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RIDGECREST SOLAR POWER PROJECT

ANALYSIS OF POPULATION AND SPECIES IMPACTS TO THE DESERT TORTOISE, DUE TO THE SITING OF THIS PROJECT IN ITS CURRENT LOCATION

BACKGROUND

The Ridgecrest Solar Power Project (RSPP or Project) is located in Indian Wells Valley, approximately 8 km (5 mi) from the city of Ridgecrest and approximately 9.6 km (6 mi) from the town of Inyokern, in Kern County, California (Figure 1). The 702 ha (1734.8 acre) RSPP abuts State Highway 395, a major north-south commerce and transportation route in California, and crosses Brown Rd., a locally-used two-lane paved road (Figure 2). A complete Project description can be found in the Project Application for Certification (AECOM 2009a).

Desert tortoise surveys were completed in Spring 2009 and observed 23 adult desert tortoises within the Project footprint. Using the current USFWS (2009) calculations, the estimated adult tortoise abundance was 57, or 8.1 adult tortoises per square kilometer [1].

ANALYSIS

The importance of a site to the local population and species can be defined by the following factors:

1. Abundance of tortoises relative to other locations within the population
2. Identified importance of the area for recovery and tortoise conservation, by CDFG and USFWS
3. Existing impacts to the site's tortoises and relative longevity of the population in light of these impacts, irrespective of the project
4. Disruption to genetic connectivity within the population that would occur due to the project
5. Cumulative population fragmentation, including the project, that could result in decreased value of the habitat surrounding the project
6. Heightened anthropogenic or other impacts that could result should the project be built

Each is discussed in detail below.

Tortoise Abundance

Estimated tortoise density at RSPP is 8.1 adult tortoises per km^2, using the USFWS calculation (USFWS 2009a) and based on the 23 adult tortoises found in 702.1 ha (1734.8 acres) (AECOM 2009b). It is possible that the actual density may be somewhat

[1] Note: The Application for Certification (AFC; AECOM 2009a) reports a different density of adult tortoises, 9.8 adult tortoises per km^2, but the final density was re-calculated as 8.1. The corrected density can be found in newer documents for the Project (e.g., Biological Assessment, 2081 Application).

less, potentially about 6 adult tortoises per km^2, or a total of about 38 adults, rather than the 57 estimated. This is based on statistical data for nine mark-recapture plots in the western Mojave Desert (Karl 2002), where about 61% of the adult tortoises that comprise the final density estimate were found on the first, 100% pass of a site.

Tortoise abundance at the RSPP is examined in this discussion relative to the following questions:

- Could the absolute value of 8.1 tortoises/km^2 be considered a high tortoise density by historic standards, when tortoise densities were higher throughout their range?
- Is 8.1 a relatively high tortoise density by today's standards?
- Could this population be a source population because of its high habitat quality, high density and/or security from threats to population viability?

RSPP Tortoise Density Compared to Other Relevant Sites. What does a density of 8.1 mean in the context of tortoise populations? Historically, density of 8.1 adult tortoise per km^2 would have been considered a low tortoise density. Table 1 shows the five trend plots studied by BLM in the western Mojave Desert that historically had the highest tortoise densities. Adult tortoise densities from the period 1979-1982 ranged from 36-92 adult tortoises per km^2. The three plots closest to the RSPP (the two Desert Tortoise Natural Area [DTNA] plots and Fremont Valley) had the highest densities. The other high-density plots in California had 38-83 adult tortoises per km^2. So, historically, 8.1 would have been considered to be very low.

Table 1. Estimated adult tortoise densities (# / km^2) for historically high density plots in California[1].

Historically High Density Plot	#Adults/km2	Year
Western Mojave Desert		
DTNA[2] Interior Plot	92	1982
DTNA Interpretive Center	69	1979
Fremont Valley	45	1981
Kramer Hills	42	1980
Lucerne Valley	36	1980
Elsewhere in California		
Chuckwalla Bench	75	1979
Goffs	83	1983
Upper Ward Valley	38	1980
Ivanpah	42	1979

1. Data Source: BLM (2005), Berry (1990, 1997)
2. Desert Tortoise Natural Area (DTNA)

This begs the question of where the value of 8.1 fits in current tortoise densities. Could this be a high density in the context of current tortoise densities? There are few recent (i.e., within the ten years prior to the 2009 RSPP surveys) available data for localized sites *where tortoises are expected*. Table 2 lists 19 locations in tortoise habitat, and excludes locations that were specifically chosen by project developers based on their anticipated lack of tortoises and other costly resources (e.g., solar project sites). Adult tortoise densities at these 19, western Mojave Desert sites range from 0-28 adult tortoises/km^2 (Table 2). The RSPP tortoise density of 8.1 falls slightly above the median density value (7.7) of these 19 sites and slightly below the mean value (8.5). So, at best, the RSPP site is a medium density, based on comparison to these sites.

Two regional sampling programs may help elucidate RSPP tortoise abundance in the context of the tortoise's geographic range in California. Density transects for the Ridgecrest area in the late 1970's estimated 8-19 tortoises per km^2 in the Project vicinity (Berry and Nicholson 1984). This was considered a relatively low tortoise density at the time because during this same sampling program, 7640 km^2 in California were estimated to have over 19 tortoises per km^2 and nine areas were estimated to have over 58 tortoises per km^2. More recent transects conducted for the West Mojave Plan (WMP) in 1999 again consistently found very low sign counts in the RSPP vicinity and Indian Wells Valley (U.S. Bureau of Land Management [BLM] 2005). On 23 of 25 transects, zero to three sign were observed; on the remaining 2 transects, four to eight sign were observed. During this same sampling program, there were many areas in the WMP planning area that had higher to substantially higher sign counts, indicating that the RSPP vicinity (Indian Wells Valley, Ridgecrest) is a low tortoise density area, compared to other locations in the tortoise's range. Consistent with the sampling results in Indian Wells Valley, recent sampling near Red Rocks State Park, west of the RSPP, suggested very low tortoise densities there as well, fewer than four adult tortoises per km^2 (Keith et al. 2005).

The WMP transects are significant in the analysis of tortoise abundance because the WMP data are relatively recent. Compared to other areas in the WMP planning area, tortoise abundance in the RSPP vicinity was low to moderately low. It follows, then, that RSPP estimated tortoise density of 8.1 adults per km^2 would also be low to moderately low.

In summary, regional sampling studies show that tortoise densities have remained consistently low in the RSPP area for 30 years. Even assuming that tortoise densities were likely to have been a little higher several decades ago than they are now, consistent with the rangewide pattern of tortoise declines (Karl 2004a, McLuckie et al. 2006, Boarman et al. 2008), the evidence strongly supports historic low densities, not dramatic declines seen on the high density areas (Table 2). Furthermore, WMP transects indicate that recent tortoise densities in the RSPP vicinity are relatively low compared to several other areas in the WMP planning area, which suggests that 8.1 adult tortoises per km^2 is a relatively low density. The density of 8.1 falls mid-range with other current documented tortoise densities on similar-sized sites in desert tortoise habitat.

Table 2. Available desert tortoise density estimates on localized sites in the western Mojave Desert. Sites were generally small, 1 km^2 or 1 mi^2, unless noted. All sites were on habitats likely to be occupied by desert tortoises.

Site	#Adults/km^2		Time or Time Span for Estimates[1]	Reference
	Time 1	Time 2		
USGS Plots				
DTNA Interior Plot	92.0	5.0	1979, **1982**, 1988, 1992 **1996**, 2002	BLM (2005), Berry (2003)
DTNA Interpretive Center	69.9	18.1	**1979**, 1985, 1989, **1993**, 2002	BLM (2005), Berry (2003)
Fremont Valley	44.8	12.7	**1981**, 1987, **1991**, 2001, 2007	BLM (2005), Jones (2008)
Fremont Peak	27.0	1.9	**1980**, 1985, 1989, **1993**, 2001, 2007	BLM (2005), Jones (2008)
Kramer Hills	44.0	13.1	1980, **1982**, 1987, 1991, **1995**, 2007	BLM (2005), Jones (2008)
Lucerne Valley	35.9	25.1	**1980**, 1986, 1990, **1994**, 2005	BLM (2005), Jones (2008)
Johnson Valley	26.6	6.2	**1980**, 1986, 1990, **1994**, 2008	BLM (2005)
Stoddard Valley	47.9		1981, **1987**, 1991	BLM (2005)
Fort Irwin Expansion Project				
MT-1	28.0		1999	Karl (1999)
NL-1	10.0		1999	Karl (1999)
Plot 1	14.0		2001	Karl (2002a)
Plot 2	5.0		2001	Karl (2002a)
Plot 3	0+		2001	Karl (2002a)
Plot 4	7.7		2001	Karl (2002a)
Plot 5	7.0		2001	Karl (2002a)
Plot 6	5.0		2001	Karl (2002a)
Plot 8	10.8-12.0		2001, 2002	Karl (2002a, b)
Plot 9	13.2-13.9		2002	Karl (2002b)
MCAGCC Land Acquisition Project:				
Johnson Valley Plot 1	7.8		2009	B. Henen, NREA, pers. comm.
Johnson Valley Plot 2	6.0		2009	B. Henen, NREA, pers. comm.
Johnson Valley Plot 3	12.5		2009	B. Henen, NREA, pers. comm.
Twentynine Palms Plot 4	10.6		2009	B. Henen, NREA, pers. comm.
Cadiz Valley Plot 5	5.0		2009	B. Henen, NREA, pers. comm.
Cadiz Valley Plot 6	0.0		2009	B. Henen, NREA, pers. comm.
Johnson Valley Plot 7	4.0		2009	B. Henen, NREA, pers. comm.

Site	#Adults/km²		Time or Time Span for Estimates[1]	Reference
	Time 1	Time 2		
Emerson Lake	3.0		2009	B. Henen, NREA, pers. comm.
Acorn	10.6		2009	B. Henen, NREA, pers. comm.
Larger Sites:				
Fort Irwin: Southern Expansion Area Clearance – 32 km^2	7.2		2006-7	A. Walde, pers. comm.
Hyundai Motor America Mojave Test Track – 18.3 km^2	1.5		2004	Karl (2004b)

1. The years listed are all the years that the site was studied. The years in bold type represent years with the highest historic density (first year in bold type) and the most recent available data. Note that while the sites may have been surveyed in years subsequent to the most recent year in bold type, density data for adult tortoises is not available.

Comparison of RSPP to USFWS Line Distance Sampling Densities. In an earlier workshop, Mr. Dick Anderson compared RSPP tortoise density to those from the USFWS' Line Distance Sampling (LDS) program that has been implemented to determine regional and rangewide trends in tortoise densities. This comparison resulted in the RSPP site appearing higher than any area within the desert tortoise's range in California, Nevada, and Utah. However, the comparison is invalid because the sampling units for the LDS program are thousands of square kilometers (Table 3), up to 9298 km^2, compared to the 7.02 km^2 RSPP site. The large sampling units used in the LDS program survey both non-tortoise habitat and occupied habitat because the transects are randomly placed within strata, (USFWS 2009b: Pages 10 and 32):

> "The expectation was that most of the rugged terrain would be sampled in this way, and the transect locations would be representative, not purposefully in better areas for encountering tortoises."

The goal of the LDS program is to provide density for each broad sampling strata, so no information is provided in the LDS report (USFWS 2009b) that would permit the reader to determine the percentage of the area within each broad sampling stratum that comprises non-habitat or varying levels of tortoise abundance. However, an examination of the smaller sampling units within the major sampling strata shows a high degree of variation in tortoise density, including several densities that are higher than at RSPP. With smaller sites still, such as those that are comparable in size to RSPP (see Table 2), it appears likely that more locations would be revealed that have higher densities than at RSPP.

The 2009 LDS report (USFWS 2009b: Page 67) also notes that the methods used in the LDS program are "not necessarily representative of the recovery unit density or the monitoring stratum density. The numbers of observed tortoises do not tell all. As an example, transects in Beaver Dam Slope were walked throughout the stratum, whereas transects walked in Coyote Springs Valley and Mormon Mesa were completed in a localized area less than one-fourth the area of those monitoring strata. This is an example of how density estimates should not be viewed as representative of the larger stratum for this year."

So, the LDS numbers are not comparable both because of the size of the LDS sampling units compared to small units such as RSPP and because of the random sampling method. The data clearly show that smaller units can have much different individual densities that are masked by blending all densities across a unit that includes both non-habitat and suitable habitat.

Designated Conservation Areas for the Desert Tortoise
The RSPP and surrounding area have not been identified by the U.S. Fish and Wildlife Service (USFWS 1994a and b) and the BLM (2005) as an important area for desert tortoise recovery and population persistence (Figure 3). Desert Wildlife Management

Table 3. Broad sampling strata used to estimate tortoise density in the federally listed portion of the species range. All but the last sampling stratum are USFWS LDS sampling strata. Major strata are in bold font, followed by monitoring strata within each larger unit. Size of each stratum is shown.

Sampling Stratum	#Adults/km²	Sampling Unit Size (km²)	Date	Source
West Mojave RU[1]	**4.7**	**9298.0**	2007	USFWS (2009)
5 sampling strata within the RU used for calculating RU values	2.4-8.2	608-3447	2007	USFWS (2009)
Eastern Mojave RU	**5.8**	**6681.0**	2007	USFWS (2009)
3 sampling strata within the RU used for calculating RU values	4.2-6.6	1862-2567		
Northeastern RU	**1.7**	**4917.0**	2007	USFWS (2009)
4 sampling strata within the RU used for calculating RU values	1.2-3.3	968.0		
Eastern Colorado RU	**5.0**	**4263.0**	2007	USFWS (2009)
3 sampling strata within the RU used for calculating RU values	4.5-7.1	755-3509		
Northern Colorado	**4.6**	**4038.0**	2007	USFWS (2009)
Upper Virgin River	**14.9**	**114.0**	2007	McLuckie et al (2008) in USFWS (2009)
Fort Irwin: Southern Expansion Area	**6.8**	**32**	2001-2	(Karl 2002)
32, one km2 sampling units	>0-25.1	1	2001-2	(Karl 2002)

1. RU = Recovery Unit

Areas (DWMAs) and designated critical habitat are both about 11 km (7 miles) south of the RSPP.

These designations appear to be consistent with tortoise density information from the RSPP studies, in the context of the remainder of the species range in the Mojave and Sonoran (California) Deserts (see above). The data on tortoise distribution and abundance provide the hard data from which population impacts can be analyzed. However, that tortoises are present at densities of 8.1 adults/km^2 has prompted conclusions that this must be high quality habitat. Actually, this is not correct. Most of the site is not high quality habitat, even El Paso Wash and the smaller wash along the southern border of the Project site. Rather than being distributed relatively evenly throughout the site, tortoises are concentrated in the better habitats on the site, those that provide greater abundance of cover and forage species. I completed a habitat assessment on 25 February by walking the entire Project site's original footprint (AECOM 2009a) and recording and assessing all habitat variables (shrub species richness, evenness, composition, density, robustness; soil consistence and texture; substrate; hydrology; topography; anthropogenic influences). The eastern portion of the site is the best habitat on the site, with a moderately diverse shrub community (*Larrea tridentata*, *Ambrosia dumosa*, with *Senna armata*, *Eriogonum inflatum*, *Cylindopuntia echinocarpa*, *Ericameria cooperi*, *Acamptopappus sphaerocephalus* and occasional *Ambrosia salsola*, *Psorothamnus fremontii*, and *Lycium andersonii*) of about 12-14% cover, gently undulating terrain with numerous runnels, soft coarse-sandy loam, and a 10-15% substrate cover of fine gravel. Proceeding west and south, habitat quality declines rapidly. The topography is relatively flat, with broad, relatively sparsely vegetated rises and long, linear swales. The shrub community has low species richness, generally represented by three species on the rises *L. tridentata* and *A. dumosa* with occasional *E. echinocarpa*; the long troughs, which carry water through the valley, contain *S. armata* and *A. salsola* as well. El Paso Wash is the largest of these troughs and has essentially the same species; they are simply more robust and appear to be slightly more dense, thus providing more cover. The lack of increased species richness and cover was surprising, as El Paso Wash has been represented as a high quality wash in several discussions about the Project site. The smaller wash along the southern border of the Project site is similar to El Paso Wash, simply smaller.

In conclusion, the habitat appears to be generally a medium to moderately low quality on most of the site, with higher quality in the northeast and slightly higher quality in the long swales and washes. Tortoise distribution on RSPP is consistent with this observation.

Even though current densities have declined dramatically on formerly high density study plots (see Table 2), many or most of those areas have the potential to increase again because the habitat that supported the higher densities still exists in most cases. On RSPP, the habitat that supports higher densities was never present, so tortoise densities aren't likely to rise to a medium density if the site is left undisturbed.

Existing Anthropogenic Impacts
The site is next to Highway 395, a heavily traveled, major commerce and transportation route in California. Heavily traveled roads are known mortality sinks for tortoises and other wildlife (Nicholson 1978, Karl 1989, Boarman 1992, LaRue 1993, Marlow and von Seckendorff Hoff 1997, Rosen et al. 2007).

In addition, the towns of Ridgecrest and Inyokern, the "ranchette" community that has expanded away from the towns proper, and local agriculture (Inyokern, mostly) degrade and fragment the area's tortoise habitat. Not only is habitat removed, in a fragmented pattern, but dogs (which prey on desert tortoises), children, and motor-based recreational activity typically expand to areas immediately outside desert towns. The result of these activities is increased loss and degradation of habitat and increased tortoise depredations and collections. Ravens, which are common in the area (pers. obs.), undoubtedly due to the subsidies provided by the town and agriculture (e.g., trash, roadkills, harvesting and tilling practices that provide prey and forage, water) are likely to already exert an influence on recruitment in the local tortoise population, the effects of which could occur at RSPP. For instance, clearance of tortoises for the Hyundai Test Track south of California City, where ravens are common due to the nearby towns (California City and Mojave) and the Mojave landfill, found no tortoises between the reproductive-sized tortoises and the very small (<a few years old) juvenile stage. There appeared to be total lack of recruitment into this population, possibly due to raven predation. At RSPP, small tortoises were observed, so some recruitment is occurring. But, Ridgecrest-area ravens

Connectivity
Based on the above analysis and aerial photographs, development of this site would not appear to impair connectivity within the population. First, there is no evidencethat there are probably still impacting recruitment to some extent.

are important population segments– i.e. those that would promote species and population persistence and recovery- to connect, given the low tortoise densities at the RSPP and a location that is already impacted by anthropogenic factors,. Second, with the updated project footprint refinement (Figure 3), connections to the El Paso Mountains pass to the south could be conserved by minimizing impacts to El Paso assuming that Project mitigation also ensures that (a) tortoises are not funneled onto the highway and Brown's Road along these corridors, and (b) OHV traffic does not increase in these washes. Undoubtedly, there would be an effect on tortoise movements, which would affect connectivity and gene flow, but the effect would not be likely to be critical to population functioning.

Cumulative Population Fragmentation
The RSPP would further fragment occupied tortoise habitat. Unlike some species of birds and mammals that might abandon an area if habitat fragmentation were to reach a certain threshold, the threshold at which fragmented habitat would become undesirable or unusable by tortoises is unknown. Furthermore, mere habitat fragmentation (i.e., patch

size and connectivity) is typically difficult to separate from the suite of impacts affecting tortoise use of an area. (For instance, tortoises occupying fragmented habitats around towns are also subject to the other negative influences associated with towns [see above]). It does not appear that development of the RSPP would result in a level of fragmentation that would reduce surrounding habitat to unusable fragments. From aerial photographs, there appears to be ample habitat, even if somewhat degraded by anthropogenic activities, in the surrounding area to support the use of the area by tortoises should the RSPP be built.

Heightened Anthropogenic or Other Impacts That Could Result
No new types of resources for tortoise predators would be added by the RSPP that are not currently in the Project vicinity.

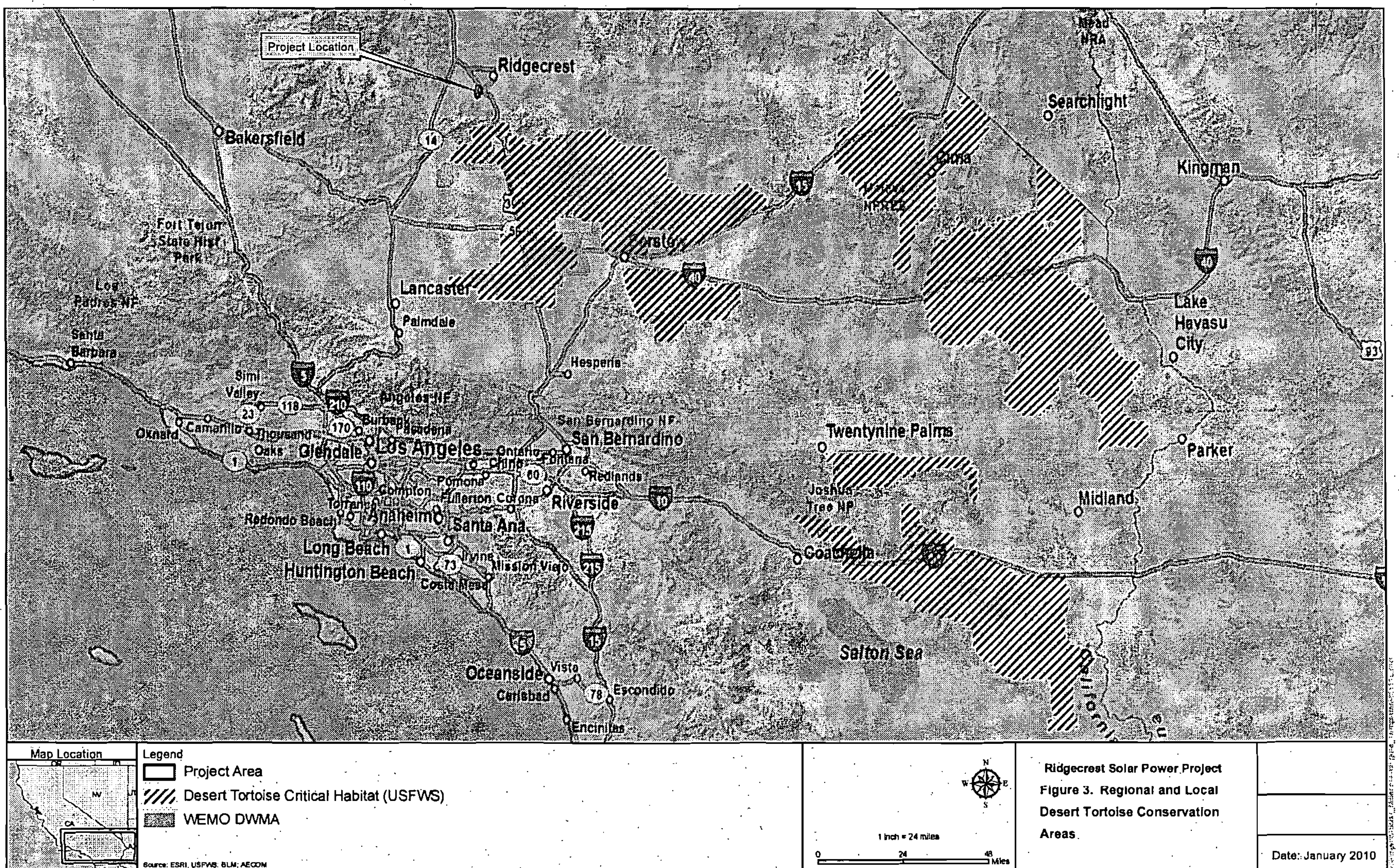
CONCLUSION

Based on the Project site tortoise abundance in the context of the rest of the species' range through the Mojave and Sonoran (California) Deserts and existing recovery and conservation approaches, as well as its location relative to existing anthropogenic effects, it is difficult to conclude that the siting of this Project in its current location would result in a biologically significant effect on the species persistence or recovery.

The Project would have indisputable effects on the tortoise, by removing habitat and disrupting movements, behavior and existing social systems. However, careful mitigation could minimize or eliminate Project-related tortoise mortality and costs to the population. Furthermore, Project mitigation has the potential to eliminate tortoise mortality on Highway 395 and decrease the current population fragmentation caused by that highway. Even though tortoise conservationists have consistently agreed that highway fencing, with culverts to permit genetic flow, is an important mitigation measure, it has rarely been achieved. Over 15 years have passed since this measure was identified in the desert tortoise recovery plan (USFWS 1994a). Private mitigation funds are a way to accomplish this. If USFWS and CDFG feel that the tortoise population in the RSPP vicinity is important for tortoise recovery, then it would be important to eliminate the highway mortality and decrease the population fragmentation.

Figure 1. Location of RSPP in a regional context. (TTEC to insert.)

Figure 2. Zoom-in of new project configuration, with Highway 395, Brown Rd. labeled.


Project Location
Ridgecrest
Bakersfield
Searchlight
Kingman
Lancaster
Palmdale
Hesperia
San Bernardino
Los Angeles
Glendale
Riverside
Anaheim
Santa Ana
Long Beach
Huntington Beach
Oceanside
Carlsbad
Escondido
Encinitas
Twentynine Palms
Lake Havasu City
Parker
Midland
Salton Sea
Map Location
Legend
Project Area
Desert Tortoise Critical Habitat (USFWS)
WEMO DWMA
Source: ESRI, USFWS, BLM, AECOM
1 inch = 24 miles
0 24 48 Miles
Ridgecrest Solar Power Project
Figure 3. Regional and Local Desert Tortoise Conservation Areas
Date: January 2010

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Existing RSPP Site Disturbances

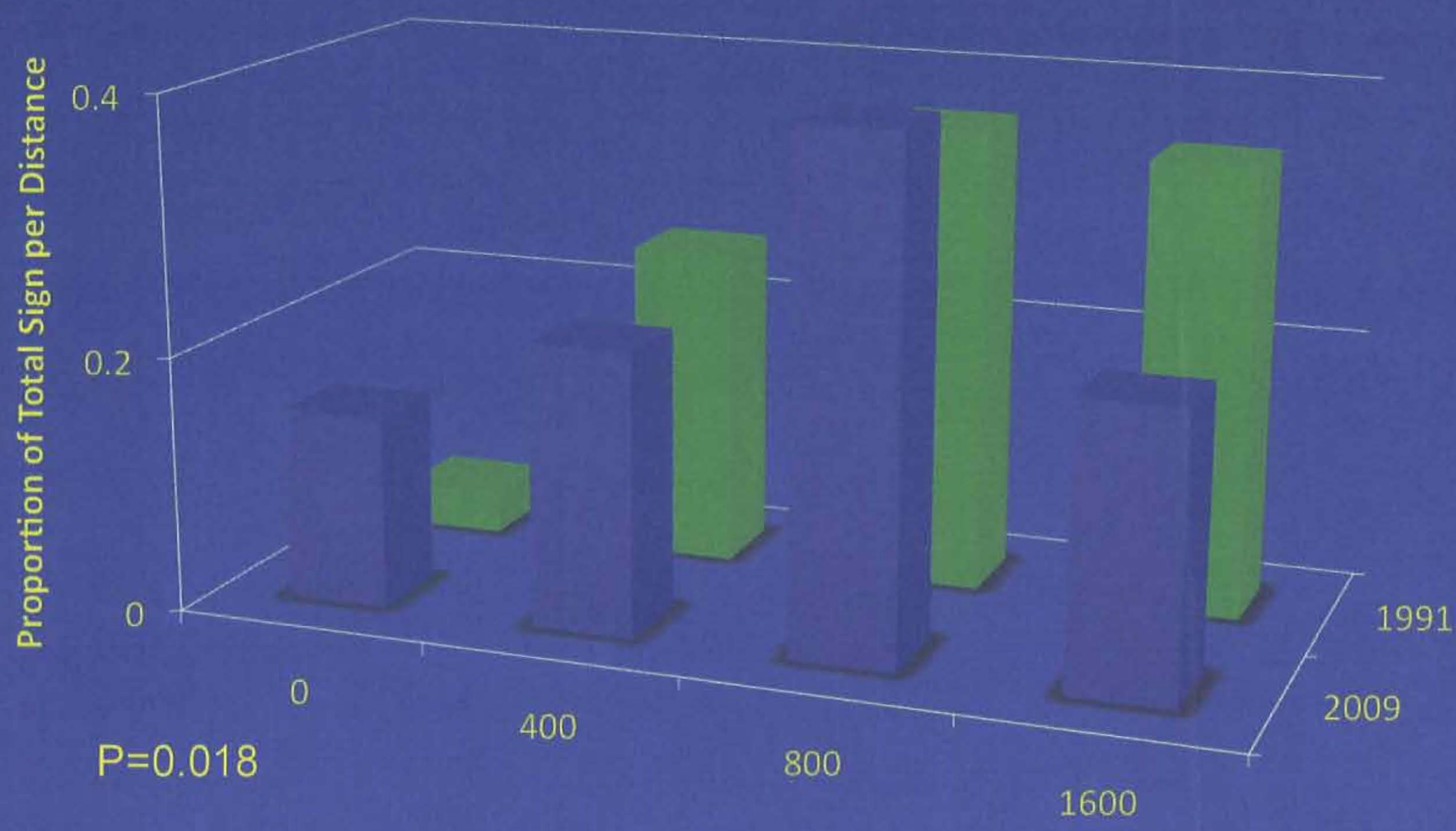
Grazing

Unexploded Ordinance (UXO)

Off Highway Vehicle Trails

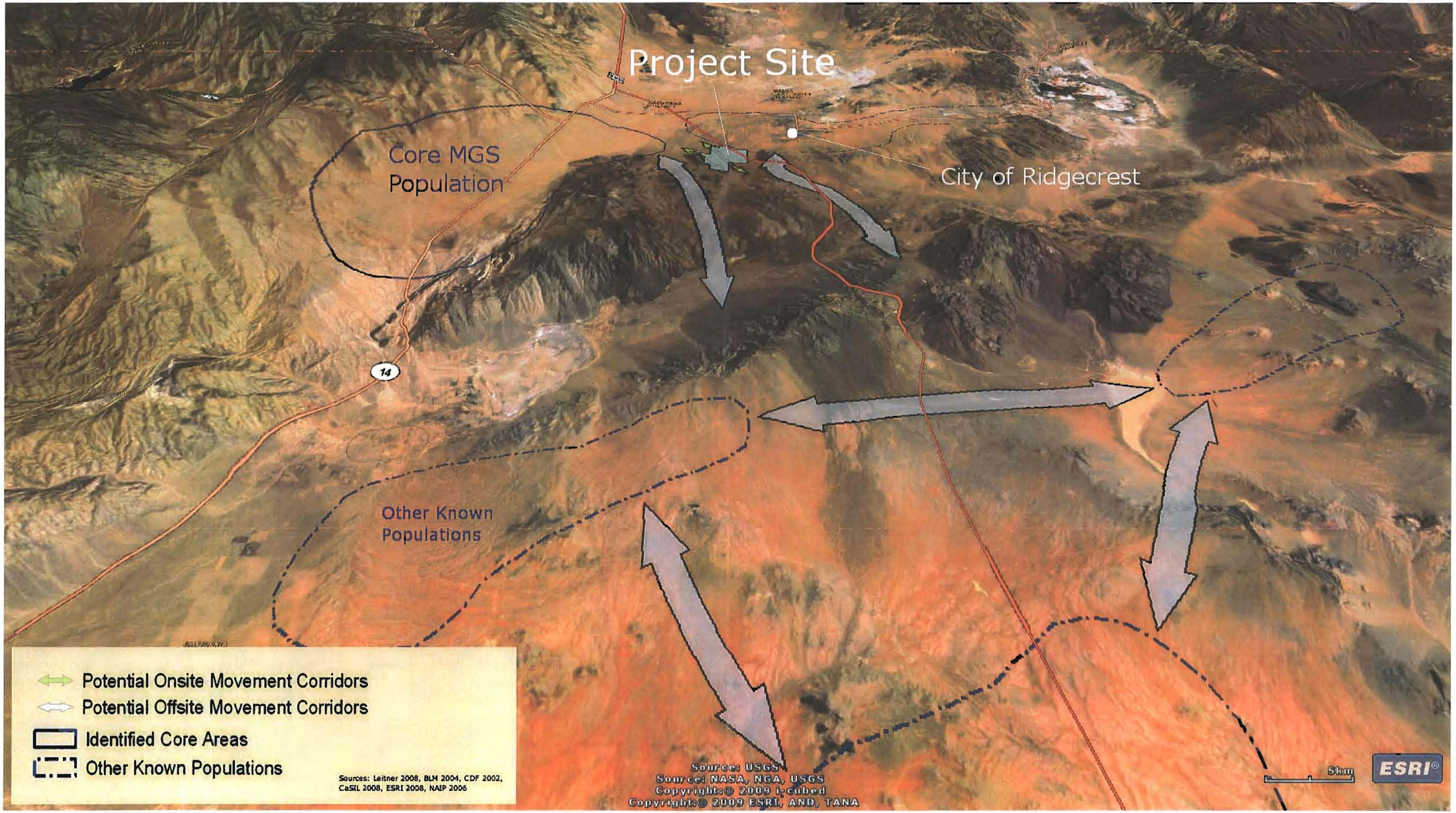
Residential Litter

Proportion of Sign Increased Near Fenced Highway



P=0.018

From Boarman 2009


Project Site
Core MGS Population
City of Ridgecrest
14
Other Known Populations
Potential Onsite Movement Corridors
Potential Offsite Movement Corridors
Identified Core Areas
Other Known Populations
Sources: Leitner 2008, BLM 2004, CDF 2002, CaSIL 2008, ESRI 2008, NAIP 2006
Source: USGS
Source: NASA, NGA, USGS
Copyright:© 2009 i-cubed
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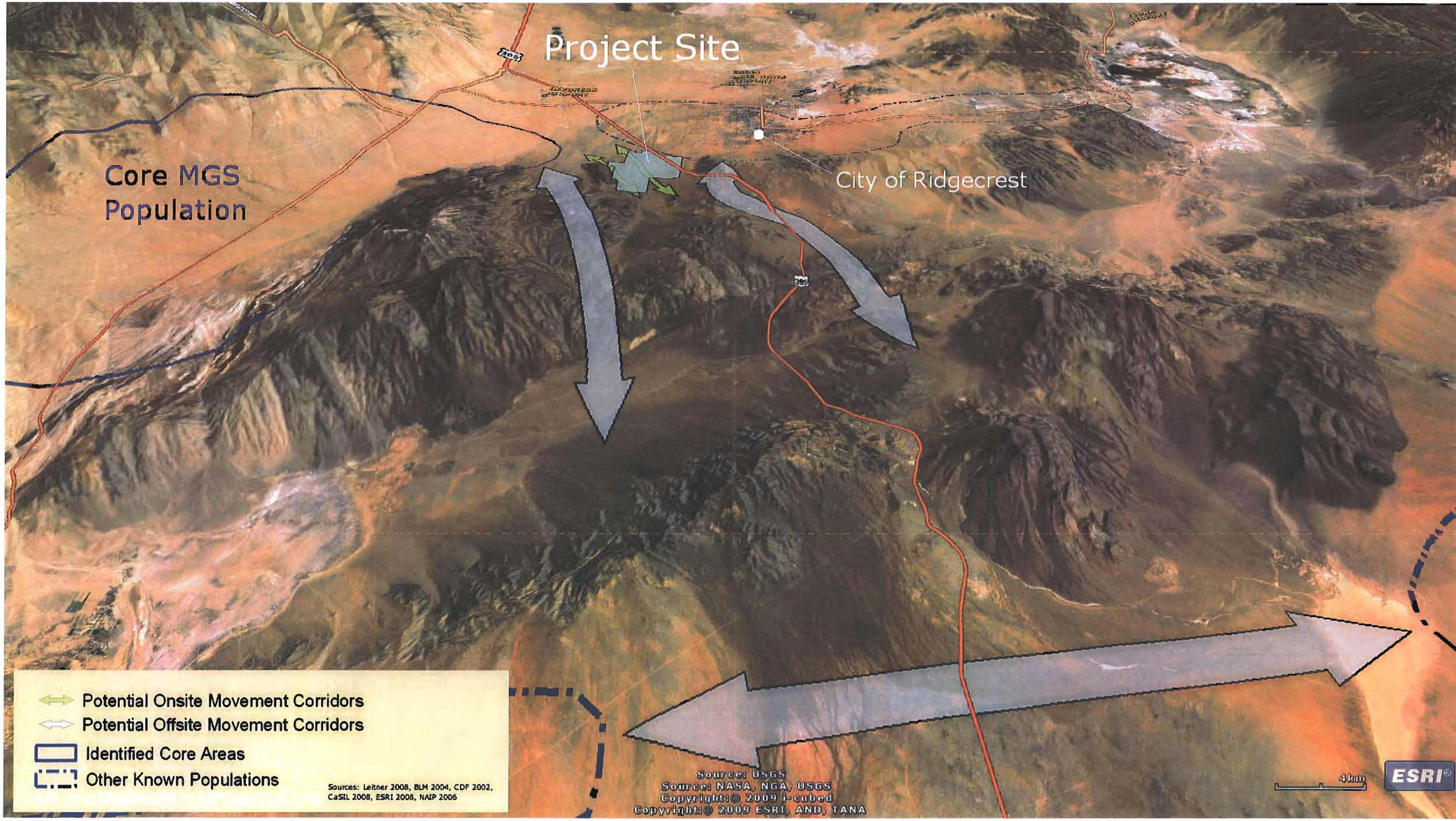
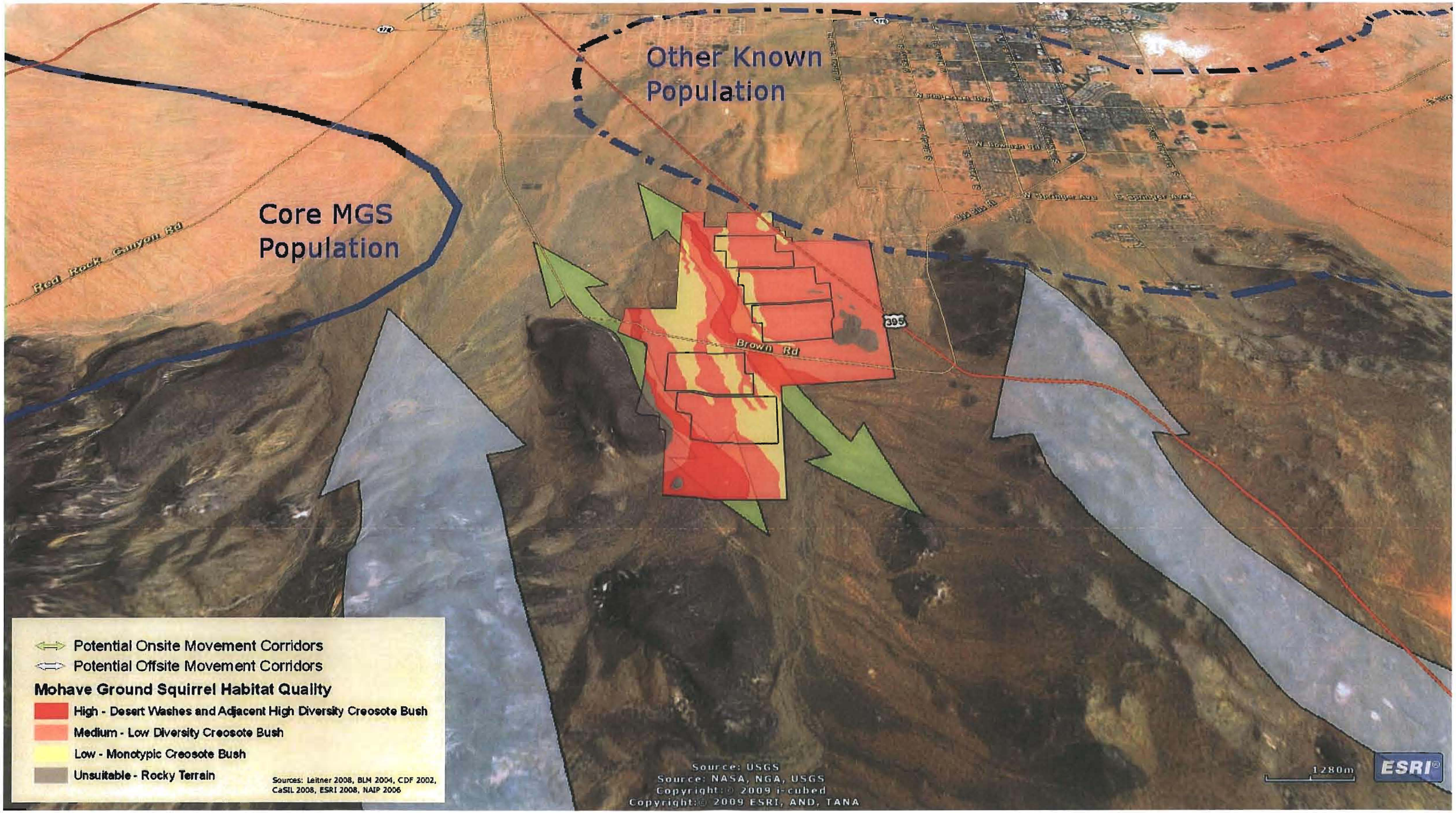
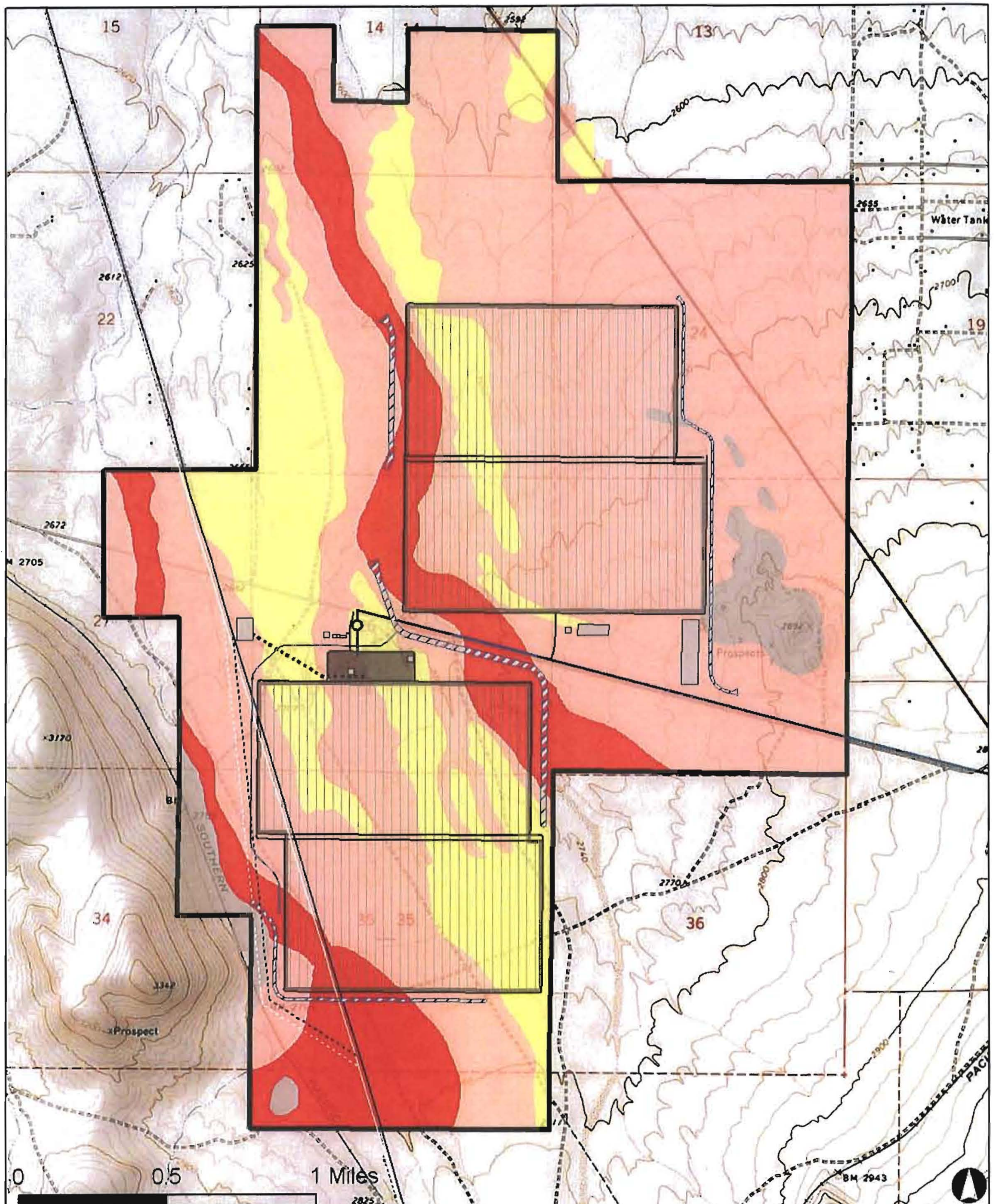
5km
ESRI®

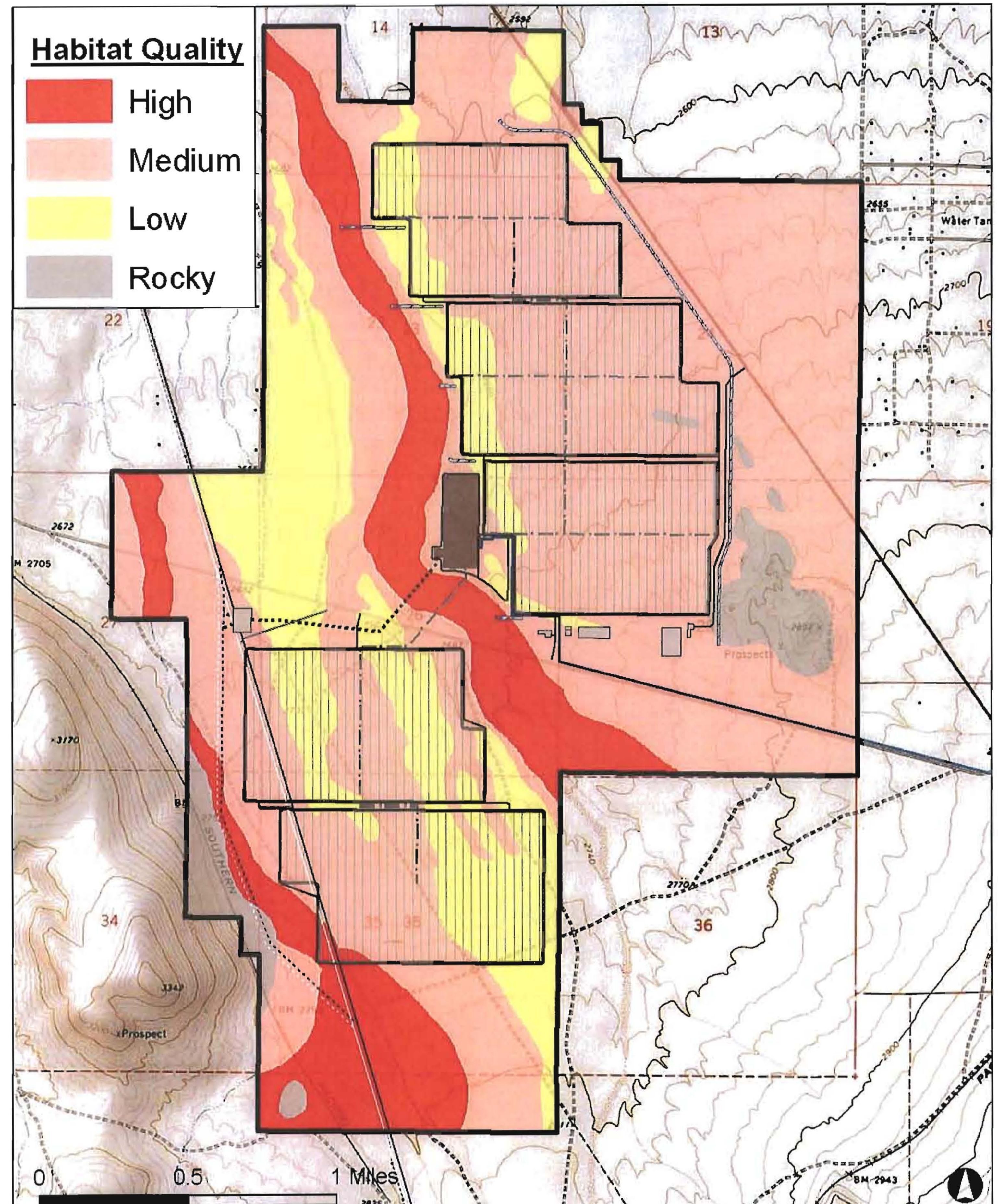

Project Site
Core MGS
Population
City of Ridgecrest
395
Potential Onsite Movement Corridors
Potential Offsite Movement Corridors
Identified Core Areas
Other Known Populations
Sources: Leitner 2008, BLM 2004, CDF 2002, CaSIL 2008, ESRI 2008, NAIP 2006
Source: USGS
Source: NASA, NGA, USGS
Copyright:© 2009 i-cubed
Copyright:© 2009 ESRI, AND, TANA
4km
ESRI

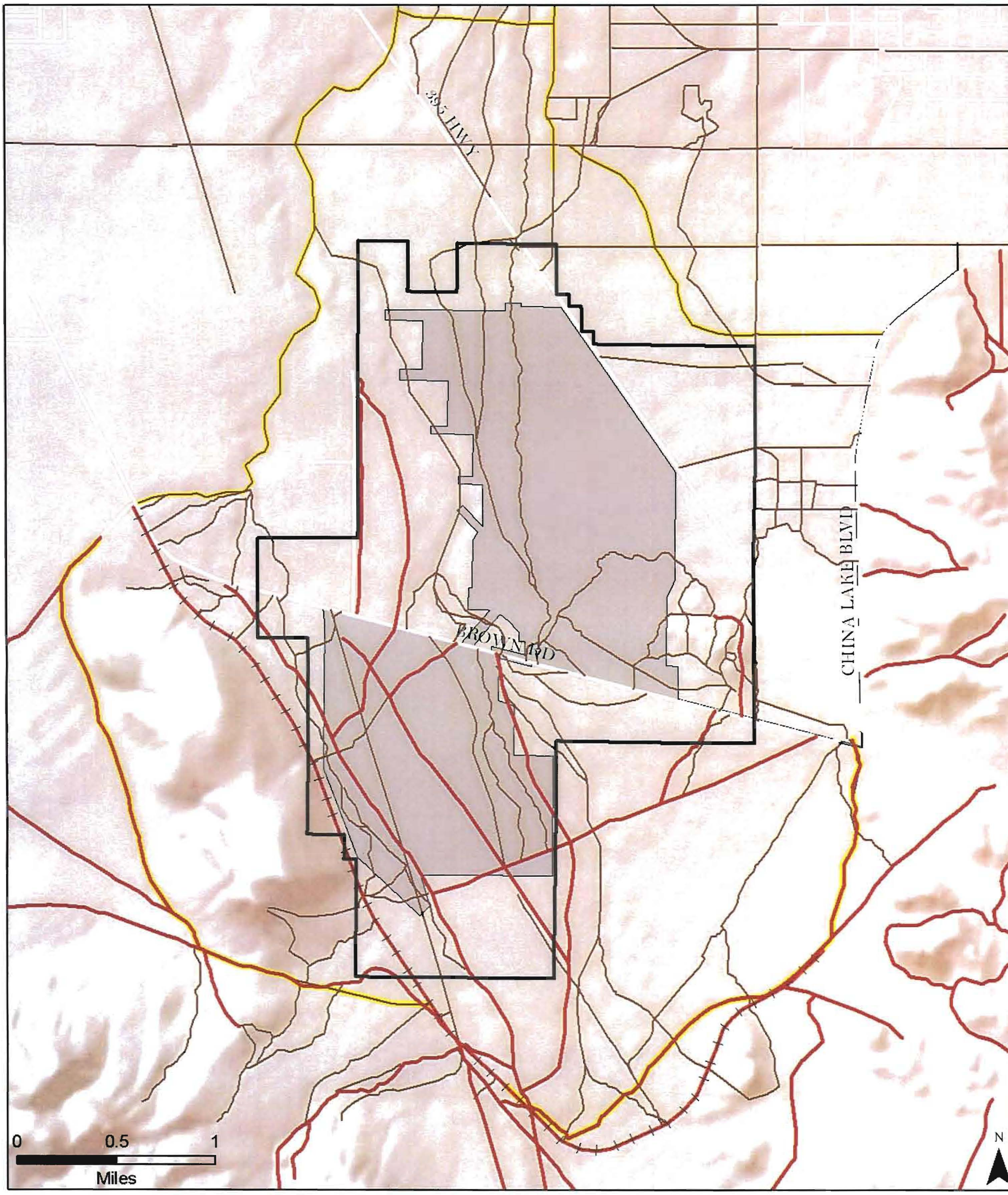

Other Known Population
Core MGS Population
Red Rock Canyon Rd
Brown Rd
395
Potential Onsite Movement Corridors
Potential Offsite Movement Corridors
Mohave Ground Squirrel Habitat Quality
High - Desert Washes and Adjacent High Diversity Creosote Bush
Medium - Low Diversity Creosote Bush
Low - Monotypic Creosote Bush
Unsuitable - Rocky Terrain
Sources: Leitner 2008, BLM 2004, CDF 2002, CaSIL 2008, ESRI 2008, NAIP 2006
Source: USGS
Source: NASA, NGA, USGS
Copyright: © 2009 i-cubed
Copyright: © 2009 ESRI, AND, TANA
1280m
ESRI

Site Layout September 2009



Site Layout February 2010





Project ROW
Disturbance Area
New Proposed Rails-to-Trail Path
Designated Official OHV Trails (per WEMO)
Unofficial OHV Trails
Existing Connection Options

Data Sources: BLM

Figure 5.15-15b – View from KOP-11 BLM Ridgeline (West) of RSPP Site-Simulated Condition