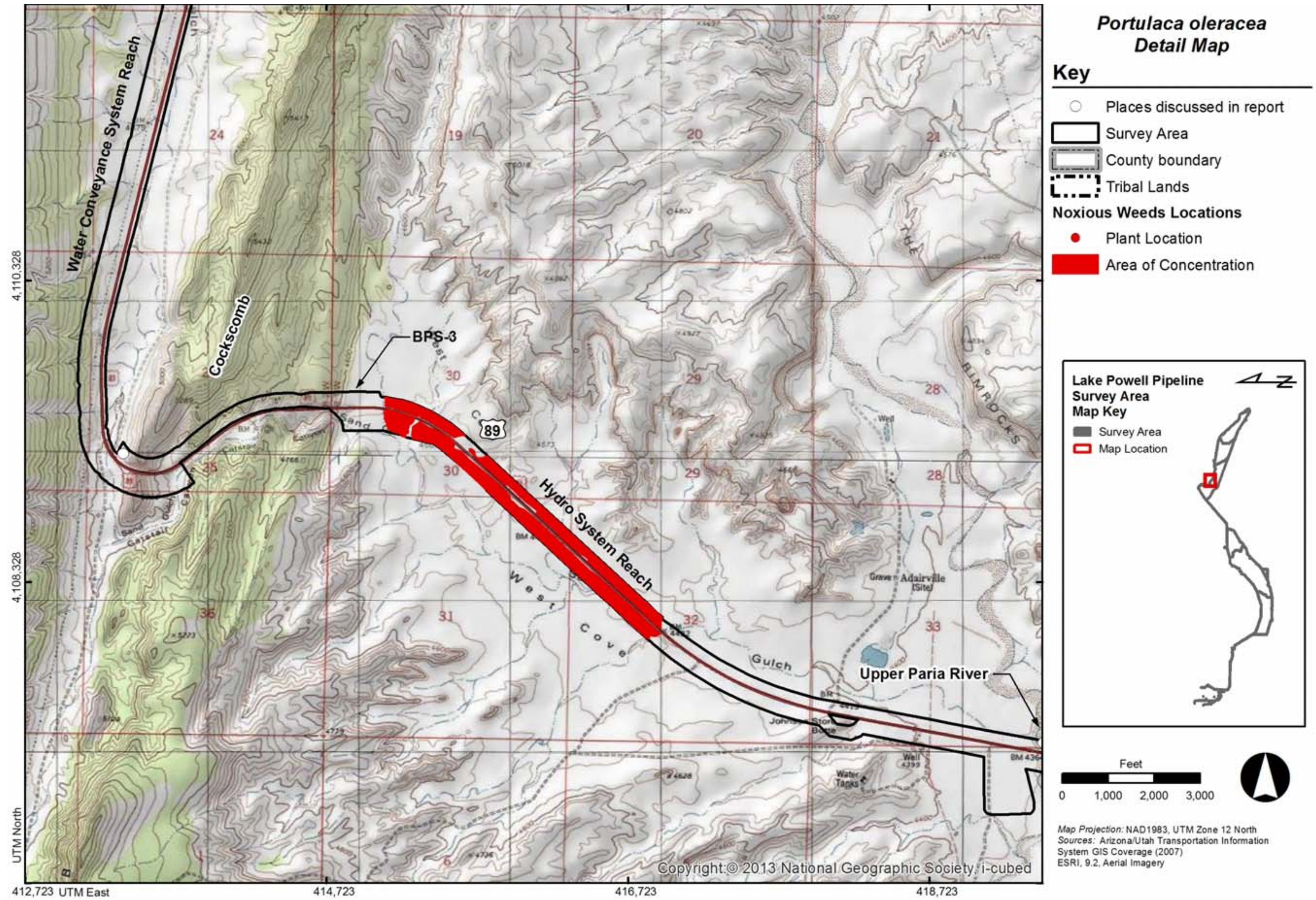

Figure 5-109
***Portulaca oleracea* Detail Map 6**

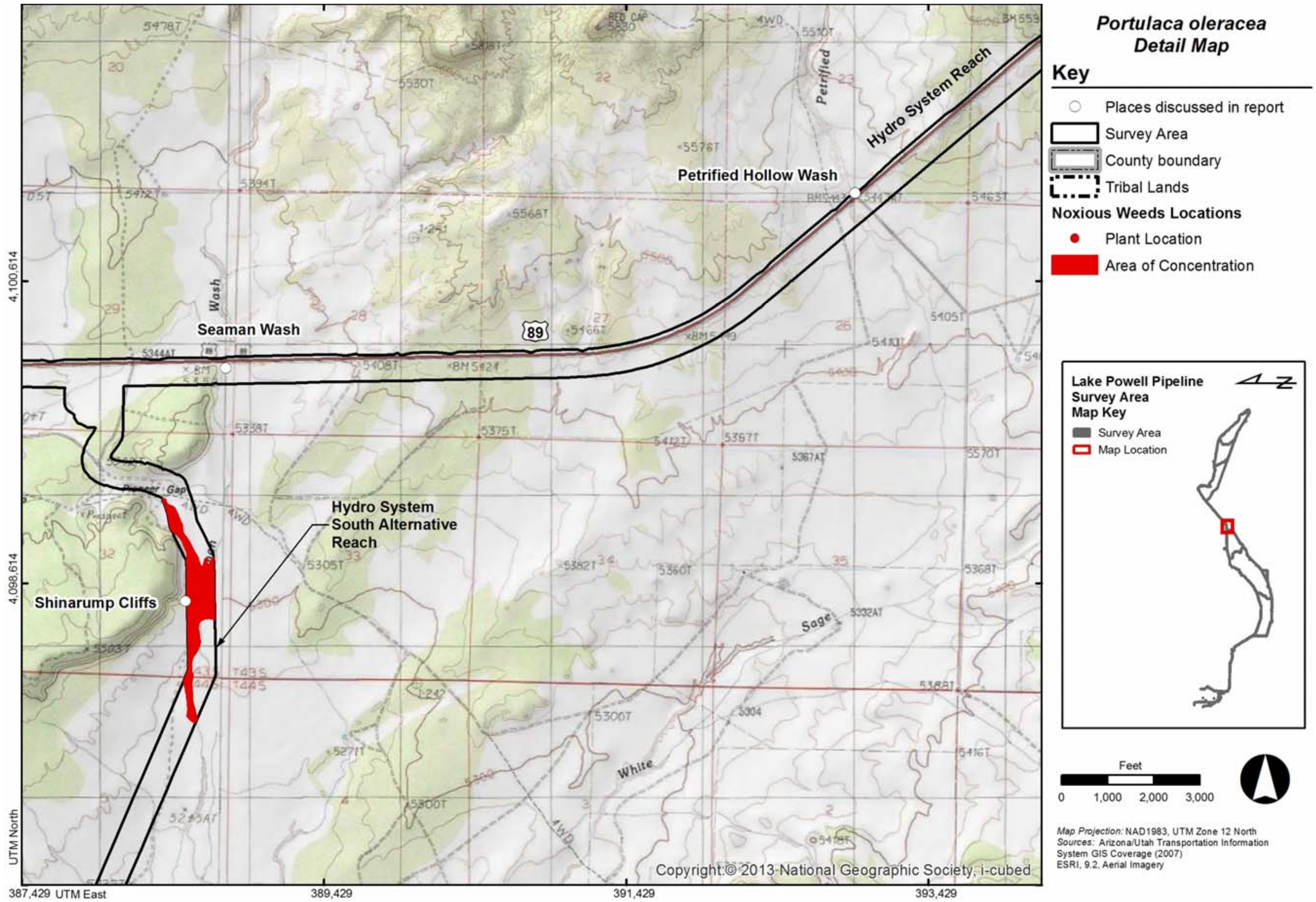

Figure 5-110
***Portulaca oleracea* Detail Map 7**

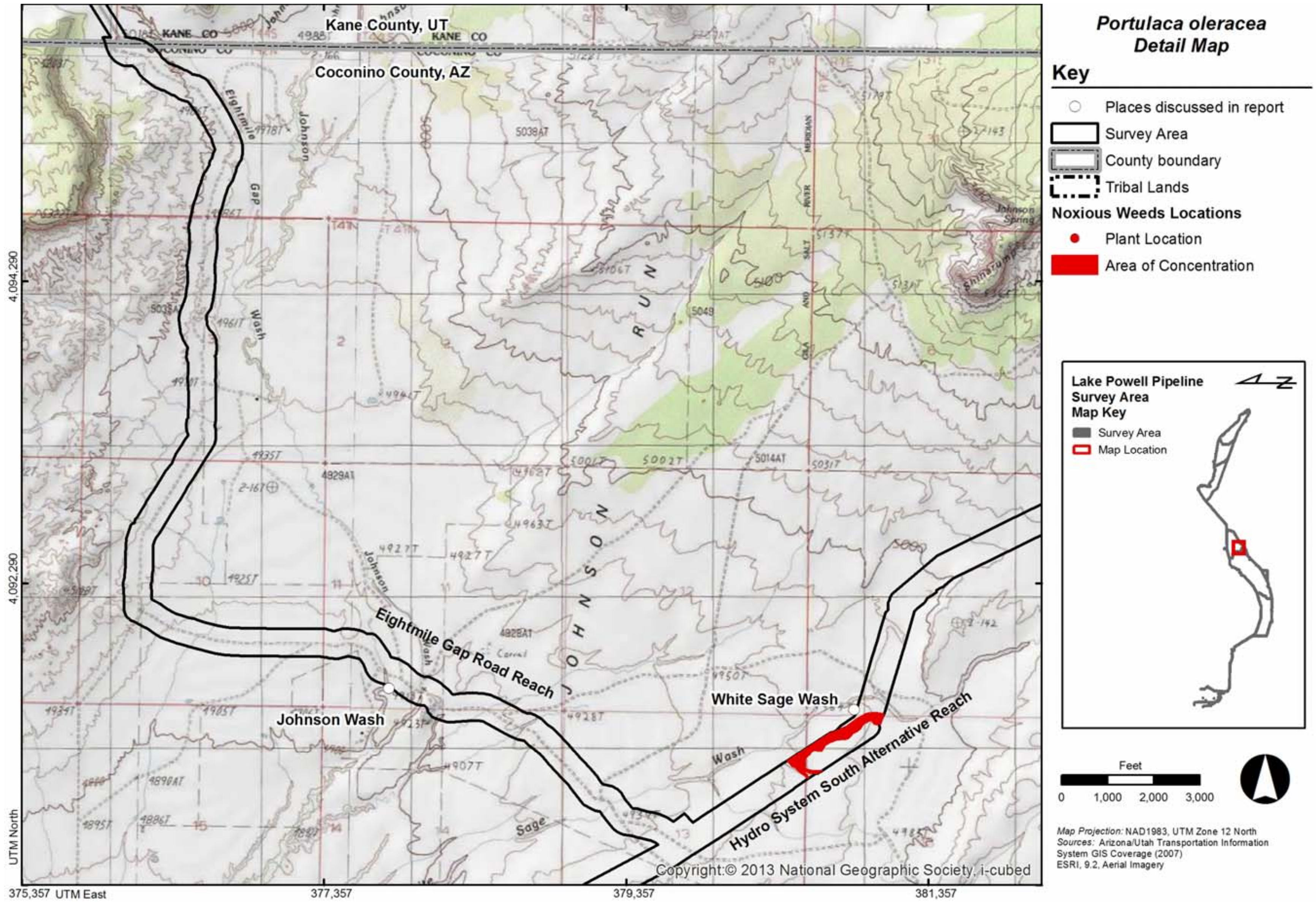

Figure 5-111
***Portulaca oleracea* Detail Map 8**

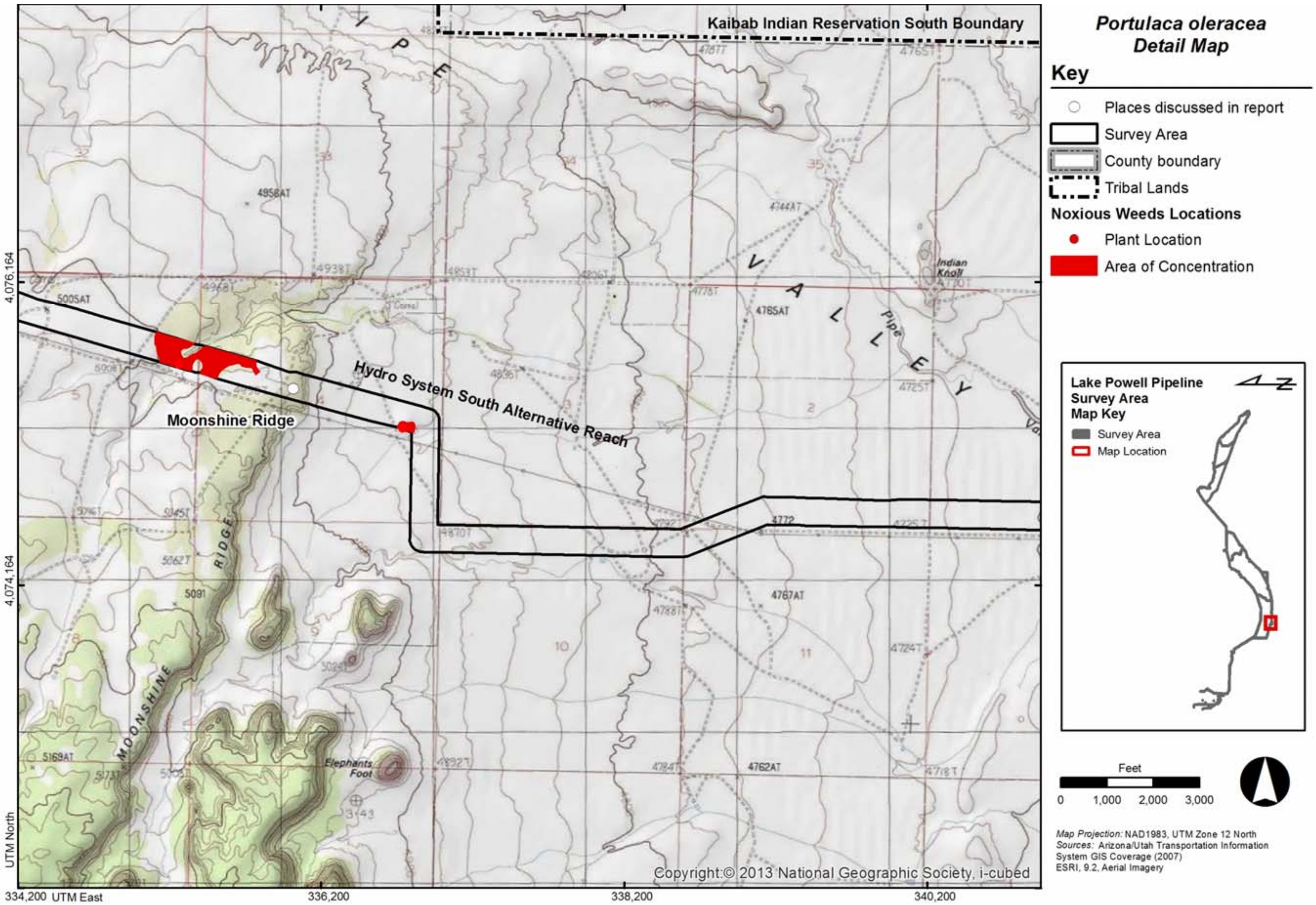

Figure 5-112
***Portulaca oleracea* Detail Map 9**

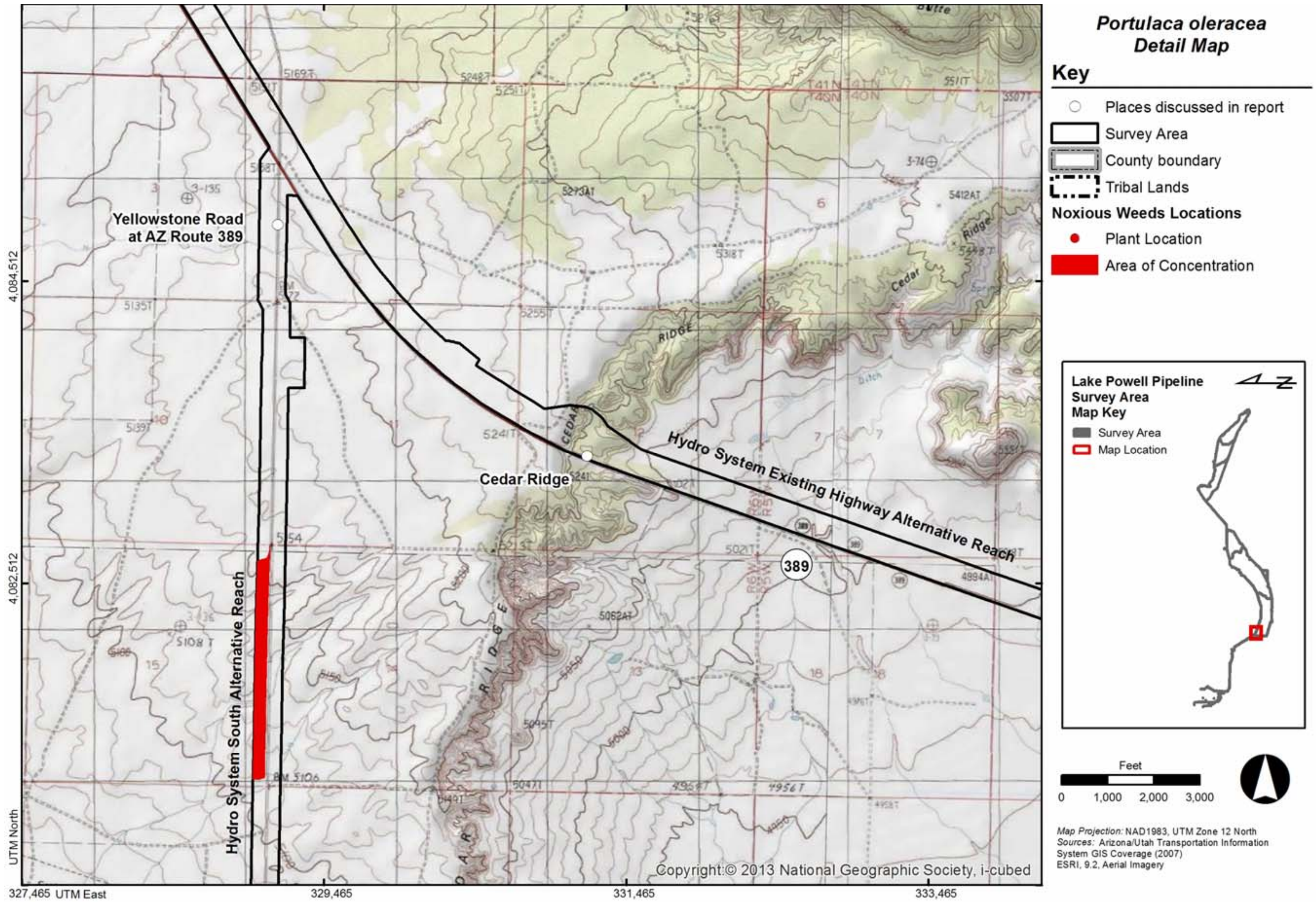

Figure 5-113
***Portulaca oleracea* Detail Map 10**

5.5.12 *Salsola tragus* (Russian thistle)

5.5.12.1 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 5-114). 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).

Figure 5-114
Close-up View of *Salsola tragus*
within the Survey Area

S. 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).

S. 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). *S. 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).

S. tragus grows vigorously in disturbed areas (Figure 5-115), and dead plants fill ravines, clog irrigation ditches, and can challenge vehicles on roadways (Welsh et al. 2008). *S. tragus* can also affect agriculture, as it serves as a host for sugar beet leafhopper, which carries a virus that affects beets, and also is the source that causes blight in spinach, tomatoes, and beans (Parker 2003).

Figure 5-115
View of *Salsola tragus* and It's Habitat
within the Survey Area

5.5.12.2 Survey Results

S. tragus was widespread throughout the survey area, ranging from the vicinity of Colorado River at Glen Canyon Dam to Hurricane (Figure 5-116). *S. tragus* was found in a total of 22 reaches. The species was encountered sporadically in the Glen Canyon to Buckskin Transmission Line 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 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. *S. tragus* 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. *S. tragus* was common throughout much of the 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. *S. tragus* was encountered while conducting surveys for special status species and noxious weeds; however, the species was also detected in a total of 193 50-meter belt transects.

S. tragus was identified in both Ecological Regions, in 20 ecological systems, and in five 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 Mojave Desert, *S. tragus* was encountered in Active and Stabilized Dune, Creosote-White Bursage Desert Scrub, Grassland, 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, 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.

5.5.12.3 Discussion

S. 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. *S. 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 continue the ability of *S. tragus* 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.

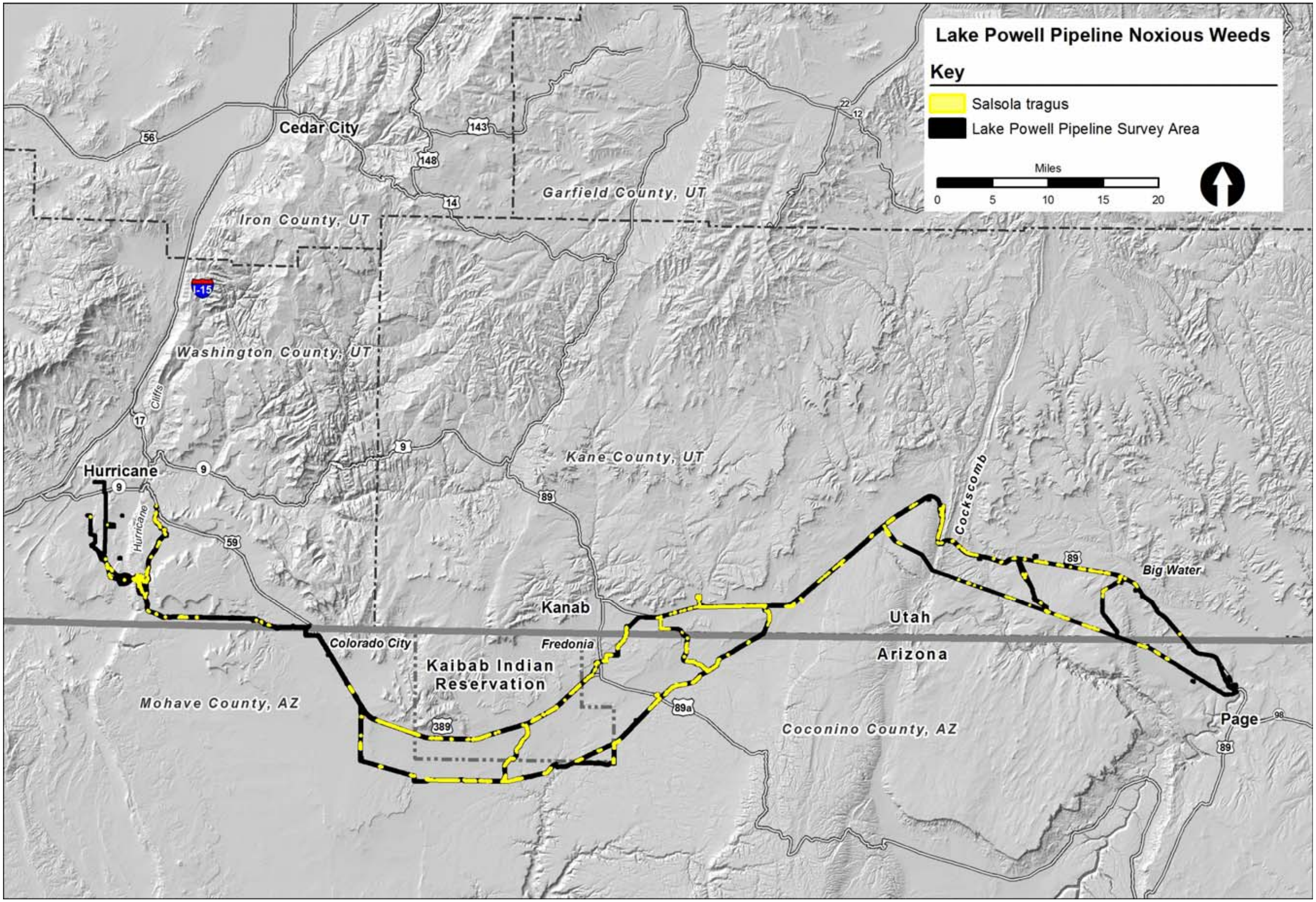

Figure 5-116
***Salsola tragus* Overview Map**

5.5.13 *Sorghum halepense* (Johnsongrass)

5.5.13.1 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 7 mm) long and 0.06 to 0.08 inch (1.5 to 2 mm) wide. Lemma awns are absent or between 0.35 and 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).

S. 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).

S. 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 ditch banks 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 5-117); it flowers from April to November (Parker 2003).

Figure 5-117
Close-up View of *Sorghum halapense*
within the Survey Area

S. 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).

5.5.13.2 Survey Results

S. halepense occurred rarely within the survey area (Figure 5-118), and in only one reach (Figure 5-119 to Figure 5-122). 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. *S. halepense* 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 # 65 and 67).

S. halepense was encountered in the Colorado Plateau and Mojave Desert Ecological Regions, where it occurred in four ecological systems and one anthropogenic land. The species was identified in Big Sagebrush Shrubland, Pinyon-Junipers Woodland, Shrub-Steppe and Colorado Plateau Wash. *S. halepense* was found in Ruderal Vegetation anthropogenic land. Most commonly, it was encountered in disturbed lands, and individuals were identified in small numbers.

5.5.13.3 Discussion

S. 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 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 within the right-of-way during pre-construction periods to control seed production.

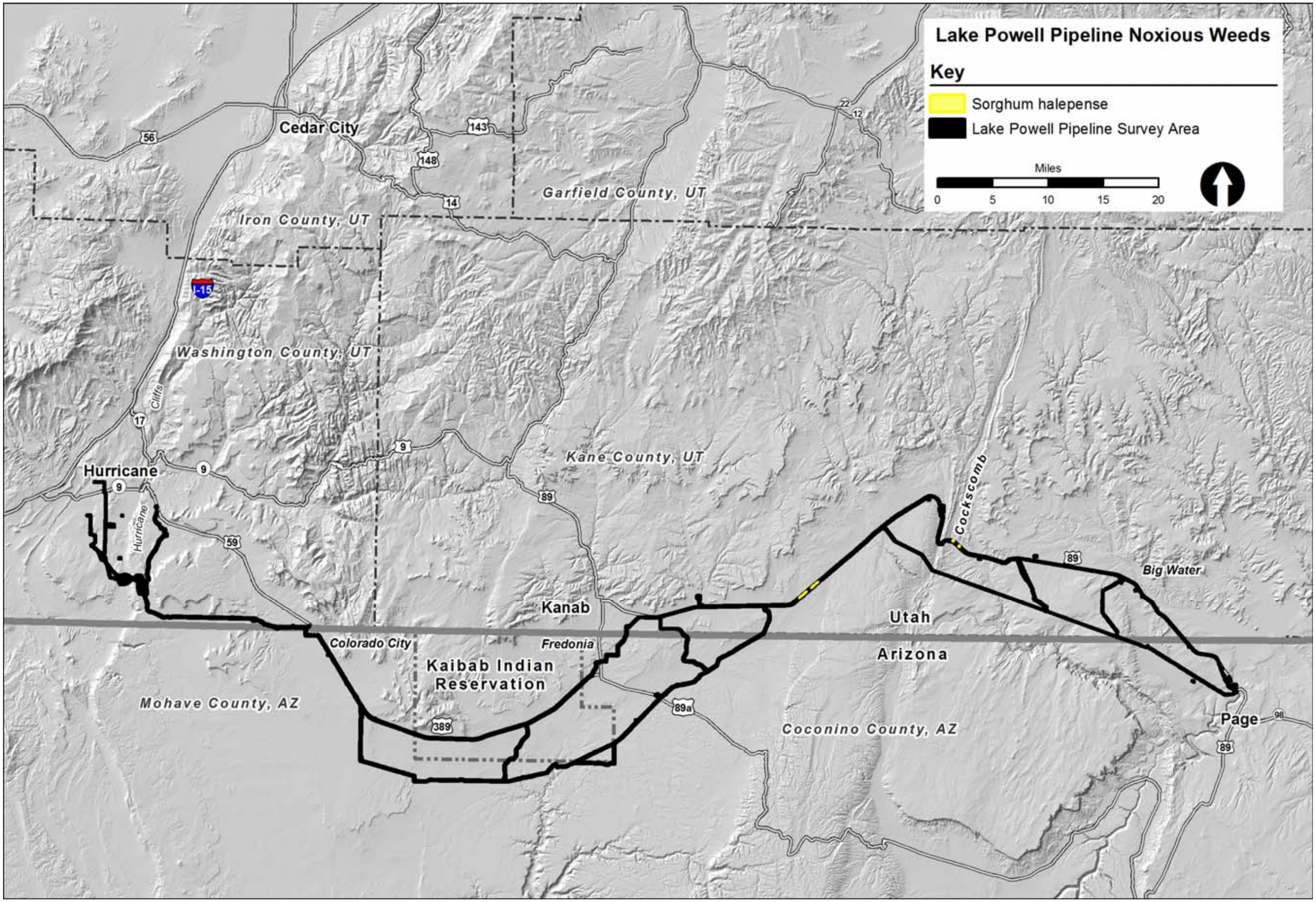

Figure 5-118
***Sorghum halepense* Overview Map**

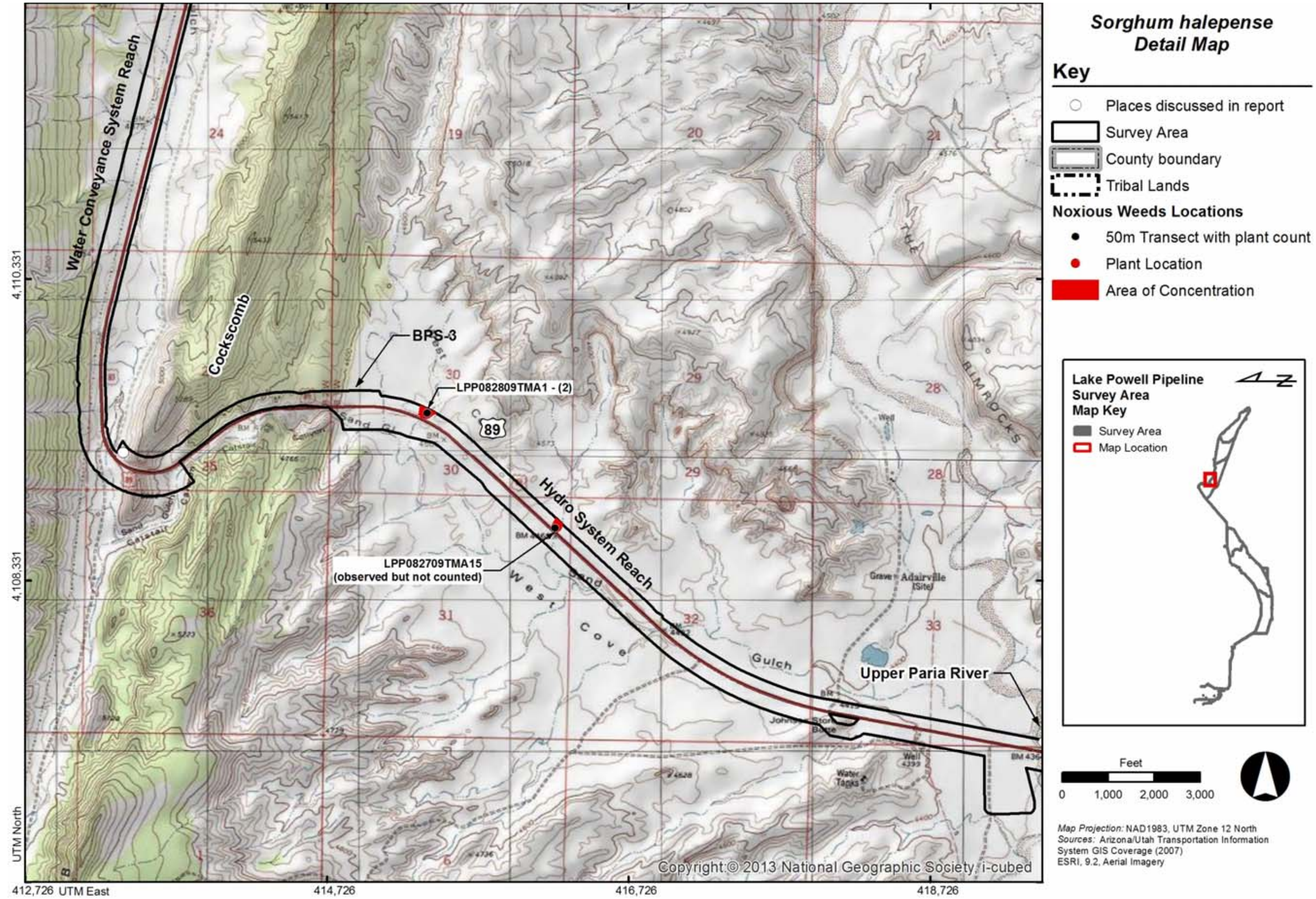

Figure 5-119
***Sorghum halepense* Detail Map 1**

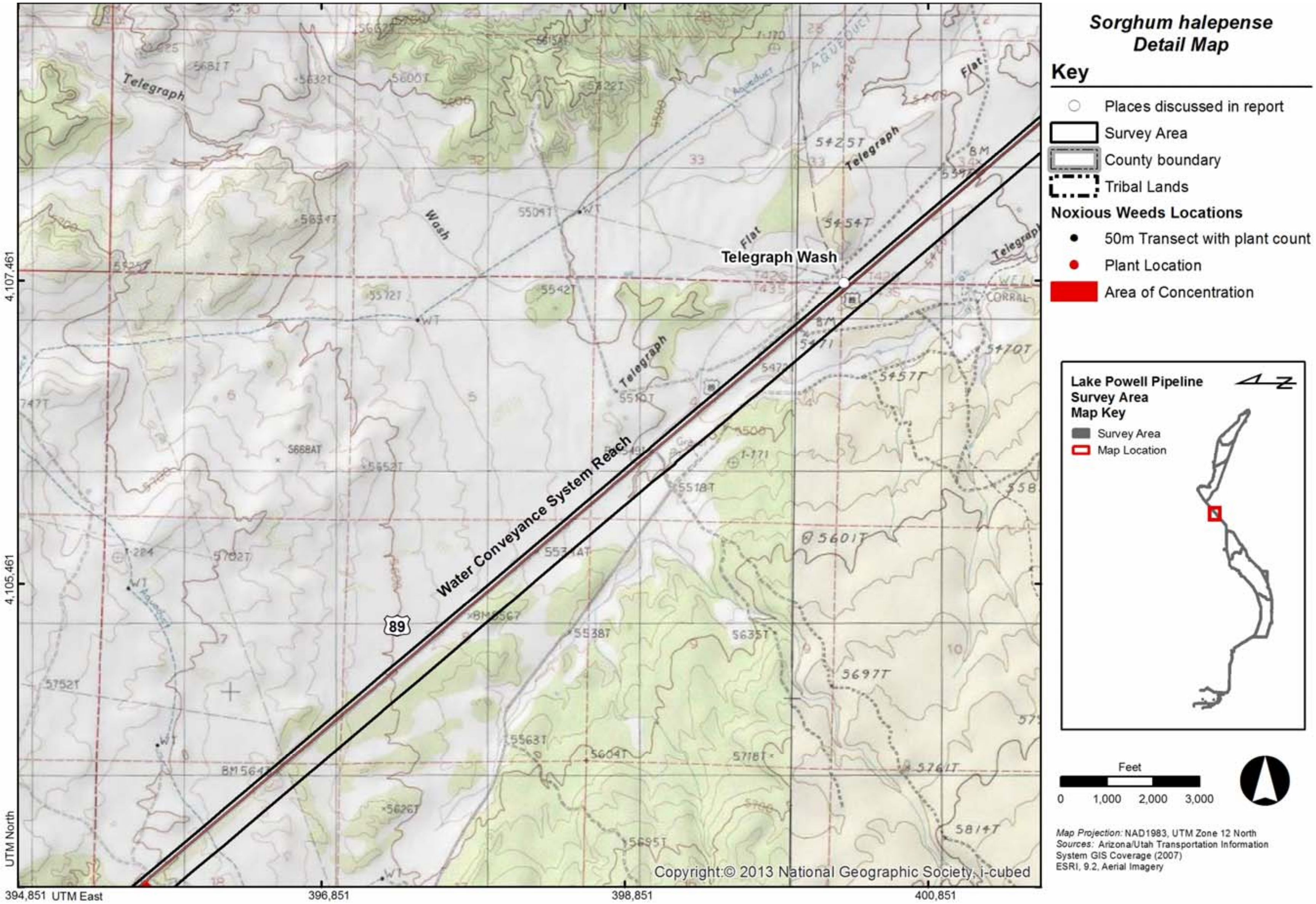

Figure 5-120
***Sorghum halepense* Detail Map 2**

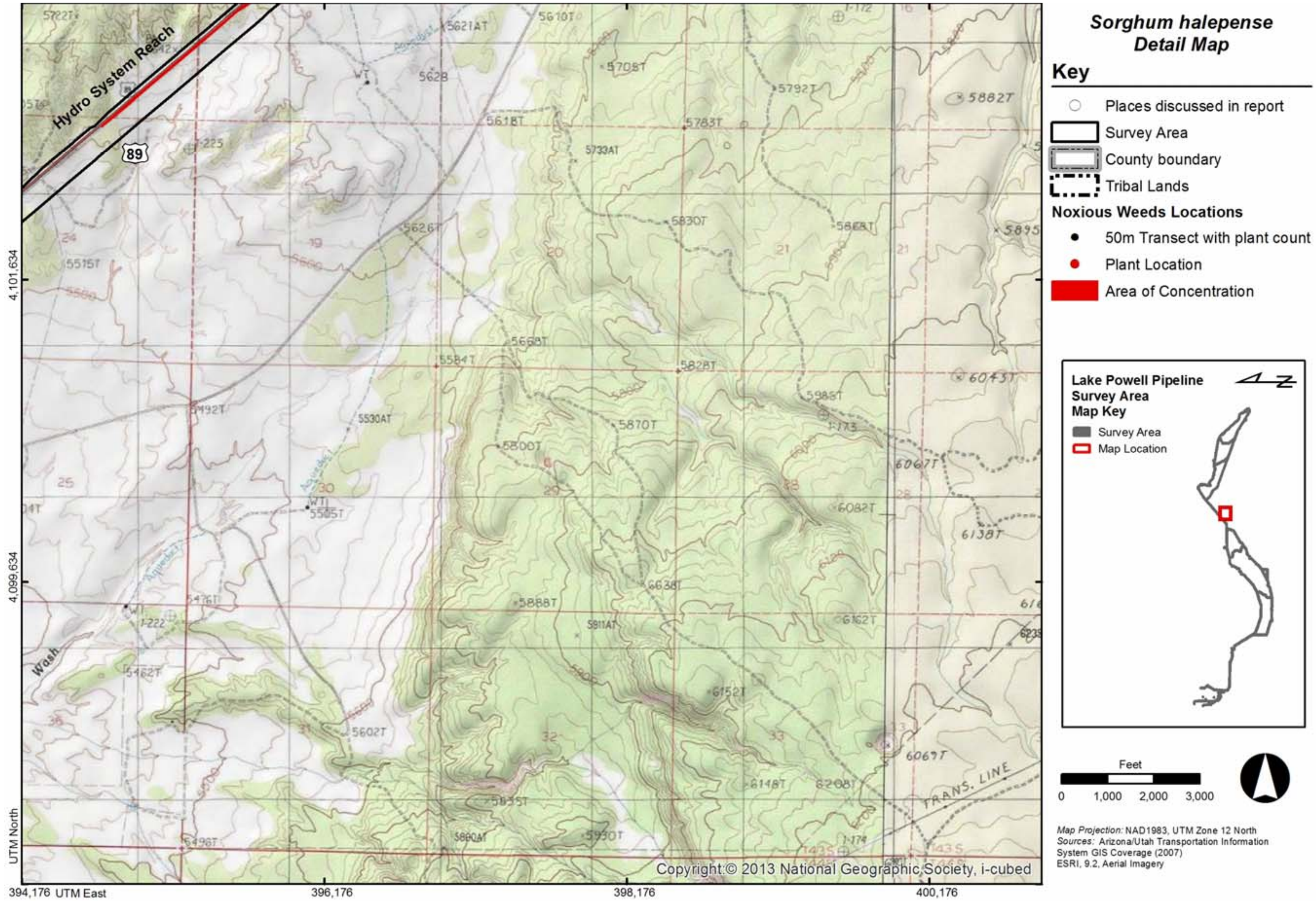

Figure 5-121
***Sorghum halepense* Detail Map 3**

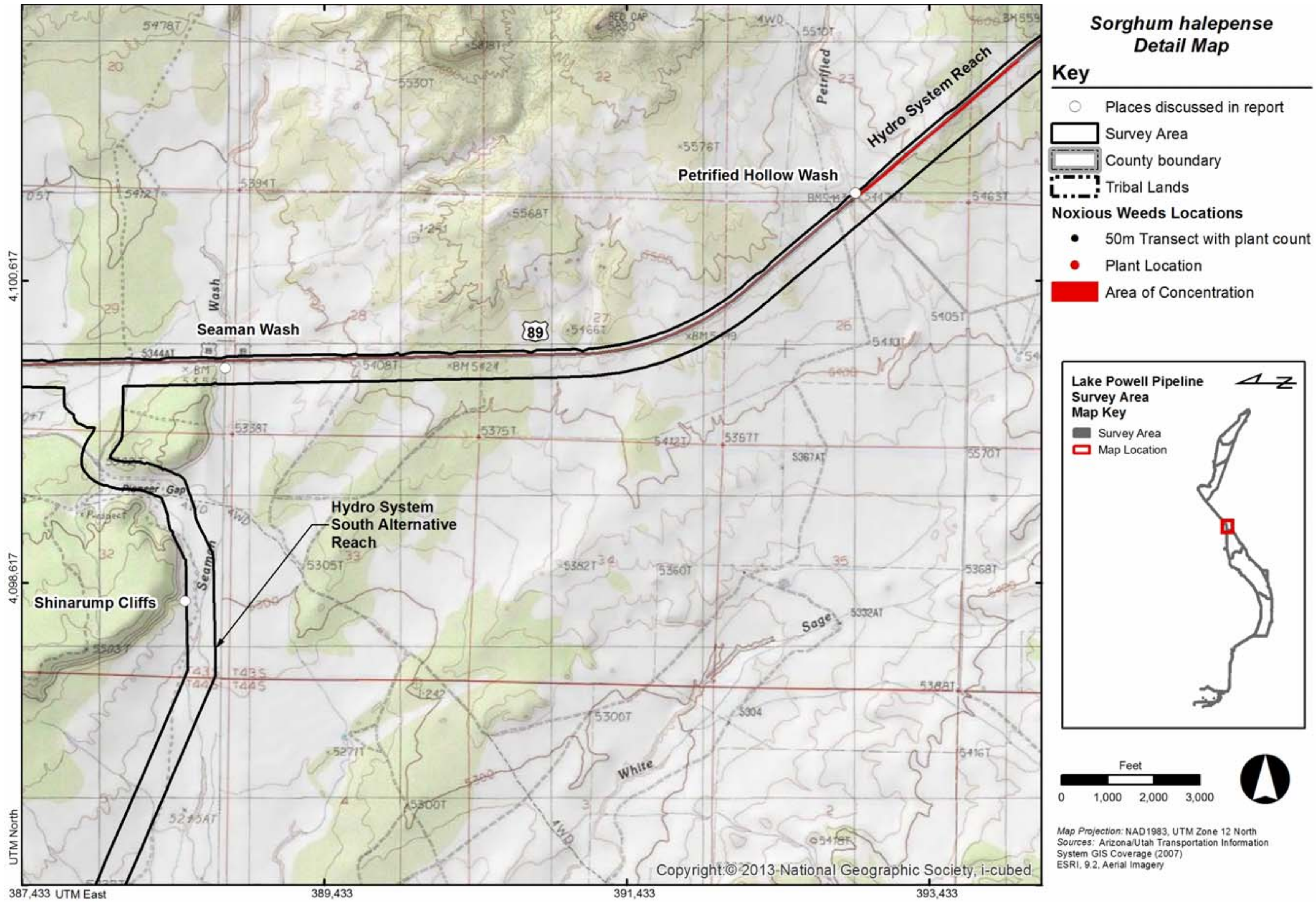

Figure 5-122
***Sorghum halepense* Detail Map 4**

5.5.14 *Tamarix* spp. (Tamarisk)

5.5.14.1 Natural History

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 5-123). 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*, *T. ramossisima*, *T. parviflora*) hybridize, further increasing confusion over identification. *T. chinensis* and *T. ramossisima* have become synonymous, 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.

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 ornamental 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 5-124), 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).

Figure 5-123
Close-up View of *Tamarix* spp.
within the Survey Area

Figure 5-124
View of *Tamarix* spp. and It's Habitat
within the Survey Area

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.

5.5.14.2 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 Hurricane (Figure 5-125). 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 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. *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. *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 both Ecological Regions, in 15 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 Mojave 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 Mojave 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.

5.5.14.3 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.

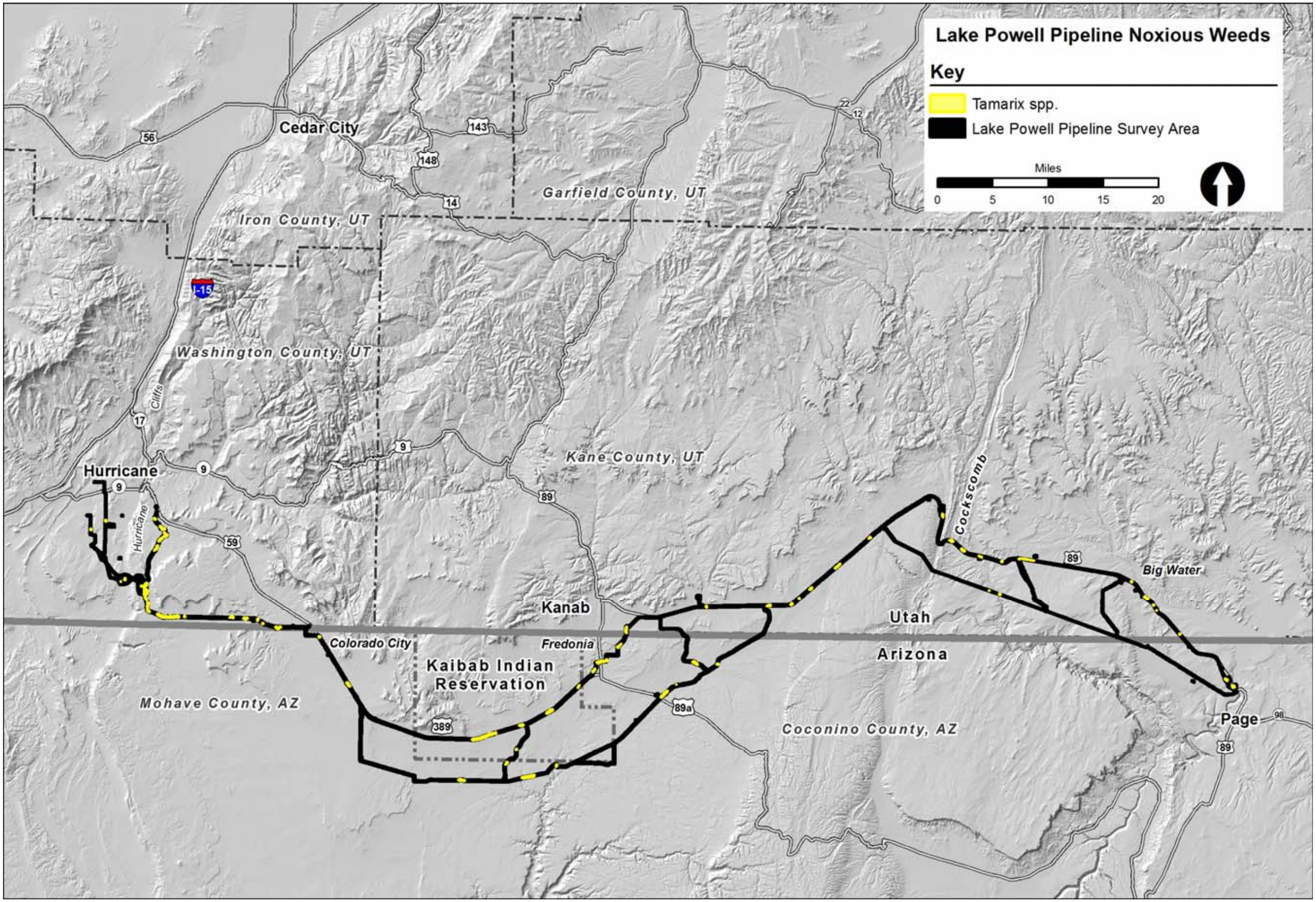

Figure 5-125
***Tamarix* spp. Overview Map**

5.5.15 *Tribulus terrestris* (Puncturevine)

5.5.15.1 Natural History

Tribulus terrestris is a mat-forming annual in the Zygophyllaceae (Caltrop Family; Figure 5-126). 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 5-127). 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 *T. terrestris* are unique enough that the species is not easily confused with any other.

T. 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 (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).

T. 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 5-126
View of *Tribulus terrestris* and Its Habitat within the Survey Area

Figure 5-127
Close-up View of *Tribulus terrestris*
within the Survey Area

5.5.15.2 Survey Results

T. terrestris was encountered infrequently within the survey area, occurring sporadically between the Colorado River at Glen Canyon Dam and the Virgin River (Figure 5-128). The species was encountered in nine reaches (Figure 5-129 to Figure 5-137). It was found at the Glen Canyon Substation and in the southeastern-most extent of the Glen Canyon to Buckskin Transmission Line 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 Greenehaven. 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. *T. terrestris* was mostly encountered while conducting special status species and noxious weed surveys; however, the species was also detected in one 50-meter belt transect (Transect # 127).

T. terrestris was found in the Colorado Plateau Ecological Region, in eight ecological systems, and four 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, Invasive Upland Vegetation, 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. *T. terrestris* was encountered in both small quantities and large populations, but was never considered a dominant component of the ecological system.

5.5.15.3 Discussion

T. terrestris occurred occasionally within the survey area, in a relatively small number of ecological systems. *T. 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 human clothing and shoes, it is highly recommended that care be taken to check clothing and shoes for its obvious fruit and remove the fruit for disposal.

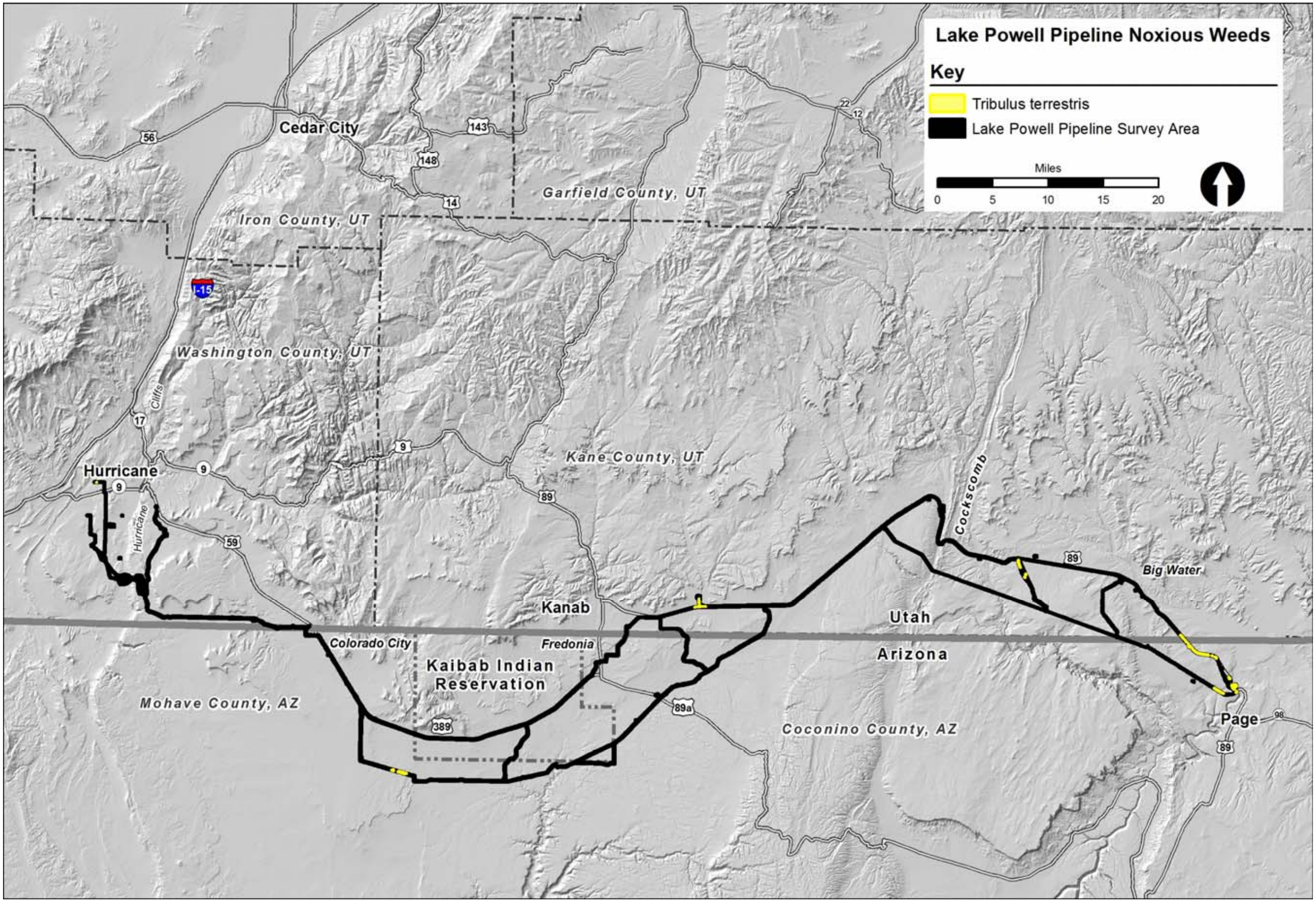

Figure 5-128
***Tribulus terrestris* Overview Map**

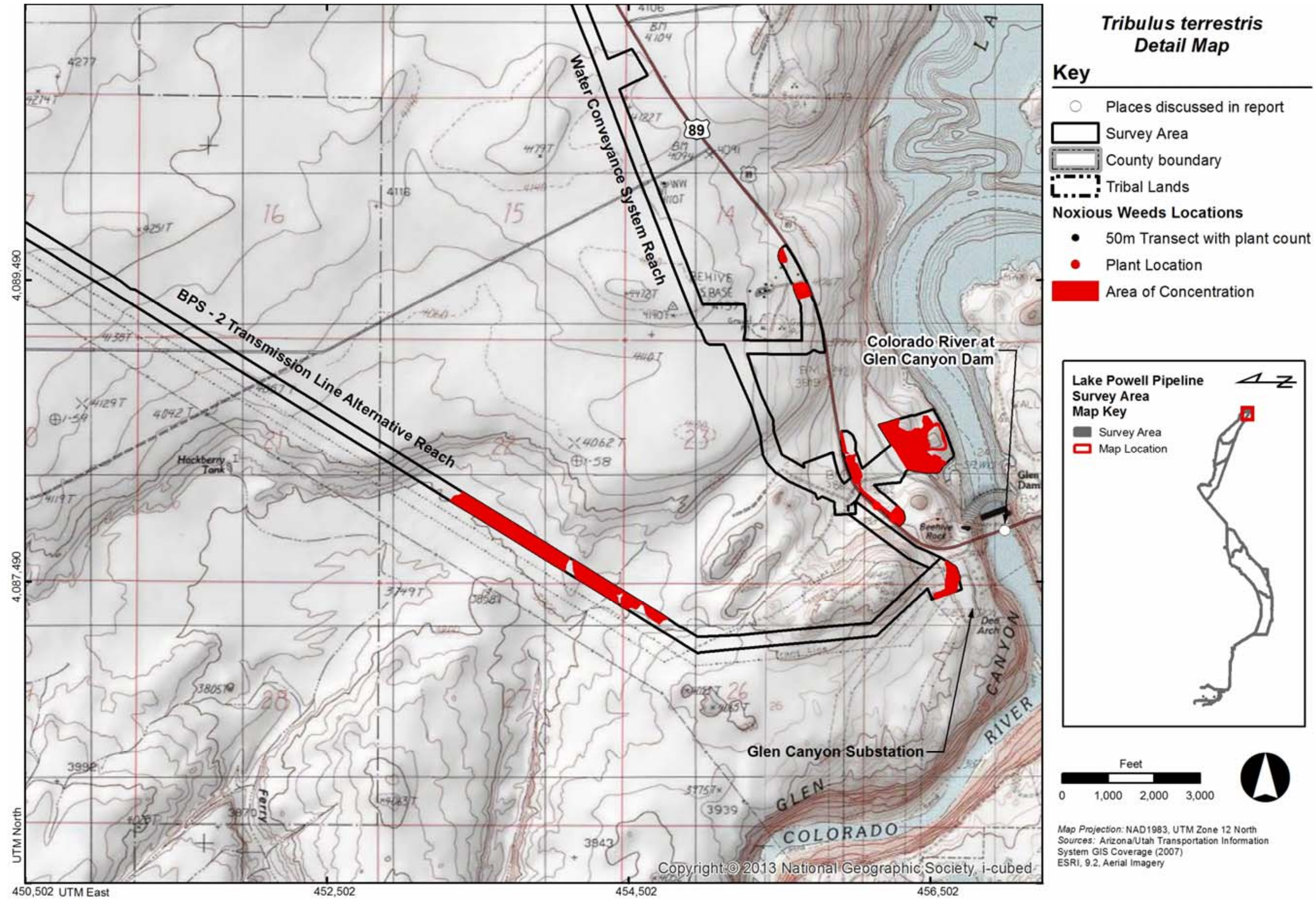

Figure 5-129
***Tribulus terrestris* Detail Map 1**

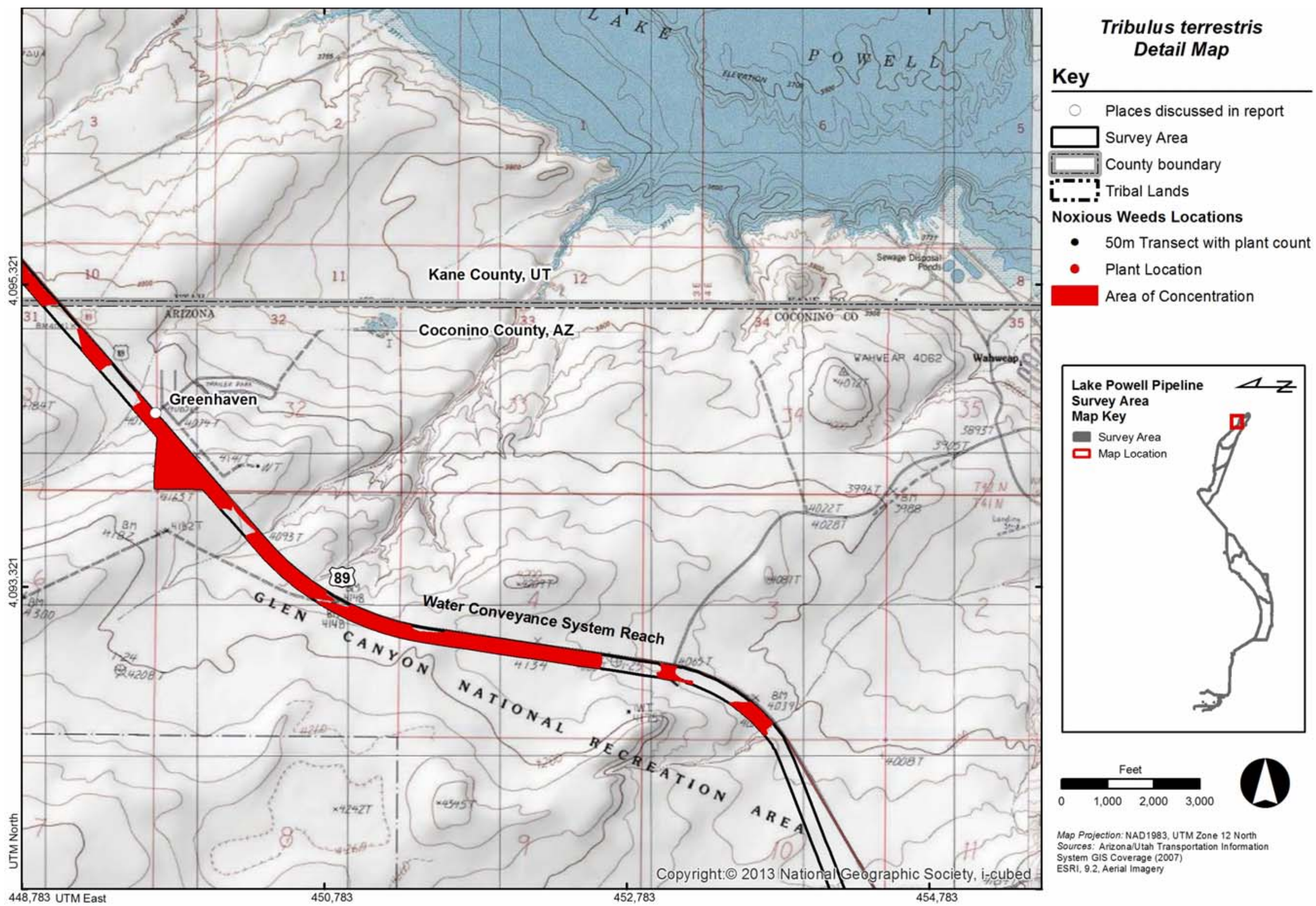

Figure 5-130
***Tribulus terrestris* Detail Map 2**

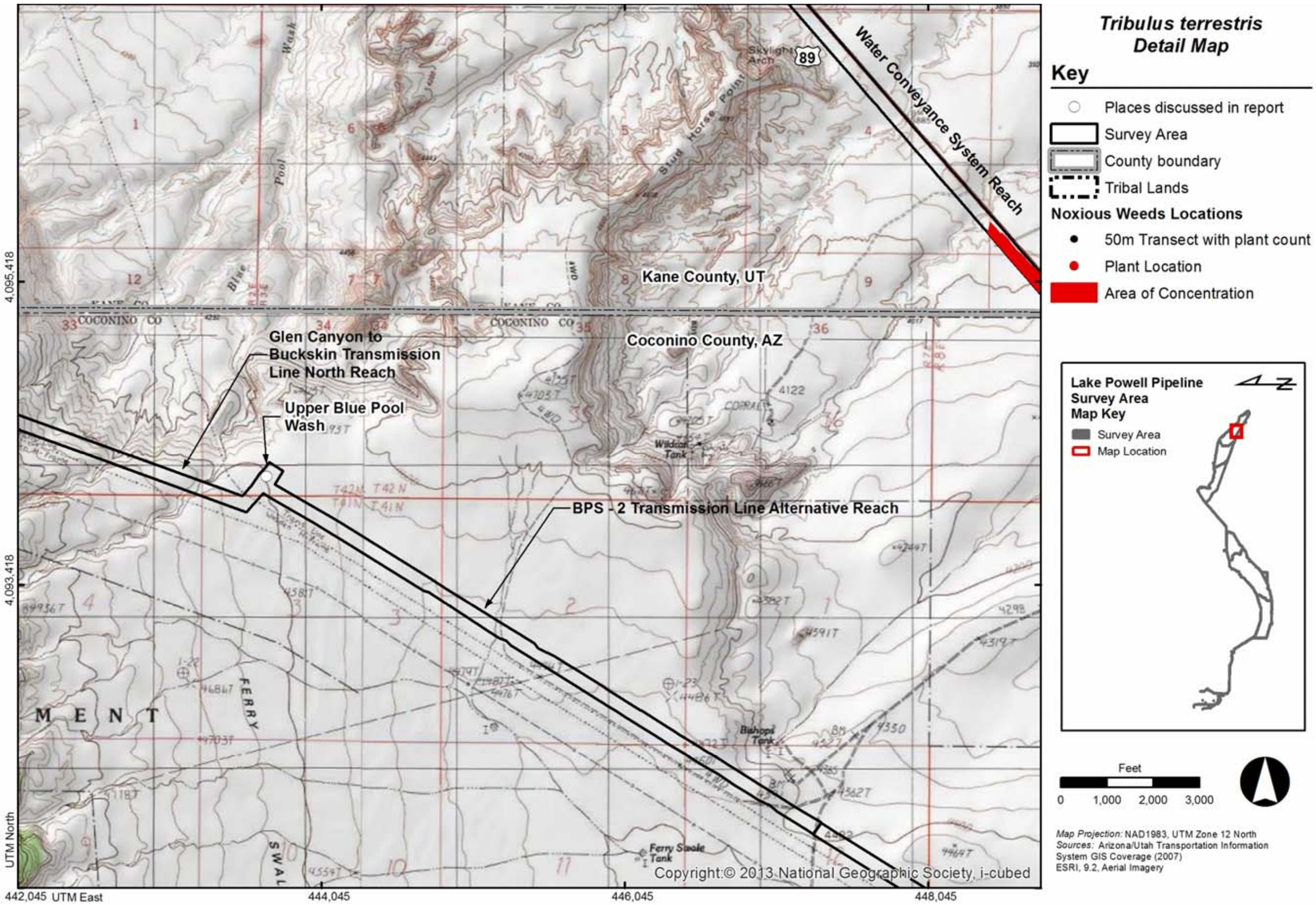

Figure 5-131
***Tribulus terrestris* Detail Map 3**

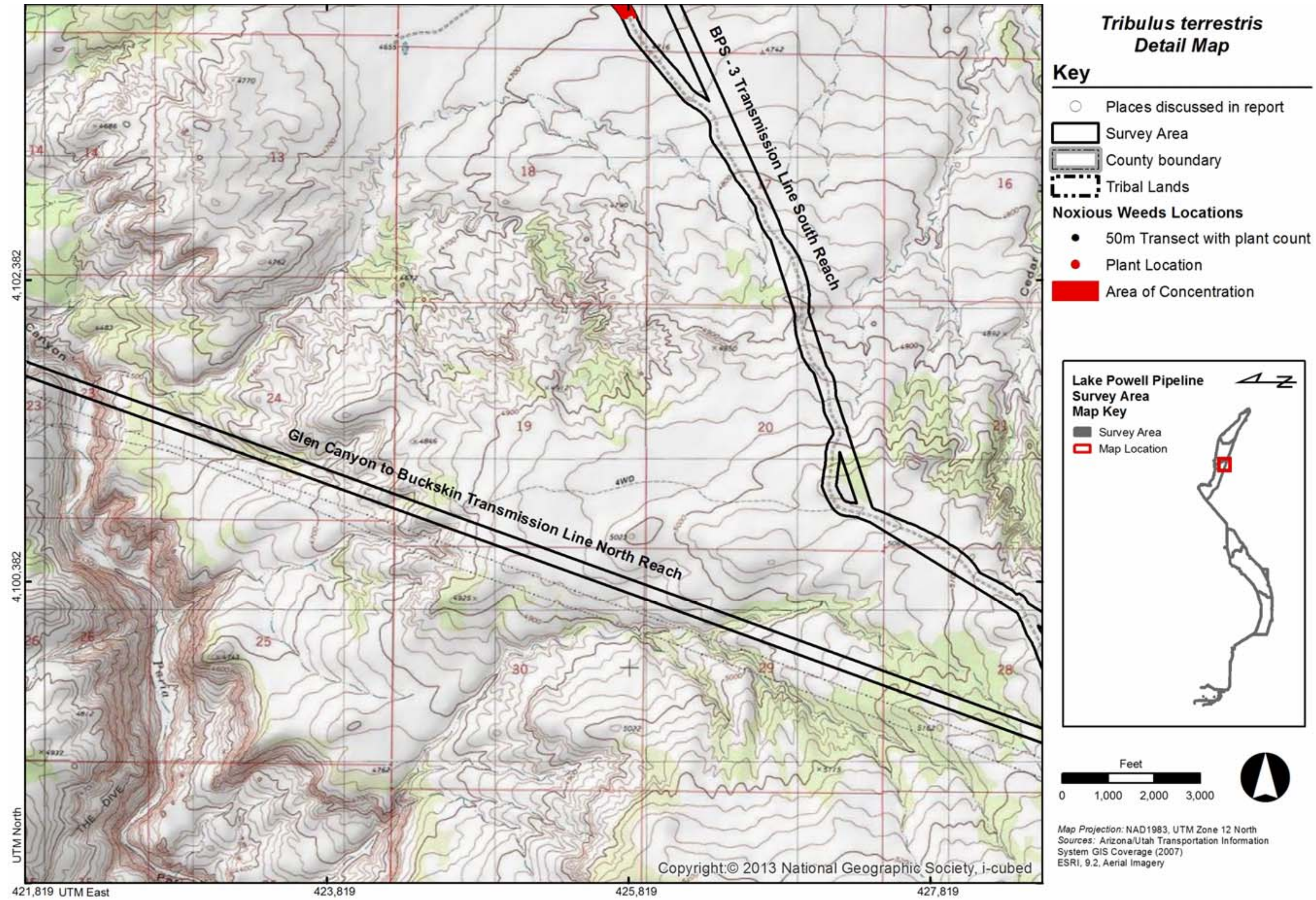

Figure 5-132
***Tribulus terrestris* Detail Map 4**

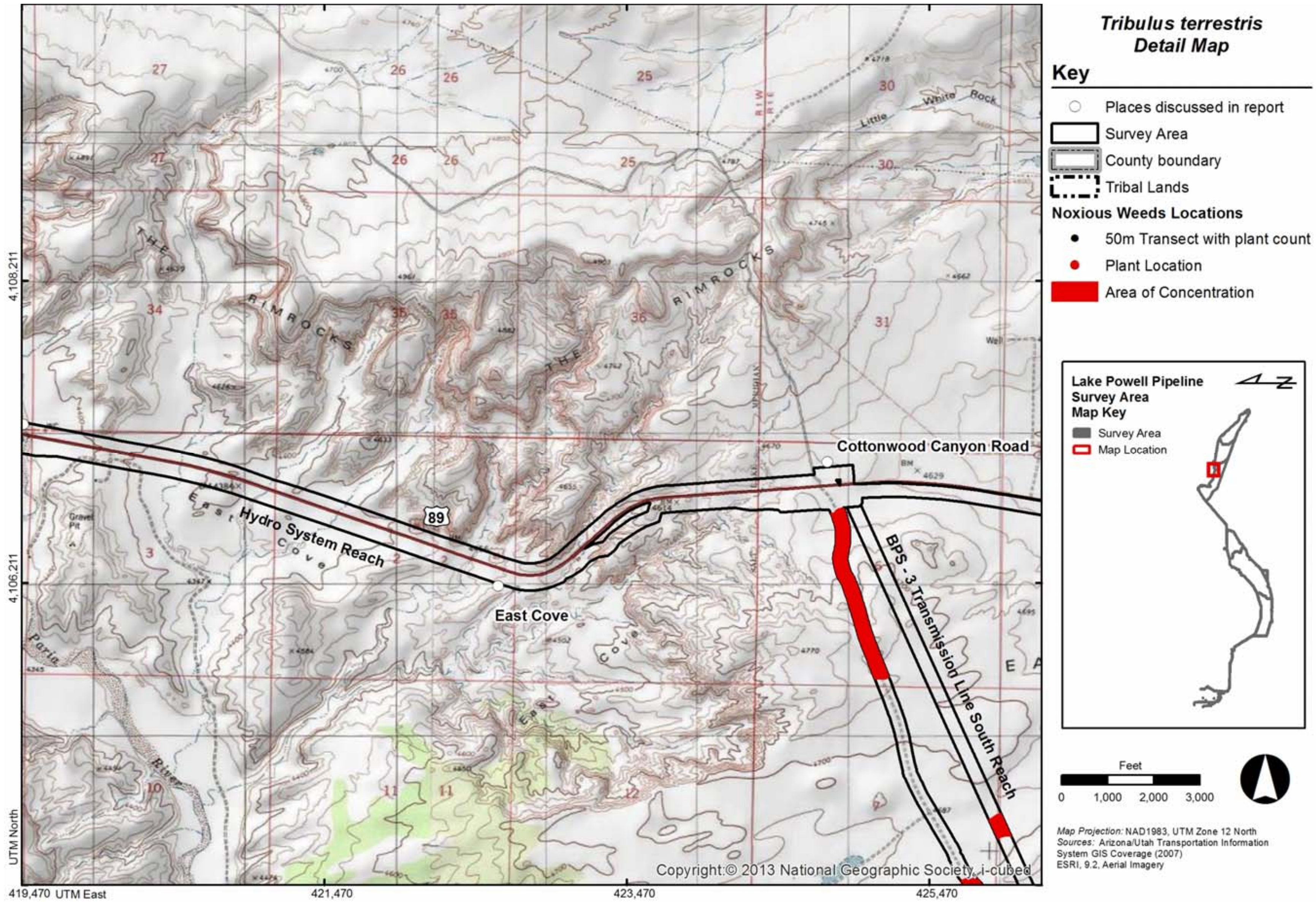

Figure 5-133
***Tribulus terrestris* Detail Map 5**

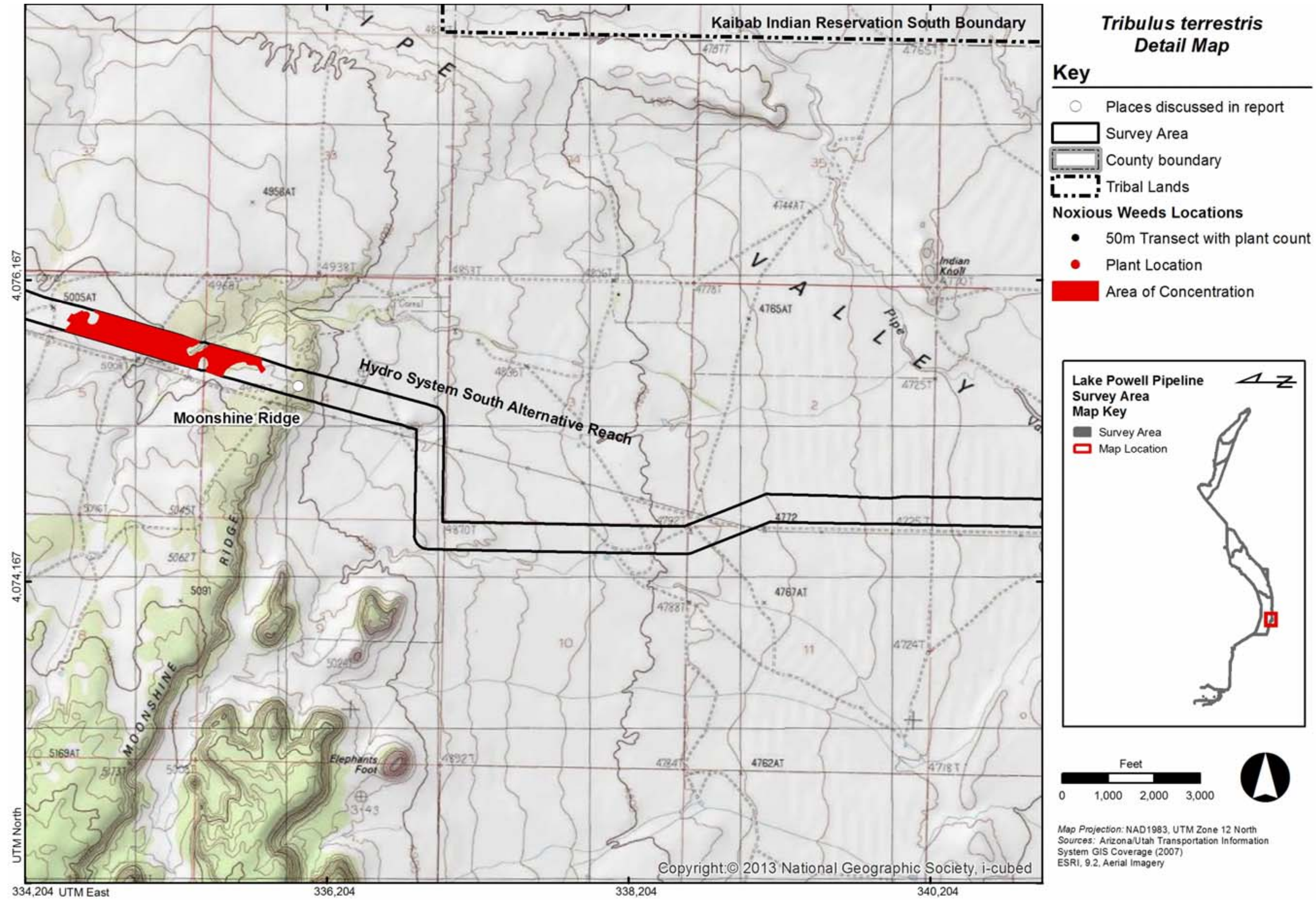

Figure 5-134
***Tribulus terrestris* Detail Map 6**

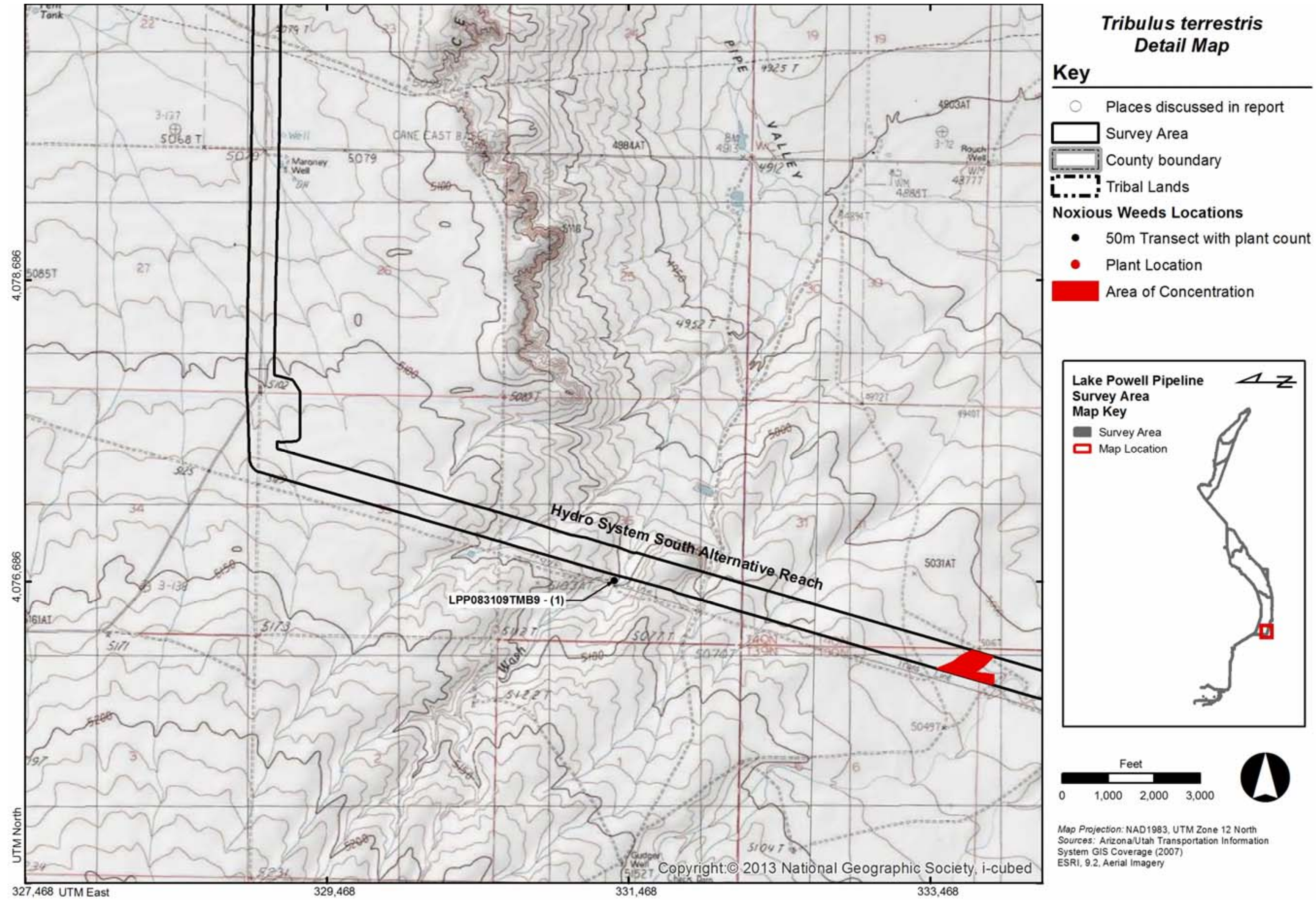

Figure 5-135
***Tribulus terrestris* Detail Map 7**

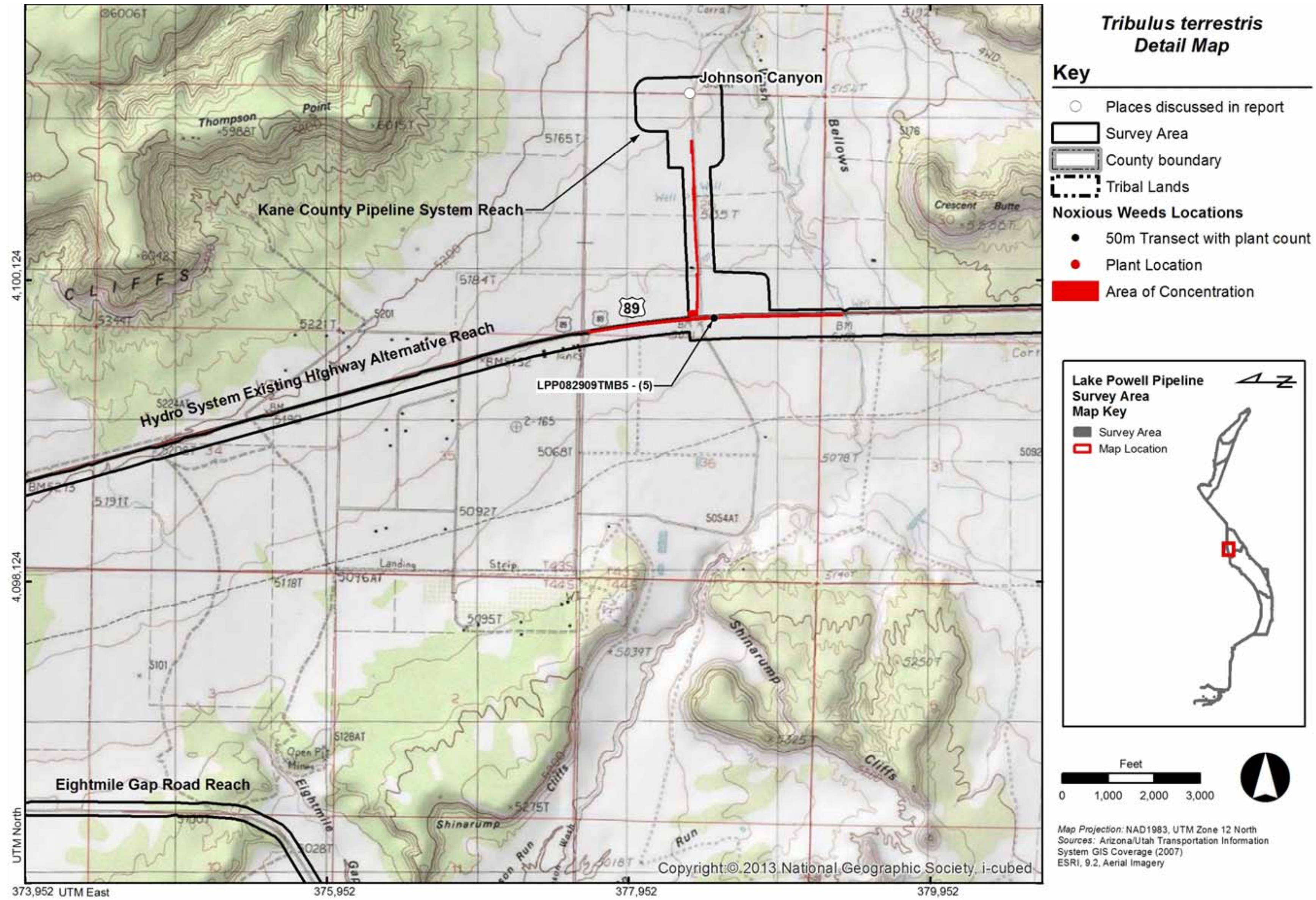

Figure 5-136
***Tribulus terrestris* Detail Map 8**

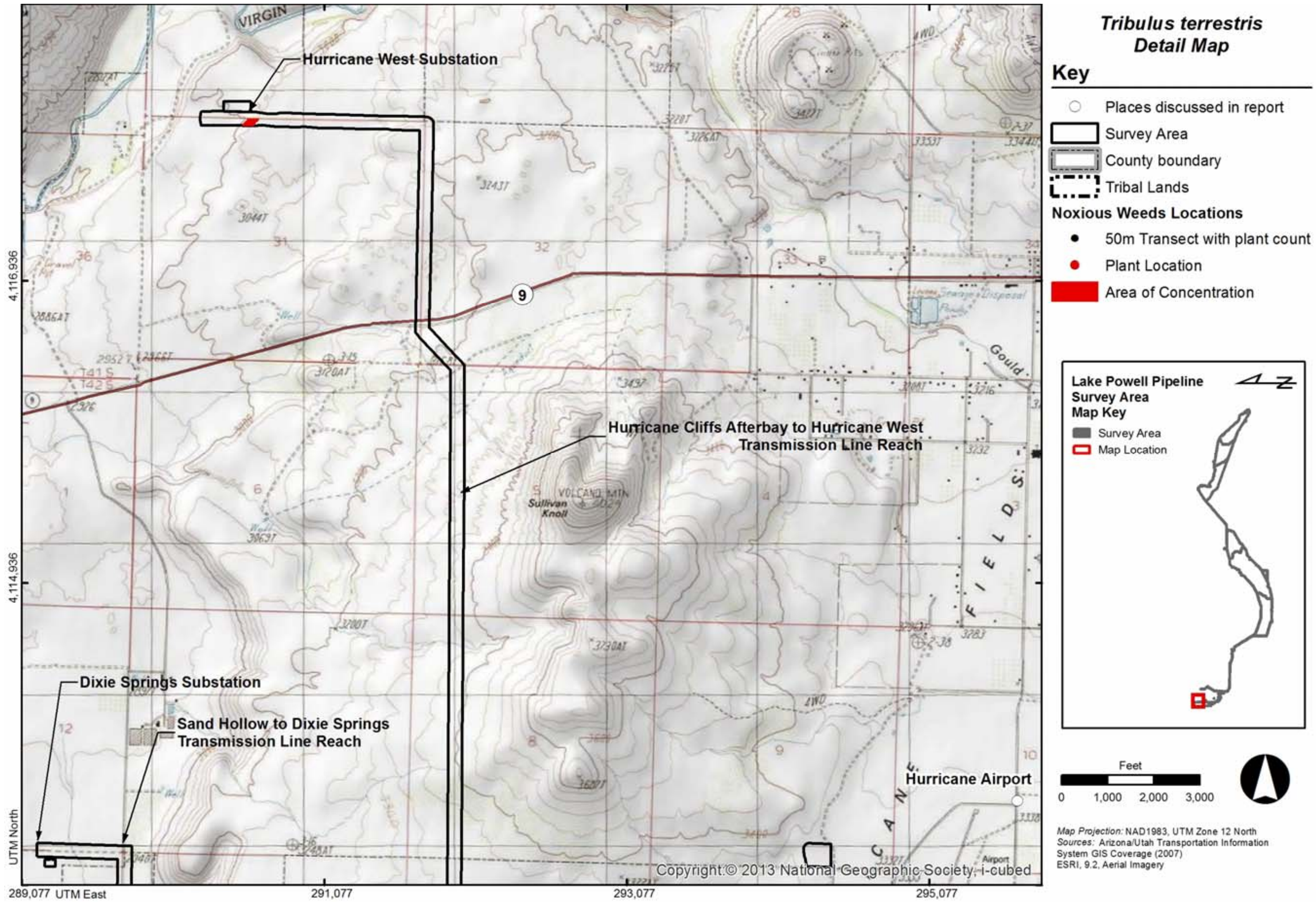

Figure 5-137
***Tribulus terrestris* Detail Map 9**

5.5.16 *Ulmus pumila* (Siberian elm)

5.5.16.1 Natural History

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 5-138). 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).

Figure 5-138
Close-up View of *Ulmus pumila*
within the Survey Area

U. pumila was introduced from Asia and has been widely cultivated throughout the United States as a shade tree and as a windbreak. *U. 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 (Sonoran Institute 2008). *U. pumila* grows commonly in moist soils and along streams, but it is also able to invade dry, sandy habitats (NDDA 2003).

U. 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).

U. 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). *U. 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).

5.5.16.2 Survey Results

U. pumila occurred rarely within the survey area (Figure 5-139), within only one reach (Figure 5-140). Individuals were found at the Colorado River at Glen Canyon Dam in the Glen Canyon Substation. *U. pumila* was not detected on any 50-meter belt transects; all encounters occurred while conducting special status species and noxious weed surveys.

U. pumila was only encountered in the Colorado Plateau Ecological Region, where it inhabited the Active and Stabilized Dune, Mixed Bedrock Canyon and Tableland, and Mixed Desert Scrub ecological systems. The species was also encountered in Developed Road and Ruderal Vegetation. Occurrences of the species were within communities dominated by native shrubs, including *Artemisia filifolia*, *Coleogyne ramosissima*, *Ephedra nevadensis*, *Eriogonum corymbosum*, and *Rhus trilobata* var. *simplicifolia*. The species was not encountered in any habitats classified as anthropogenic lands.

5.5.16.3 Discussion

U. 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.

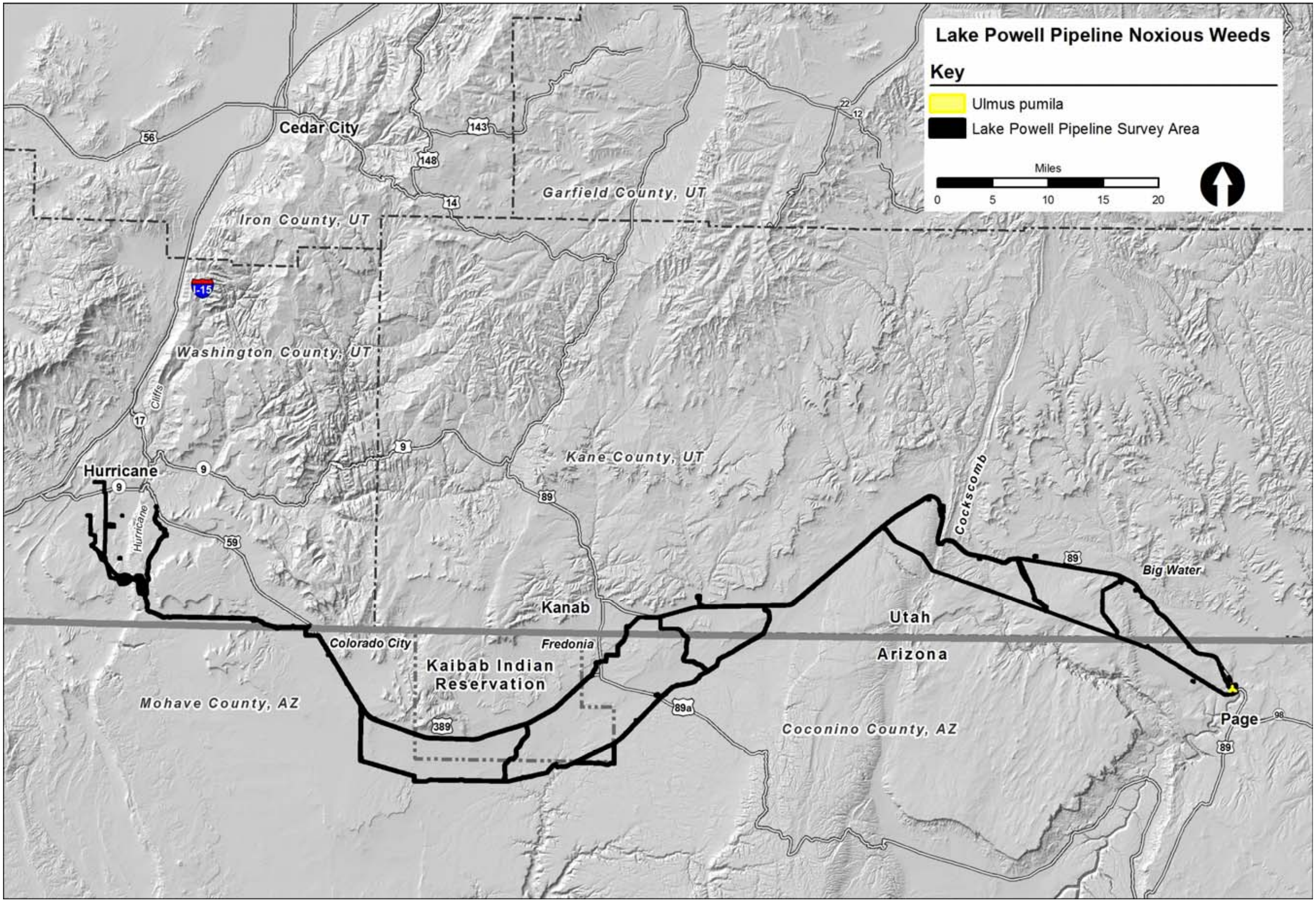

Figure 5-139
***Ulmus pumila* Overview Map**

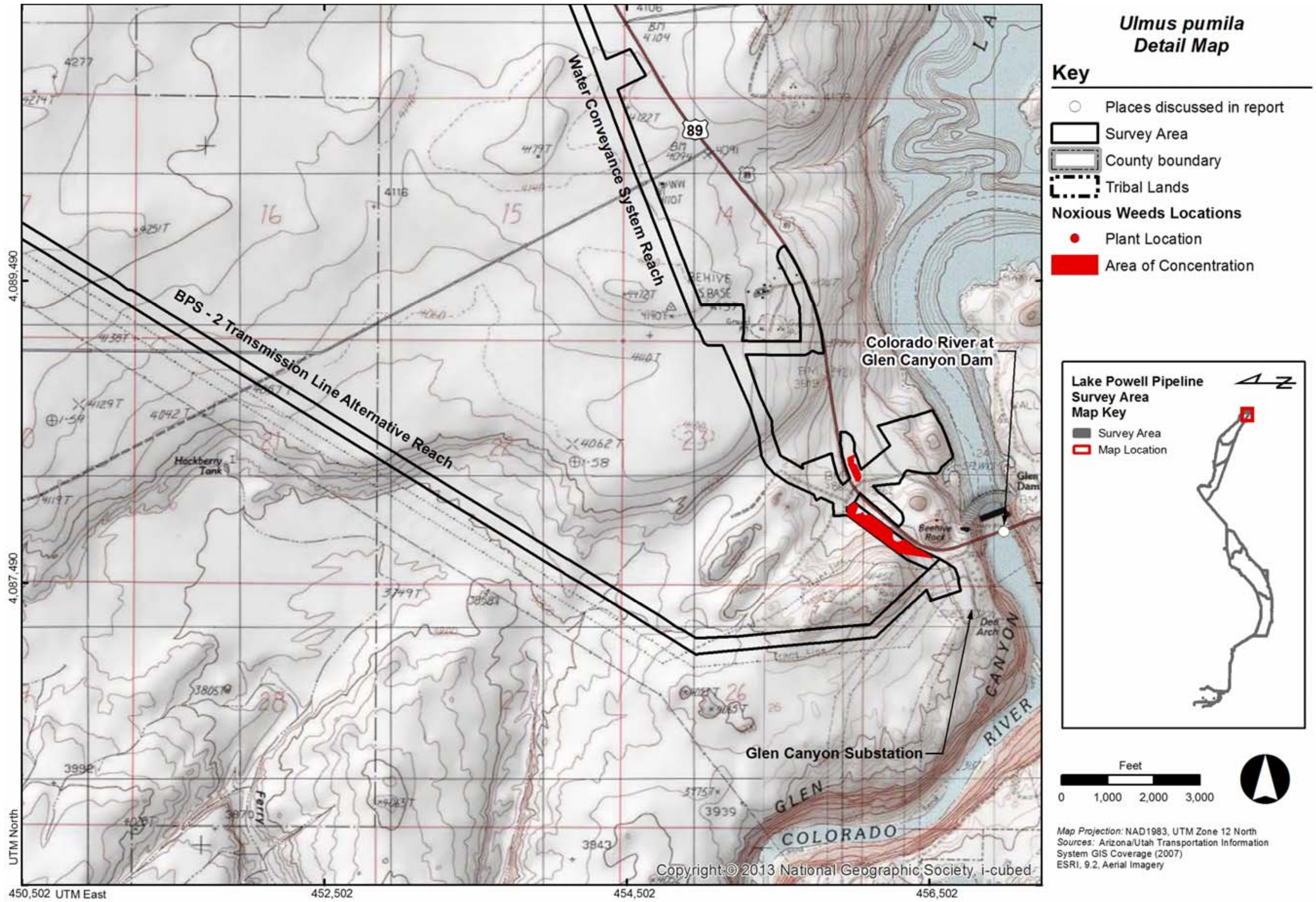

Figure 5-140
***Ulmus pumila* Detail Map**

Chapter 6
Best Management Practices and Effects Analysis

6.1 Introduction to Best Management Practices

The protection, mitigation and enhancement measures for special status plant species would begin with the foundation of BMPs, which constitute the most effective and practical methods to avoid, minimize or reduce construction effects on naturally occurring landscapes. 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 effects. The development of specific conservation strategies and protective measures, which strive to reduce effects 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 effects on known rare plants and sensitive habitats and aid in the prevention of noxious weed dispersal. 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 (pipelines, penstocks, transmission lines, pump stations, hydro stations, forebay and afterbay reservoirs), 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

BMPs and mitigation would address protected or species afforded special protections and their habitat as practicable. The following are general BMPs that would be considered for implementation to avoid and/or minimize overall project related effects:

BMP-G1: Employ a Resource Advisor to design (or develop) and recommend implementation of specific conservation strategies and protective measures (endorsed by the land management agencies and USFWS). A designated resource advisor would also coordinate natural resource conflicts and concerns.

BMP-G2: On-site project personnel would be educated about protected species and the importance of minimizing effects on individuals and habitats. All project personnel would be informed of the BMPs, protective measures, and conservation strategies.

BMP-G3: All applicable BMPs, protective measures, and conservation strategies would be applied to all un-surveyed designated habitats for federal and state listed and 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: Equipment staging areas and fueling areas would be located outside of sensitive habitats, preferably in previously disturbed areas outside of areas with known noxious and invasive species occurrences.

BMP-G5: Appropriate BMPs would 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 would 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 exposed soil areas with soil erosion control fencing.

BMP-G9: Construct roads and other disturbed sites to minimize sediment discharge into streams, riparian areas, and wetlands.

BMP-G10: Stream sediment loads would be managed by not washing equipment or vehicles in streams, riparian areas or wetlands. Equipment or vehicles would be inspected and cleaned as necessary to remove weed seeds before entering federal and state listed and sensitive species designated habitats. Equipment and vehicles would only be washed in designated locations where material would be captured/contained and removed off-site to an approved disposal area so that invasive plant material would not be spread.

BMP-G11: Require that no servicing or refueling of equipment occurs within 1/8-mile of streams, reservoirs, or associated wetlands.

BMP-G12: Pipeline and penstock construction would not block, dam, or change the natural course of any drainage. If excavation occurs in a streambed, the streambed may be protected with suitable stabilizing materials. Mineral and silt accumulated due to construction activities would be deposited into approved locations. If disturbance occurs, a streambed would be restored to its original configuration, including natural grade, condition, and alignment.

BMP-G13: Vegetation slash not containing noxious and invasive or special status plants would be disposed of by removal to an agreed upon location. In upland areas, vegetation could be disposed of by: piling and burning, windrowing at the base of fill slopes, and chipping and scattering.

BMP-G14: 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 would be contained and properly disposed of.

6.1.2 Restoration/Rehabilitation Measures

Restoration and rehabilitation treatments are an integral part of control and management of future invasions of invasive species, and to prevent further harm to sensitive plants 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 effects from the direct and indirect effects 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 and penstock 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 effects. The general restoration BMPs presented 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 would be re-vegetated with a mix of species that is best suited to meet the erosion control objective, with consideration for range, wildlife, or fuels management objectives.

BMP-R/R2: When rehabilitating designated sensitive habitats affected by project related activities, seeds from regionally native or approved non-native species of grasses and herbaceous vegetation would be used in areas where reseeding is necessary to stabilize soils, prevent erosion, or provide temporary wildlife forage and/or cover. Additional plant species would be considered and approved by the appropriate land management agency where conditions are not realistic for the success of native seed revegetation.

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 would 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 would be salvaged and reapplied during reclamation and plant debris could be left on-site to serve as mulch. Disturbed soils would be reclaimed as quickly as possible or protective covers could be applied. Topsoil material would be segregated and not mixed or covered with subsurface material.

6.1.3 Special Status Plants

The implementation of the following BMPs would avoid or reduce the impacts of construction activities on special status species within the LPP Project corridor.

BMP-SS1: Protection by avoidance of known individuals and locations of habitats known to be occupied by federally listed species and other special status plant species.

BMP-SS2: Special status plant species present in the area of disturbance may be salvaged and transplanted into restoration areas.

BMP-SS3: Collect perennial special status plant seeds and seed plants on-site. Seeds may 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: Protect newly seeded areas from livestock grazing for at least two growing seasons.

6.1.4 Noxious Weeds and Invasive Species

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 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.

6.1.4.1 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 would be made 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 may be performed for invasive plant species.

6.1.4.2 Invasive Species - Excavated Material

BMP-IS5: Excavated material taken from sites that contain invasive plants would not 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.

6.1.4.3 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 would 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 would 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 would 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 would be cleaned of all visible soil and plant material before leaving the project site. Equipment would 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 would 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 stations that contain runoff from washing equipment (containment would be in conformance with wastewater discharge regulations), high pressure air, brush, broom, or other hand tools (used without water).

6.1.4.4 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 would be piled on site to dry out. Brush piles are recommended for woody shrubs, trees, and vines.

- Herbicide: Herbicide applications would 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, vegetation type, and toxicity to special status plants could be considered in determining the risk of herbicide contamination.

BMP-IS15: Herbicide use would be limited to nonpersistent, immobile herbicides and would 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 would be used.

BMP-IS17: Herbicides would not be applied during rain.

BMP-IS18: Appropriate herbicide-free buffer zones would 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 33 biogeographically distinct segments based on MWH reaches (Appendix E), which are generally ordered from east to west. A map of MWH reach names is contained in Appendix A.

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 highest number of special status plants (including the highest number of *Pediocactus sileri*) occurs within the Hydro System Existing Highway Alternative along Highway 389. Special status plant species were documented in 6 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 affected 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 33 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 resources 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 U.S. 89 in a northwesterly direction, ending at the community of Big Water (Appendix E). 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). One special status species was encountered in the segment: *Phacelia mammalariensis*. 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.

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 U.S. 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 U.S. 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 U.S. 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 Greenehaven, 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 U.S. 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 U.S. 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 Shrubland 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 U.S. 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*. U.S. 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.

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 U.S. 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 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 recommendations are BMPs of particular applicability to this segment. Further discussion of each is 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)
- Revegetate disturbed soils (BMP- R/R1)
- Salvage and transplant perennial special status plants (BMP-R/R6)
- 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: U.S. 89 at Glen Canyon Dam to Upper Blue Pool Wash

Reach 2: Glen Canyon to Buckskin Transmission Line

Overview:

The U.S. 89 to Glen Canyon Dam to Upper Blue Pool Wash Segment would include a proposed transmission line and equipment site. The segment begins at U.S. 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. *Phacelia mammalariensis*, a special status species, was 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*.

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 U.S. 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 U.S. 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:

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.

Invasive and noxious 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 2,400 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)
- Dispose of all construction waste (BMP-G17)
- Revegetate disturbed soils (BMP-R/R1)
- Salvage and transplant perennial special status plants (BMP-R/R7)
- 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: *[NOT INCLUDED IN CURRENT PROJECT ALTERNATIVES]*

6.5.4 Segment 4: Cedar Mountain to U.S. 89

Reach 6: BPS-2 Transmission Line

Overview:

The Cedar Mountain to U.S. 89 Segment would include the placement of a transmission line. The segment begins at Cedar Mountain and extends north to U.S. 89, near Big Water. An unimproved road traverses the segment, with access points at Big Water and Cedar Mountain; however, the route is nearly impassable 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.

Route:

The Cedar Mountain to U.S. 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.

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 U.S. 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.

Special status plants:

No special status plants were found on this segment.

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 this segment. Further discussion of each is provided in Section 6.1 above.

- Protect erosion prone land (BMP-G8)
- 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)
- 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 U.S. 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.

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 U.S. 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 U.S. 89 Segment, and the other at 1.48 miles, the Upper Blue Pool Wash to U.S. 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 U.S. 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 U.S. 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 U.S. 89, and supports Grassland and Shrub-Steppe ecological systems. Adjacent to U.S. 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 U.S. 89, and Ruderal Vegetation was identified in road cuts.

Special status plants:

No special status plants were found on this segment.

Invasive and noxious weeds:

Tamarisk spp. occurred north of U.S. 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 U.S. 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)
- 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 E). 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.

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 U.S. 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.

Special status plants:

No special status plants were found on this segment.

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)
- 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.
- 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 line. The segment originates at Flat Top, and extends north to U.S. 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.

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 U.S. 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.

Special status plants:

No special status plants were found on this segment.

Invasive and noxious weeds:

Salsola tragus was concentrated in localized areas where livestock gather, such as in watering areas and under shade trees.

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 E). 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*. The segment was relatively free of invasive weeds.

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 alignment then crosses 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:

One special status species was potentially encountered within the segment: *Lupinus caudatus* var. *cutleri*. Confirmation of this species was not possible, 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. 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.

Invasive and noxious weeds:

The segment was relatively free of invasive weeds.

Impacts:

The construction and maintenance of roads along the proposed transmission line alignment 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)
- 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)
- 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. The segment begins at Cottonwood Canyon Road and extends west along U.S. 89, ending at the east side of the Cockscomb (Appendix E). Lands occurring in the segment are administered 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.

Route:

The Cottonwood Canyon Road to Cockscomb Segment begins adjacent to U.S. 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 alignment would run north of Johnson Store Butte (at 4.41 miles) 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 U.S. 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 U.S. 89.

Special status plants:

No special status plants were found on this segment.

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 U.S. 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 U.S. 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 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)
- Avoid stream bed modification (BMP-G12)
- 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)

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 U.S. 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. One special status species was identified, including *Lupinus caudatus* var. *cutleri* and cryptobiotic soils are present within the segment. Noxious weeds encountered by the survey included *Convolvulus arvensis*, *Erodium cicutarium*, *Salsola tragus*, and *Tamarix* spp.

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 U.S. 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 Pahreah (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 U.S. 89. The Radiance uranium mines were also located in the segment, 0.40 miles north of the junction of House Rock Valley Road and U.S. 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 U.S. 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:

One special status plant was 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 *L. caudatus* var. *cutleri*.

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 U.S. 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 U.S. 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)
- Avoid 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)
- Salvage and transplant perennial special status plants (BMP-SS1)
- Avoid 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

Reaches 2 and 5: Glen Canyon to Buckskin Transmission Line and 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 U.S. 89 (Appendix E). 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.

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 is one proposed alternative transmission line alignment within this segment: the Glen Canyon to Buckskin Transmission Line. The segment trends northwest up Fivemile Mountain. The segment would end at U.S. 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.

Special status plants:

No special status plants were found on this segment.

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)
- 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: *[NOT INCLUDED IN CURRENT PROJECT ALTERNATIVES]*

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 U.S. 89 from the Kimball Valley to nearly Petrified Hollow Wash (Appendix E). 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 *Pediomelum epipsilum* and *Lupinus caudatus* var. *culteri*. Noxious species along the segment includes *Erodium cicutarium*, *Salsola tragus*, *Tamarix* spp., and *Halogeton glomeratus*.

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 U.S. 89. This segment intersects with the Fivemile Road segment at the junction of Fivemile Mountain Road and U.S. 89; passes two quarries; and crosses Buckskin Gulch and Telegraph Wash. The Kimball Valley to Telegraph Flat segment continues along U.S. 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 U.S. 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 have 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 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 *Pediomelum epipsilum* and *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. *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. Comparing plant densities, both 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 dominance by *Salsola tragus* were mapped as Invasive Upland Vegetation. Ruderal Vegetation was along the right-of-way of U.S. 89, reflecting the result of a reseeding of the highway right- of-way.

Special status plants:

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 U.S. 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 U.S. 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 crosses the wash or is 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)
- Avoid 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)
- Salvage and transplant perennial special status plants (BMP-SS1)
  - *Pediomelum epipsilum* are located in the footprint of the pipeline
- Avoid 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 U.S. 89, for 3.9 miles, from Telegraph Flat to Seaman Wash (Appendix E). 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. The special status plant species *Pediomelum epipsilum* is present. *Erodium cicutarium*, *Salsola tragus*, *Halogeton glomeratus*, and *Tamarix* spp. are present as noxious species.

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 U.S. 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 U.S. 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 U.S. 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 U.S. 89 right-of-way.

Special status plants:

There is one special status plant in this segment: *Pediomelum epipsilum*. *P. epipsilum* is most abundant in *Juniperus osteosperma* woodlands on high clay content soils. Further discussion on the 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)
- Avoid 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)
- Salvage and transplant perennial special status plants (BMP-SS1)
- Avoid 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: *[NOT INCLUDED IN CURRENT PROJECT ALTERNATIVES]*

6.5.16 Segment 16: Seaman Wash to Eightmile Gap Road

Reach 16: Hydro System South Alternative

Overview:

A pipeline would occupy this segment. The Seaman Wash to Eightmile Gap Road segment begins at three different points along U.S. 89. The three join in two locations along Seaman Wash, then continue as one segment southwest to the junction with Eightmile Gap Road near Johnson Wash (Appendix E). 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 administers the land as GSENM. There were three special status plants (*Pediocactus sileri*, *Phacelia pulchella* var. *atwoodii*, and *Pediomelum epipsilum*) and two noxious plants (*Salsola tragus* and *Erodium cicutarium*) found along this segment.

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 U.S. 89 to east of Petrified Hollow segment, the Telegraph Flat to Seaman Wash segment, and the Seaman Wash to Eightmile Gap Road at U.S. 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 U.S. 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:

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:

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 mile 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 mile 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 *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)
- Avoid 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) (not applicable to Siler pincushion cactus)
- Salvage topsoil (BMP-R/R6) (not applicable to Siler pincushion cactus) (not applicable to Siler pincushion cactus)
- Salvage and transplant perennial special status plants (BMP-SS1) (not applicable to Siler pincushion cactus)
- 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 U.S. 89

Reach 16: Hydro System South Alternative

Overview:

A pipeline would occupy this segment. The Seaman Wash to Eightmile Gap Road at U.S. 89 segment begins at Seaman Wash along U.S. 89, parallels the highway, and ends at the junction with Eightmile Gap Road (Appendix E). 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.

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 U.S. 89, the segment crosses 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 U.S. 89. The next segment that continues southwest is the Eightmile Gap Road at U.S. 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 agricultural 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 (U.S. 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 U.S. 89 is classified as Ruderal Vegetation.

Special status plants:

No special status plants were found on this segment.

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 U.S. 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)
- Avoid 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)
- 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)

6.5.18 Segment 18: U.S. 89 to Thompson Point

Reach 17: Kane County Pipeline System

Overview:

A pipeline would occupy this segment. The U.S. 89 to Thompson Point segment extends 1.8 miles north and west from U.S. 89 along Johnson Canyon Road (BLM Route 501; Appendix E). 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.

Route:

The segment, as described above, extends north from a point along the Seaman Wash to Eightmile Gap Road at U.S. 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 (U.S. 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 murdockii* 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)
- 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)

6.5.19 Segment 19: Eightmile Gap Road at U.S. 89 to Fredonia

Reach 15: Hydro System Existing Highway Alternative

Overview:

A pipeline would occupy this segment. The Eightmile Gap Road at U.S. 89 to Fredonia segment begins at the junction of U.S. 89 and Eightmile Gap Road (Appendix E). The segment tends west on the roadbed of Old U.S. 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 U.S. 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*.

Route:

The Eightmile Gap Road at U.S. 89 to Fredonia segment begins in Utah at Eightmile Gap Road, where it is a continuation of the Seaman Gap to Eightmile Road at U.S. 89 segment. Another segment would also start at this location, the Eightmile Gap Road at U.S. 89 to Johnson Run segment. The Eightmile Gap Road at U.S. 89 to Fredonia segment leaves the U.S. 89 right-of-way and parallels it by following the roadbed of Old U.S. 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 U.S. 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 U.S. 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 U.S. 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)
- Avoid 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)
- 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 U.S. 89 to Johnson Run

Reach 15: Hydro System South Alternative

Overview:

The Eightmile Gap Road at U.S. 89 to Johnson Run segment extends south from U.S. 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. One special status plant (*Phacelia pulchella* var. *atwoodii*) and three noxious weeds (*Salsola tragus*, *Erodium cicutarium*, and *Tamarix* spp.) are found within this segment.

Route:

At the north end, the Eightmile Gap Road at U.S. 89 to Johnson Run segment connects with the junction of the Seaman Wash to Eightmile Gap Road at U.S. 89 segment to the east and the Eightmile Gap Road at U.S. 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* 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 follows an existing roadway that would be used as an access road for pipeline construction. Impacts from use of the roadway and roadway maintenance during and after construction would be similar to the current condition, though minor improvements may be necessary to allow for its use by project vehicles.

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)
- Avoid stream bed modification (BMP-G12)

- Revegetate disturbed soils (BMP-R/R1)
- Install and maintain sediment and seed traps (BMP-R/R4)
- 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)

6.5.21 Segment 21: Eightmile Gap Road to Kanab Creek Canyon

Reaches 16 and 19: Hydro System South Alternative and 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 U.S. 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 E). 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.

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 U.S. 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 U.S. Highway 89A (U.S. 89A). A construction staging area is proposed adjacent to U.S. 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 Formation, 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 heading below). Mixed Low Sagebrush Shrubland is dominated by *Artemisia nova* and on very droughty soils. There are sparsely vegetated washes throughout the segment.

Special status plants:

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 Section 6.1 above.

- Protect erosion prone land (BMP-G8)
- Avoid 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)
    - Some of the best soils are in areas of valley-fill deposits where swales support thick stands of *Artemisia tridentata* ssp. *vaseyana*.
- 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 U.S. 89A in Fredonia, crosses Kanab Creek, and then continues south-west to Arizona Route 389 (Appendix E). 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*.

Route:

The Fredonia to Kaibab Indian Reservation East Boundary survey segment begins at the U.S. 89A bridge over Lost Spring Wash. It is a continuation of the Eightmile Gap Road at U.S. 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.

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 Section 6.1 above.

- Protect erosion prone land (BMP-G8)
- Avoid 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)
- 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)

6.5.23 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 E). A pipeline 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.

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 stomata 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 thompsoniae* var. *atwoodii*. In the only other known location for *E. thompsoniae* 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 Twomile 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* 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* and *Cryptantha semiglabra*. Detailed information on the number of individuals found in various vegetation types can be found in Chapter 4 Special Status Species and Chapter 5 Noxious Weeds and Invasive Species. The geology discussion above provides more specific details about the habitat preferences for *Pediocactus sileri* 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 status 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. *Cryptantha semiglabra* was locally abundant on the slopes below outcrops; locally common on mud washes; occasional on gypsum outcrops; and rare in arroyos.

The Reservation harbors the largest known populations of *Pediocactus sileri*, a federally listed threatened species. This species appears 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.

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* spp. 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:

The following recommendations are BMPs of particular applicability to this segment. Further discussion of each is provided in Section 6.1 above. Avoidance of gypsum badland habitat is the single most important BMP in this segment.

- 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.
- Avoid stream bed modification (BMP-G12)
- 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.
- 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)

6.5.24 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 E). A pipeline 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.

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 Section 6.1 above.

- Protect erosion prone land (BMP-G8)
- Avoid stream bed modification (BMP-G12)
- 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-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 389 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 E). 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*.

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.

Special status plants:

No special status plants were found on this segment.

Invasive and noxious 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-dominated 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 follows an existing roadway that would be used as an access road for pipeline construction. Impacts from use of the roadway and roadway maintenance during and after construction would be similar to the current condition, as the roadway is regularly maintained as a route to the Toroweap Overlook of the Grand Canyon.

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)
- Avoid stream bed modification (BMP-G12)
- Revegetate disturbed soils (BMP-R/R1)
- Install and maintain sediment and seed traps (BMP-R/R4)
- 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)

6.5.26 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 E). 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 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.

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.

Invasive and noxious 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 BMPs of particular applicability to this segment. Further discussion of each is provided in Section 6.1 above.

- 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.
- Avoid stream bed modification (BMP-G12)
- 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 cactus habitat.
- Install and maintain sediment and seed traps (BMP-R/R4)
- Salvage topsoil (BMP-R/R6)
- 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)

6.5.27 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 E). 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.

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.

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.

Special status plants:

No special status plants were found on this segment.

Invasive and noxious 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 BMPs of particular applicability to this segment. Further discussion of each is provided in Section 6.1 above.

- Protect erosion prone land (BMP-G8)
- 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 Reservation West Boundary to Colorado City

Reaches 15 and 9: Hydro System Existing Highway Alternate and 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 Arizona State Route 389 the entire length, with one equipment site on the south side. The segment ends in Colorado City (Appendix E). A pipeline, transmission line, and various sites for equipment, staging, and hydroelectric generation 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.

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 Arizona State Route 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. No special status species taxa were 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.

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 or 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.

Invasive and noxious 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 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 is especially important where the pipeline crosses Cedar Ridge
- 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-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 ASLD, the BLM, and SITLA. The vegetation, landscape and geology within the segment is diverse. One special status plant, *Pediocactus sileri*, was 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.

Route:

The segment begins at the junction of Township Road and Arizona State Route 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).

Invasive and noxious 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 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)
- 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) (not applicable to Siler pincushion cactus)
- Avoid gypsum badlands with special status plants (BMP-SS2)
- Salvage and transplant perennial special status plants (BMP-SS3) (not applicable to Siler pincushion cactus)
- 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 E). 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 woodland 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.

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 LaVerkin 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 Forebay 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.

Special status plants:

No special status plants were found on this segment.

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 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-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 hydroelectric generating 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 E). 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 Mojave Desert tortoise habitat, which would be partly inundated by a reservoir.

Route:

The Afterbay segment would be connected to the Forebay segment via a tunnel. Two segments originate 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 Mojave Desert Ecological Region. The dominant vegetation is Creosote bush-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.

Special status plants:

No special status plants were found on this segment.

Invasive and noxious weeds:

Bromus rubens, *Salsola tragus* and *Erodium cicutarium* were pervasive in this segment.

Impacts:

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 Mojave Desert tortoise habitat creates the possibility of a tortoise being trapped in a trench.

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)
- 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: *[NOT INCLUDED IN CURRENT PROJECT ALTERNATIVES]*

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 E). A tunnel and pipeline would occupy this segment. Ownership is BLM for the southern half, thence private, BLM, and finally WCWCD at the northern end. The vegetation is primarily Active and Stabilized Dune, Creosote bush-White Bursage Desert Scrub, and Shrub- Steppe. There are no special status plants along this segment. *Erodium cicutarium* occurs in more heavily-grazed areas.

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 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 Mojave 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 Creosote bush-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. The segment terminates in a reservoir.

Special status plants:

No special status plants were found on this segment.

Invasive and noxious weeds:

Erodium cicutarium occurs in more heavily-grazed areas.

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 excavation 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 Section 6.1 above.

- Protect erosion prone land (BMP-G8)
- 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)

6.5.34 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 E). The land ownership is BLM, with the exception of the northern half of a short stretch near Sand Hollow Road, which is owned by

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.

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 descending 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 Mojave 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 Creosote bush-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.

Special status plants:

No special status plants were found on this segment.

Invasive and noxious weeds:

Erodium cicutarium occurs in more heavily-grazed areas.

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.

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)
- Dispose of all construction waste (BMP-G17)
- Install and maintain sediment and seed traps (BMP-R/R4)
- Revegetate disturbed soils (BMP-R/R1)
- Maintain livestock fencing and gates (BMP-SS5)
- Control equipment movement in areas with noxious or invasive plants (BMP-IS10)

6.5.35 Segment 35: *[NOT INCLUDED IN CURRENT PROJECT ALTERNATIVES]*

6.5.36 Segment 36: Sand Hollow Reservoir to Dixie Springs Substation

Reaches 27 and 28: Sand Hollow to Dixie Springs Transmission Line 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 E). Land ownership is split almost evenly between private land and 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.

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 Mojave Desert Ecological Region. To the south of Sand Hollow Draw is Active and Stabilized Dune dominated by *Artemisia filifolia*. Creosote bush-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.

Special status plants:

No special status plants were found on this segment.

Invasive and noxious 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)
- 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)

6.5.37 Segment 37: Sand Mountain to Virgin River

Reaches 29 and 30: Hurricane Cliffs Afterbay to Hurricane West Transmission Line and 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 E). 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.

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 LaVerkin (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 surface 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 Mojave Desert Ecological Region. These include: Creosote bush-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.

Invasive and noxious 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)
- Avoid stream bed modification (BMP-G12)
- 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)

6.5.38 Segment 38: *[NOT INCLUDED IN CURRENT PROJECT ALTERNATIVES]*

6.5.39 Segment 39: The Divide to Point of Interconnection Substation

Reach 33: HS-4 (Alt.) Transmission Line

Overview:

The Divide to Point of Interconnection Substation Segment would include a proposed transmission line. The segment begins at The Divide and ends at the Point of Interconnection Substation (Appendix E). 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. There are no special status plants found along this segment. Several noxious weeds were identified in the segment, including: *Elaeagnus angustifolia*, *Erodium cicutarium*, *Halogeton glomeratus*, *Salsola tragus*, and *Tamarisk* spp.

Route:

The Divide to LaVerkin 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 the Point of Interconnection Substation south of Utah Route 59.

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, U.S. 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 Hayden 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.

Ecological systems:

All of the ecological systems in The Divide to LaVerkin Creek Segment are in the Colorado Plateau Ecological Region. 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 State Route 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-Juniper Woodland. The Colorado Plateau Wash Ecological System is also present in many washes throughout the segment.

Special status plants:

No special status plants were found on this segment.

Invasive and noxious 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). *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 Point of Interconnection Substation is currently actively grazed.

Impacts:

Areas that are classified as Invasive Upland Vegetation may serve as point sources for the spread of invasive weeds along the proposed transmission line corridors could provide a route for invasive weeds to colonize adjacent natural lands.

Excavation and other disturbance associated with proposed project 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)
- 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-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)

6.5.40 Segment 40: *[NOT INCLUDED IN CURRENT PROJECT ALTERNATIVES]*

6.5.41 Segment 41: *[NOT INCLUDED IN CURRENT PROJECT ALTERNATIVES]*

6.5.42 Segment 42: *[NOT INCLUDED IN CURRENT PROJECT ALTERNATIVES]*

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.

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 268.3 miles (157.4 miles of 600-foot wide corridor and 110.9 miles of 300-foot wide corridor) totaling 20,465 acres. This figure represents 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). Three hundred and ninety-two 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, 51 were found to have habitat requirements that coincided with the ecological parameters within the survey area. During surveys, seven special status species were observed; one species is listed as threatened under the ESA (*Pediocactus sileri*); four of the species are listed as sensitive by the BLM (*Cryptantha semiglabra*, *Lupinus caudatus* var. *cutleri*, *Pediomelum epipsilum*, and *Phacelia pulchella* var. *atwoodii*); and two of the species are listed as species of concern by GCNRA (*Echinocactus polycephalus* var. *xeranthemoides* and *Phacelia mammalariensis*). Thirteen species on the Kaibab Band of Paiute Indians' list of Plants of Cultural Concern were detected during the special status plant and noxious weed surveys.

The field surveys identified 14,371 individual plants through direct counts and extrapolation based on transect data. The majority of special status plants fell on BLM lands (6,754 individuals) and on the Kaibab Indian Reservation (5301 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 27 ecological systems occurring within the survey area. The Colorado Plateau Gypsum Badlands Ecological System supported the greatest diversity of special status species (4 species). The Colorado Plateau Gypsum Badlands Ecological System also supported high counts of special status species (7,696 individuals), although this is largely due to the density of *Cryptantha glabra* (3,285 individuals) and *Pediocactus sileri* (2,934 individuals). A listing of special status species by the reach in which they occurred is provided at the end of the conclusion section.

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 highest number of special status plants (including the highest number of *Pediocactus sileri*) occurs 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 would reduce the impacts of construction activities on special status species within the LPP corridor.

- BMP-SS1: Protection by avoidance of known individuals and locations of habitats known to be occupied by federally listed species and other special status plant species.
- BMP-SS2: All special status plant species present in the area of disturbance should be salvaged and transplanted in restoration areas (except for Siler pincushion cactus; impacts on individual plants would be avoided)
- 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: Protect newly seeded areas from livestock grazing for at least two growing seasons.

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. Sixteen weed species were observed; 9 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, *Erodium cicutarium* (24 ecological systems and five anthropogenic lands), *Bromus rubens* (23 ecological systems and five anthropogenic lands), *Bromus tectorum* (23 ecological systems and five anthropogenic lands), *Salsola tragus* (20 ecological systems and five six anthropogenic lands) and *Tamarix* spp. (15 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

Noxious/Invasive Weeds: *Brassica tournefortii*, *Bromus rubens*, *Bromus tectorum*, *Erodium cicutarium*, *Salsola tragus*, *Tamarix* spp.

BPS-2

Noxious/Invasive weeds: *Bromus tectorum*, *Portulaca oleracea*

BPS-2 Transmission Line

Noxious/Invasive Weeds: *Brassica tournefortii*, *Bromus tectorum*, *Portulaca oleracea*, *Salsola tragus*

Eightmile Gap Road

Special Status Plants: *Phacelia pulchella* var. *atwoodii* 5 individuals

Noxious/Invasive Weeds: *Bromus rubens*, *Bromus tectorum*, *Elaeagnus angustifolia*, *Erodium cicutarium*, *Onopordum acanthium*, *Salsola tragus*, *Tamarix* spp.

Forebay

Noxious/Invasive Weeds: *Bromus rubens*, *Bromus tectorum*, *Erodium cicutarium*, *Salsola tragus*, *Tamarix* spp.

Glen Canyon Substation

Special Status Plants: *Phacelia mammalariensis* 1,688 individuals

Noxious/Invasive Weeds: *Erodium cicutarium*, *Portulaca oleracea*, *Tribulus terrestris*

Glen Canyon to Buckskin Transmission Line

Noxious/Invasive Weeds: *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

Special Status Plants: *Lupinus caudatus* var. *cutleri* 33 individuals, *Phacelia mammalariensis* 1 individual

Noxious/Invasive Weeds: *Asclepias subverticillata*, *Bromus tectorum*, *Erodium cicutarium*, *Salsola tragus*, *Tamarix* spp.

Hurricane Cliffs Afterbay to Hurricane West Transmission Line

Noxious/Invasive Weeds: *Bromus rubens*, *Bromus tectorum, Convolvulus arvensis*, *Elaeagnus angustifolia*, *Erodium cicutarium*, *Tamarix* spp., *Tribulus terrestris*

Hurricane Cliffs to Sand Hollow Transmission Line

Noxious/Invasive Weeds: *Bromus rubens*, *Bromus tectorum*, *Erodium cicutarium*, *Salsola tragus*

Hydro System

Special Status Plants: *Pediocactus sileri* 7 individuals

Noxious/Invasive Weeds: *Bromus rubens*, *Bromus tectorum*, *Convolvulus arvensis*, *Elaeagnus angustifolia*, *Erodium cicutarium*, *Halogeton glomeratus*, *Onopordum acanthium*, *Portulaca oleracea*, *Salsola tragus*, *Sorghum halapense*, *Tamarix* spp.

Hydro System South Alternative

Special Status Plants: *Phacelia pulchella* var. *atwoodii* 1,346 individuals

Noxious/Invasive Weeds: *Asclepias subverticillata*, *Bromus tectorum*, *Convolvulus arvensis*, *Erodium cicutarium*, *Salsola tragus*, *Tamarix* spp.

Hydro System Existing Highway Alternative

Special Status Plants: *Cryptantha semiglabra* 3,314 individuals, *Pediocactus sileri* 2,938 individuals, *Pediomelum epipsilum* 30 individuals

Noxious/Invasive Weeds: *Aegilops cylindrica*, *Asclepias subverticillata*, *Brassica tournefortii*, *Bromus rubens*, *Bromus tectorum*, *Convolvulus arvensis*, *Elaeagnus angustifolia*, *Erodium cicutarium*, *Halogeton glomeratus*, *Onopordum acanthium*, *Salsola tragus*, *Tamarix* spp., *Tribulus terrestris*

Hydro System Existing Highway Alternative and Hydro System South Alternative

Special Status Plants: *Pediomelum epipsilum* 1,642 individuals

Hydro System South Alternative

Special Status Plants: *Echinocactus polycephalus* var. x*eranthemoides* 9 individuals, *Pediocactus sileri* 1 individual, *Pediomelum epipsilum* 37 individuals, *Phacelia pulchella* var. *atwoodii* 1,346 individuals

Noxious/Invasive Weeds: *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

Noxious/Invasive Weeds: *Bromus tectorum*, *Erodium cicutarium*, *Salsola tragus*

Kane County Pipeline System

Noxious/Invasive Weeds: *Asclepias subverticillata*, *Bromus rubens*, *Bromus tectorum*, *Elaeagnus angustifolia*, *Erodium cicutarium*, *Portulaca oleracea*, *Salsola tragus*, *Tribulus terrestris*

Mount Trumbull Road

Noxious/Invasive Weeds: *Bromus tectorum*, *Convolvulus arvensis*, *Salsola tragus*, *Tamarix* spp.

Paria Substation

Noxious/Invasive Weeds: *Bromus tectorum*, *Erodium cicutarium*, *Salsola tragus*

Penstock from Afterbay to Sand Hollow Hydro for Peaking Option

Noxious/Invasive Weeds: *Brassica tournefortii*, *Bromus rubens*, *Bromus tectorum*, *Erodium cicutarium*, *Salsola tragus*

Penstock from Afterbay to Sand Hollow Hydro for Pump Storage Option

Noxious/Invasive Weeds: *Bromus rubens*, *Bromus tectorum*, *Erodium cicutarium*, *Salsola tragus*

Sand Hollow to Dixie Springs Transmission Line

Noxious/Invasive Weeds: *Bromus rubens*, *Bromus tectorum*, *Erodium cicutarium*, *Salsola tragus*, *Tamarix* spp.

Water Conveyance System

Special Status Plants: *Lupinus caudatus* var. *cutleri* 21 individuals, *Pediomelum epipsilum* 1,263 individuals

Noxious/Invasive Weeds: *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 Hydro System

Special Status Plants: *Pediomelum epipsilum* 2,464 individuals

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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 bristlelike 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 blade of most grasses; strap-shaped inner whorl of flower parts.

Microbiotic — see cryptobiotic.

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 taxonomic category 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.

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 Conservancy District
LPP	Lake Powell Pipeline
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
TDS	Total Dissolved Solids
UAH	University of Arizona Herbarium
UDWRe	Utah Division of Water Resources
UNPS	Utah Native Plant Society
U.S.	United States
U.S. 89	U.S. Highway 89
U.S. 89A	U.S. Highway 89A
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

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Appendix A
Lake Powell Pipeline Place Names and Reaches Map

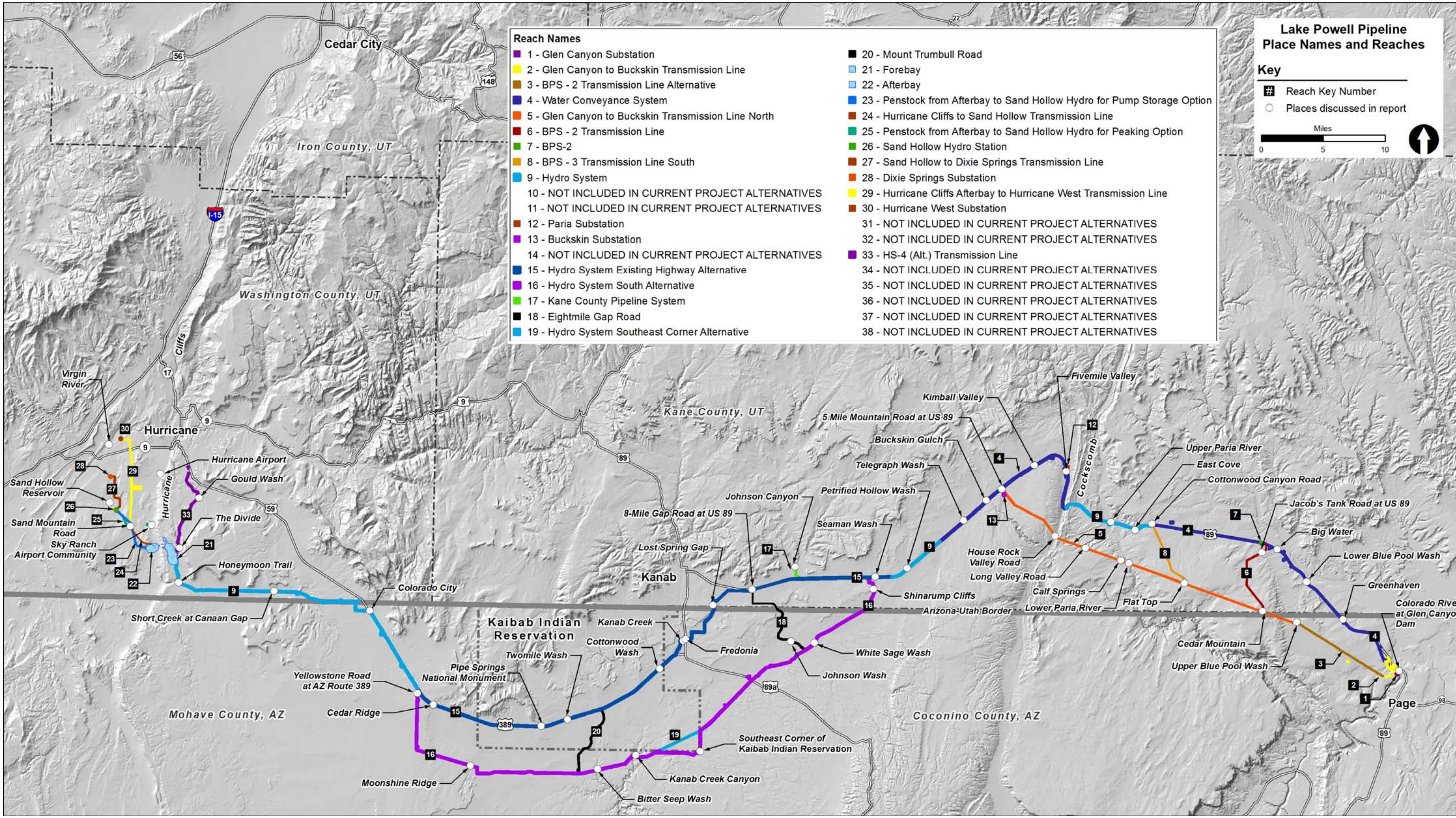

Figure A–1
LPP Place Names and Reaches

Appendix B
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 C
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 D
Lake Powell Pipeline 50 Meter Transect Locations

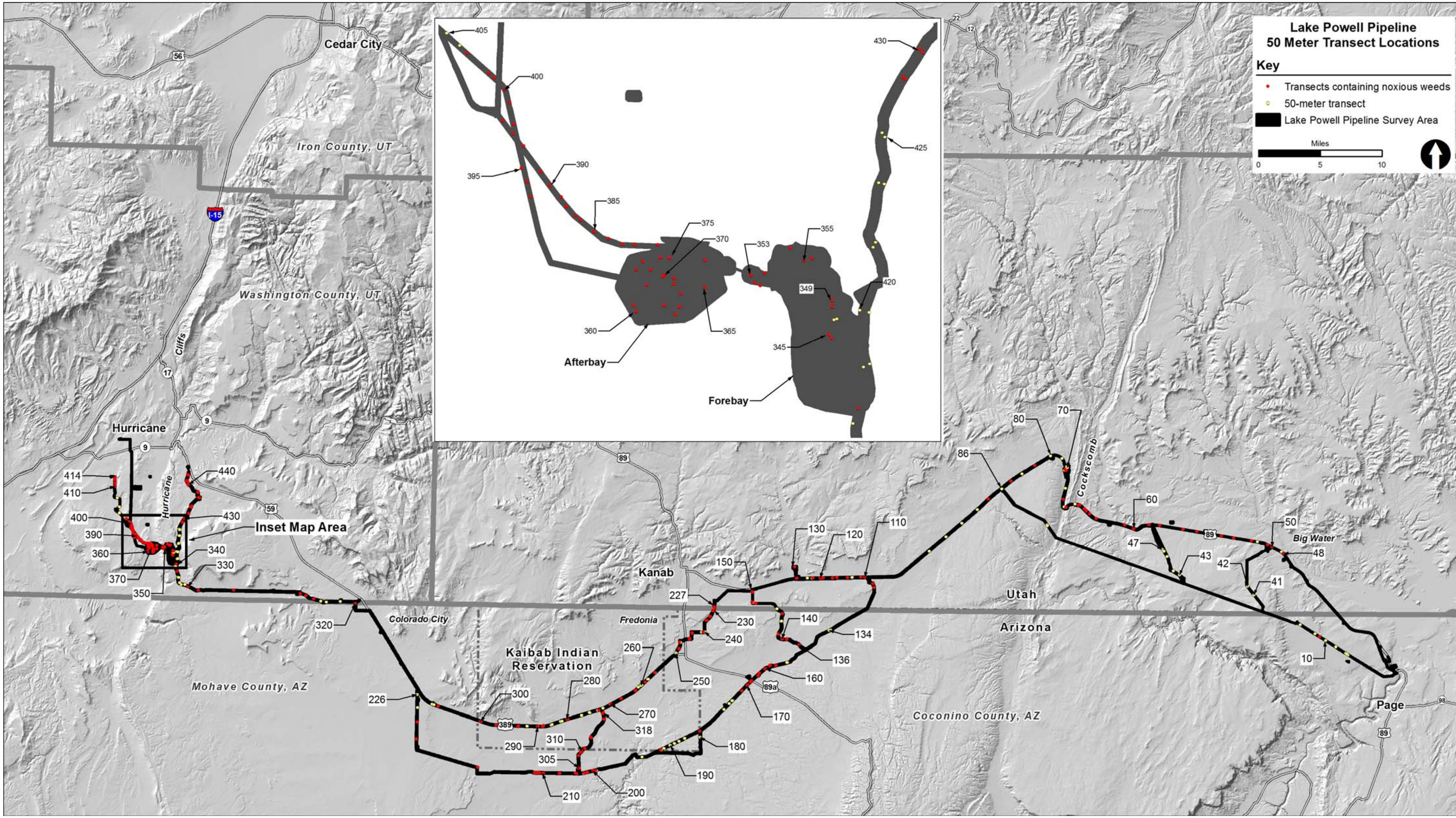

Figure D–1
LPP 50-Meter Transect Locations Map

Appendix E
Lake Powell Pipeline Effects Analysis Map

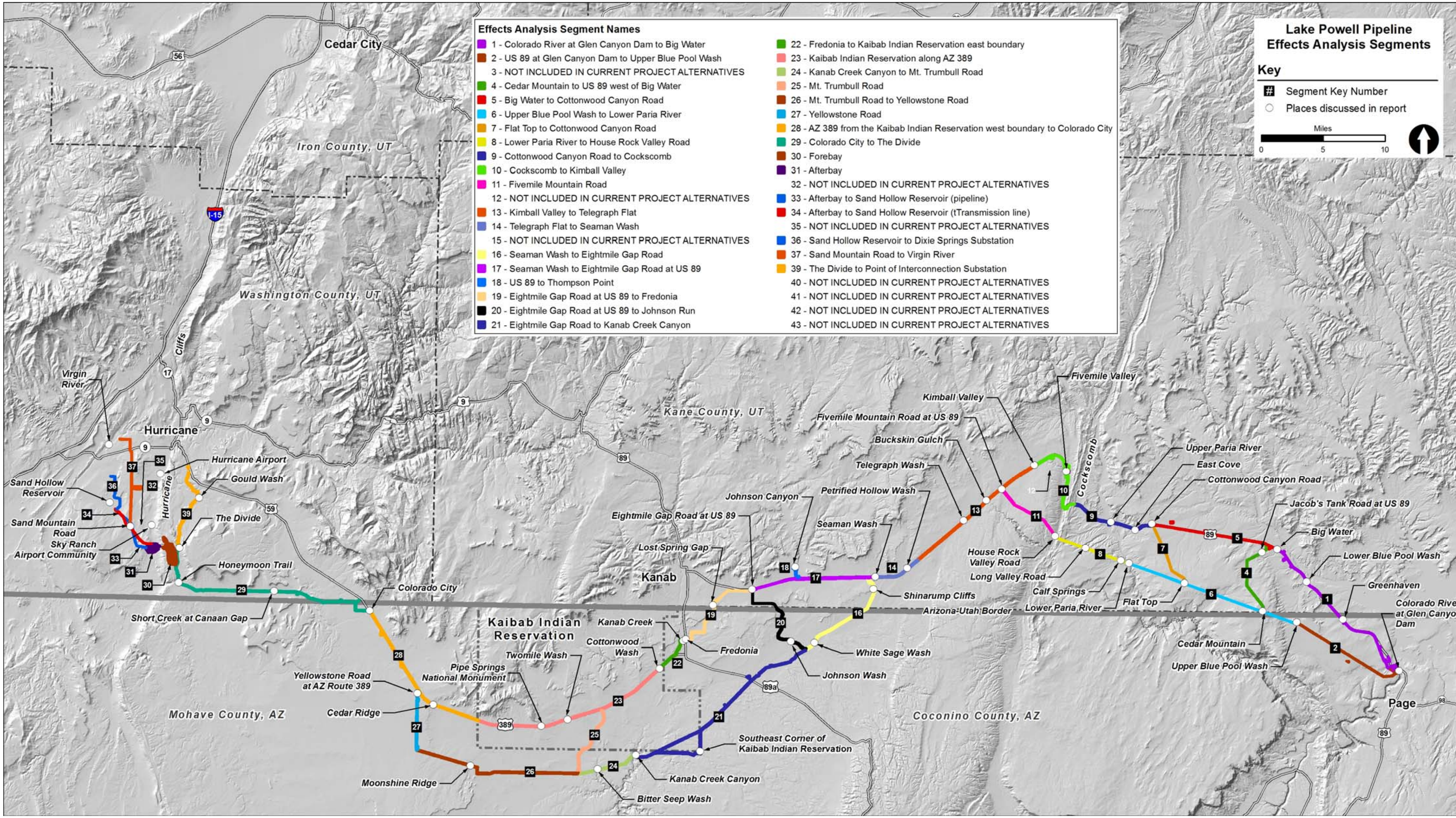

Figure E–1
LPP Effects Analysis Map