2012 PREFEASIBILITY ACTIVITIES
ARIZONA HEDGEHOG CACTUS
ACTION AREA SURVEY
(CONSERVATION MEASURE 5)

RESOLUTION COPPER MINING

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March 2013
Job No. 807.73 (807.68)

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EXECUTIVE SUMMARY

WestLand Resources, Inc. (WestLand) was retained by Resolution Copper Mining (RCM) to conduct surveys for Arizona hedgehog cactus (AHC; *Echinocereus arizonicus* var. *arizonicus*) in conformance with the monitoring requirements of the Resolution Copper Mining Pre-feasibility Activities Plan of Operations (PoO; WestLand 2010a) and the Tonto National Forest's (TNF) Finding of No Significant Impact (FONSI; TNF 2010).

Pursuant to mitigation and monitoring measures prescribed by the PoO, survey of the Pre-feasibility Activities Action Area (the Action Area[1]) for AHC is required every two years. The Action Area includes a 100-ft (30-m) wide corridor centered on each of the roadways and a 500-ft (152-m) radius around each drill pad. To facilitate field work, surveys were expanded outside of the Action Area to include a 500-ft (152-m) by 500-ft (152-m) square area centered on proposed and existing drill sites and an additional 50 ft (15 m) of width along each side of the access roads for a total width of 200 ft (60 m) (the Survey Area; ***Figures 1-3***). The Survey Area includes National Forest System lands, as well as private and State lands totaling approximately 727 acres (294 hectares; 537 acres [217 hectares] along roadways and 190 acres [77 hectares] within and around 33 drill sites). All data collected during this survey have been recorded in GIS and Access databases that WestLand maintains for long term monitoring purposes.

WestLand conducted the first required AHC survey of the Action Area in 2010 (the 2010 Survey). During the 2010 Survey, 346 AHC were identified, mapped, and tagged; and a sub-sample of these were marked to allow for stem growth measurement in future surveys. The goals of the monitoring survey in 2012 (the 2012 Survey) were to revisit the AHC tagged in 2010, count stem numbers, record dead stems or plants, and to measure stem and tubercle growth. Additionally, an effort was made to identify, map, and tag AHC that may have been overlooked in the 2010 Survey, particularly young recruits that may have been small seedlings in 2010.

Surveys for AHC were conducted from April 2, 2012 through May 3, 2012. WestLand field biologists conducted pedestrian surveys of those portions of the Survey Area that were safely accessible and considered AHC habitat or potential AHC habitat. Four surveyors walked parallel belt transects that averaged 30 ft (9 m) in width per person. During the survey, the biologists documented previously marked AHC and tagged new AHC that were not identified during the 2010 Survey. Direct access within the Survey Area was sometimes limited by rugged terrain and geologic formations; therefore, visual surveys for AHC were conducted with binoculars in areas that were determined to be unsafe or inaccessible.

A total of 98 additional AHC were located during the 2012 Survey. Similar to previous investigations, AHC were generally detected within the northeastern portion of the Survey Area along [redacted]. However, a few isolated AHC were found in new locations, [redacted], [redacted]

[1] Action Area as defined in the Biological Opinion issued by the US Fish and Wildlife Service (USFWS) and as identified in the PoO (USFWS 2010; WestLand 2010a)

[redacted]

During the 2012 Survey, WestLand located 343 of the 346 AHC tagged during the 2010 Survey and located all eight AHC tagged during construction monitoring performed in 2011. As evidenced by the discrepancy in the two survey results, three AHC tagged in 2010 were not located during the 2012 Survey: one AHC (tag number 298) was moved to Boyce Thompson Arboretum (BTA) in 2010, and two AHC (tag numbers 122 and 252) were presumed to have been illegally collected. These two plants were located immediately adjacent to FR 320 and FR 2466, respectively. Ten AHC tagged in 2010 were identified as dead by field biologists during the 2012 Survey. In addition to locating the previously tagged AHC, WestLand mapped, tagged, and recorded data for the 98 new AHC identified during the 2012 survey.

A sub-sample of the AHC tagged during the 2010 Survey was measured for stem and tubercle growth during the 2012 Survey. The average stem growth rate was measured as 1 inch (2.5 cm) per year, and the average tubercle growth rate was one and a half per year.

Of the 98 additional AHC tagged during the 2012 Survey, it was assumed that relatively small plants were new seedlings in 2010 and 2011. Specifically, 26 plants were measured in 2012 at less than or equal to five inches in height thus exhibiting potential for low detectability during the 2010 and 2011 surveys. The remaining 72 AHC newly detected in 2012 and the eight AHC identified in 2011 would have been detectable in 2010 based on their height; however, these plants were not identified at that time. In consideration of these factors, detectability of AHC in the 2010 Survey was determined to be 81 percent.

Conservation Measure 8 (CM8) developed during Section 7 consultation between the TNF and USFWS required the seeding of AHC on Forest Service Roads to be identified by the TNF and the USFS. During implementation of CM8 the TNF and the USFWS agreed that in addition to seeding, 20 AHC obtained from Boyce Thompson Arboretum would be transplanted within the Survey Area. As part of this reporting and documentation effort, transplanted AHC and the 20 seeding sites planted to implement CM8 have been documented to facilitate future monitoring.

A total of 459 live AHC are currently known and tagged within the Survey Area based on the following results of the 2012 Survey and implementation of CM8:

- 343 of the 346 AHC tagged during the 2010 survey were located during the 2012 Survey (one plant was moved to BTA and two are presumed to have been illegally collected);
- Eight AHC that were detected during the 2011 construction monitoring were located during the 2012 Survey;
- 98 AHC were newly detected during the 2012 Survey; and
- 10 AHC tagged during the 2010 Survey were found dead during the 2012 Survey;
- 20 AHC were transplanted within the Survey Area in 2012 to meet the obligations identified in CM8.

1. INTRODUCTION

WestLand Resources, Inc. (WestLand) was retained by Resolution Copper Mining (RCM) to conduct surveys for Arizona hedgehog cactus (AHC; *Echinocereus arizonicus* var. *arizonicus*) within portions of the Resolution Pre-feasibility Action Area (the Action Area) in conformance with the biannual monitoring requirements of the Resolution Copper Mining Pre-feasibility Activities Plan of Operations (PoO; WestLand 2010a) and the Tonto National Forest's Finding of No Significant Impact (FONSI; TNF 2010). Pursuant to mitigation and monitoring measures identified in the PoO and described by the Pre-feasibility Activities Biological Assessment & Evaluation (BA&E; WestLand 2009), survey of the Pre-feasibility Activities Action Area (the Action Area[2]) within AHC habitat or potential AHC habitat is required every two years.

WestLand conducted the first required AHC survey of the Action Area in 2010 (the 2010 Survey). During the 2010 Survey, 346 AHC were identified, mapped, and tagged; and a sub-sample of these were marked to allow for stem growth measurement in future surveys. An additional eight AHC were identified and tagged during construction monitoring performed in 2011. The goals of the monitoring survey in 2012 (the 2012 Survey) were to resurvey the 2010 Survey Area, to revisit the AHC tagged in 2010 and 2011, record growth data on previously recorded plants, and document stem/plant mortality.

The remaining sections in this document provide the following: background information specific to AHC (***Section 2***); a description of methods for the 2012 Survey (***Section 3***); results of the 2012 Survey with supporting documentation such as representative photographs, data tables, and figures (***Section 4***); and a summary of the survey results (***Section 5***).

2. BACKGROUND

AHC is federally listed as endangered without critical habitat throughout its entire range in Arizona. On October 25, 1979, the U. S. Fish & Wildlife Service (USFWS) published the final rule listing the AHC as an endangered species (USFWS 1979). AHC is known to occur in portions of the highlands of Pinal and Gila Counties. AHC are 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 (AGFD 2008, TNF 1996). This species occurs from 3,300 ft to 5,700 ft (1,006 m to 1,737 m) on open slopes and cracks and crevices between boulders in Interior Chaparral and Madrean Evergreen Woodland habitats (TNF 1996).

The distribution of the AHC 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 the AHC is more commonly found on stable rock formations such as Apache Leap Tuff and Schultze Granite (Cedar Creek Associates 1994). These rock types weather very slowly, form stable ridges and outcrops, and provide

[2] Action Area as defined in the Biological Opinion issued by the USFWS and as identified in the PoO (USFWS 2010; WestLand 2010)

opportunities for AHC to establish and grow. The remaining two rock types that are known to be associated with the AHC are either poorly distributed within the known range of the species (Pioneer Quartzite) or weather more rapidly (Pinal Schist). These rock types create a soil substrate that is colonized by dense stands of vegetation and do not appear to be colonized by AHC to the same extent as certain kinds of tuff or granite.

The taxonomy of the red-flowered species of *Echinocereus* has been in confusion for nearly a century. First collected by Orcutt in the type locality in 1922, he named it *E. arizonicus* in 1926 (Orcutt 1926). Benson included eight varieties of *E. triglochidiatus* in *The Cacti of Arizona*, naming AHC, *E. triglochidiatus* var. *arizonicus* (Benson 1982). In 1989, Ferguson named AHC, *E. coccineus* var. *arizonicus* (Ferguson 1989). More recently, *E. arizonicus, E. coccineus* and *E. triglochidiatus* have been proposed as separate species based on their morphology, number of chromosomes, molecular studies, and habitat (Blum 1998, Zimmerman and Parfitt 2003, Baker 2006). *E. triglochidiatus* and *E. arizonicus* are both diploid species (having two copies of each pair of chromosomes) with perfect flowers, but *E. triglochidiatus* has scaly spines that are not present in *E. arizonicus. E. coccineus* is a tetraploid species (having four copies of each pair of chromosomes, representing a doubling of chromosomes from an ancestral species), has sexually dimorphic flowers, and has more ribs than the other two species (Baker 2006). The online databases, NatureServe and USDA Plants refer to Ferguson in naming AHC, *E. coccineus* var. *arizonicus*. Based on Baker's (2006) report of *E. coccineus* being tetraploid and *E. arizonicus* being a diploid species, Ferguson's (1989) classification appears to be incorrect. The USFWS use Benson's nomenclature, *E. triglochidiatus* var. *arizonicus,* but for this document we follow the more recent taxonomy and therefore refer to AHC as *E. arizonicus* var. *arizonicus* to identify the federally listed subspecies.

3. METHODS

3.1. SURVEY AREA

The Action Area includes a 100-ft (30-m) wide corridor centered along each of the roadways included in the PoO and a 500-ft (152-m) radius around each drill pad. Only those portions of the Action Area that are considered AHC habitat or potential AHC habitat, as defined in the BA&E, were included in the survey. Potential AHC habitat includes those areas that: 1) occur within the reported elevation range of this species; 2) occur in biotic communities similar to those known to be preferred by this species; and 3) contain bedrock geology that is known to support AHC. Those areas that contain these habitat elements and have documented occurrences of AHC are referred to as AHC Habitat. For ease of field logistics a 500-ft (152-m) by 500-ft (152-m) square, rather than the 500-ft (152-m) radius, centered on proposed and existing drill sites, was surveyed. Surveys were also expanded outside of the Action Area along the roadways. This expanded area included an additional 50 ft (15 m) along each side of the access roads for a total width of 200 ft (60 m) (the Survey Area; ***Figures 1 and 2***). The Survey Area included National Forest System lands, as well as private and State land and totaled approximately 727 acres (294 hectares; 537 acres [217 hectares] along roadways and 190 acres [77 hectares] within and around 33 drill sites; ***Figures 1 and 2***).

The specific portions of the Action Area that do not contain AHC Habitat or Potential AHC Habitat and were not surveyed include: [redacted] These areas are generally west and south of Apache Leap. ***Appendix A*** lists each of the drill sites and roads discussed in the BA&E and identifies which areas were surveyed, which areas were excluded from survey, and the rationale for exclusion for the 2010 and 2012 surveys.

3.2. SURVEY METHODS

WestLand field biologists familiar with AHC characteristics conducted surveys from April 2, 2012 through May 3, 2012. The survey was scheduled to coincide with the flowering season of the AHC when the brilliant red blooms enhance observers' ability to detect the plant.

The Survey Area was surveyed by observers walking parallel belt transects that averaged 30 ft (10 m) in width. Virtually, the entire Survey Area was potentially accessible to pedestrian surveys. However, due to safety concerns, visual surveys of inaccessible cliff walls and rock outcroppings were conducted with binoculars**.** Binocular surveys were conducted from a safe vantage point that offered the best view of the target area. The observer surveyed the area in overlapping sweeps with the binoculars, choosing obvious landmarks to use as reference points.

During the ground search, transect widths were determined by the density of vegetation. In dense stands of vegetation transects widths were reduced as appropriate in order to achieve full survey coverage. Within each transect, observers slowly walked in a zigzag pattern inspecting the ground surface to the front, sides, and rear. To facilitate control, the outside observer maintained position with the aid of a Trimble® Geo XH GPS unit in which the perimeter of the Survey Area had been previously uploaded. Transects were organized to take advantage of topography, road cuts, vegetation openings, or other similar features of the landscape to ensure efficient and complete coverage of all portions of the Survey Area.

Upon locating a newly detected and untagged AHC, the plant was marked with a numbered metal tag that was either attached to a rebar stake pounded into the ground or affixed directly to an adjoining rock face with concrete cutter nails. Data collected on individual plants was recorded onto a field data sheet. Data collection began with taking representative photographs of side and top views of each plant. The location of the AHC was then documented by GPS coordinates (NAD 83) stored in a handheld Garmin™ GPS. A sketch was drawn of each plant with individual stems alpha-numerically labeled. Tabular data collected from each plant included the total number of stems, the height of each stem, and the number of vegetative offsets (pups). Once data was collected for a plant, an intensive search for other AHC was conducted within the immediate vicinity of each cactus located.

Upon locating a tagged AHC from the 2010 Survey, a more limited set of metrics were taken: the GPS coordinates (NAD 83) of the plant's location were stored in a handheld Garmin™ GPS, a photo of the plant was taken, and the number of stems and pups were counted. In addition, WestLand recorded

characteristics of a plant if it appeared to be dead or in poor condition generally noted by dead stems, basal shrinkage, discoloration, and/or animal damage.

All data, including scanned images of the field datasheets and photographs were entered into an Access database for analysis, management and record keeping purposes. These data were compared to the 2010 data to determine the rate of reproduction (stem growth and stem number increase), and rate of regression and mortality (stem and plant health) for individual plants.

3.3. STEM HEIGHT, GROWTH RATE, TUBERCLES, AND VEGETATIVE OFFSETS

For a sub-sample of 50 plants identified during the 2010 Survey, the stem height was measured over two years in order to calculate an average rate of growth. During the 2010 Survey, field technicians marked the uppermost spine cluster (tubercle) of each rib on a number of stems with yellow Testors paint. In 2012 field technicians measured the height of the new growth above the marked tubercle to the nearest 0.01 inch using a digital caliper and counted the number of tubercles above the marked tubercle to determine new growth. At the request of USFWS, Testors paint was not used to mark the cacti in 2012 and will no longer be used in future monitoring efforts.

3.4. SURVEY DETECTABILITY

Detectability is the probability that a member of the population of interest is included in the count at the time or location of survey. Factors affecting detectability are species abundance, sampling methods, and sampling conditions, as well as annual variation in phenology (MacKenzie et al. 2002, McCarthy et al. 2012). In addition, species size, coloration, and location in the terrain will also influence detectability. There are a number of ways to maximize detectability: use a properly prepared team, time the survey to coincide with species detectability (i.e., flowering period of plant species), use multiple observers, and perform repeated counts (Pollock et al. 2004). Repeat sampling of the Survey Area over multiple years will enable the estimation of detection probability of AHC to inform the interpretation of survey data across years.

4. RESULTS AND DISCUSSION

4.1. SURVEY RESULTS

Similar to the 2010 survey, AHC were generally located in the northern and eastern portions of the Survey Area on National Forest System and private lands. AHC has not been detected on State lands in the Survey Area. The locations of AHC detected during the 2010 and found alive in 2012 and those detected for the first time in 2012 are provided in ***Figure 3***, while ***Table 1*** summarizes the distribution of AHC by road and drill site in the Survey Area for 2010, 2011, and 2012.

Table 1. Location of AHC Tagged in 2010, 2011, and 2012 by Road Segment and Drill Site

Road Segment/Drill Site	No. of AHC Tagged 2010	No. of AHC Tagged 2011	No. of AHC Tagged 2012	No. AHC Dead or Missing 2012	Total No. of Live AHC
[redacted]	164	8	53	6	219
[redacted]	79	0	20	0	99
[redacted]	53	0	3	5	51
[redacted]	29	0	3	1	31
[redacted]	11	0	10	0	21
[redacted]	10	0	6	1	15
[redacted]	0	0	1	0	1
[redacted]	0	0	1	0	1
[redacted]	0	0	1	0	1
TOTALS	**346**	**8**	**98**	**13**	**439**

WestLand located 343 of the 346 AHC tagged during the 2010 Survey and the eight AHC found during construction monitoring performed in 2011. In addition, WestLand mapped, tagged, and recorded data for an additional 98 AHC found during the 2012 Survey (***Table 2***). One of the AHC tagged in 2010 and not located in 2012 (tag number 298) was moved to BTA in 2010. Two AHC (tag numbers 122 and 252) that were located immediately adjacent to FR 320 and FR 2466, respectively, in 2010 were not located in 2012. The disposition of these plants (numbers 122 and 252) is not known. . Of the AHC tagged in 2010 and located in 2012, ten were dead, two were not relocated, and one was moved; thus the total number of AHC now known to occur in the Survey Area is 439. A summary of AHC detection numbers from 2010 to 2012 is provided below in ***Table 2***.

Table 2. Summary of AHC Detection Numbers (2010-2012)

Number of Plants Detected in 2010	346
Number of Plants Newly Detected in 2011	8
Number of Plants Newly Detected in 2012	98
Number of Dead Plants Detected in 2012	-10
Number of 2010 Plants Not Detected in 2012	-2
Number of Plants Detected in 2012 Moved to Boyce Thompson Arboretum	-1
Number of Live AHC Known in Survey Area in 2012	439*

* Twenty additional AHC were transplanted into the Survey Area in 2012, therefore, the total known AHC count in the Survey Area is currently 459 AHC.

The plants newly detected in 2012, including the 26 seedlings, were interspersed through the known population indicating an actively reproducing population. One newly detected AHC was found in the northeastern portion of Oak Flat (***Figure 3, Sheet 1***), the only one currently known to occur within this area. There were 10 newly detected AHC identified along [redacted], one of which was a seedling. In addition, one AHC was observed outside the drill pad disturbance footprint but within the survey area buffer of drill [redacted], the only AHC known in this area (***Figure 3, Sheet 2***). There were 10 newly detected AHC identified along [redacted] and drill [redacted], one of which was a seedling (***Figure 3, Sheet 3***). There was one newly detected AHC on [redacted], the only one known to occur along this road (***Figure 3, Sheet 4***). There were 43 newly detected AHC on [redacted] and drill [redacted] (nine of which were seedlings), along with four of the AHC found dead in 2012. The dead AHC were all within the survey area buffer, but not within the drill pad and road improvement disturbance footprint (***Figure 3, Sheet 5***). There were six newly detected AHC on [redacted] (four of which were seedlings), along with one of the AHC found dead this year (***Figure 3, Sheet 6***). There were 16 newly detected AHC on [redacted], four of which were seedlings (***Figure 3, Sheet 7***). There were three newly detected AHC found on drill [redacted], two of which were seedlings (***Figure 3, Sheet 8***). There were three newly detected AHC found on [redacted], along with four of the AHC found dead this year. There has been no construction or drilling activities by RCM along this road. There was one newly detected AHC on drill [redacted] which was a seedling (***Figure 3, Sheet 9)***. There were three newly detected AHC found on drill [redacted], one of which was a seedling, along with one of the dead AHC found this year (***Figure 3, Sheet 10***). This site is heavily utilized by ATV traffic and there has been no construction or drilling activities by RCM on this site.

The field data sheets and representative photographs of each plant are provided in a digital format on a DVD provided as ***Attachment B*** of this report. All of the data collected and links to each photo page and datasheet have been entered into an Access database for long-term record keeping.

4.2. STEM HEIGHT, GROWTH RATE, AND VEGETATIVE OFFSET RESULTS

The number of new stems on the AHC tagged during the 2010 Survey and located during the 2012 Survey ranged from one to five. A representative photo of the increase in height and number of stems of AHC is shown in ***Appendix B, Photos 3 and 4***.

The stem height of the 98 new AHC detected during the 2012 Survey ranged from one inch to more than 10 in. The size class distribution of newly detected AHC by stem height is graphically illustrated in ***Figure 4***. Twenty-six plants were measured to be less than or equal to five inches in height.

Of the plants marked with Testors paint during in 2010, the stem growth rate ranged from 0.4 inch (1 cm) to 3.0 inch (7.5 cm) per year, with the average being 1.1 inch (2.5 cm) per year (N = 55). The number of new tubercles ranged from one to seven, with the average being three. The stem growth measurements and number of new tubercles from 2010 to 2012 are presented in ***Table 3***.

Table 3. Stem Growth Measurements of Marked AHC from 2010 to 2012. Up to five stems measured in 2010[1]. Data here reflect the stems marked with Testors Paint and remeasured in 2012. Missing data indicated with '*'.

Plant Tag Number	Stem Growth (in.) / Number of New Tubercles					Average Stem Growth (in.)	Average Number of New Tubercles
	Stem 1	Stem 2	Stem 3	Stem 4	Stem 5		
247	1.24 / 2	1.01 / 2	1.18 / 2	1.02 / 2	0.65 / 1	1.02	1.8
248	0.97 / 2	0.93 / 2	0.90 / 0	1.15 / 2	0.92 / 2	0.97	1.6
249	2.17 / 4	0.89 / 2	1.83 / 4	*	*	1.63	3.3
250	0.67 / 1	1.04 / 2	0.49 / 1	0.73 / 1	*	0.73	1.3
251	1.88 / 4	1.85 / 4	*	*	*	1.86	4
253	1.98 / 4	2.29 / 3	1.56 / 4	1.57 / 4	*	1.85	3.8
254	3.26 / 5	3.88 / 6	3.58 / 6	1.89 / 5	3.68 / 7	3.26	5.8
255	2.58 / 5	2.61 / 5	1.97 / 4	*	*	2.39	4.7
256	3.78 / 5	*	*	*	*	3.78	5
257	2.50 / 4	2.03 / 3	2.01 / 3	1.50 / 2	1.64 / 3	1.93	3
258	1.69 / 3	*	*	*	*	1.69	3
259	1.36 / 2	2.09 / 3	*	*	*	1.72	2.5
260	0.85 / 1	0.77 / 2	0.71 / 1	0.70 / 1	0.67 / 1	0.74	1.2
261	1.23 / 2	*	*	*	*	1.23	2
262	1.77 / 3	2.47 / 4	1.84 / 3	*	*	2.02	3.3
263	1.47 / 3	*	*	*	*	1.47	3
264	2.24 / 4	3.18 / 5	3.23 / 6	2.72 / 5	2.75 / 5	2.82	5
266	2.28 / 3	2.22 / 3	*	*	*	2.25	3
267	2.15 / 4	2.24 / 3	1.98 / 3	1.51 / 3	1.83 / 3	1.94	3.2
268	1.84 / 3	1.62 / 3	2.65 / 4	*	*	2.04	3.3
269	2.12 / 3	2.24 / 3	1.77 / 3	2.78 / 3	2.47 / 4	2.28	3.2

Table 3. Stem Growth Measurements of Marked AHC from 2010 to 2012. Up to five stems measured in 2010[1]. Data here reflect the stems marked with Testors Paint and remeasured in 2012. Missing data indicated with '*'.

Plant Tag Number	Stem Growth (in.) / Number of New Tubercles					Average Stem Growth (in.)	Average Number of New Tubercles
	Stem 1	Stem 2	Stem 3	Stem 4	Stem 5		
270	3.04 / 4	3.28 / 4	3.86 / 4	*	*	3.39	4
271	1.80 / 3	1.66 / 2	2.25 / 4	1.69 / 3	1.38 / 2	1.75	2.8
272	2.06 / 3	1.12 / 2	2.34 / 4	*	*	1.84	3
273	1.16 / 2	1.06 / 2	1.75 / 3	1.40 / 2	1.32 / 2	1.34	2.2
274	1.83 / 4	1.67 / 4	1.87 / 4	1.88 / 4	1.11 / 3	1.67	3.8
275	2.15 / 4	1.80 / 4	2.17 / 4	*	*	2.04	4
276	1.96 / 4	*	*	*	*	1.96	4
277	1.61 / 3	2.14 / 4	1.60 / 4	2.08 / 4	1.86 / 4	1.86	3.8
278	1.14 / 2	1.79 / 3	1.95 / 3	*	*	1.63	2.7
279	1.00 / 2	0.48 / 1	*	*	*	0.74	1.5
280	1.37 / 3	0.57 / 1	*	*	*	0.97	2
281	2.24 / 5	*	*	*	*	2.24	5
282	1.75 / 3	1.65 / 3	2.08 / 4	2.00 / 4	1.94 / 4	1.88	3.6
283	1.77 / 4	*	*	*	*	1.77	4
284	3.98 / 5	3.08 / 4	1.74 / 3	2.07 / 3	2.39 / 3	2.65	4.5
285	1.36 / *	*	*	*	*	1.36	*
286	0.70 / 2	1.01 / 2	0.58 / 1	1.07 / 1	0.81 / 2	0.84	1.6
287	1.88 / 3	2.11 / 3	1.94 / 3	1.92 / 3	1.63 / 3	1.90	3
288	0.69 / 1	2.46 / 4	2.69 / 4	*	*	1.95	3
300	1.77 / 2	3.05 / 4	2.67 / 3	2.08 / 2	2.76 / 3	2.47	2.8
301	3.62 / 6	3.98 / 7	3.41 / 7	*	*	3.67	6.7
302	1.09 / 2	0.97 / 2	0.99 / 2	1.13 / 2	*	1.04	2
304	0 / 0	0.94 / 2	1.24 / 3	*	*	0.73	1.7
305	1.15 / 2	1.26 / 2	1.50 / 2	1.43 / 2	*	1.33	2
306	1.98 / 4	2.35 / 4	2.12 / 4	2.20 / 4	1.79 / 3	2.09	3.8
307	2.47 / 5	2.67 / 4	2.66 / 5	*	*	2.60	4.7
308	2.49 / 4	3.28 / 5	1.09 / 1	2.39 / 4	*	2.31	3.5
310	2.48 / 4	2.18 / 4	1.85 / 3	2.81 / 4	*	2.33	3.8
311	1.35 / 3	1.23 / 3	1.19 / 3	1.19 / 3	*	1.96	3
313	2.66 / 4	*	*	*	*	2.66	4
314	2.07 / 4	2.05 / 4	2.27 / 4	1.36 / 3	*	1.94	3.25
315	1.09 / 1	1.07 / 2	0.43 / 1	1.14 / 2	1.10 / 1	0.96	1.4
316	1.52 / 2	1.31 / 2	*	*	*	1.42	2
317	2.31 / 5	*	*	*	*	2.31	5
Average						**1.88**	**3.24**

[1] In 2010, a maximum of five stems were marked per individual AHC. Although an individual plant may have had five or more stems, due to the growth structure of the plant, it may not have been practical to mark five stems.

Presence of vegetative offsets (pups) were identified on 49 percent or 214 of 439 live AHC surveyed in 2012. Of the 214 (49%) AHC with offsets, the number of offsets per plant ranged from one to 12, with an average of 3.5 offsets per plant and a median of two offsets per plant.

4.3. DETECTABILITY OF AHC IN 2010

Detectability of AHC in the 2010 Survey was calculated from the number of AHC identified in the 2010 and 2012 surveys. Of the 98 new AHC detected during the 2012 Survey, it was assumed that 26 small plants (those less than or equal to 5 inches) were seedlings less than three inches in height in 2010. Compared to larger, mature plants, they were most likely undetectable during the 2010 Survey (***Appendix B, Photos 1 and 2***). However, 72 new AHC detected in 2012 would have been present and detectable in 2010 based on their height, but they were not observed by survey teams prior to the 2012 Survey. Considering these factors, detectability for the 2010 Survey was calculated by dividing the number of AHC detected in 2010 (346) by the total number of AHC detected in 2010 and newly detected in 2011 and 2012 (346 + 8 + 98 = 452) subtracted by those seedlings that were five inches or less (26) in 2012. The detectability percentage was determined to be 81 percent and was derived by the following calculation: 346 / (452 - 26) = 81%.

4.4. CONSERVATION MEASURE 8 – AHC TRANSPLANTS AND SEEDING AREAS

WestLand collaborated with the Resolution Copper Company, the Tonto National Forest and BTA personnel to transplant the 20 mature AHC in March of 2012. In addition, ten seeding areas were seeded with 50 seeds each in March, and an additional 10 seeding areas were seeded with 50 seeds each in July of 2012. Data was recorded on stem height and number of stems, and photographs were taken of each transplanted AHC. The locations of each transplanted AHC and seeding area are provided in ***Figure 2***, while ***Table 4*** summarizes the distribution of transplanted AHC and seeded area by road and drill site in the Survey Area. These AHC are entered into the database created by WestLand for all marked AHC located within the Survey Area.

Table 4. Locations of CM8 AHC Transplants and Seeding Areas by Road Segment and Drill Site

Road Segment/Drill Site	No. of AHC Transplants	No. of AHC Seeding Areas
[redacted]	16	16
[redacted]	4	4
TOTALS	**20**	**20**

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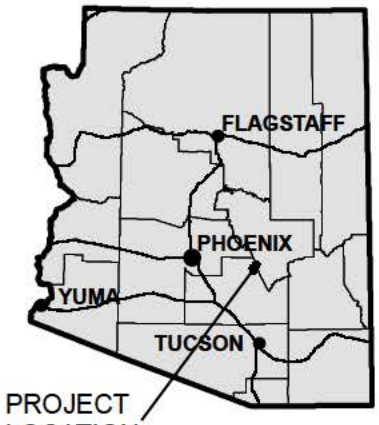
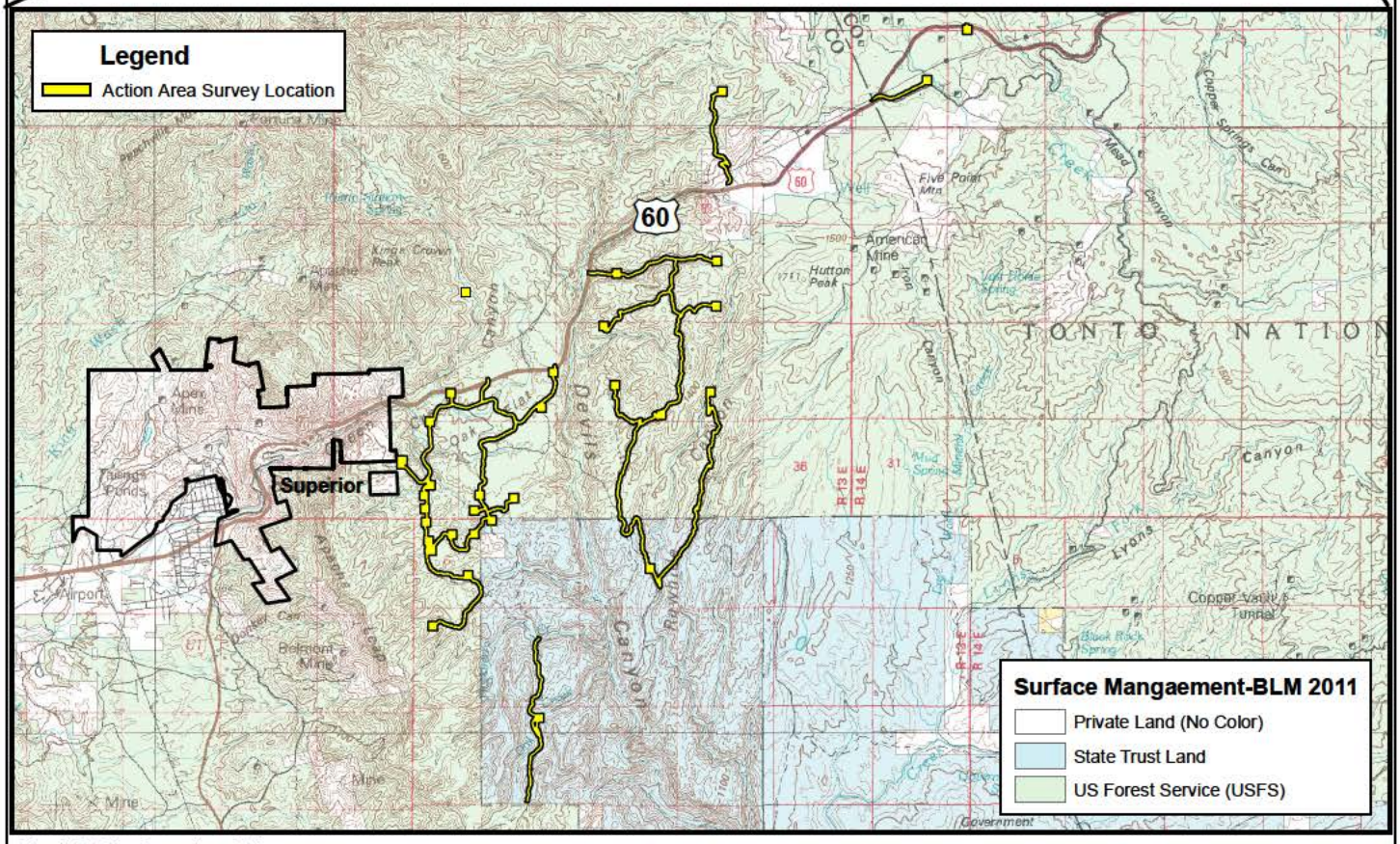
FIGURES





Pinal & Gila Counties, Arizona,
Superior & Pinal Ranch
USGS 7.5' Quadrangles

N

0 5,000 10,000 Feet

WestLand Resources, Inc.
Engineering and Environmental Consultants

RESOLUTION COPPER MINING
2012 Arizona Hedgehog Cactus Survey Report

VICINITY MAP

Figure 1

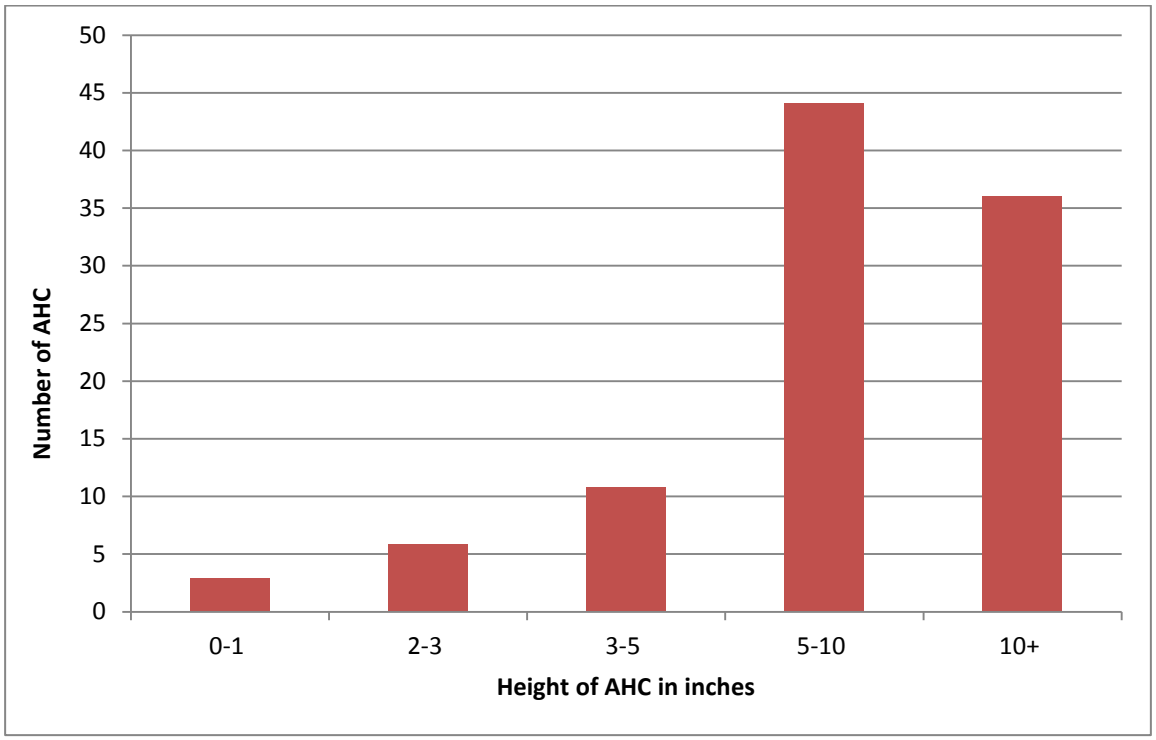


Figure 4. Size Class Distribution by Height of Newly Detected AHC During 2012 Monitoring Survey (N = 98).

APPENDIX A

NAMES, OWNERSHIP, AND SURVEY STATUS OF ROAD AND DRILL SITE LOCATIONS IN 2010 AND 2012

Activity Name	Location	Public and Private Land	2010 Survey Status	2012 Survey Status
[redacted]	[redacted]	Forest Service	Surveyed	Surveyed
NEW ACCESS ROADS				
2 new access roads [redacted]	[redacted]	Forest Service	Surveyed	Surveyed
New access road [redacted]		Forest Service	Surveyed	Surveyed
New access road [redacted]		Forest Service	Surveyed	Surveyed
4B		Forest Service and State	Surveyed	Surveyed

APPENDIX B

REPRESENTATIVE PHOTOS OF AHC FROM 2010 AND 2012

Photo 1. Example of AHC seedling found in 2012 that would have been undetectable in 2010 (AHC Tag 405)

Photo 2. Example of AHC seedling found in 2012 that would have been undetectable in 2010 (AHC Tag 423)

Photo 3. Photo of AHC Tag 254 in 2010

Photo 4. Photo of AHC Tag 254 in 2012 showing stem growth

Photo 5. Photo of AHC Tag 49 in 2010

Photo 6. Photo of AHC Tag 49 in 2012 showing multiple stem dieback

Photo 7. Photo of AHC Tag 7 in 2010

Photo 8. Photo of AHC Tag 7 in 2012 showing multiple stem dieback

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Representative Photos of Arizona Hedgehog Cactus
Observed in 2010 and 2012

APPENDIX B

APPENDIX C

DVD OF DATA SHEETS AND PHOTOS OF AHC OBSERVED IN 2010 AND 2012