Post-Telegraph Fire Assessment of Arizona Hedgehog Cacti near Superior, Arizona

Prepared for:

RESOLUTION COPPER

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Appendices

1. INTRODUCTION AND BACKGROUND

WestLand Engineering and Environmental Services (WestLand) was retained by Resolution Copper (Resolution) to assess the impacts of the Telegraph Fire on Arizona hedgehog cactus (AHC; *Echinocereus triglochidiatus* var. *arizonicus*) located east of the town of Superior in Pinal County, Arizona (**Figure 1**). As part of this effort, WestLand conducted post-fire sampling of AHC in the vicinity of the Proposed Project Area, Agency Preferred Alternative, and JI Ranch as described in the *FINAL Environmental Impact Statement Resolution Copper Project and Land Exchange* (USDA 2021). The Telegraph Fire was a wildfire ignited on June 4, 2021 and eventually fully contained on July 3, 2021 with a final mapped fire perimeter of 180,757 acres, as reported by the Tonto National Forest (TNF; InciWeb 2021, accessed online 2/15/2022). The mapped burn area includes portions of the Proposed Project Area, Agency Preferred Alternative, and JI Ranch. The Proposed Project Area and Agency Preferred Alternative are referred to collectively in this document as the "Project Area." The Project Area comprises individual components including the East Plant Site, 230-kV Powerline Corridor, and Tailings Pipeline Corridor. JI Ranch is a 272-acre property owned by Resolution that is known to support AHC habitat, approximately 100 acres of which is intended for use as an AHC conservation area (USFWS 2020). Resolution has conducted AHC propagation activities at JI Ranch since 2011, including transplanting propagated AHC into natural habitat onto the property in 2016 and 2020. A summary of the 2016 and 2020 AHC transplanting efforts at JI Ranch is provided in **Appendix A**.

To inform the post-fire assessment, WestLand conducted post-fire sampling of AHC known to occur within and in the vicinity of the East Plant Site, the 230-kV Powerline Corridor, and JI Ranch (**Figure 1**). The post-fire sampling was conducted from October 11 to 22, 2021, approximately 4 months after the Telegraph Fire was extinguished. The plant sampling methodology includes evaluations of survivorship, health, and the presence of fire damage to plant tissue. In addition to AHC sampling, WestLand conducted ground truthing efforts comparing TNF fire perimeter and burn severity mapping data to burn conditions observed in the field. The results of the ground truthing efforts were used to make inferences regarding the survivorship and health status of AHC documented by WestLand prior to the Telegraph Fire but located outside of the burn perimeter mapped by the TNF. The post-fire AHC sampling results were combined with WestLand's separate pre- and post-fire AHC survey data to assess the post-fire status of AHC located within the Project Area and at JI Ranch. Representative photographs depicting AHC habitat and individuals documented during the post-fire sampling efforts are provided in **Appendix B**.

The remaining sections in this document provide: background information specific to AHC (**Section 2**); a description of the post-fire assessment methods (**Section 3**); and the post-fire assessment results (**Section 4**). References cited are included in **Section 5**.

2. ARIZONA HEDGEHOG CACTUS BACKGROUND

AHC is federally listed under the Endangered Species Act (ESA) as endangered without critical habitat (USFWS 1979b). Draft recovery plans for the species have been developed (Baker 2013, Fletcher 1984,

USFWS 1991) but have not yet been finalized. In 2019, the U.S. Geological Survey in cooperation with the U.S. Fish and Wildlife Service (USFWS) and Arizona Ecological Services published an open file report compiling and assessing available AHC survey and monitoring data to support the recovery of the species (Thomas et al. 2019). AHC is also protected by the Arizona State Legislature (A.R.S. Chapter 7, Arizona State Legislature 2019) as a Highly Safeguarded Native Plant and is protected from international trade by the Convention of International Trade in Endangered Species (UNEP-WCMC 2014).

AHC was initially collected in 1922 near the Gila and Pinal County boundary, between Superior, Arizona and Miami, Arizona (type locality), and named *Echinocereus arizonicus* in 1926 (Orcutt 1926). AHC was included as variety *arizonicus* in one of eight varieties of *E. triglochidiatus* in *The Cacti of the United States and Canada* (Benson 1982). AHC has also been named *E. coccineus* var. *arizonicus* (Ferguson 1989), but more recent studies have proposed *E. arizonicus, E. coccineus* and *E. triglochidiatus* as separate species based on morphology, number of chromosomes, molecular studies, and habitat (Baker 2006, Blum et al. 1998, Zimmerman and Parfitt 2003). The PLANTS Database, U.S. Department of Agriculture (USDA), refers to Ferguson (1989) in naming AHC *E. coccineus* var. *arizonicus* (NRCS 2021, accessed 11/24/2021). However, 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. Two online databases, Interagency Taxonomic Information System, which serves as a standard for classifications that has gained broad acceptance in taxonomic literature, and Nature Serve Explorer, which provides information about rare and endangered species, accept *E. arizonicus* as correct (ITIS 2021, NatureServe 2021, websites accessed 11/24/2021). The Flora of North America refers to the variety as a subspecies of *E. arizonicus* (Zimmerman and Parfitt 2003). While revisions to the taxonomy of AHC may need to be addressed at the federal level, AHC is currently listed under the ESA as *E. triglochidiatus* var. *arizonicus* (USFWS 1979b), and this document follows that nomenclature.

AHC is a green succulent with cylindroid stems and brilliant red flowers (AGFD 2020, Thomas et al. 2019). Stems occur singly or most often in clusters of four to twenty (AGFD 2020), though up to 143 stems have been recorded on a single individual (Baker 2013). Stems are robust, averaging 3 inches in diameter but commonly exceeding 4 inches, and are generally longer than the stems of similar varieties of hedgehog cacti (AGFD 2020). Stems have an average of nine ribs (AGFD 2020, Baker 2013). Spines are smooth and occur on areoles, with each areole containing an average of nine radial spines and three central spines (Baker 2013). Central spines are thick, averaging nearly 1 millimeter (mm) in diameter (Baker 2013). The largest central spine per areole is typically deflexed (pointed downwards) (AGFD 2020). Relative to other *Echinocereus*, AHC spines are shorter and more robust (AGFD 2020). Flowers occur on the upper-third of stem ribs (AGFD 2020) and are stout, mostly erect, and measure up to 16 mm broad and 93 mm long (Baker 2013). The reported flower blooming period ranges from mid-April to mid-May (AGFD 2020, Baker 2013).

AHC occupies portions of the highlands of Pinal and Gila Counties between Superior and Globe, Arizona. Its known range extends from the Superstition Wilderness south to Devils Canyon, east along U.S. 60 to

Top of the World and south to the Mescal and Pinal mountains (AGFD 2020, Baker 2013, Viert 1996). The range includes two small subpopulations, the Apache Peak subpopulation (which is likely of the Santa Rita hedgehog cactus species [*Echinocereus santaritensis*]) north of the city of Globe and the El Capitan subpopulation south of Globe (Baker 2013, Fehlberg 2013). Other varieties of red claret-cup cacti are intermingled with AHC at the edge of its distribution (Baker 2013), but only red claret-cup cacti near the type locality for AHC are considered "classical var. *arizonicus*", and these are the only populations subject to protection under the ESA (USFWS 1979a, Viert 1996).

The majority of predicted AHC habitat occurs on lands managed by TNF, with smaller portions of predicted habitat occurring on lands managed by the San Carlos Apache Tribe, Bureau of Land Management, ASLD, and private entities (Baker 2013). AHC commonly occurs from 3,300 ft to 5,700 ft but ranges up to 6,360 ft. (AGFD 2020) in Interior Chaparral and Madrean Evergreen Woodland habitats (Viert 1996) as mapped by Brown (1994). Suitable substrate includes bedrock open slopes where individuals occur in cracks and crevices and between boulders on stable rock formations such as Apache Leap Tuff, Schultze Granite and Pioneer Quartzite (Viert 1996). Pinal Schist, another rock type associated with AHC occupancy, weathers more rapidly and creates a soil substrate that is often colonized by dense stands of vegetation and is inhabited by AHC at lower densities (Baker 2013).

3. METHODS

This post-fire assessment was informed by a desktop evaluation of TNF Telegraph Fire perimeter (InciWeb 2021) and Geographic Information System burn severity mapping developed using Sentinel 2 satellite remote sensing data from June 13, 2021 and the Normalized Burn Ratio and differenced Normalized Burn Ratio algorithms described by the U.S. Department of Agriculture (Parsons et al. 2010). WestLand's pre-fire and post-fire AHC survey data was also used in the assessment. Pre-fire survey data includes AHC known to occur within the East Plant Site and the 230-kV Powerline and Tailings Pipeline corridors based on data reported in 2019 (WestLand 2019), AHC known to occur on TNF lands between JI Ranch and the Tailings Pipeline Corridor based on survey data collected from March 29 to May 7, 2021 (WestLand 2021), and previously unpublished survey data collected during a JI Ranch AHC inventory survey conducted from April 12 to 16, 2021. Post-fire survey data includes previously unpublished data collected during JI Ranch AHC inventory surveys conducted from August 23 to 26 and October 25 to 28, 2021, and data collected during post-fire AHC sampling within, and in the vicinity of, the Project Area and JI Ranch from October 11 to 15, 2021 and from October 19 to 22, 2021. The desktop assessment and field data collection methodologies used to inform the post-fire assessment are described in **Sections 3.1 and 3.2**, respectively.

3.1. DESKTOP ASSESSMENT

WestLand created a web map containing the TNF Telegraph Fire perimeter and burn severity mapping data described in **Section 3**. The burn severity mapping data was displayed as 67 by 67 feet (ft) pixels categorized as Low Severity, Moderate Low Severity, Moderate High Severity, and High Severity. Areas

within the TNF-mapped fire perimeter exhibiting very low or no burn severity according to the GIS mapping algorithm were not assigned a burn severity category. The Project Area components, the JI Ranch property boundary, and AHC known by WestLand to occur within the Project Area, JI Ranch, and/or within the mapped burn perimeter were added to the web map. WestLand used these AHC locations as the basis for post-fire AHC field sampling efforts described in **Section 3.2.1**.

3.2. FIELD DATA COLLECTION

WestLand collected field data using two methodologies: one for post-fire sampling conducted within and in the vicinity of the Project Area and JI Ranch; and the other for separate pre- and post-fire JI Ranch AHC inventory surveys.

3.2.1. Post-fire Sampling

WestLand collected post-fire survivorship and health data on a subset of the AHC identified during the Desktop Assessment (**Section 3.1)** from October 11 to 15, 2021 and from October 19 to 22, 2021. A total of 727 AHC were sampled (**Figure 1**). Sampled AHC includes all AHC detected in observed burn areas at JI Ranch (including areas outside of the TNF-mapped fire perimeter) and a subset of AHC known by WestLand to occur at the East Plant Site within the 230-kV Powerline Corridor and on TNF lands between JI Ranch and the Tailings Pipeline Corridor. Data collected for each live AHC sampled include:

- **Location**—locations were recorded using a handheld tablet with GPS capabilities.
- **Photographs**—close-up photographs of the plant's top and side, and an additional photograph of the plant in its landscape setting with surrounding habitat.
- **Health assessment**—plants were designated one of the following health categories:
  - Good—the plant is characterized predominantly by plump greens stems.
  - Fair—the plant is characterized predominantly by shrinkage or discoloration (due to fire damage or otherwise).
  - Poor—the plant is characterized primarily by necrosis (due to fire damage or otherwise).
- **Number of live stems**—a cumulative count of all living main stems, secondary stems, and pups.
- **Height**—a straight-line vertical measurement from the base of the plant to the upper-most portion of the plant (excluding spines and reproductive structures).[1] Measurements were recorded to the nearest mm.
- **Width**—a straight-line horizontal measurement across the widest portion of the plant (excluding spines and reproductive structures). Measurements were recorded to the nearest mm.
- **Plant herbivory**—estimated by percentage of the plant surface area exhibiting evidence of herbivory.

[1] Plant height was measured vertically for field measurement consistency. Because of this, the recorded heights of AHC growing on slopes may be exaggerated in some cases.

- **Fire damage**—estimated by percentage of the plant surface area exhibiting burnt plant tissue.
- **Expected mortality due to fire**—a qualitative field assessment of the likelihood of plant mortality due to fire damage, substantiated by rationale. Categories: None, Low, Medium, High, Already Dead.

Dead plants were also recorded, along with Location, Photographs, and Fire damage data.

Surveyors also recorded a burn severity assessment of the landscape within a 33-ft radius of each plant location. The burn severity assessment was based on the characteristics of Soil Burn Severity Class Factors described in Appendix E of the *Field Guide for Mapping Post-Fire Soil Burn Severity* (Parsons et al. 2010). The burn severity assessment categories assigned in the field include Low Severity, Moderate Low Severity, Moderate High Severity, High Severity, and Unburned. While sampling AHC surveyors also performed periodic ground truthing of the TNF-mapped fire perimeter.

3.2.2. JI Ranch Inventory Surveys

The JI Ranch AHC inventory survey data used in this assessment includes all AHC detected within the JI Ranch property boundary but outside of the observed burn areas identified during the AHC-post fire sampling activities described in **Section 3.2.1**. The inventory survey data were collected from April 12 to 16, August 23 to 26, and October 25 to 28, 2021. Data collected for each live AHC recorded during the inventory surveys includes Location, Photographs, Health assessment, Number of live stems, Height, Width, and Plant herbivory, as described in **Section 3.2.1**. Dead plants were also recorded, along with Location and Photographs.

4. RESULTS

4.1. RESOLUTION PROJECT AREA

AHC known by WestLand to occur within the Project Area based on the desktop assessment are shown in **Figure 2**. None of the AHC sampled within the Resolution Project Area (**Figure 3**) exhibited fire damage. Observations recorded during ground truthing efforts indicated that the TNF-mapped fire perimeter was generally accurate, with a maximum observed distance of approximately 165 ft between the TNF-mapped fire perimeter and the field-verified burn perimeter. Surveyors also noted that the fire did not reach portions of the 230-kV Powerline and Tailings Pipeline corridors located north of U.S. 60 where the majority of AHC within the Project Area occur (**Figure 2**).

4.2. JI RANCH

The locations of all live AHC detected at JI Ranch based on pre- and post-fire data collection are shown in **Figures 3 and 4**. Live AHC recorded after the Telegraph Fire includes those within the observed burn perimeter and all AHC located on the JI Ranch property north of U.S. 60, where no evidence of fire damage was observed. Live AHC recorded from April 12 to 16, 2021 (before the Telegraph Fire) includes AHC

located on the JI Ranch property south of U.S. 60 but outside of the observed burn perimeter. WestLand infers that these live AHC recorded prior to the Telegraph Fire but located outside of the observed burn perimeter survived the effects of the Telegraph Fire. Based on these data and inference, 1,062 live AHC were documented on JI Ranch in 2021, and these individuals survived the effects of the Telegraph Fire. The health status of these 1,062 cacti are shown in **Figure 4**. Four hundred and sixteen AHC located within the observed burn perimeter survived the Telegraph Fire as assessed from October 11to 22, 2021. Two hundred and eight of these AHC (50%) were determined to be in Good health, 146 (35%) were determined to be in Fair health, a 62 were determined to be in Poor health (15%).

4.3. AHC SURVIVORSHIP AND GIS BURN SEVERITY MAPPING DATA

This subsection provides the results of AHC post-fire survivorship in areas containing burn severity mapping data described in **Section 3**. These data may broadly inform future analyses of AHC survivorship in other areas affected by the Telegraph Fire. One hundred and thirty-six of the AHC surveyed during the October 11to 22, 2021 post-fire sampling efforts are located within mapped burn severity pixels. AHC survivorship by mapped burn severity category is presented in **Table 1**. Important to note is that high plant density, GPS accuracy limitations, and fire damage to plants and plant identification tags made it impossible in some cases for surveyors to match individual plants sampled after the fire to data recorded on the same individual plants during pre-fire surveys. As a result, some plants recorded as dead during the post-fire sampling may have already been dead prior to the Telegraph Fire, and some plants recorded during the post-fire sampling may not have been detected during pre-fire surveys.

Table 1. AHC Survivorship in Mapped Burn Severity Category

Mapped Burn Severity Category	# Live AHC	# Dead AHC	Total	% Survivorship
Low	86	19	105	82%
Moderate Low	14	12	26	54%
Moderate High	2	3	5	40%

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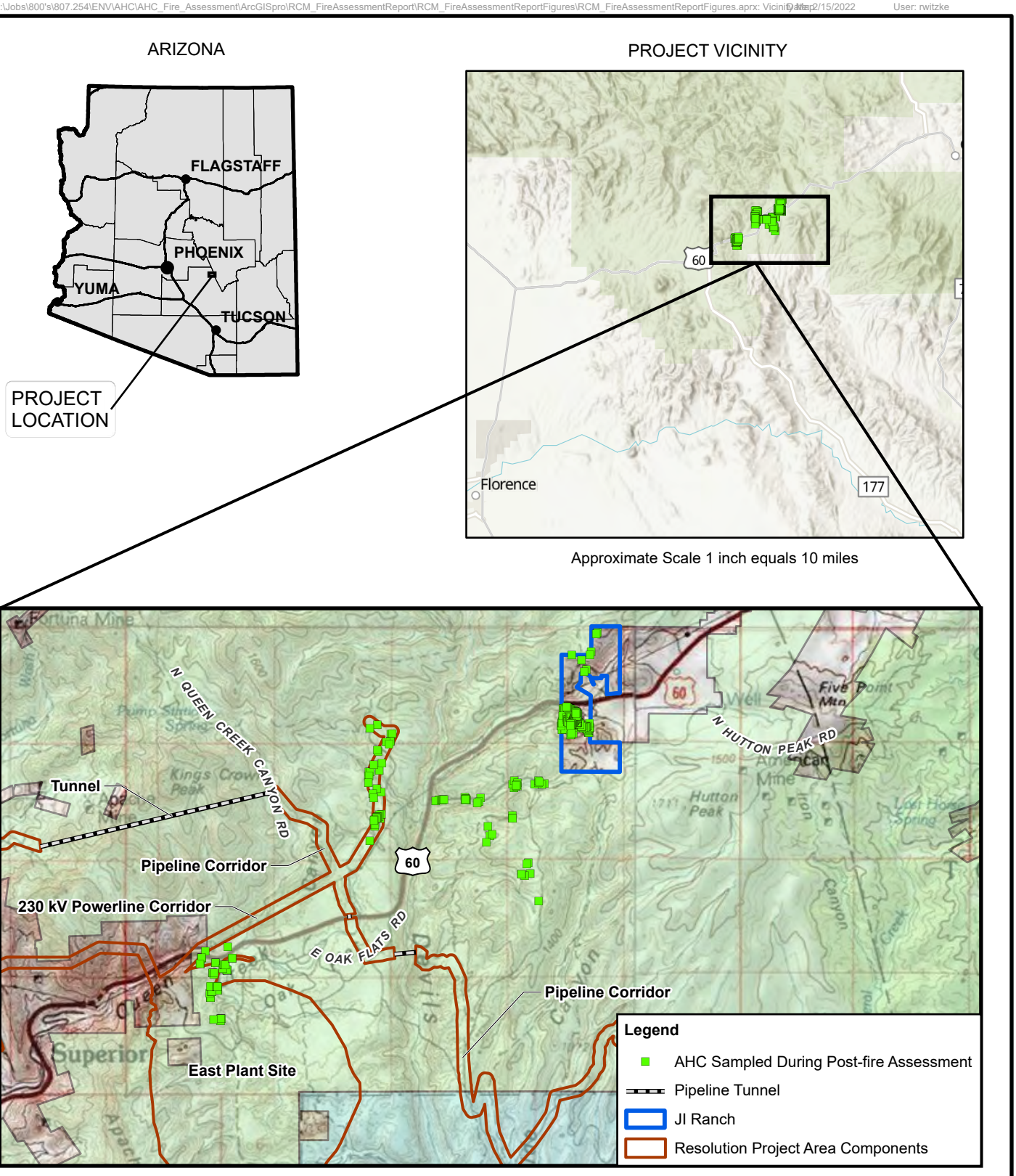
FIGURES



T1S, R13E, Portions of Sections 14-16, 21-23, 26, 29, and 32,
Pinal County, Arizona,
Mesa 1:100,000 USGS Quadrangle
Surface Management: BLM 2019 (WRI Modified 2019)
Image Source: ArcGIS Online, World Topographic Map

N

0 0.6 1.2 Miles

0 1 2 Kilometers

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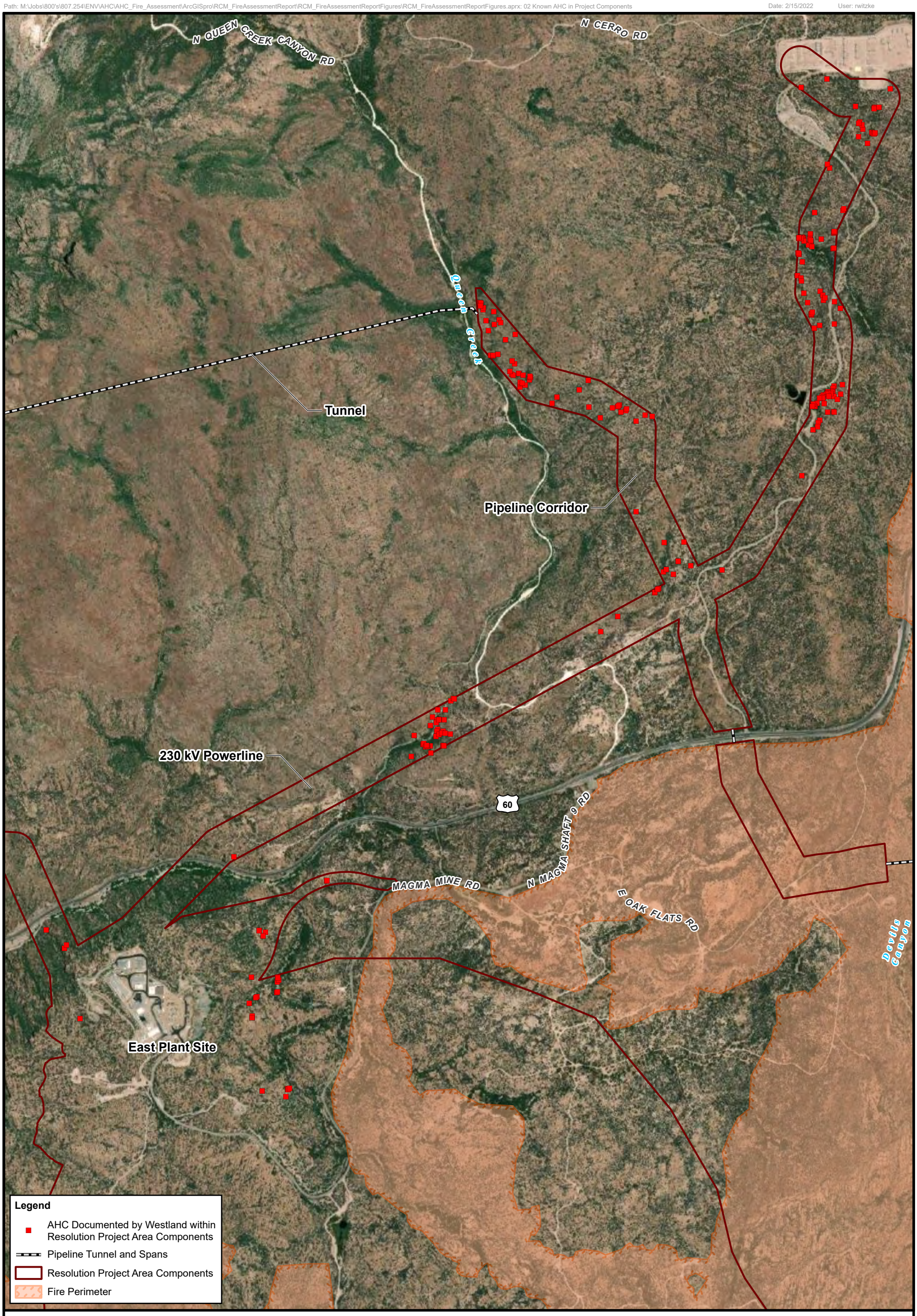
AHC Telegraph
Fire Assessment Report

VICINITY MAP
Figure 1



AHC Within:
T1S, R13E, Portions of Sections 15, 16, 21, 22, 28-30, and 32,
Pinal County, Arizona
Image Source: Maxar 05/20/2020
Data Source: USFS Fire Intensity Mapping and Burn Perimeter

N

0 600 1,200 Feet

0 200 400 Meters

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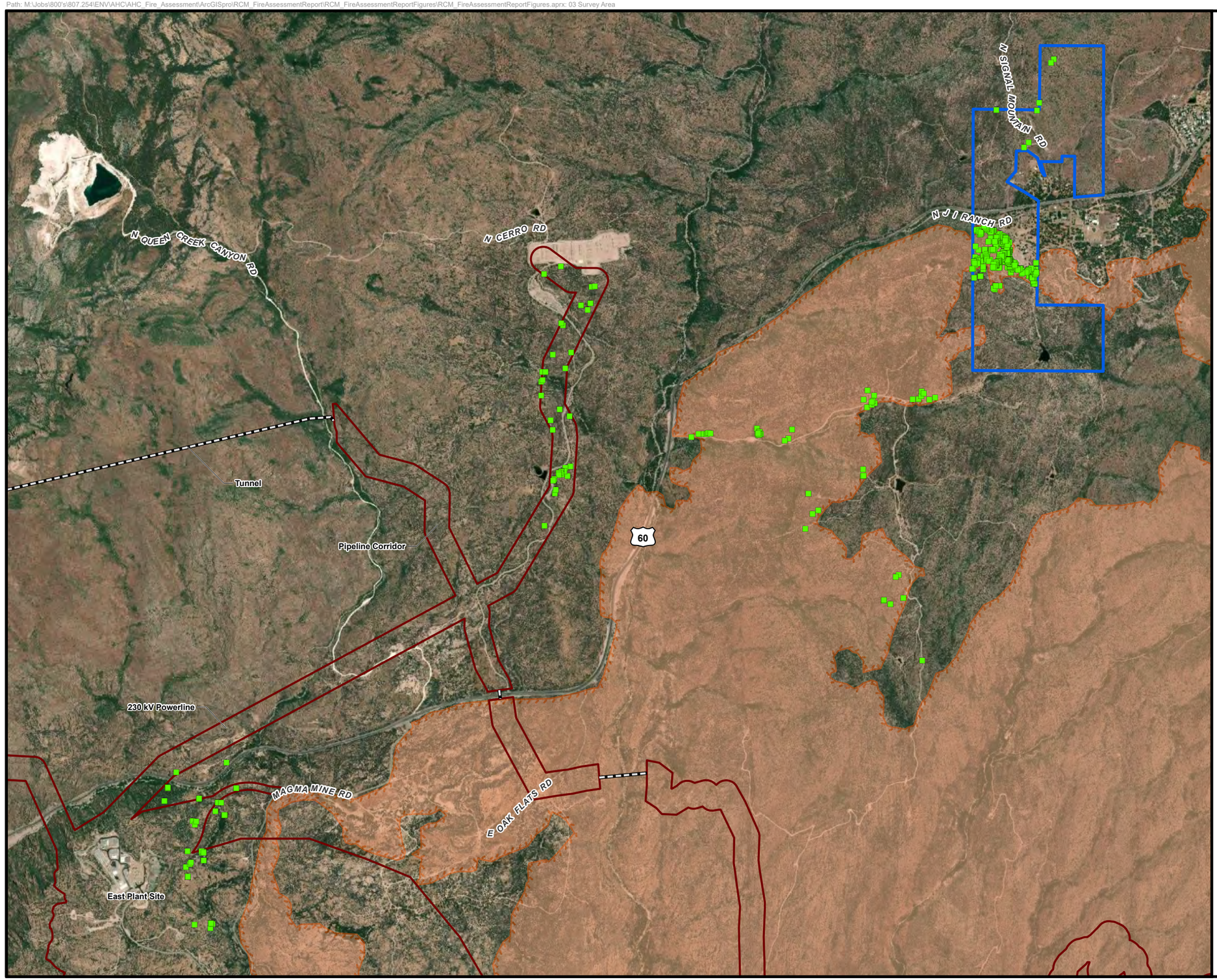
AHC Telegraph Fire Assessment Report

KNOWN AHC WITHIN THE
RESOLUTION EIS PROJECT AREA COMPONENTS

Figure 2



T1S, R13E, Portions of Sections 14-16, 21-23, 26, 29, and 32, Pinal County, Arizona
Image Source: Maxar 05/20/2020
Data Source: USFS Fire Intensity Mapping and Burn Perimeter

Legend

- AHC Sampled During Post-fire Assessment
- Pipeline Tunnel and Spans
- JI Ranch
- Resolution Project Area Components
- Fire Perimeter

N

0 1,000 2,000 Feet

0 300 600 Meters

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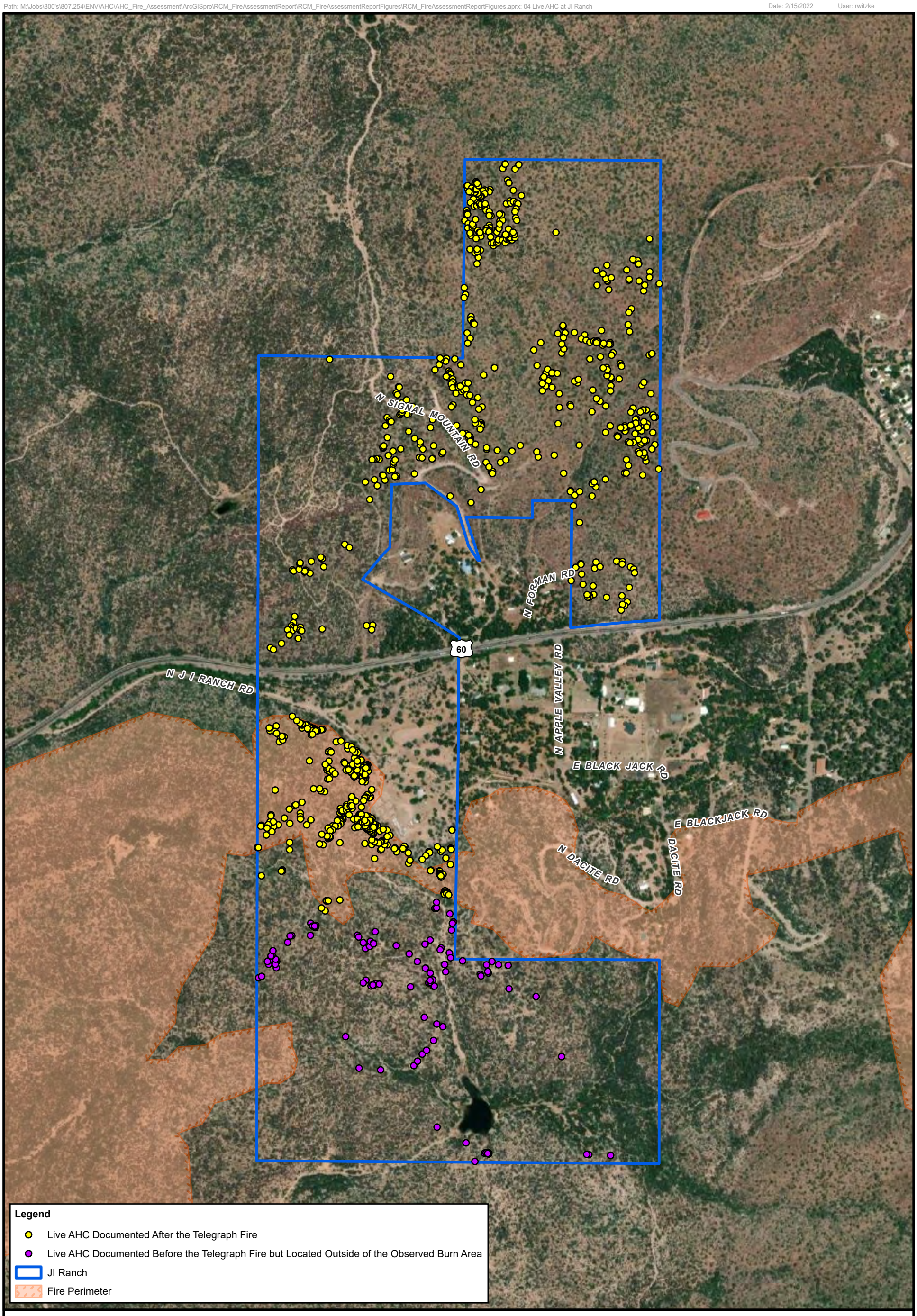
AHC Telegraph
Fire Assessment Report

AHC SAMPLED DURING
POST-FIRE ASSESSMENT

Figure 3



JI Ranch Within:
T1S, R13E, Portions of Sections 14 and 23,
Pinal County, Arizona
Image Source: Maxar 05/20/2020
Data Source: USFS Fire Intensity Mapping and Burn Perimeter

N

0 300 600 Feet

0 100 200 Meters

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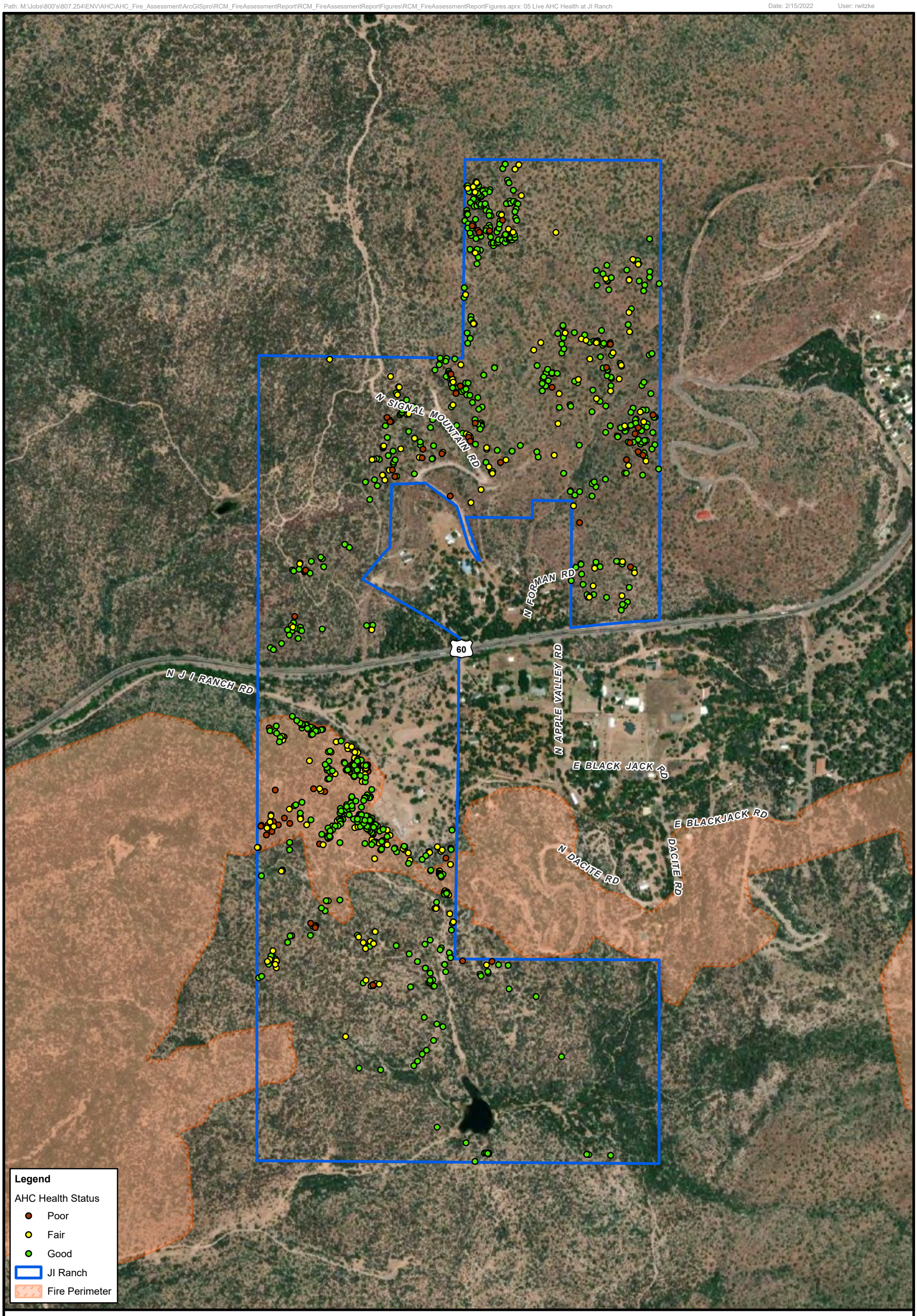
AHC Telegraph
Fire Assessment Report

LIVE AHC AT JI RANCH

Figure 4



JI Ranch Within:
T1S, R13E, Portions of Sections 14 and 23,
Pinal County, Arizona
Image Source: Maxar 05/20/2020
Data Source: USFS Fire Intensity Mapping and Burn Perimeter

N

0 300 600 Feet

0 100 200 Meters

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AHC Telegraph
Fire Assessment Report

LIVE AHC AT JI RANCH WITH HEALTH STATUS

Figure 5

APPENDIX A
AHC Transplants at the JI Ranch:
ESA Section 7 Conservation Measure
02EAAZ00-2020-F-0822

Arizona Hedgehog Cactus Transplants at the JI Ranch

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1. INTRODUCTION

Resolution Copper (Resolution) has proposed to develop conservation lands for the federally endangered Arizona hedgehog cactus (AHC; *Echinocereus triglochidiatus* var. *arizonicus*; USFWS 1979) as part of conservation measures brought forward in support of Endangered Species Act (ESA) Section 7 Consultation (No. 02EAAZ00-2020-F-0822). AHC has been documented within the proposed disturbance limits of Resolution activities.[1] The U.S. Forest Service (USFS) submitted a Biological Assessment (BA) to the U.S. Fish and Wildlife Service (USFWS) in June 2020 (USDA 2020), and the USFWS subsequently concluded that the Project is likely to adversely affect AHC (USFWS 2020). In response, Resolution has proposed the conservation of roughly 100 acres of private lands located in Pinal County, Arizona within an area known as JI Ranch (Project Area; **Figure 1**). Resolution has propagated AHC at the JI Ranch since 2011 and has previously transplanted AHC into the Project Area in 2016 (WestLand 2016c). Resolution retained WestLand Engineering & Environmental Services (WestLand) in 2020 to transplant the remaining AHC propagated by Resolution onto JI Ranch.

2. ARIZONA HEDGEHOG CACTUS

The AHC is federally listed under the Endangered Species Act (ESA) as endangered without critical habitat (USFWS 1979). AHC is also protected by the Arizona State Legislature (A.R.S. Chapter 7, Arizona State Legislature 2019) as a Highly Safeguarded Native Plant and is protected from international trade by the Convention of International Trade in Endangered Species (UNEP-WCMC 2014). While draft recovery plans for the species have been developed (Baker 2013, Fletcher 1984), a plan has yet to be finalized. In 2019, the U.S. Geological Survey (USGS), in cooperation with the USFWS and Arizona Ecological Services, published an open file report compiling and assessing available AHC survey and monitoring data to support the recovery of the species (Thomas et al. 2019).

AHC is a green succulent with cylindroid stems and brilliant red flowers (AGFD 2020, Thomas et al. 2019). Stems on AHC often occur in clusters of four to twenty stems, averaging 3 inches in diameter, and are generally longer than the stems of similar varieties of hedgehog cacti (AGFD 2020). Stems have an average of nine ribs (AGFD 2020, Baker 2013), with flowers occurring on the upper third of stem ribs (AGFD 2020). Relative to other *Echinocereus*, AHC spines are shorter and more robust (AGFD 2020). The reported flower

[1] WestLand has conducted numerous AHC surveys in the Project Area (defined in **Section 3**) and vicinity (WestLand 2004a, 2008, 2009, 2010, 2011a, b, 2013a, c, 2014a, 2016a, b, 2017, 2018, 2019, 2020a) and has detected AHC during surveys of the Pre-feasibility Action Area (WestLand 2021, 2008, 2010, 2013a, 2014a, 2016b, 2018), the East Plant Site (WestLand 2016a, 2017, 2020a), the 230-kV Powerline Corridor, and the Skunk Camp North Revised Corridor (WestLand 2020a [Figure 2], 2020b). In May 2020, an additional AHC survey was completed on approximately 100 acres of a since dismissed alternative powerline route that was being considered as part of the Skunk Camp North Revised Corridor. Ultimately, direct disturbance would be limited to access roads, pipeline placement (to be installed below grade where practicable), powerline structure footprints, and the mine subsidence area (or fracture limit, as described in the *FINAL Environmental Impact Statement Resolution Copper Project and Land Exchange*).

blooming period ranges from mid-April to mid-May (AGFD 2020, Baker 2013) and fruits from May to July (AGFD 2020).

The range of AHC extends from the Superstition Wilderness, south to Devils Canyon, east along US-60 to Top of the World, Arizona and south to the Mescal and Pinal mountains (AGFD 2020, Baker 2013, Viert 1996, WestLand 2013b), and it is known to occupy portions of the highlands in the Pinal and Gila counties between Superior and Globe, Arizona. The known range of AHC includes two small subpopulations: the Apache Peak subpopulation north of Globe, and the El Capitan subpopulation south of Globe (Baker 2013). The majority of AHC habitat occurs on lands managed by TNF, with smaller portions of predicted habitat occurring on lands managed by the San Carlos Apache Tribe, Bureau of Land Management, Arizona State Land Department, and private entities (Baker 2013).

AHC occurs from 3,300 to 5,700 feet above mean sea level (AMSL; AGFD 2020) in Interior Chaparral and Madrean Evergreen Woodland habitats, as mapped by Brown (1994). Suitable substrate includes bedrock open slopes where individuals occur in cracks and crevices and between boulders on stable rock formations such as Apache Leap Tuff, Schultze Granite, Pinal Schist, and Pioneer Quartzite (Viert 1996, WestLand 2013b). AHC occur at the highest densities in areas where boulders, exposed bedrock, and rock fissures are more common than a robust soil matrix (Viert 1996). Cedar Creek observed that AHC seemed to prefer shade for at least part of the day, although AHC also is generally found in areas with low shrub and herbaceous material in the vicinity (Viert 1996). An experimental manipulation of rocks and shade cover yielded high rates of survival for AHC exposed to both no rock cover and rock cover (Siegwarth 2014). For this reason, while AHC are often found in rocky areas that provide shade, it is unclear whether site selection is more dependent on the rocky substrate or if rocky substrate in conjunction with shade is preferred as microhabitat.

3. PROEJCT AREA

The Project Area is located within the proposed conservation easement at JI Ranch, located 5.9 miles northeast of Superior along U.S. Highway 60 in the Pinal Mountains (**Figure 1**). The vegetation community and geomorphology within the JI Ranch are consistent with the habitat associated with AHC. The Project Area is broadly mapped as Interior Chaparral (Brown 1994), and accordingly, the dominant plant species on the site include scrub live oak (*Quercus turbinella*) and pointleaf manzanita (*Arctostaphylos pungens*). Geomorphology at JI Ranch is characterized by Apache Leap tuff bedrock outcrops, a surface area covered with cobbles and boulders, approximately 6 to 18 inches to lithic bedrock (Soil Survey 2020). The soils are predominantly comprised of Woodcutter complex derived from weathered tuff and a parent material consisting of loamy and gravelly alluvium, with 15 to 50 percent slopes (Soil Survey 2020, accessed 12/21/2020). Elevation at the site ranges from 4,400 to 4,640 feet AMSL, which lies within the elevational breadth preferred by AHC.

The JI Ranch is home to hundreds of naturally-occurring AHC (WestLand 2004b). In addition to the naturally-occurring population that was detected in previous WestLand surveys, Resolution began propagating AHC at JI Ranch in 2011 under a shade structure (WestLand 2014b). These propagated AHC were subsequently monitored and ultimately transplanted into natural habitat on the property in two cohorts: 364 propagated individuals were transplanted in 2016 (WestLand 2016c), and the remaining 280 individuals were transplanted into the same general area in 2020 (see **Section 4**).

4. METHODS

4.1. TRANSPLANT AND MONITORING METHODS

AHC are known to have high survivorship when transplanted during the spring or fall (Siegwarth 2014); therefore, WestLand biologists prioritized transplantation of AHC in the fall, during October and November. WestLand adapted AHC transplant methodology from AHC research conducted by the Arizona Department of Transportation (ADOT) and the Boyce Thompson Arboretum (BTA) (Siegwarth 2014), and this methodology is provided below.

Previous research has indicated that some desert species have exhibited higher rates of success after translocation if planted in the same orientation from which the plant originated (University of Arizona 2005). Thus, prior to translocation, AHC were marked using white correction liquid on a single spine of each individual to mark the south side of the cactus. Each individual cactus was also individually marked with a small metal vegetation tag engraved with a unique ID using a carbide etching pen. Vegetation tags were attached to cobble adjacent to cacti using 24-gauge steel wire. After marking, a subset of the JI Ranch transplants (n=96 out of 280 total cacti) were divided into four groups based on four pre-determined transplant methods (see **Section 4.2**). All AHC were watered prior to translocation.

At each transplant location, a hole was dug that matched the size of the cactus to be transplanted. Specifically, holes were dug deep enough to allow for a taproot (or primary root) to extend fully and wide enough to provide adequate spacing for lateral roots to extend outward from the base of the plant. Prior to planting, each AHC was extracted from the transplant pot and the soil around the roots was loosened to encourage outward root growth. During planting, the roots were covered by the original soil removed from the newly dug hole. The soil around the root structure was lightly compacted and built up slightly around the base of the plant to provide stability.

After transplantation, each transplant location was marked with both the internal GPS on tablets and on a Garmin™ handheld GPS units. Representative photographs of the plants top, side, and landscape setting were taken, and the current reproductive activity and the health of each cactus was characterized. Reproductive activity was measured as a cumulative count of all fruits, buds, fertilized and unfertilized flowers. When a reproductive structure contained flower petals sprouting from an immature fruit, one

reproductive structure was recorded. While the AHC were transplanted outside of the flowering and fruiting season, desiccated flowers and fruits from the 2020 flowering season were still present on many of the cacti, providing an estimate of reproductive activity (see **Section 5**).

Cactus health was characterized in several ways, including a count of the number of live stems, the size of the cactus, presence or absence of herbivory, and a categorical measures of plant health. All live stems were counted on each cactus, including cumulative count of all living main stems, secondary stems, and pups. Cactus size was determined by measuring the height and width of each cactus. The height of each cactus was measured as a straight-line, vertical measurement, from the base of the plant to the upper-most portion of the plant, excluding spines and reproductive structures.[2] The width of each cactus was measured as a straight line across the widest portion of the plant, excluding spines and reproductive structures.[3] All measurements were recorded to the nearest millimeter (mm). Lastly, plants were assigned to a categorical measure of plant health, using the following categories:

- **Good**. The plant is characterized predominantly by plump, green stems (i.e., less than 25% discoloration).
- **Fair**. The plant is characterized predominantly by shrinkage or discoloration (25 – 50% discoloration).
- **Poor**. The plant is characterized predominantly by necrosis (over 50% discoloration).

In addition to the AHC that were transplanted in 2020, all previously transplanted AHC from 2016 were visited to determine the current health status of each plant within the JI Ranch conservation parcel. While the populations transplanted in 2016 and in 2020 were transplanted at different times, they will be monitored as a single population during future survey efforts. All field data were collected using a *Survey123* survey datasheet within the ArcGIS platform on Samsung tablets. Data were subsequently backed up to the WestLand server. To maintain data integrity, AHC data that were found to be incorrect in later analysis were excluded from final counts.

4.2. TREATMENT METHODS

AHC is often associated with rocky substrates, low vegetative cover, and shade, yet it is unclear which type of transplant location is best for AHC based on variable survivorship of AHC across types of transplant microhabitats (Siegwarth 2014, WestLand 2016c; see **Section 2**). As such, WestLand planted a subset of AHC into each treatment and individually marked each cactus with an aluminum vegetation tag to track its growth and reproductive success to inform future transplant efforts. The four treatments included: 1) AHC transplants provided with added rocks with shade (**Photograph 1**), 2) AHC transplants provided with added

[2] Plant height was measured vertical to gravity for field measurement consistency. Because of the measurement technique, the recorded heights of AHC growing on slopes may be exaggerated in some cases.

[3] Plant width was measured horizontally for field measurement consistency. Because of the measurement technique, the recorded widths of AHC growing on slopes may be understated in some cases.

rocks but no shade (**Photograph 2**), 3) AHC transplants were not provided with rocks but were provided with shade from vegetation (**Photograph 3**), and 4) AHC transplants were not provided with either rocks or shade (**Photograph 4**). For the added rock treatment, WestLand biologists placed rocks adjacent to AHC. For the added shade treatment, AHC were placed adjacent to larger plants (usually *Q. turbinella* or *A. pungens*) or positioned at the base of some rocky feature within the natural landscape of the JI Ranch where they would receive protection from the sun.

5. RESULTS

WestLand biologists and Tribal Monitors[4] documented previously transplanted AHC from October 20 to 22 and transplanted an additional 280 AHC into suitable habitat at the JI Ranch November 9 to 12, amounting to approximately 20 total person-days of survey effort (**Table 1**).

Table 1. 2020 Arizona Hedgehog Cactus Transplant Effort

2020 Monitoring and Transplant Dates	Number of Staff	Number of Person-days[1]
October 20-22	4	6
November 9-12	4	14

[1] A person day is equal to approximately 8 hours of work effort by one person and includes mid-day vehicle and hiking travel time within the JI Ranch but does not include travel time to and from lodging in the morning and afternoon.

WestLand biologists evaluated the health and reproductive status of the previously transplanted cacti in 2016 and of the transplants conducted in 2020 (see **Table 2** for details regarding health and reproductive status of AHC at the JI Ranch). Of the 131 cacti transplanted in 2016, 7 percent were in **Poor** condition, 26 percent were in **Fair** condition, and 67 percent were in **Good** condition. Of the 280 AHC transplanted in 2020, 8 percent were in **Poor** condition, 50 percent were in **Fair** condition, and 41 percent were in **Good** condition. AHC planted in the experimental treatments were of comparable size, number of live stems, and health category (**Table 2**). Cacti transplanted in 2016 and 2020 were predominantly characterized as having one stem (n = 83 and n = 274 cacti, respectively), while cacti transplanted in 2016 were more likely to have more than one stem than cacti transplanted in 2020. Unsurprisingly, given that the transplants and reproductive status of the cacti were determined outside of the primary flowering season (i.e., in April and May), there were few flowers or buds detected, although some dried flowers and buds were identified on the 2020 transplants. This likely reflects that the 2020 cacti were housed under a shade structure until transplantation, while the 2016 transplants were more exposed to the elements. On average, the cacti transplanted in 2016 were larger than the cacti transplanted in 2020.

[4] The Tonto National Forest Tribal Monitor Program includes tribal cultural and biological specialists from represented tribal communities including the White Mountain Apache Tribe, Gila River Indian Community, Yavapai-Apache Nation, Hopi Tribe, Pueblo of Zuni, Ak-chin Indian Community, and Mescalero Apache Tribe. The monitors intensively survey alongside archaeologists and biologist from WestLand to identify places of cultural significance using Traditional Ecological Knowledge (TEK).

Table 2. Status of AHC Transplants at the JI Ranch[1]

Transplant Cohort	# of AHC	AHC Health			Number of Live Stems				Number of Flowers				Number of Buds		Average Height (mm)	Average Diameter (mm)
		Poor	Fair	Good	0	1	2	3+	0	1	2	3+	0	1		
2016 Transplanted AHC	131	9	34	88	0	83	31	16	130	1	0	0	130	0	136.9	91.6
2020 Transplanted AHC	280	22	141	116	3	274	2	1	224	47	7	2	274	4	126.8	88.5
No Treatment	184	22	109	52	181	2	1	0	143	35	5	1	180	2	127.3	68.9
Rocks + shade	24	0	7	17	0	24	0	0	23	1	0	0	24	0	123.33	66.58
Rocks + no shade	24	0	8	16	0	24	0	0	17	5	2	0	23	1	120.92	66.83
No rocks + shade	24	0	7	17	0	24	0	0	20	4	0	0	24	0	129.13	67.58
No rocks + no shade	24	0	10	14	0	24	0	0	21	2	0	1	23	1	130.75	66.54

[1] Numbers reflect status of transplanted AHC within the JI Ranch boundaries in 2020. AHC attribute totals may not reflect total subpopulation numbers due to data collection errors resulting in <NULL> values for certain attributes. All <NULL> values were excluded.

6. DISCUSSION

Resolution has proposed the conservation of roughly 100 acres of private lands at JI Ranch to support the recovery of AHC. To this end, AHC were propagated and transplanted in 2016 and in 2020 by WestLand. Previous transplant efforts indicated that it is unclear what type of microhabitat AHC prefer (i.e., the degree of shade and number of rocks present) (Siegwarth 2014). WestLand therefore placed AHC into experimental treatments and characterized current plant health and reproductive success to track the success of AHC in each treatment. These data will support and inform transplant efforts for AHC both within the JI Ranch and in other transplant programs.

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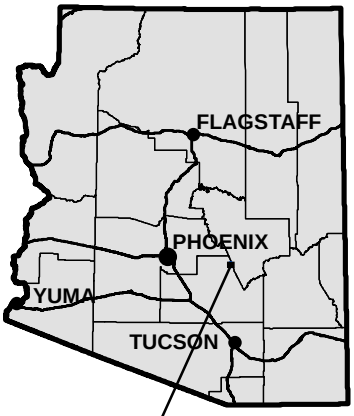
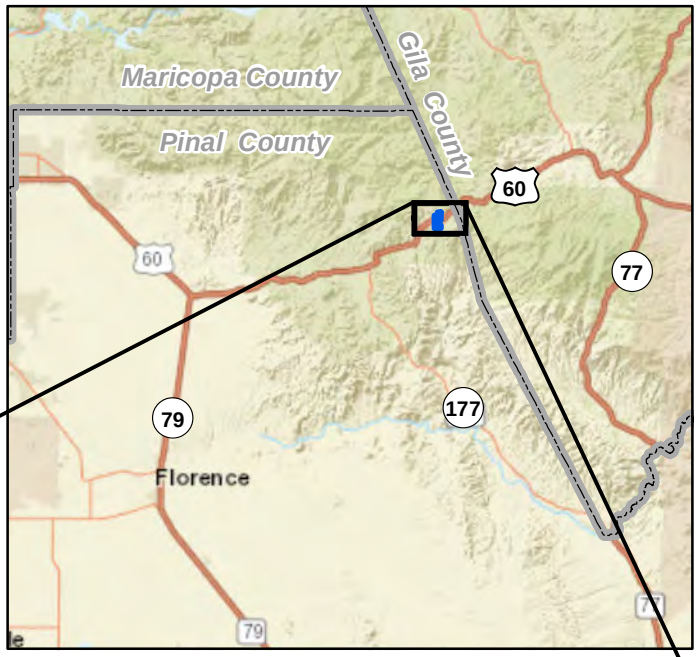
FIGURES

ARIZONA



PROJECT VICINITY



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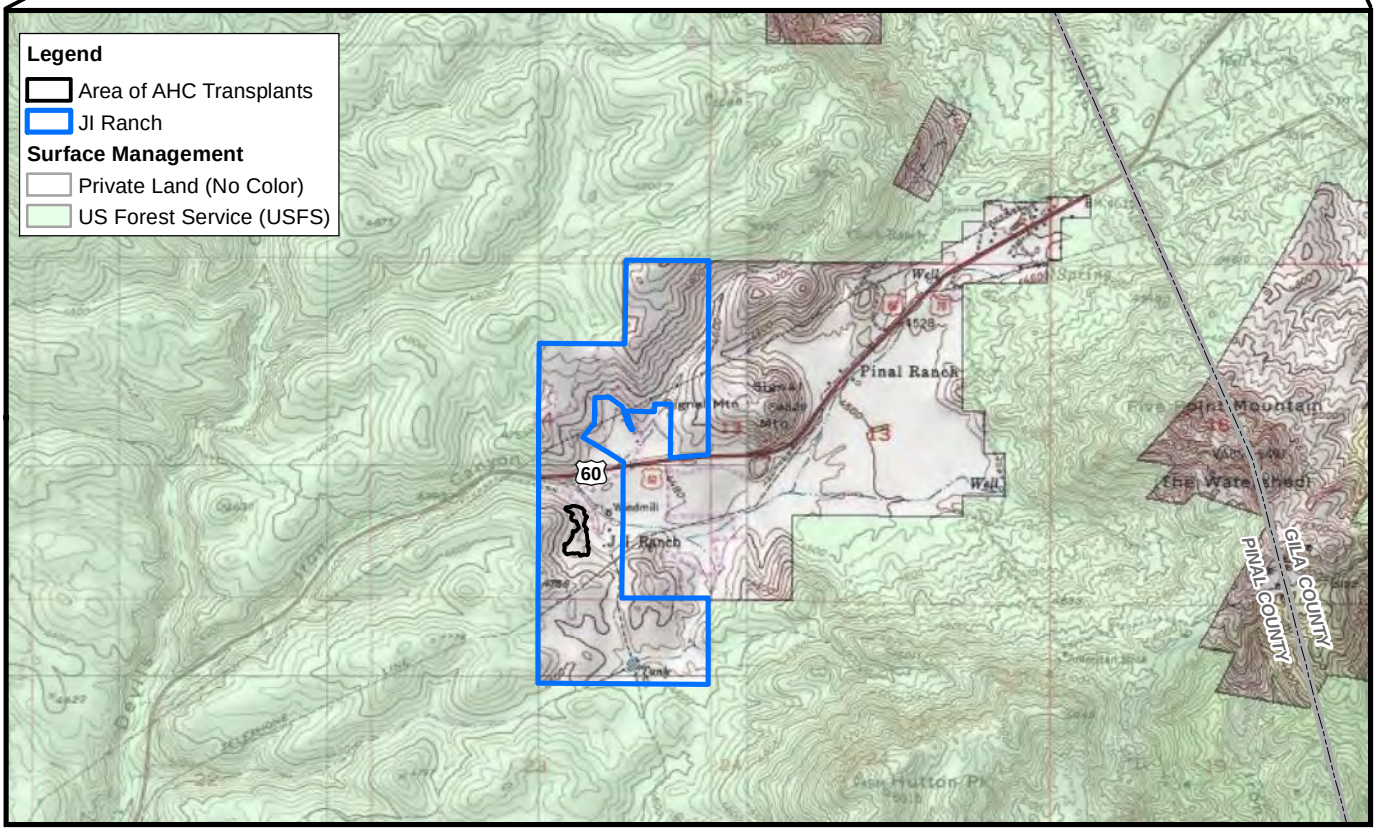


JI Ranch within:
T1S, R13E, Portions of Sections 14 and 23, Pinal County, Arizona
Superior 7.5' USGS Quadrangle.
Surface Management, BLM 2019, WRI Modified 2019
Image Source: ArcGIS Online World Street Map

WestLand Resources

N

0 1,500 3,000 Feet

0 500 1,000 Meters

RESOLUTION COPPER

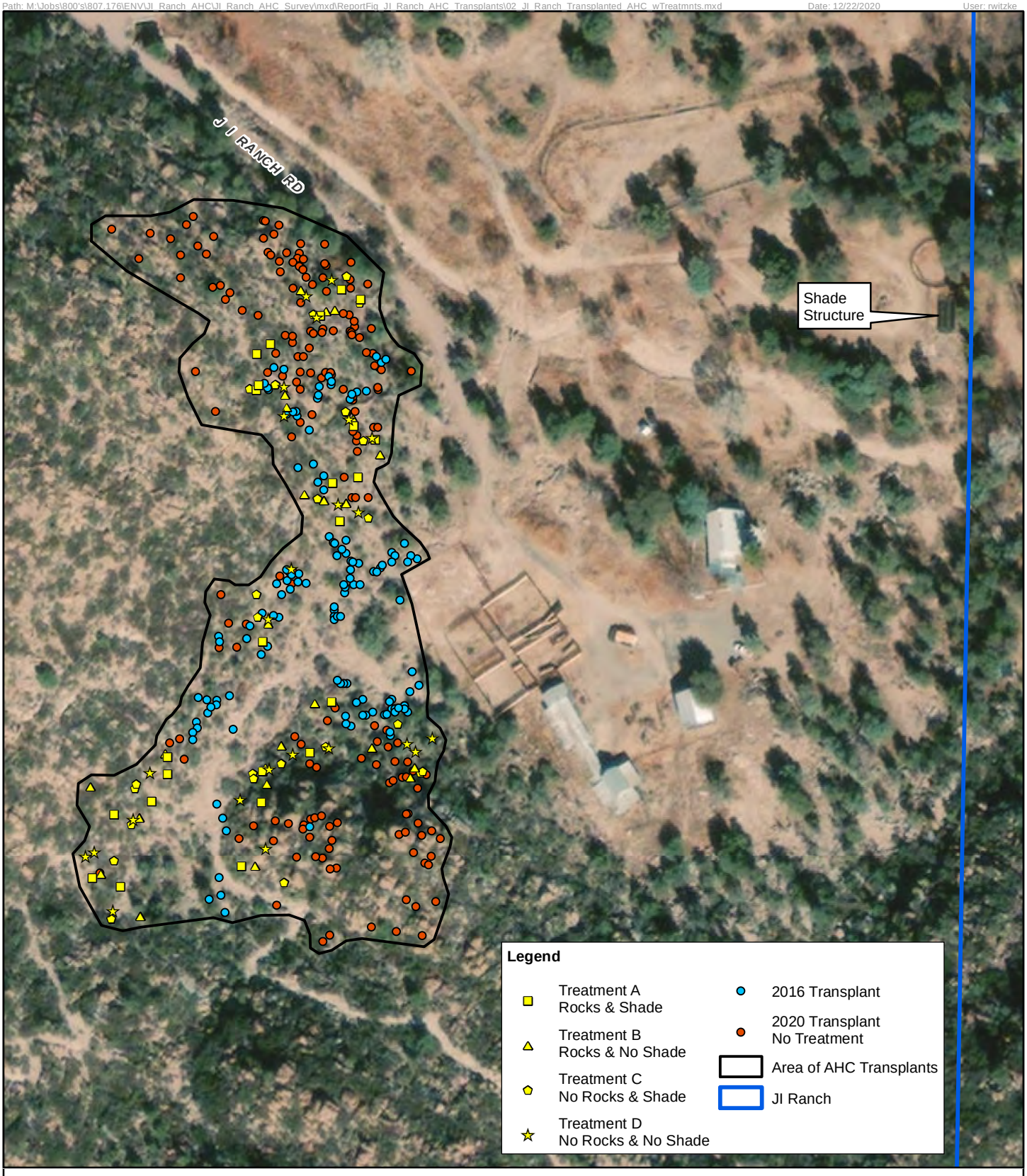
JI Ranch

Arizona Hedgehog Cactus Transplants

VICINITY MAP

Figure 1

Path: M:\Jobs\800's\807.176\ENV\JI_Ranch_AHC\JI_Ranch_AHC_Survey\mxd\ReportFig_JI_Ranch_AHC_Transplants\02_JI_Ranch_Transplanted_AHC_wTreatmnts.mxd Date: 12/22/2020 User: rwitzke



JI Ranch Transplants within:
T1S, R13E, Portion of Section 14,
Pinal County, Arizona
Image Source: ArcGIS Online World Imagery 2-6-2018

WestLand Resources

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0 70 140 Feet

0 25 50 Meters

RESOLUTION COPPER

JI Ranch
Arizona Hedgehog Cactus Transplants

JI RANCH TRANSPLANTED AHC
WITH ADDED TREATMENT
TRANSPLANT LOCATIONS

Figure 2

APPENDIX B
Representative Photographs

Photo 1. An AHC located at the East Plant Site. None of the AHC sampled in the Resolution Project Area exhibited fire damage.

Photo 2. An AHC located at the East Plant Site. None of the AHC sampled in the Resolution Project Area exhibited fire damage.

Photo 3. An AHC located in the 230kV Powerline Corridor. None of the AHC sampled in the Resolution Project Area exhibited fire damage.

Photo 4. An AHC located in the 230kV Powerline Corridor. None of the AHC sampled in the Resolution Project Area exhibited fire damage.

Photo 5. U.S. 60 is visible in the background. The Telegraph Fire was restricted largely to areas south of U.S. 60 (pictured at left).

Photo 6. U.S. 60 is visible in the background. The Telegraph Fire was restricted largely to areas south of U.S. 60 (pictured in foreground).

Photo 7. Overview of JI Ranch south of U.S. 60.

Photo 8. A portion of JI Ranch within the Telegraph Fire burn perimeter.

Photo 9. A portion of JI Ranch south of U.S. 60, outside the Telegraph Fire burn perimeter.

Photo 10. An AHC within the JI Ranch burn perimeter. The AHC is pictured at bottom center.

Photo 11. An AHC within the burn perimeter at JI Ranch. Plant Health and Fire Damage were assessed as Good and 0%, respectively.

Photo 12. An AHC within the burn perimeter at JI Ranch. Plant Health and Fire Damage were assessed as Fair and 40%, respectively.

Photo 13. An AHC within the burn perimeter at JI Ranch. Plant Health and Fire Damage were assessed as Poor and 80%, respectively.

Photo 14. A dead AHC within the burn perimeter at JI Ranch. Fire Damage was assessed as 100%.

Photo 16. TNF lands between JI Ranch and the Resolution Project Area, within the Telegraph Fire burn perimeter.

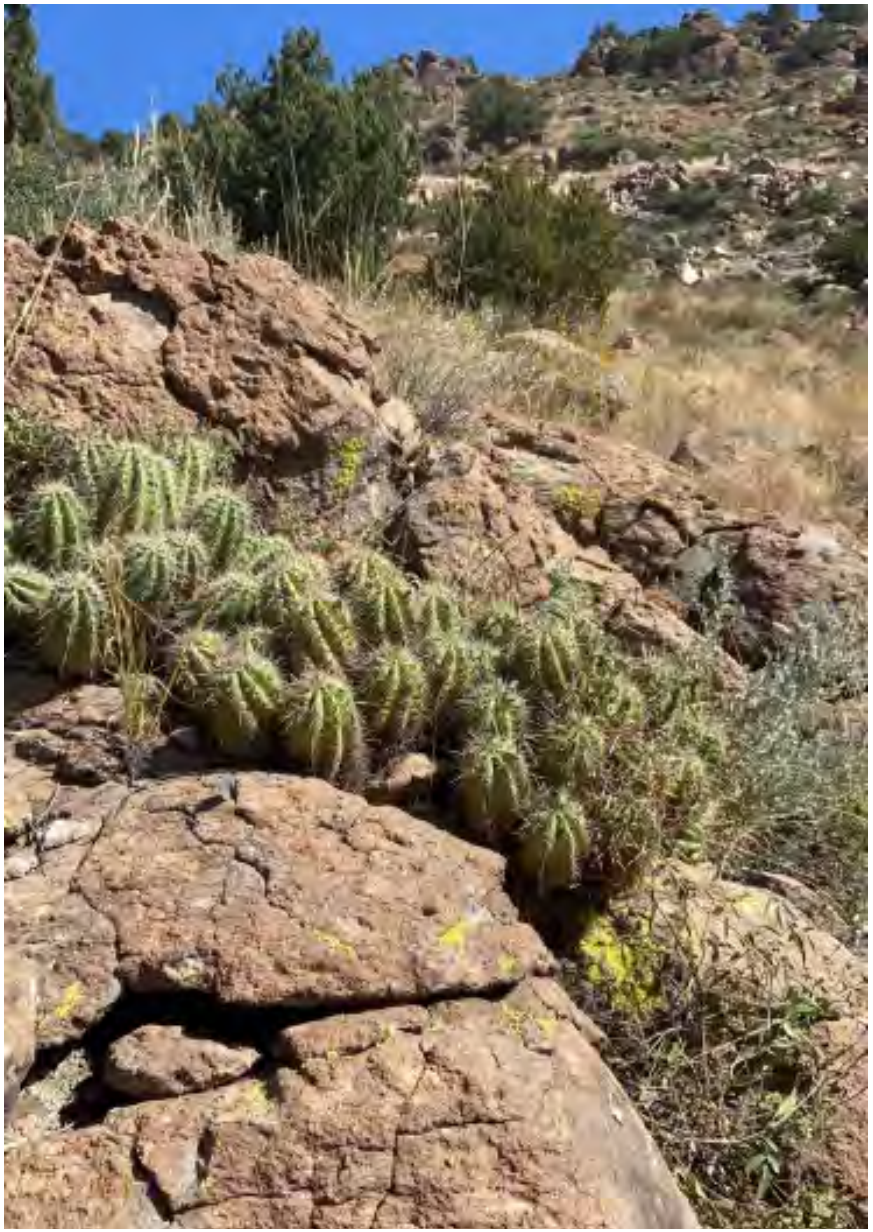

Photo 15. No evidence of fire damage was observed on JI Ranch north of U.S. 60.