

2004 ARIZONA HEDGEHOG CACTUS SURVEY
Federal Parcel, Pinal County, Arizona



Prepared for:

Resolution
Copper Company

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DECEMBER 2004
Job No. 807.09

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EXECUTIVE SUMMARY

WestLand Resources, Inc. (WestLand) was retained by Resolution Copper Company (Resolution) to conduct a survey for Arizona hedgehog cactus (*Echinocereus triglochidiatus* var. *arizonicus*; ETA) on the approximately 1,224-hectare (3,025-acre) Federal Parcel (the Parcel). The Parcel is in the Tonto National Forest east of the town of Superior in Pinal County, Arizona.

Resolution proposes to obtain the Parcel by way of a land exchange. In support of this effort, WestLand has been conducting baseline resource investigations on the Parcel. The purpose of this survey was to identify existing locations of the ETA in accordance with established protocols and procedures.

Nine Arizona hedgehog cacti were found on the Parcel (1 plant per 136 hectares [336 acres]). The Arizona hedgehog cactus densities found on the Parcel are far less than those found in areas northeast of the Parcel for the Carlota project in 1992 and 1993. Arizona hedgehog cacti densities found in that area were 1 to 8 plants per hectare (2 to 20 plants per acre).

The predominant rock type on the Parcel east of Apache Leap is Apache Leap tuff, one of the geologic formations typically associated with Arizona hedgehog cactus habitat. This formation covers approximately 90 percent of the Parcel. No obvious reasons for the extremely low densities of the plant on the Parcel are apparent. However, the Apache Leap tuff is comprised of several layers with various degrees of welding which are visually differentiated by rock color. Some of these layers may provide a more suitable substrate for the Arizona hedgehog cactus than others, but no direct association was observed.

1. INTRODUCTION AND BACKGROUND

1.1 STATEMENT OF PURPOSE

WestLand Resources, Inc. (WestLand) was retained by Resolution Copper Company to conduct an Arizona hedgehog cactus (*Echinocereus triglochidiatus* var. *arizonicus*; ETA) survey on the approximately 1,224-hectare (3,025-acre) Federal Parcel (the Parcel), located east of the town of Superior in Pinal County, Arizona. The Parcel occupies a portion of Section 36, Township 1 South, Range 12 East; portions of Sections 1 and 2, Township 2 South, Range 12 East; portions of Sections 28, 29, 30, 31, and 32, and Section 33, Township 1 South, Range 13 East; and a portion of Section 6, Township 2 South, Range 13 East (Figure 1). The Parcel is currently public land, managed by the US Forest Service (USFS) within the Tonto National Forest.

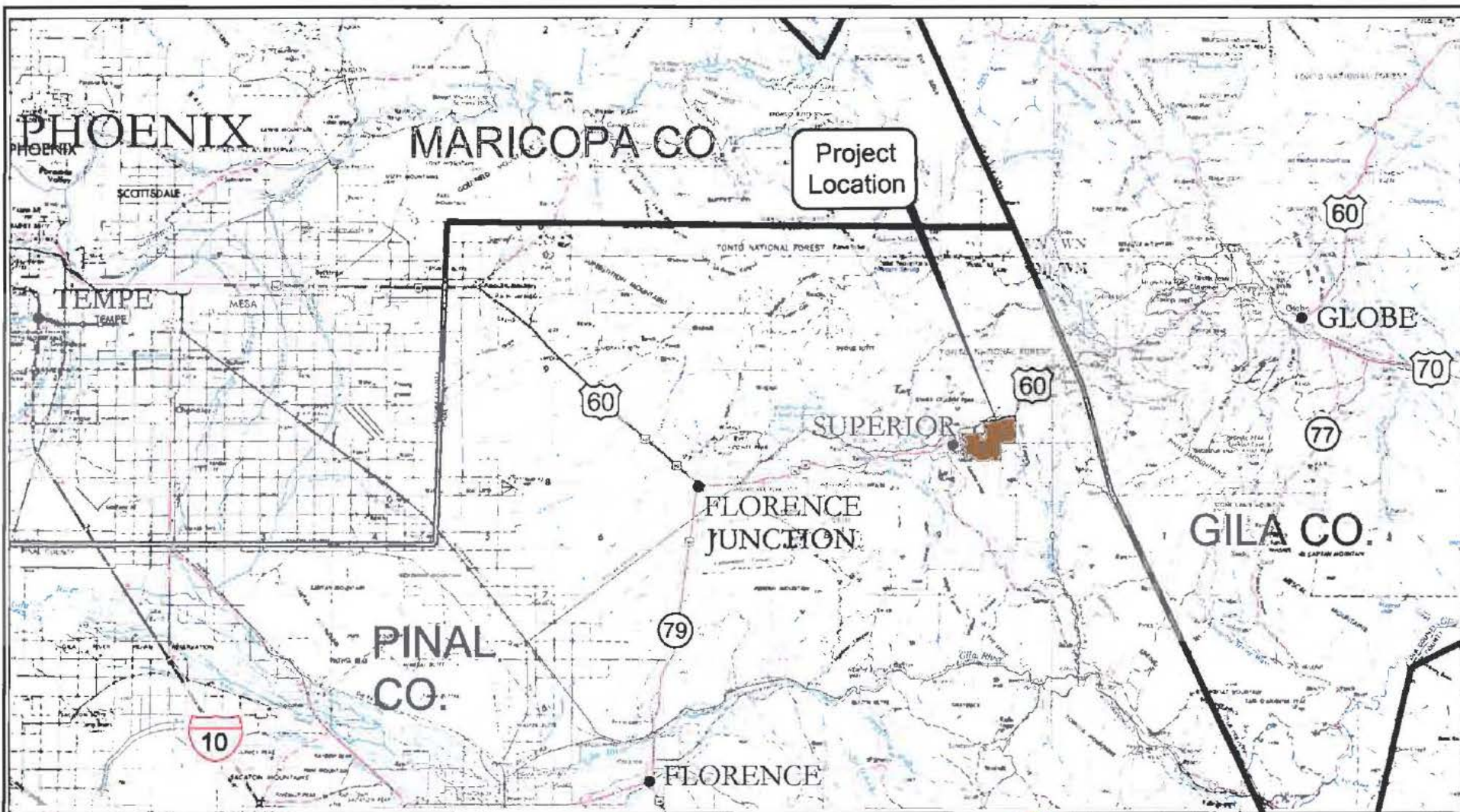
Resolution proposes to obtain the Parcel by way of a land exchange. In support of this effort, WestLand has been conducting baseline resource investigations on the Parcel. The purpose of this survey was to identify existing locations of the ETA in accordance with established survey protocols and procedures.

1.2 SITE DESCRIPTION

The Parcel is located in the Pinal Mountains within the Central Highlands Province, a transition zone between the Colorado Plateau and the Basin and Range Provinces. Elevation within the Parcel varies from approximately 900 to 1,500 meters (3,000 to 5,000 feet) above mean sea level. Over 90 percent of the area of the Parcel is covered by the Apache Leap tuff, the youngest consolidated geologic formation, which forms the cap of the Apache Leap escarpment on the western portion of the Parcel. Underlying units are volcanic and sedimentary rocks exposed at the foot of the Apache Leap escarpment. A late Tertiary/early Quaternary weakly consolidated gravel and conglomerate unit overlies the Apache Leap tuff in a small area on the eastern portion of the Parcel.

The soils associated with the Apache Leap tuff are classified as Lithic Torriorthents, and were formed as a residuum weathered from the tuff (Brown, 1994). These soils are shallow, gravelly, and strongly sloping to very steep soils and, consequently, are well drained.

The Parcel is dominated by plant species associated with Interior Chaparral (east of Apache Leap) and Sonoran Desertscrub biotic communities (west of Apache Leap), as described by Brown (1994). Relatively isolated patches of xeriparian and mesoriparian vegetation are located throughout the Parcel around stock tanks and in association with ephemeral drainages, Rancho Rio Creek, and Queen Creek.



Pinal County, Arizona
Mesa 1:250,000 USGS Map

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0 6.5 13 KM
Approx. Scale 1" = 13 KILOMETERS



Resolution
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2004 ARIZONA HEDGEHOG CACTUS SURVEY,
FEDERAL PARCEL

VICINITY MAP
Figure 1

1.3 SUMMARY OF PREVIOUS SURVEYS CONDUCTED IN THE PARCEL VICINITY

Several previous surveys for ETA have been conducted on or near the Parcel:

- The broadest scope was covered by Cedar Creek Associates (in USFS 1996), in which a 100-percent survey of the nearby Carlota Mine site (13 kilometers [9 miles] northeast of the Parcel) was expanded to include a review of all data pertaining to the species. The initial survey of the Carlota site identified 1150 individual plants, and the majority of the plants were found in the "Dry-slope Desert Brush community occurring on the Apache Leap Tuff (also known as dacite)." Combining these findings with studies of three other areas, Cedar Creek Associates concluded that the ETA "occupies an area of about 18,900 acres (or nearly 30 square miles)" and that the "preponderance of existing data strongly suggest these [Apache Leap Tuff and Schultze granite] are preferred substrates for Arizona hedgehog." Furthermore, "[g]iven these sources of data, the average density of Arizona hedgehog within the Schultze granite and dacite formations is 64.05 and 5.72 individuals per acre, respectively."
- A biological evaluation of six drill pad sites within the Parcel, conducted by SWCA, Inc. in 2001, identified no ETA within the 22-acre study area along FR315. The geologic formation underlying the study area was Apache Leap Tuff.
- A biological evaluation of six additional drill pad sites within the Parcel, conducted by WestLand in 2001, identified no ETA within the study area near the previously studied drill pad sites. Again, the geologic formation underlying this study area was Apache Leap Tuff.
- A biological evaluation of one drill pad site within the Parcel, conducted by WestLand in 2002, identified no ETA within the study area. This site was also near the previously studied drill pad sites, and also located atop the Apache Leap Tuff.
- An intensive survey of a 121-hectare (300-acre) area adjoining the Parcel on the north side of US 60 was conducted by WestLand in late 2002 and early 2003. Eighty-four plants were found on that site (plus one plant observed on the south side of US 60), which is also located on Apache Leap Tuff.
- Additional broad surveys for ETA on the Parcel were conducted by WestLand in the spring of 2003. Utilizing the spring flowering period to advantage, this work consisted of wide-area pedestrian surveys searching for the distinctive scarlet red flowers of the ETA. One plant was found near Oak Flat Campground, and one along Queen Creek on a steep cliff.

Based on these results, it appears that ETA is correlated with Apache Leap Tuff on the north side of US 60 (off-site) but, as of the end of 2003, only one ETA was found south of US 60. As stated in WestLand (2003b), "[n]o obvious reasons for the veritable absence of ETA on the south side of US 60 are apparent."

1.4 DESCRIPTION, STATUS, RANGE, AND HABITAT

Prior to conducting the field surveys, WestLand personnel conducted a literature and file search to obtain current information regarding the range and habitat requirements of ETA. The following sections provide a species account for the ETA.

1.4.1 Description

ETA was first discovered and described in the mid-1800s in the mountains and canyons between Globe and Superior, Arizona.

ETA has dark green cylindroid stems that occur singly or in clusters of a few stems. Large, robust stems range from 23 to 41 cm (9.2 to 16.4 in.) high and 7.5 to 10.0 cm (3.0 to 4.0 in.) in diameter. Each stem has seven to 12 robust tuberculate ribs. ETA has one to three gray or pinkish central spines; the largest central spine is deflexed (points down). Its five to 11 radial spines are slightly curved. The accompanying photograph was taken



Representative Arizona hedgehog cactus (*Echinocereus triglochidiatus arizonicus*) on the Parcel.

of an ETA found on the Parcel (Cactus 3); this photograph shows the cactus' stem and spine characteristics. A unique characteristic of the *Echinocereus* genus is that the flowers burst through the sides of the stems, leaving scar tissue on the stem above the spine. ETA flowers are bright red (no bluish or lavender hues), which is the distinguishing feature from other hedgehog cacti found below 1,800 m (6,000 ft.) Flowers are produced on the upper third of stem ribs and are broad, about 5.0 cm (2.0 in.) in diameter and 7.4 cm (2.96 in.) long. Relative to other *Echinocereus*, ETA spines are shorter and more robust. One other *Echinocereus* species was encountered during our survey effort, *Echinocereus fasciculatus* (EF); however, the identity of the two species was not confused. In addition to the difference in spine length and width between these two *Echinocereus* species, two other considerable differences exist in the appearance of these the two plants; 1) EF has a dense coverage of spines compared to that of ETA, and 2) the EF flower color is pink to magenta but bright red in the ETA.

1.4.2 Status

ETA is listed as an endangered species under the federal Endangered Species Act without Critical Habitat by the US Fish and Wildlife Service (USFWS) (40 FR 61556; Oct. 15, 1979), as Highly Safeguarded by the State of Arizona (Arizona Native Plant Law, 1993), and as a USFS Sensitive species (USFS, 2003). ETA was listed as an endangered species because the limited geographic range of this plant increases its

vulnerability to threats from mining, off-road vehicle use, illegal collecting, and road and utility construction.

Controversy over the taxonomy of this species prevents the USFWS from developing a recovery plan or finalizing the draft taxonomy for the species. There are several populations of similar cacti growing in the mountains of the southwestern United States and in northern Mexico that are closely related to ETA. Up until the mid-1980s it was thought that there were eight different varieties of the species *Echinocereus triglochidiatus*, one of which is *arizonicus* or ETA. The other varieties have the same flower shape, color, and development (called a "claret-cup" flower because it is shaped like a claret wine goblet) but have different spine, stem and rib characteristics. It is assumed that all of the varieties were able to interbreed with one another because there are many populations that appear to be intermediate between two neighboring varieties.

At this point in time, there are three recognized varieties of the species *Echinocereus triglochidiatus*: *triglochidiatus*, *mojavensis*, and *arizonicus*. Recently, some botanists have suggested that the populations of hedgehog cactus growing in the mountains of Cochise County, Arizona, and southeast New Mexico are the same as *arizonicus* or ETA. In the past these populations have been called *E. triglochidiatus* var. *neomexicanus*. The Cochise County cacti are thought to be the same as *arizonicus* because they are "robust" (large stems) and the diameter of their spines is large ("thick-spined"). If these populations are indeed the same variety as *arizonicus*, then the geographic distribution of the Arizona hedgehog cactus may be considered far more widespread than if the populations are distinct. Ramifications of this to the listing status of the ETA, if the Cochise County cacti are ETA, are unclear.

1.4.3 Range and Habitat

ETA, as currently defined, is found in Pinal County in the vicinity of Dripping Springs, the Superstition and Mescal mountains, the highlands between Globe and Superior, and in Devils Canyon and Queen Creek along the Gila/Pinal County line. Known habitat requirements include open slopes or the understory of a more open canopy in cracks and crevices between boulders, rather than the dense shrub overstory of the Interior Chaparral biome dominant on the Parcel. The substrate that is known to support this species has geologic parent materials consisting of volcanic tuff, dacite, and granite.

The distribution of ETA within its range appears to be closely associated with four major rock types: Tertiary Apache Leap tuff (dacite), Cretaceous or Tertiary Schultze granite, Precambrian Apache Group Pioneer quartzites, and Precambrian Pinal schist. Cedar Creek Associates' observations of more than 1,000 specimens located during field surveys for the nearby Carlota Project indicate that ETA prefers stable rock formations such as the Apache Leap tuff and Schultze granite (Cedar Creek Associates, 1994). These rock types weather very slowly, forming stable ridges and outcrops, which provide opportunities for ETA to establish and grow. The remaining two rock types that are known to be associated with ETA are either poorly distributed within the known range of ETA (Pioneer quartzites) or weather more rapidly (Pinal schist) creating a soil substrate that is colonized by dense stands of vegetation and do not appear to be used by ETA to the same extent as the tuff or granite.

2. METHODS

A qualified WestLand field crew of three to five surveyors conducted an ETA survey of the Parcel on April 5 through 28, 2004. Survey methods employed by Westland for the ETA were based on previous cactus survey protocols that were designed in consultation with the USFWS and the USFS.

Two methods were used to survey the Parcel for ETA. Most of the Parcel was surveyed by observers walking parallel transects as described below. Due to the rugged nature of the geologic formations that occur within the Parcel, visual surveys of inaccessible cliff walls, opposing slopes, deep canyons, and outcroppings were conducted by glassing with 8x48 or 10x50 power binoculars. Binocular surveys, when necessary, were conducted from a point that offered the best view of the target area. The observer glassed the area in overlapping sweeps with the binoculars, choosing obvious landmarks to use as reference points for the sweeps. Figure 2 provides a map of the areas surveyed by the two methods.

On-ground survey transect widths were determined by the density of vegetation. Belts of no more than 25 meters (80 feet) in width (12.5 meters [40 feet] on each side) were surveyed by each observer. In dense stands of vegetation, transect widths were reduced to 10 meters (30 feet) in total width (or less) depending on transect site-specific conditions. Within each survey belt, observers walked in a zigzag pattern inspecting the ground surface to the front, sides, and rear as they progressed across the transect. In this manner, the effort was maximized to gain view of the ground surface. The line of observers moved at a pace set by the slowest member to avoid unnecessary duplication of effort and missing portions of the survey belt. To facilitate control, the outside observer maintained position of the transect with the aid of compass or hand-held GPS unit and/or tied flagging along his path to assist in the location of the adjacent sweep. Sweeps were organized to take advantage of topography, road cuts, or other features of the landscape to ensure efficient and accurate coverage of all portions of the delineated survey areas.

Upon finding an ETA, a more intensive search was conducted within a 100-meter (300-foot) radius surrounding the cactus. Field personnel recorded the number of stems, ribs, and spines, and the length of the tallest and shortest stems in inches. In addition, observations on location, habitat and elevation, slope, and aspect were recorded. These data, along with Universal Transverse Mercator (UTM) coordinates in North American Data 1927 (NAD 27), were recorded on the *Arizona Hedgehog Cactus Survey Data Sheet* for each cactus found on the Parcel.

3. RESULTS AND DISCUSSION

WestLand mapped, tagged, and recorded data on the seven ETA that were found during the initial survey effort. The field data sheets for these plants are provided in Appendix B. Subsequently two additional plants were located on the Parcel. The locations of the ETA found on the Parcel are depicted on Figure 3.

ETA are very thinly distributed across the Parcel. UTM coordinates (NAD 27) of ETA located during the survey are provided in Table 1. The accuracy of the UTM coordinates is approximately 6 meters (± 20 feet). Appendix A provides photographs of Cacti 1 through 6 and Cacti 8 and 9. Cactus 7 was not photographed because it was inaccessible.

Table 1. Arizona hedgehog cacti on the Federal Parcel (NAD 27).

Cactus No.	UTM Coordinates		Survey Method	General Location
	Easting	Northing		
1			Ground	Oak Flat Camp Ground
2			Ground	Section 33, Township 1 South, Range 13 East
3			Ground	Queen Creek northwest portion of Parcel
4			Ground	Queen Creek northwest portion of Parcel
5			Ground	Queen Creek northwest portion of Parcel
6			Ground	Queen Creek northwest portion of Parcel
7*	--	--	Binocular	Ridgeline north of US 60
8**			Ground	Queen Creek tributary east of Superior Mine
9**			Ground	Queen Creek tributary east of Superior Mine

*Cactus No. 7 was located by binocular survey and was physically inaccessible; therefore, no GPS coordinates or photograph were taken for this plant.

**Cacti 8 and 9 were found while conducting amphibian surveys on the Parcel.

4. CONCLUSIONS

An ETA survey was conducted on the Parcel by WestLand biologists from April 5 through 28, 2004. Nine ETA were found on the approximately 1,224-hectare (3,025-acre) Parcel. The ETA densities found on the Parcel (one plant per 136 hectares [336 acres]) are far less than those found in areas northeast of the Parcel at the Carlota Project in 1992 and 1993 (1 to 8 plants per hectare [2 to 20 plants per acre]).

The predominant rock type on the Parcel east of Apache Leap is Apache Leap tuff, one of the geologic formations typically associated with ETA habitat. This tuff formation covers approximately 90 percent of the Parcel. No obvious reasons for the extremely low densities of ETA on the Parcel are apparent. However, the Apache Leap tuff is comprised of several layers with various degrees of welding which are visually differentiated by rock color (i.e., brown [densely welded]; gray and vitrophyre [partly welded]; basal, top of white, upper white, lower white [unwelded]). Some of these layers may provide a more suitable substrate for ETA than others, but no direct association was observed.

5. REFERENCES

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APPENDIX A
ARIZONA
HEDGEHOG CACTUS
PHOTOGRAPHS



Cactus 1



Cactus 2



2004 Arizona Hedgehog Cactus Survey
ARIZONA HEDGEHOG CACTUS PHOTOGRAPHS
Sheet 1



Cactus 3



Cactus 4



Cactus 5



Cactus 6



Cactus 8



Cactus 9

APPENDIX B
ARIZONA HEDGEHOG
SURVEY
DATA SHEETS

