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Desert Tortoise (*Gopherus agassizii*) Translocation throughout the Species Range within Southern Nevada District and Caliente Field Office, Nevada

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1 Introduction

1.1 Identifying Information

1.1.1 Title/EA#/Type of Project: **Desert Tortoise (*Gopherus agassizii*) Translocation throughout the Species Range within Southern Nevada District and Caliente Field Office, Nevada, DOI-BLM-NV-S010-2012-0080-EA, Population Augmentation**

1.1.2 Location: **Southern Nye and Clark Counties within Southern Nevada District BLM and southern Lincoln County within Caliente Field Office BLM, Nevada. See Appendix A.**

1.1.3 Preparing Office and Lead Agency: **Bureau of Land Management, Las Vegas Field Office (Lead Office) in coordination with Pahrump, Red Rock/Sloan, and Caliente Field Offices.**

1.1.4 Introduction

This programmatic environmental assessment evaluates the impacts associated with allowing desert tortoise (Gopherus agassizii) translocation at potential recipient areas within Clark, southern Nye, and southern Lincoln Counties, Nevada. Potential areas are intended to allow for more flexibility and options in addition to the ongoing use of the Large Scale Translocation Site. Translocation includes the moving of tortoises from the Desert Tortoise Conservation Center to areas on the landscape and back into the wild. Translocated tortoises have the potential to play an important role in recovery of the species through population augmentation, monitoring, research, and other recovery actions.

1.1.5 Background Information

The desert tortoise was listed as a federally endangered species under emergency rule in August 1989 (Vol. 54 Federal Register p. 32326) and later listed as threatened in April 1990 (Vol. 55 Federal Register p. 12178). The listing included the Mojave Desert population of desert tortoises west and north of the Colorado River in Utah, Arizona, California, and Nevada. The USFWS developed the Desert Tortoise Recovery Plan and designated critical habitat the same year (USFWS 1994). In 2011, The USFWS released the Revised Recovery Plan for the Mojave Population of the Desert Tortoise *(Gopherus agassizii)*.

Shortly after the Federal listing, Clark County, Nevada in cooperation with (and under the auspices of the USFWS) the cities of Las Vegas, North Las Vegas, Henderson, Boulder City, and Mesquite, the BLM, and NDOW, along with environmental groups and public land users, developed the Short-Term Habitat Conservation Plan (STHCP). This plan initially called for the euthanasia of displaced tortoises that were diseased, injured, or healthy desert tortoises that could not be placed in an adoption program. Shortly thereafter, the Clark County Board of Commissioners passed a resolution on September 17, 1991 directing the County's Implementation and Monitoring Committee to seek other placement efforts in addition to adoption, including translocation and research, to preclude the necessity of euthanasia of healthy desert tortoises. This resulted in the accumulation of hundreds, and later thousands, of desert tortoises at the BLM's Desert Tortoise Conservation Center (DTCC).

The DTCC was originally constructed in 1990 under a settlement agreement between the U. S. Justice Department and the Southern Nevada Homebuilders Association, City of Las Vegas, and State of Nevada to provide a facility to conduct desert tortoise research and hold displaced desert tortoises. The DTCC was operated by Southern Nevada Environmental Inc. (SNEI) until 2008, followed by the Great Basin Institute from 2008 – 2009. In 2009 the San Diego Zoo (SDZ) assumed operations through an agreement with FWS. The SDZ receives, on average, 1,000 tortoises each year from the public in addition to the current occupancy of about 2,700.

In August 1995, Clark County developed the Clark County Desert Conservation Plan (CCDCP) which incorporated many elements from the STHCP while addressing other conservation issues, including the disposition of displaced desert tortoises. Appendix D of the plan analyzed the relative costs associated with holding desert tortoises indefinitely or implementing a translocation program. The analysis estimated that it would cost approximately $10,000,000 over the 30-year life of the plan to hold and care for an expected 21,000 desert tortoises that might be recovered from development activities or turned in by pet owners.

In 1996, Clark County developed an environmental assessment for a translocation and research program on BLM lands (known as LSTS) near Jean, Nevada. The first translocation effort occurred in April 1997 when approximately sixty desert tortoise hatchlings, two juveniles, and eight adults were relocated to the LSTS. The area includes approximately 26,200 acres bordered on the east by I-15, the north by State Route 161, the west by the Spring Mountains, and the south by a proposed fence a few miles north of the Nevada/California state line. The EA covered the translocation of up to 1200 desert tortoises to the site along with research to evaluate the effectiveness of the translocation effort. This original environmental assessment also covered the construction of approximately 7.2 miles of new tortoise fence, installation of seven cattle guards, and the retrofitting of approximately 10 miles of existing fence along the I-15 right-of-way.

A second EA was prepared in 200 which allowed an additional 3,400 desert tortoises to be released in the LSTS over a 36-month period (March 2003 – March 2007). This document was then superseded by a third document, the 2005 Desert Tortoise Translocation EA allowing for increased numbers and duration (up to 30,000 and 30 years) at the LSTS and opportunities for additional translocation sites on the Boulder City Conservation Easement (BCCE) and Desert National Wildlife Refuge (DNWF) with stipulations. In the last 15 years, just over 9,000 tortoises of all age classes and genders have been translocated to the LSTS from the DTCC.

1.2 Purpose and Need for Action

The existing environmental assessment only allows the continuation of desert tortoise translocation on BLM land within the LSTS. Translocation to the BCCE and the DNWF require stipulations that are currently either not completed, not feasible and/or unnecessary due to recent translocation guidance issued from the FWS (Appendix B). Other areas on BLM land were not approved through the 2005 environmental assessment. The BLM proposes to provide opportunities for population augmentation at areas outside the LSTS.

Section 4(f) of the Endangered Species Act requires that recovery plans be prepared for listed species. The recovery plans are a tool for guiding the recovery process and can be used as a road map for species recovery. The 2011 Revised Recovery Plan for the Mojave Population of the Desert Tortoise includes population augmentation as a recovery strategy and recovery action. A programmatic environmental assessment to cover the range of desert tortoise within Southern Nevada District (SND) and Caliente Field Office (CFO) would allow for a streamlined population augmentation implementation process.

1.3 Decision to be Made

The decision to be made is whether to allow desert tortoise population augmentation within Southern Nevada District and Caliente Field Office.

1.4 Conformance with Land Use Plans

The translocation alternatives evaluated in this document are in conformance with the Record of Decision for the BLM's Las Vegas Resource Management Plan (BLM 1998). Though not specifically addressed in the RMP, the alternatives identified in this document are not in conflict or inconsistent with the plan.

> SS-3. Manage desert tortoise habitat to achieve the recovery criteria defined in the Tortoise Recovery Plan and ultimately to achieve delisting of the desert tortoise. When the population in a recovery unit meets the following criteria it may be considered recovered and eligible for delisting (see recovery criteria listed in Recovery Plan).
>
> SS-4. Encourage the obtainment and dissemination of knowledge regarding the Mojave Desert ecosystem including desert tortoise biology.

The proposed action is also in conformance with the following management action from the Ely District Record of Decision and Approved Resource Management Plan (BLM 2008).

> Management Actions – Special Status Species, SS-28: Coordinate with the U.S. Fish and Wildlife Service and Nevada Department of Wildlife to develop approved translocation research projects for desert tortoises (also see Appendix D).

The proposed action also implements recovery action 3 "augment depleted populations through a strategic program" from the Revised Recovery Plan for the Mojave Population of the Desert Tortoise (*Gopherus agassizii*) (USFWS 2011a).

1.5 Lead Agency

The BLM, Las Vegas Field Office is the lead office for the proposed action in coordination with Pahrump, Red Rock/Sloan, and Caliente Field Offices.

1.6 Scoping and Public Involvement and Issues

1.6.1 Internal

BLM Internal scoping was completed from June 18th to August 11th, 2012. The comments are incorporated in Chapter 2 and 3.

1.6.2 External

The BLM will send post cards to interested parties with information and guidance for providing feedback and comments during the 30 day comment period. BLM will also utilize Facebook and Twitter in addition to a news release for notification of the availability of the draft environmental assessment and comment period.

2 Description of Alternatives Analyzed in Detail

2.1 Description of the Proposed Action

Potential recipient areas for desert tortoise translocation are identified using criteria developed by an interdisciplinary team (Chapter 5) and translocation guidance provided by the FWS (USFWS 2011b; USFWS 2011c; USFWS 2012 in Appendix B). Appendix A, Figure 1 describes a large-scale overview of potential translocation area and additional information (Figure 2-9) that will be used to narrow to site-specific locations. BLM does not assume special designations at locations determined eligible for population augmentation. Additionally, recipient areas are not expected to experience restriction or deviation from current multiple use management activities as a result of tortoise translocation. Population augmentation activities can occur under this programmatic environmental assessment for 10 years or until the existing condition has significantly differed from the analysis and does not represent the existing environment.

Areas to be Considered:

Potentially available recipient areas for desert tortoise translocation (all maps are in Appendix A):

1. Generally below 5,500 feet elevation and the recipient site supports desert tortoise habitat suitable for all life stages. (Figure 1)
2. Suitable habitat within 175 km of the Desert Tortoise Conservation Center, as determined by the "Guidance to Apply to an Environmental Assessment for Translocation of Mojave Desert Tortoise" (Figure 1; USFWS 2012 located in Appendix B)
3. Habitat quality supported by the U.S. Geological Survey desert tortoise habitat model (USGS 2009), when appropriate, typically category 0.6 to 1 (Figure 5).
4. Areas at least 4 miles (6.5 kilometers) from an unfenced (desert tortoise exclusion fence) major paved road that experiences high use (i.e. interstates and state highways)(Figure 6).
5. Preference will be given to areas with additional management prescriptions or designations for the protection of the species and/or where desert tortoise populations have been depleted or extirpated yet still support suitable habitat (Figure 4).
6. Further site-specific evaluations will be completed and translocation will follow FWS guidance for translocation (USFWS 2011 multiple documents) and additional guidance for health assessments (USFWS 2012, Appendix B) or subsequent documents.

Areas that will be avoided include:

- Land within Southern Nevada Public Land Management Act (SNPLMA) and Resource Management Plan (RMP) disposal boundaries (Figure 7)

- Major recreation areas (i.e. frequent race course areas, designated open areas, or casual use areas experiencing high activity levels) (Figure 8),
- Existing or anticipated large scale site-type right-of-way (ROW) areas (Figure 7),
- Solar Energy Zones(SEZ) (Figure 7),
- Active mineral sites including areas with mining plans, notices, community pits, and free use permits (Figure 9), and
- dry lake beds

*Flexibility is required for allowing and incorporating on-the-ground evaluation results (physical barriers to movement, habitat quality, access etc.). Additionally, criteria adjustments may be necessary to allow for adaptive management as identified through effectiveness monitoring.

2.1.1 On-the-Ground Process

Surveys, site and resident population assessments may be completed under the authority of the ESA Section 10(a)(1)(A) Recovery Permit issued by the FWS to the DTRO or through Section 7(a)(1) consultation. Access to recipient areas for evaluations, implementation, or monitoring will be on existing roads, trails, and dry washes (or following other area designation restrictions) potentially followed by cross-country foot travel. New disturbance will be minimal and only required if an artificial burrow is needed. Post translocation monitoring will be adjusted based on site-specific research needs. Monitoring techniques may include mark/recapture surveys methods and/or telemetry, or similar transmitter, utilizing one or more biologists following approved protocols.

2.1.2 Desert Tortoises Available for Translocation

The individuals within the DTCC resident tortoise population and other tortoises surrendered that are determined "translocatable" by FWS guidelines (Appendix B) will potentially be located within the recipient areas. Translocatable tortoises are those that have a high probability of surviving in the wild and a low probability of posing risk to wild populations. These are healthy tortoises and are assumed to be from within 150 km and will be translocated within 175 km of the DTCC. These determinations are further explained in the most recent guidance from the FWS for genetic and disease risk are located in Appendix B.

2.1.3 Adaptive Management Approach to Desert Tortoise Translocation

Due to the complexity of the project, large area, and timeframe, the BLM will be utilizing an adaptive management approach. Adaptive management is a formal, systematic, and flexible approach to learning from the results of management actions, accommodating change, and improving management. It involves synthesizing existing knowledge, exploring alternative actions, and making explicit forecasts about results. Management actions and monitoring programs will be carefully designed to generate reliable feedback. Actions and objectives are then adjusted based on this feedback in order to continue to achieve the desired outcomes. In addition, decisions, actions, and results are carefully documented and communicated to others, so that knowledge gained through translcoation is passed on rather than lost when individuals move or leave the organization.

This adaptive management process is flexible and generally involves four phases: planning, implementation, monitoring, and evaluation. As the BLM obtains new information, we are able to evaluate monitoring data and other resource information to periodically refine and update desired outcomes (goals and objectives), management actions, and allowable uses. This allows for the continual refinement and improvement of management prescriptions and practices.

2.2 No Action Alternative

No new recipient areas would be approved on BLM land, only ongoing translocation to the LSTS would persist. The existing 2005 translocation EA approved the BCCE and DNWF with stipulations needing to be completed before translocation could take place. While the 2005 EA approved translocation of up to 30,000 desert tortoises over the life of the EA, exceeding carrying capacity would continue to be a concern. Holding capacity concerns and increasing costs at the DTCC would persist. The resident tortoise population would not be readily utilized as a recovery tool.

2.3 Alternatives Considered but not Analyzed in Detail

2.3.1 All Areas Included in Alternative A Excluding Wilderness Areas

This alternative was considered in a Minimum Requirement Decision Guide analysis but eliminated from further consideration in the EA. Due to the unknown site-specific habitat quality of non-wilderness, it is likely that some locations within wilderness would be utilized. Site-specific analysis will also determine the number of tortoises to be used for population augmentation. As habitat loss, fragmentation, and development on non-wilderness lands continue, designated wilderness may continue to be optimal locations for translocation of native species reduced in other locations.

3 Affected Environment

3.1 Critical Elements

The following elements of the human environment are subject to requirements specified in statue, regulation, or executive order and must be considered in all BLM environmental assessments. Critical element determined to be affected by the proposed action will be carried forward for further analysis.

Critical Element	**Affected (Y/N)**
Air Quality	N
Areas of Critical Environmental Concern	N
Cultural Resources	N
Farm Lands (prime or unique)	N
Floodplains	N
Native American Religious Concerns	N
Threatened or Endangered Species	Y
Wastes, Hazardous or Solid	N
Water Quality Drinking/Ground	N
Wetlands/Riparian Zones	N
Wild and Scenic Rivers	N
Wilderness	Y

3.2 Action Alternative

3.2.1 Threatened and Endangered Species

Desert Tortoise (Gopherus agassizii)

Desert tortoises occupy a variety of habitats from flats and slopes dominated by creosote scrub at lower elevations to rocky slopes in blackbrush and even juniper woodlands at higher elevations. Within these vegetation types, desert tortoises potentially can survive and reproduce where their basic habitat requirements are met. These requirements include a sufficient amount and quality of forage species; shelter sites for protection from predators and environmental extremes; suitable substrates for burrowing, nesting, and overwintering; various plants for shelter; and adequate area for movement, dispersal, and gene flow. Desert tortoises spend much of their time underground during hibernacula and often use burrows or cover sites even during the active season. The desert tortoise active season in southern Nevada includes the last two weeks of March, April, May, September, and October. These timeframes can be influenced by ambient temperature and rainfall events.

The Mojave Desert is relatively rich in winter annuals, which serve as an important food source for the desert tortoise. Tortoises will also forage on perennial grasses, woody perennials, and cacti as well as non-native species such as red brome and red-stem filaree. Tortoises can also adjust their metabolism to respond to limited forage and water loss, up to a year with no access to free water.

Desert tortoises can occur from below sea level to an elevation of 7,300 feet but typically occupy creosote scrub below 5,500 feet. Throughout most of the Mojave Desert, tortoises occur most commonly on gently sloping terrain with sandy-gravel soils with sparse cover of low-growing shrubs. Soils must be friable enough for digging burrows, but firm enough so that burrows do not collapse.

Density estimates of adult tortoises vary among recovery units and years. Current mean densities within the three recovery units included in the project area are listed in the table below (USFWS 2011a and USFWS 2012 in Appendix B).

Recovery Unit	**Mean RU Density (tortoises/km^2); (tortoises/mile^2)**
Northeastern Mojave	2.8/km^2; 7.4/mi^2
Eastern Mojave	4.2/km^2; 11/mi^2
Colorado Desert	5.3/km^2; 13.9/mi^2

Desert tortoise activities are concentrated in areas known as home ranges. Male home ranges are larger than female home ranges. Home ranges can vary as a result of availability of habitat requirement, reproduction activities, and social interactions (O'Connor et al. 1994). Home range size can be up to 1.5 square miles with occasional distances of up to 7 miles (Berry 1986). During drought years, desert tortoises may travel longer distances to find forage over larger areas, increasing the likelihood of encounters with sources of injury or mortality including humans and other predators.

3.2.2 Wilderness Areas and Wilderness Study Areas

The United States Congress established the National Wilderness Preservation System to assure that an increasing population, accompanied by expanding settlement and growing mechanization, does not occupy and modify all areas within the United States. Wilderness designation is intended to preserve and protect certain lands in their natural state. The Wilderness Act of 1964 and subsequent enabling legislation for specific areas, identifies wilderness uses and prohibited activities. Although wilderness character is a complex idea and is not explicitly defined in the Wilderness Act, wilderness characteristics are commonly described as:

- Untrammeled – area is unhindered and free from modern human control or manipulation.
- Natural – area appears to have been primarily affected by the forces of nature.
- Undeveloped – area is essentially without permanent improvements or human occupation and retains its primeval character.
- Outstanding opportunities for solitude or a primitive and unconfined type of recreation – area provides outstanding opportunities for people to experience solitude or primeval and unrestricted recreation, including the values associated with physical and mental inspiration and challenge.
- Supplemental values – complementary features of scientific, education, scenic or historic values.

The project may have the potential to affect 17 wilderness areas within the BLM Southern Nevada and Ely Districts including: Arrow Canyon Wilderness, Clover Mountains Wilderness, Delamar Mountains Wilderness, Eldorado Wilderness, Ireteba Peaks Wilderness, Jumbo Springs Wilderness, La Madre Mountain Wilderness, Lime Canyon Wilderness, Meadow Valley Range Wilderness, Mormon Mountains Wilderness, Mt. Charleston Wilderness, Muddy Mountains Wilderness, North McCullough Wilderness, Rainbow Mountain Wilderness, South McCullough Wilderness, Spirit Mountain Wilderness, and Wee Thump Joshua Tree Wilderness.

In general, trammeling activities in these wilderness areas may include various measures in the management of wildland fire, treatments of non-native invasive weeds, restoration of habitat with native vegetation, removal of vegetation due to livestock grazing, transplanting of native wildlife species to and from the areas, big and small game wildlife water developments, dams, and installations associated with grazing allotments such as fences, pipelines, and water troughs. These areas appear to be substantially free from the effects of modern civilization. Some changes to the indigenous species composition have occurred including the introduction of non-native species. Some areas continue to receive livestock use within active grazing allotments while others are affected by feral cattle where allotments have been closed. The wilderness areas have few permanent improvements or other evidence of modern human presence or occupation. Installations may include items associated with range developments (e.g., fences, pipelines, water troughs and reservoirs, corrals), big and small game wildlife water developments, dug wells, abandoned mining sites, dams, closed vehicle routes, permanent fixed anchors (i.e., bolt and hanger), graffiti, and aircraft crash sites. From jagged peaks and ridges, rugged escarpments, and narrowly carved canyons to open gently sloping bajadas and hidden valleys, the wilderness areas provide outstanding recreation both in the type and diversity of activities possible. In these areas visitors have the chance to experience hiking, backpacking, hunting, canyoneering, horseback riding, rock climbing, photography, wildlife viewing, and nature study. The few restrictions that may apply include those addressing length of stay, campfires, camping, group size, fees, permits, human waste, stock use, cross-country travel, collection of vegetation, technical rock climbing, rockhounding, geocaching, and dogs. Some additional features that may be found in these areas include unique geologic formations, paleontological resources such as dinosaur trackways, historic and prehistoric archaeological resources such as Civilian Conservation Corps era installations and petroglyphs, and threatened sensitive and endangered plant and animal species such as the Las Vegas bearpoppy and desert tortoise.

4 Environmental Effects

4.1 Action Alternative

4.1.1 Threatened and Endangered Species

4.1.1.1 Desert Tortoise (Gopherus agassizii)

Species translocations or releases have been utilized to establish, reintroduce, or augment populations with varying levels of success. Potential negative impacts to the resident and translocated tortoises, as a result of translocation, are expected to be substantially decreased by following FWS guidelines and approved protocols (USFWS 2009; USFWS 2011a; USFWS 2011b; USFWS 2011c; USFWS 2012).

Unpredictable movement patterns are likely from all translocated animals. Translocation studies have shown that straight-line movement distances of desert tortoises following release can be over 3.73 miles in the first year for some desert tortoises (Berry 1986, Field et al. 2007, Nussear 2004). Dispersal movements away from the release site was the greatest during the first 2 weeks after translocation, then decreased according to a study in the LSTS (Field et al 2007). However, Field et al. (2007) and Nussear (2004) showed translocated desert tortoises appear to reduce movement distances following their first post-translocation hibernation to a level that is not significantly different from resident populations. Increase movement distances result in increased time above ground and opportunities for predation. Potential recipient areas will be more than 4 miles from major mortality hazards like unfenced roads and other condensed development, unless natural of artificial barriers block movement. Tortoise placement restrictions, similar to protective distances, will reduce the direct impacts to individual tortoises.

Studies have documented various sources of mortality for translocated individuals, including predation, exposure, fire, disease, crushing by cattle, and flooding (Nussear 2004, Field et al. 2007, Berry 1986, U.S. Army 2009, 2010). Because of the post-translocation movements exhibited by desert tortoises, some potential also exists for desert tortoises to die on roads during the period when translocated individuals are seeking new home range locations. The majority of tortoise mortality is expected to occur in the first year. After the first year, the individuals in the translocated population are likely to settle into new home ranges and mortality is likely to decrease. After settling occurs, the translocated tortoises will have an opportunity to thrive in the wild.

Translocating desert tortoises may also adversely affect resident desert tortoises within the project area due to local increases in population density. Increased densities may result in an increased inter-specific encounters, spread of upper respiratory tract disease or other diseases, an increased incidence of aggressive interactions between individuals, and an increased incidence of predation that may not have occurred in the absence of translocation. FWS guidance limits the number of tortoises that can be translocated based on the population densities for the recovery unit, decreasing the impacts from over population. Additionally, density-dependent effects on resident populations are likely to be minor because desert tortoises will be released in a dispersed pattern. Finally, only tortoises determined to be healthy and asymptomatic will be translocated. Tortoise densities have decreased within the recovery units included in the project areas. Population augmentation is a tool for benefitting the species and recovery strategy for delisting.

Because past studies have documented similar levels of mortality between translocated, recipient, and control site populations, it is estimated that a similar proportion of the control and recipient site populations could parish. It is not anticipated that increased mortality will be the direct result of translocation because other factors are likely to be the primary driver of the mortality in the region.

Desert tortoises will eat many species of plants. However, at any time, most of their diet consists of a few species (Nagy and Medica 1986; Jennings 1993; Avery 1998). Their preferences can change during the course of a season (Avery 1998) and over several seasons (Esque 1994 in Avery 1998). Dietary overlap exists between tortoises, other wildlife, cattle, wild horses, and burros. Cattle may browse upon plant species that serve as forage or thermal cover species for desert tortoises (see Appendix C). However, translocation areas will be evaluated prior to release of tortoises, and areas with inadequate vegetation would not be deemed suitable for translocation. Implementing FWS translocation guidance should ensure these potential effects are minimized or avoided.

Translocation and population augmentation can be used as a recovery tool, opportunities for research, and in combination with monitoring of environmental factors over a large landscape. The desert tortoise is a well studied species but additional opportunities to increase our knowledge base as a result of translocation will continue to benefit the species.

4.1.1.2 No Action alternative

No tortoise translocation would occur on BLM lands outside of the LSTS. Positive and negative impacts to threatened and endangered species, the desert tortoise, would not exist from tortoise translocation and associated population augmentation.

4.1.2 Wilderness Areas

4.1.2.1 Proposed Action

Translocation of the desert tortoise would negatively impact the untrammeled character of wilderness by introducing human manipulation into the ecosystem. This short term trammeling would result in beneficial effects in the long term by reestablishing desert tortoise into their native habitat and would correct previous trammeling that has occurred as the tortoise population declined. Previous trammeling on tortoise populations are the result of natural and human-caused activities. The human-caused threats directly and indirectly include expanding development, off-highway vehicles, invasion of non-native grasses and weeds, fire, collection, poachers, sheep and cattle grazing, mining, and drought.

This proposal would not benefit nor impair the undeveloped quality since no developments would be removed or would any be installed. Also, no motorized or mechanized equipment would be utilized within the wilderness boundaries. The only surface disturbing activity potentially occurring within wilderness would be digging burrows with non-mechanized hand tools only. This disturbance would be kept to a minimum by selecting the appropriate release locations and reducing the need to provide an 'artificial' burrow.

Naturalness would be improved by this action by augmenting the existing population of the threatened desert tortoise. This alternative would have minimal impacts on solitude during the translocation and subsequent monitoring of the released individuals. The translocation efforts would typically be completed in one day and involve only a small group of people. No impacts to primitive and unconfined recreation would occur. This alternative would promote the re-establishment of the desert tortoise in its native habitat, thereby improving the ecological component of the wilderness.

In addition to the impacts to wilderness characteristics described above, additional factors were considered to determine the impacts to wilderness values. No impacts to heritage or cultural resources are anticipated. This alternative would marginally support traditional skills as the tortoises are hiked into wilderness. No vehicles or motorized equipment would be used. A shovel or other hand tools may be used to dig the burrows, should they be required. Provisions in each of the enabling legislations (Lincoln County Conservation, Recreation & Development Act (2004) & Clark County Conservation of Public Land and Natural Resources Act of 2002): "…management activities to maintain or restore fish and wildlife populations and the habitats to support such populations may be carried out within wilderness…" The costs for translocation of the tortoises into wilderness would largely be expenses associated with travel to and from the area, and personnel time. This would be only marginally more expensive than translocation of the tortoises outside wilderness, since the animals may need to be hiked in somewhat further than at non-wilderness locations. Equipment costs would be vehicles and hand tools. The duration of the proposed action would be over the next 10+ years. Constraints on timing for tortoise translocation are highly temperature dependent and would likely occur in spring and fall. Tortoises would not be translocated immediately prior to winter to help ensure the tortoises survival. This alternative does not pose significant safety risk to visitors, personnel or contractors. The project will be implemented outside wilderness, and to be implemented in wilderness no additional safety issues are identified. Standard risks associated with hiking and using hand tools apply, but are generally found to be a low risk.

4.1.2.2 No Action

No negative or beneficial impacts to the untrammeled and undeveloped character of the wilderness would occur under the No Action. Not allowing translocation of desert tortoise to its native habitat would not positively impact the naturalness of these areas by restoring this indigenous species. The wilderness areas would not benefit from the conservation of a native species, which is ecologically adapted to the area. Opportunities for seeing this native, federally threatened species would not be improved. The inability to re-establish this threatened species in its native habitat would not improve the ecological component (similarly the natural character) of these wilderness areas.

In addition to the impacts to wilderness characteristics described above, additional factors were considered to determine the impacts to wilderness values. The inability to re-establish this native population would not improve the visitors/ chances of seeing this threatened species, and thereby not improve the recreational experience and visitor's enjoyment of the wilderness resource. No impacts to the scenic, scientific, historical, and educational uses are expected. For Conservation, the Wilderness Act in Section 2 (c) defines wilderness as a place "…where the earth and its community of life are untrammeled by man…" and that is "…protected and managed so as to preserve its natural conditions…" The No Action would not benefit the natural conditions and natural functions through restoration of an endangered species.

4.2 Cumulative Effects

A cumulative impact, as defined by the CEQ, "results from the incremental impact of [an] action when added to other past, present, and reasonably foreseeable future actions, regardless of what agency (federal or nonfederal) or person undertakes such other actions" (40 CFR 1508.7). The cumulative impacts analyses presented in the following sections encompass the direct and indirect impacts potential impacting factors for activities associated with reasonably foreseeable future actions.

4.2.1 Threatened and Endangered Species

The Federal Land Policy and Management Act of 1976 (FLPMA) (43 U.S.C. 1701) Sec. 102 states that it is the policy of the United States that the public lands be retained in Federal ownership, unless as a result of land use planning procedure, it is determined that disposal of a particular parcel will serve the national interest. In addition, FLPMA establishes procedures for acquisition of non-Federal land for public purposes, the exchange of lands, and withdrawals of uses on the lands. Acquisitions, exchanges, disposals, and withdrawals are determined through land use planning and legislative acts. The Las Vegas RMP and preceding land use plans outlined areas where these activities could occur within the project area. The Southern Nevada Public Lands Management Act of 1998, as amended (SNPLMA; Public Law 105-263), and other legislative acts passed since the RMP was signed modified these boundaries legislatively. SNPLMA in conjunction with the RMP, identified an area surrounding Las Vegas totaling 74,000 acres for land disposal. Methods of land disposal include competitive auctions, direct sales, sales through Recreation and Public Purpose Act (R&PP), reservations and land exchanges.

BLM proposes to continue to dispose of lands as outlined in the 1998 RMP. As of June 2004, there were 46,701 acres of public land available for disposal within the boundary designated by SNPLMA and expanded by the Clark County Act. In 2008, approximately 26,000 acres remain unallocated. The annual average rate of land sales that have occurred from 1998 to 2008 with the enactment of SNPLMA have been 4,000 acres per year. Due to recent downturns in the economy, current averages are expected to be less. Using the previous rate, the remaining land within the Las Vegas disposal boundary area would be disposed by 2015. However, the BLM does not impose a limit on the amount of lands available for auction annually; the amount is based on the demand by the local governments to include parcels in the nomination process. Outside the Las Vegas Valley, approximately 113,500 acres of public land is available for disposal.

As the development of the Las Vegas Valley continues, so does the cumulative loss of desert tortoise habitat. Continued infrastructure construction creates physical barriers to tortoise movements and gene dispersal. Desert tortoise habitat would continue to be fragmented, reduced in quality, and quantity. Impacts of land sale/conveyance on the desert tortoise Mojave population were analyzed under the Las Vegas Valley Programmatic Biological Opinion (1-5-96-F-023R.3 as amended). That biological opinion determined that the loss of approximately 125,000 acres of desert tortoise habitat in the Las Vegas Valley would not jeopardize the continued existence of the species. No critical habitat for the species will be affected. Cumulative impacts of population augmentation on BLM land include the implementation of recovery actions that can lead toward species delisting. Successful population augmentation will result in healthier populations and populations that are better suited to respond to future human cause impacts to the land. Population augmentation can be used as a tool to offset human caused physical barriers to tortoise movements and gene dispersal.

4.2.2 Wilderness Areas

Past Actions

Wilderness Management Plans have been completed for Muddy Mountains Wilderness, Clover Mountains Wilderness, Delamar Mountains Wilderness, Meadow Valley Range Wilderness, Mormon Mountains Wilderness, North McCullough Wilderness, South McCullough Wilderness, and Wee Thump Joshua Tree Wilderness. Activities within these wilderness areas have included implementing actions such as restoration of closed vehicle routes to a natural state, completing trailhead parking areas, installing signs and informational kiosks, construction of hiking trails, removal of developments, removal of non-native invasive plan species, planting and seeding with native plants, and acoustic monitoring. Installation of wildlife water developments occurred over the past 30 years with inspection occurring annually and maintenance occurring as needed. Emergency actions have included water hauls via helicopter to the Poppy wildlife water development. The NDOW has conducted gathers of bighorn sheep to other areas, including the Delamar Mountains Wilderness in December 2007. Commercial services have been authorized in Rainbow Mountain Wilderness and La Madre Mountain Wilderness.

Present Actions

WMP and EA for Arrow Canyon Wilderness and another for Rainbow Mountain Wilderness and La Madre Mountain Wilderness is in progress and anticipated to be signed in 2013. An Environmental Impact Statement is being prepared for 8 wilderness areas that are administered in part by the National Park Service, Lake Mead National Recreation Area and BLM; this document is anticipated to be approved in 2013. Planning documents address actions such as designed trails, restoration of closed vehicle routes to a natural state, signing and staging areas, removal of developments, treatments of non-native invasive species, geologic sampling, graffiti removal, and climbing bolt replacement. Actions to implement existing WMPs are currently being implemented. An emergency Stabilization & Restoration project is planned for winter 2012. The upgrade to the Poppy wildlife water development in North

McCullough Wilderness has been authorized and will be implemented in early 2013. The NDOW will be conducting inspection, maintenance, and repairs on wildlife water developments within 6 wilderness areas.

Reasonably Foreseeable Future Actions

Implementation of actions determined in the WMPs would occur, including future wildlife fire management activities, and when necessary Emergency Stabilization & Rehabilitation projects. Hazardous fuels reductions of non-native invasive weeds and restoration with native plant species is proposed for Arrow Canyon Wilderness. The Red Rock/Sloan Field Office is undergoing a process to amend the Resource Management Plan to consider policy to allow new bolting for climbing routes in Rainbow Mountain Wilderness and La Madre Mountain Wilderness. Bighorn sheep gathers have been requested by NDOW beginning fall 2012. The WMPs for Mt. Charleston Wilderness, and comprehensive plan for Lime Canyon Wilderness and Jumbo Springs Wilderness is anticipated for completion in winter 2013.

5 Tribes, Individuals, Organizations, or Agencies Consulted

5.1 Interdisciplinary team

The following agencies were represented at the interdisciplinary team meetings:

Bureau of Land Management
- Las Vegas Field Office
- Caliente Field Office
- Nevada State Office

U.S. Fish and Wildlife Service
- Desert Tortoise Recovery Office
- Nevada Ecological Services
- Desert National Wildlife Refuge

U.S. Geological Survey (Pacific Southwest Area)

Nevada Department of Wildlife

San Diego Zoo Global

6 List of Preparers

Jessie Stegmeier, Wildlife Biologist
Lisa Christianson, Air Resource Specialist
Sendi Kalcic, Wilderness Specialist
Susan Rowe, Archeologist
John Evans, Planning and Environmental Coordinator
Krystal Johnson, Wild Horse and Burro Specialist
Boris Poff, Hydrologist
Greg Marfil, Fuels Specialist
Dave Fanning, Geologist
George Varhalmi, Geologist
Billy Williams, Range Technician (weeds)
Dorothy Jean Dickey, Reality Specialist
Katie Kleinick, Resource Specialist
Fred Edwards, Botanist, Range and Forestry Lead
Brenda Warner, Recreation Specialist
Marilyn Peterson, Recreation Specialist
Karri-Ann Thorpe, Reality Specialist
Brenda Wilhight, Reality Specialist
Mark Slaughter, Supervisory Resource Specialist
Alicia Styles, Wildlife Biologist
Thomas (Travis) Young, Planning and Environmental Coordinator
Nicholas Pay, Archaeologist
Elvis Wall, Native American Coordinator
Clinton Wertz, Assistant Field Manager
Mark D'Aversa, Hydrologist
Kyle Teel, Fuels and Forestry
Alan Kunze, Geologist
Cameron Boyce, Range Specialist
Ty Chamberlin, Reality Specialist
Elizabeth Domina, Recreation Specialist
Emily Simpson, Wilderness Specialist

7 Best Management Practices

- Follow FWS DTRO guidance for survey protocols, handling, and monitoring techniques
- Follow posted speed limits (25 mph in Clark County) and other motor vehicle restrictions as appropriate
- Vehicle access will be limited to designated routes, roads, trails, or dry washes (dependent on location and Special designation)
- Check under vehicles for tortoises before moving
- Follow fire restrictions (general occur any time between May15th and October 1st).
- Follow best management practices to reduce/eliminate the spread of invasive weeds
- Coordinate with agencies for data exchange of baseline surveys, tortoise gps locations, research topics and papers, etc.

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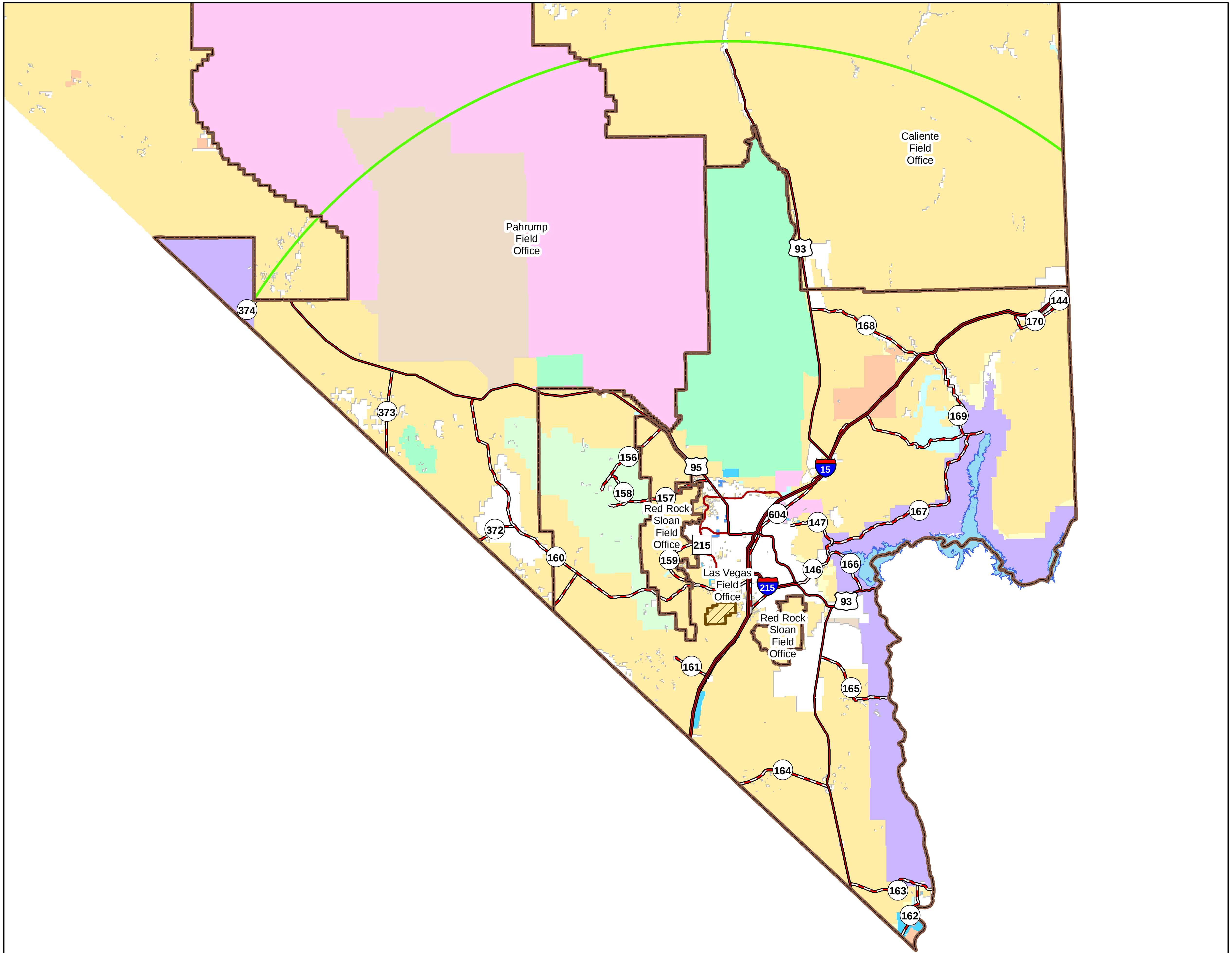
9 Appendix A: Maps

Figure 1
Project Overview



Legend

- Desert Tortoise Conservation Center Management Area
- BLM Field Office Boundary
- 175km DTCC buffer

Land Status

- Bureau of Indian Affairs
- Bureau of Land Management
- Bureau of Reclamation
- City of Las Vegas
- Clark County, NV
- Department of Defense
- Department of Energy
- Fish and Wildlife Service
- Forest Service
- National Park Service
- Nevada State
- Private

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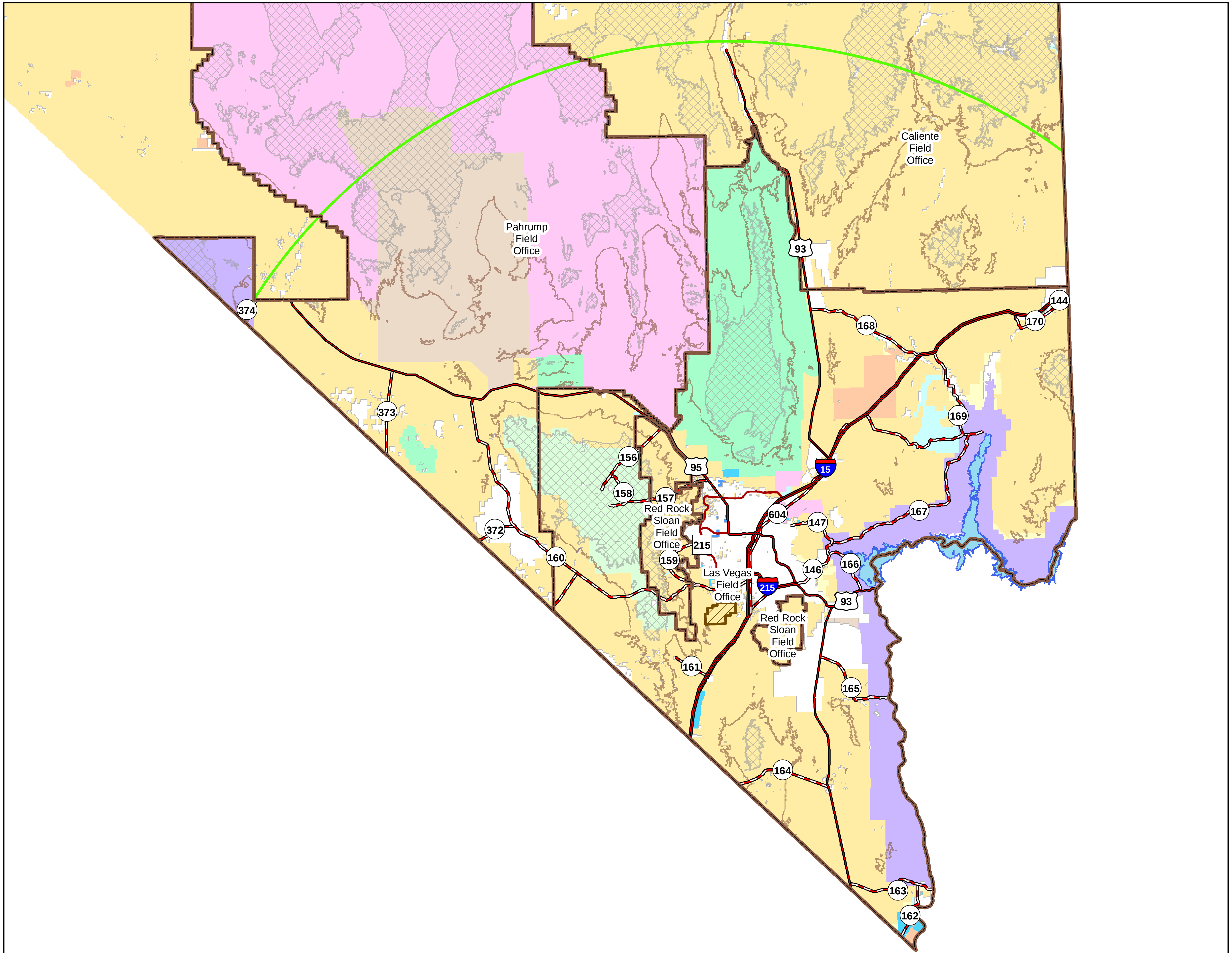
Figure 2
Elevation Considerations



Legend

- Desert Tortoise Conservation Center Management Area
- BLM Field Office Boundary
- 175km DTCC buffer

Elevation

- Greater than 5500 feet
- 4200 feet

Land Status

- Bureau of Indian Affairs
- Bureau of Land Management
- Bureau of Reclamation
- City of Las Vegas
- Clark County, NV
- Department of Defense
- Department of Energy
- Fish and Wildlife Service
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Figure 3
Wilderness and WSA

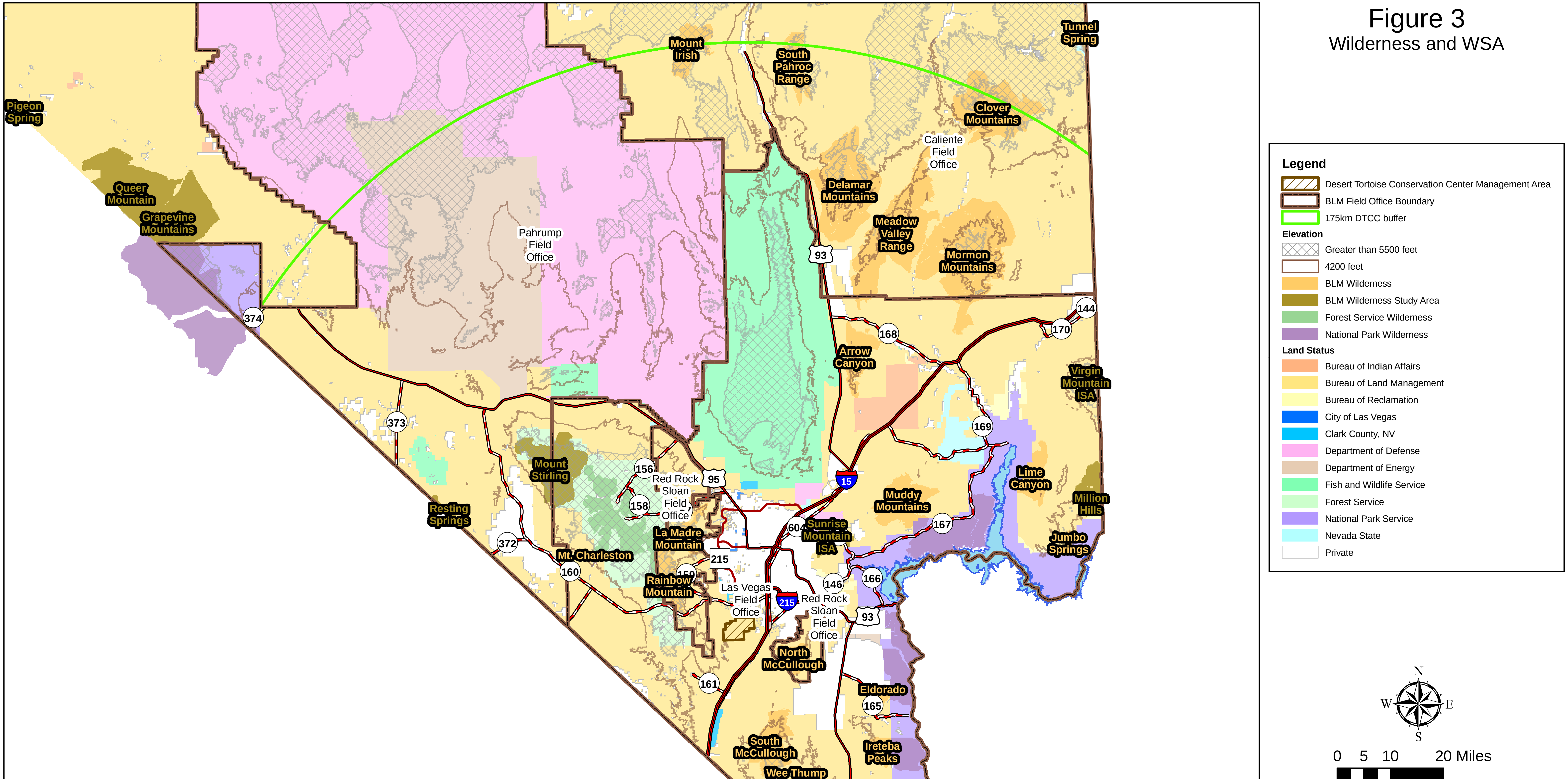

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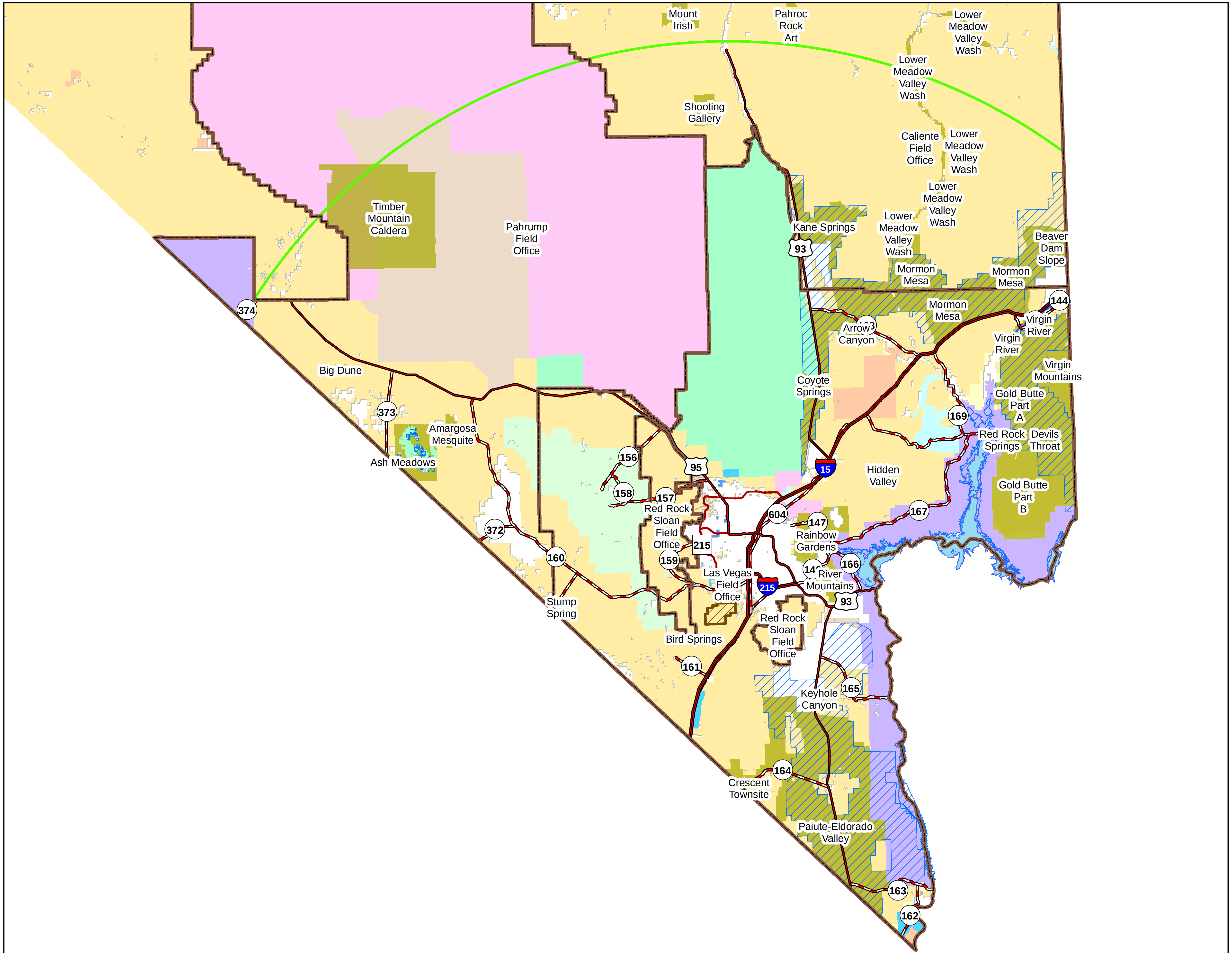
Figure 4
ACEC and Critical Habitat



Legend

- Desert Tortoise Conservation Center Management Area
- BLM Field Office Boundary
- 175km DTCC buffer
- Desert Tortoise Critical Habitat
- ACEC

Land Status

- Bureau of Indian Affairs
- Bureau of Land Management
- Bureau of Reclamation
- City of Las Vegas
- Clark County, NV
- Department of Defense
- Department of Energy
- Fish and Wildlife Service
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- Nevada State
- Private

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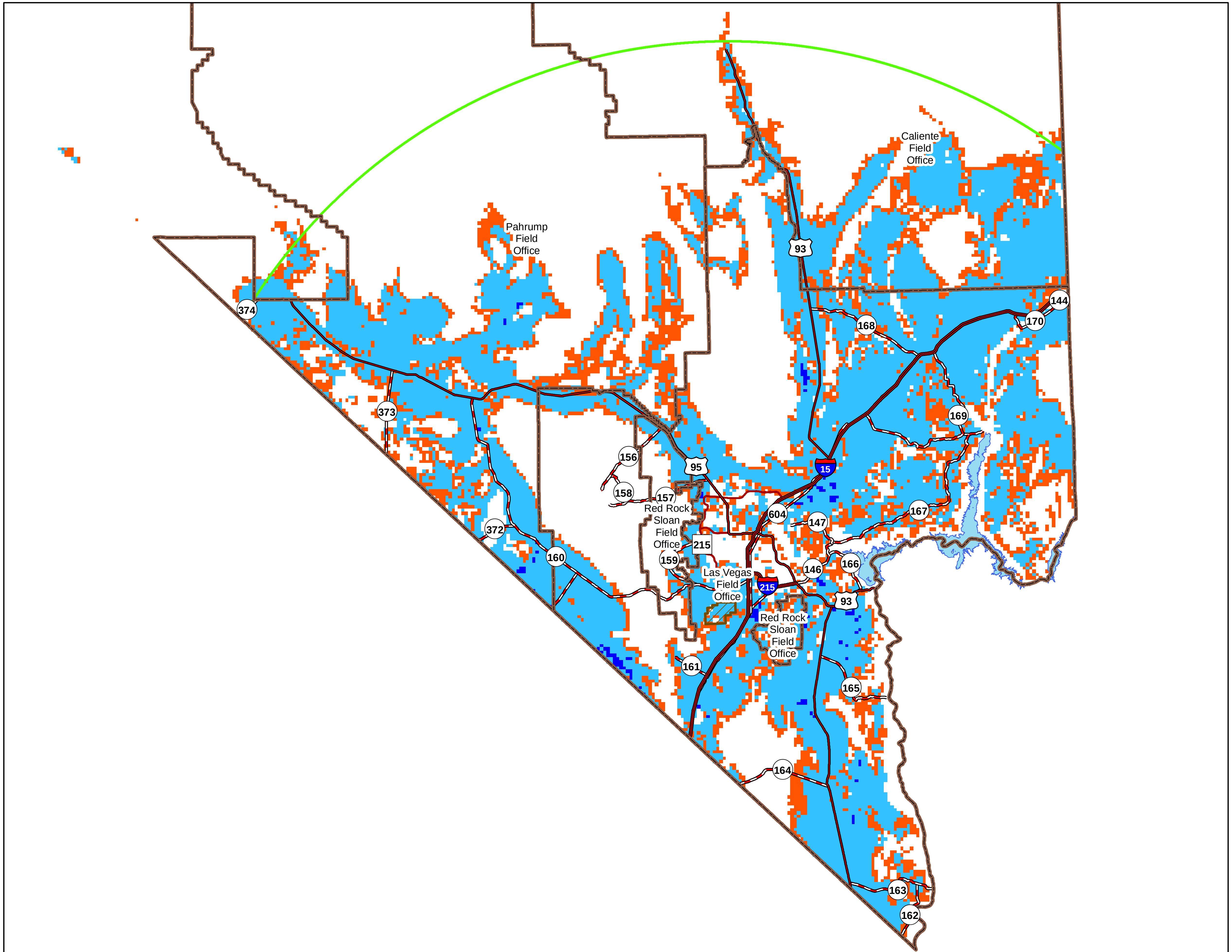
Figure 5
USGS Desert Tortoise Habitat Model



Legend

- Desert Tortoise Conservation Center Management Area
- BLM Field Office Boundary
- 175km DTCC buffer

USGS Tortoise Model

- 0 - 0.6
- 0.6 - 0.7
- 0.7 - 0.8
- 0.8 - 0.9
- 0.9 - 1

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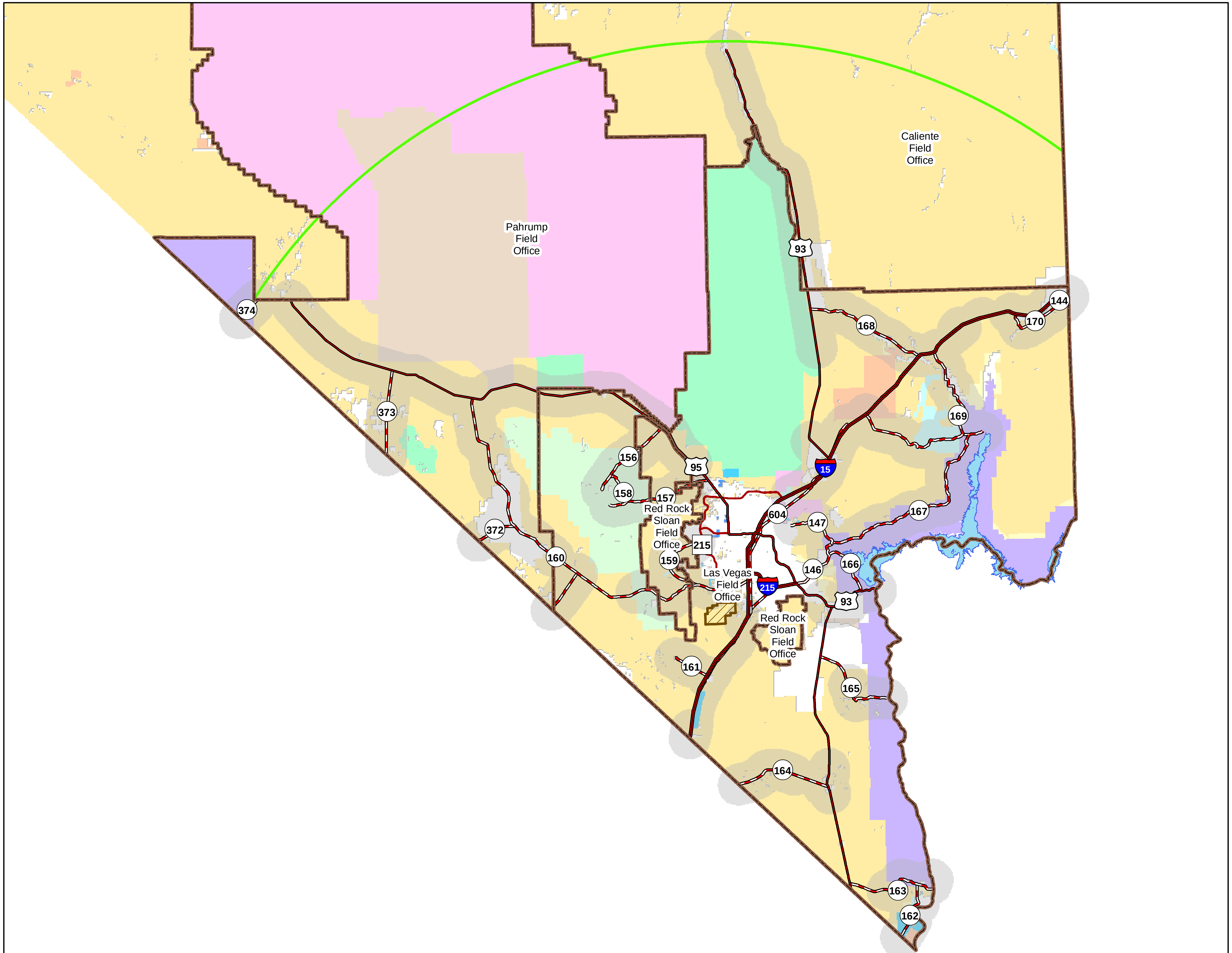
Figure 6
Avoidance Area: Unfenced Road



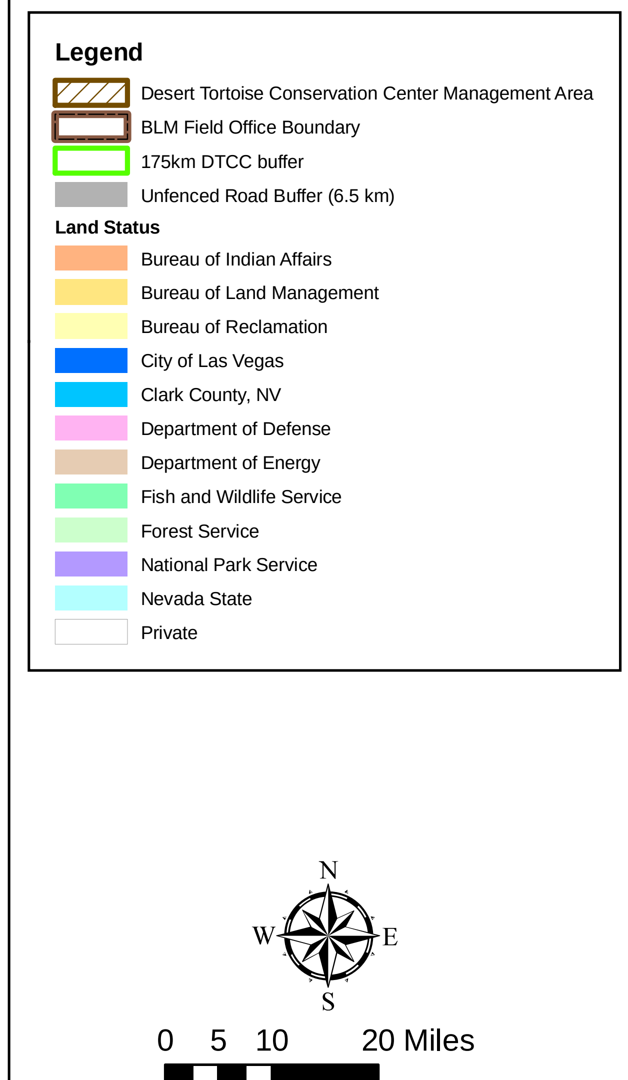
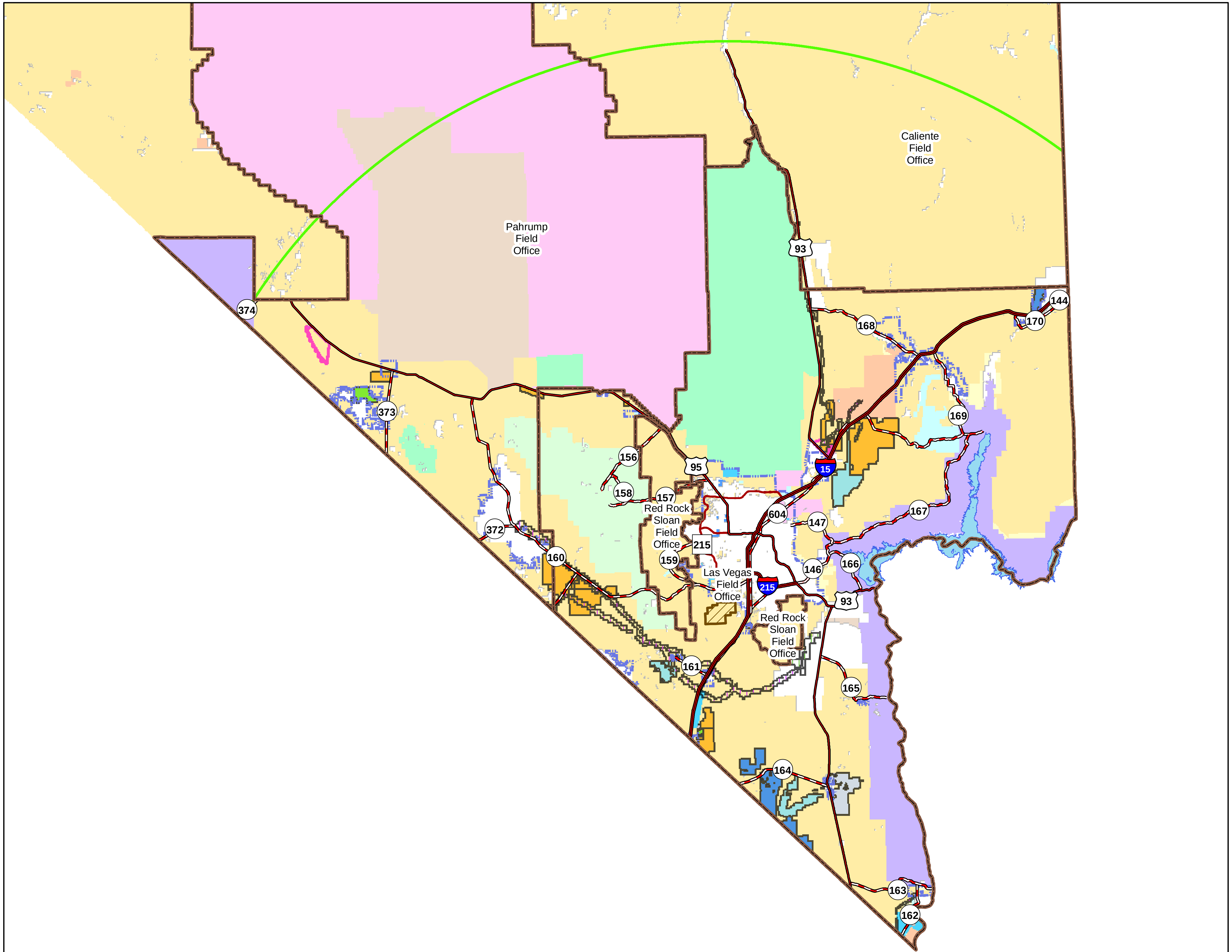


Figure 7
Avoidance Area: Development



Legend

- Desert Tortoise Conservation Center Management Area
- BLM Field Office Boundary
- 175km DTCC buffer
- SNDO Disposal Boundary

SNDO RECO Project

- ROW - OG Pipeline, Pending
- ROW - Power Transmission - FLPMA, Authorized
- ROW - Power Transmission - FLPMA, Pending
- ROW - Solar Development Facility, Authorized
- ROW - Solar Development Facility, Pending
- ROW - Wind Development Facility, Pending
- ROW - Wind Project Test, Authorized
- ROW - Wind Project Test, Pending
- Withdrawal - BLM - Miscellaneous, Pending

Land Status

- Bureau of Indian Affairs
- Bureau of Land Management
- Bureau of Reclamation
- City of Las Vegas
- Clark County, NV
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Figure 8
Off-Road Racing

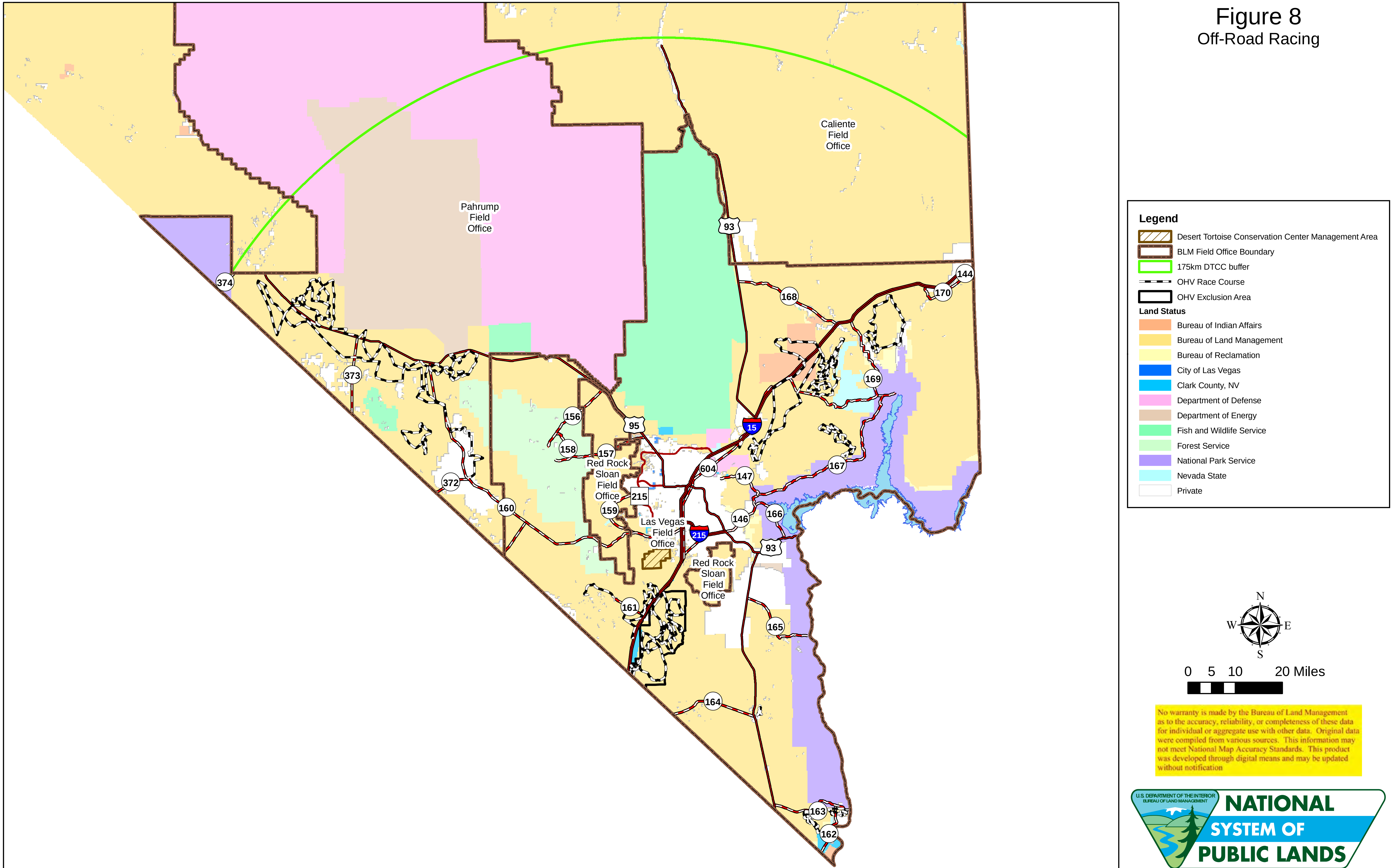

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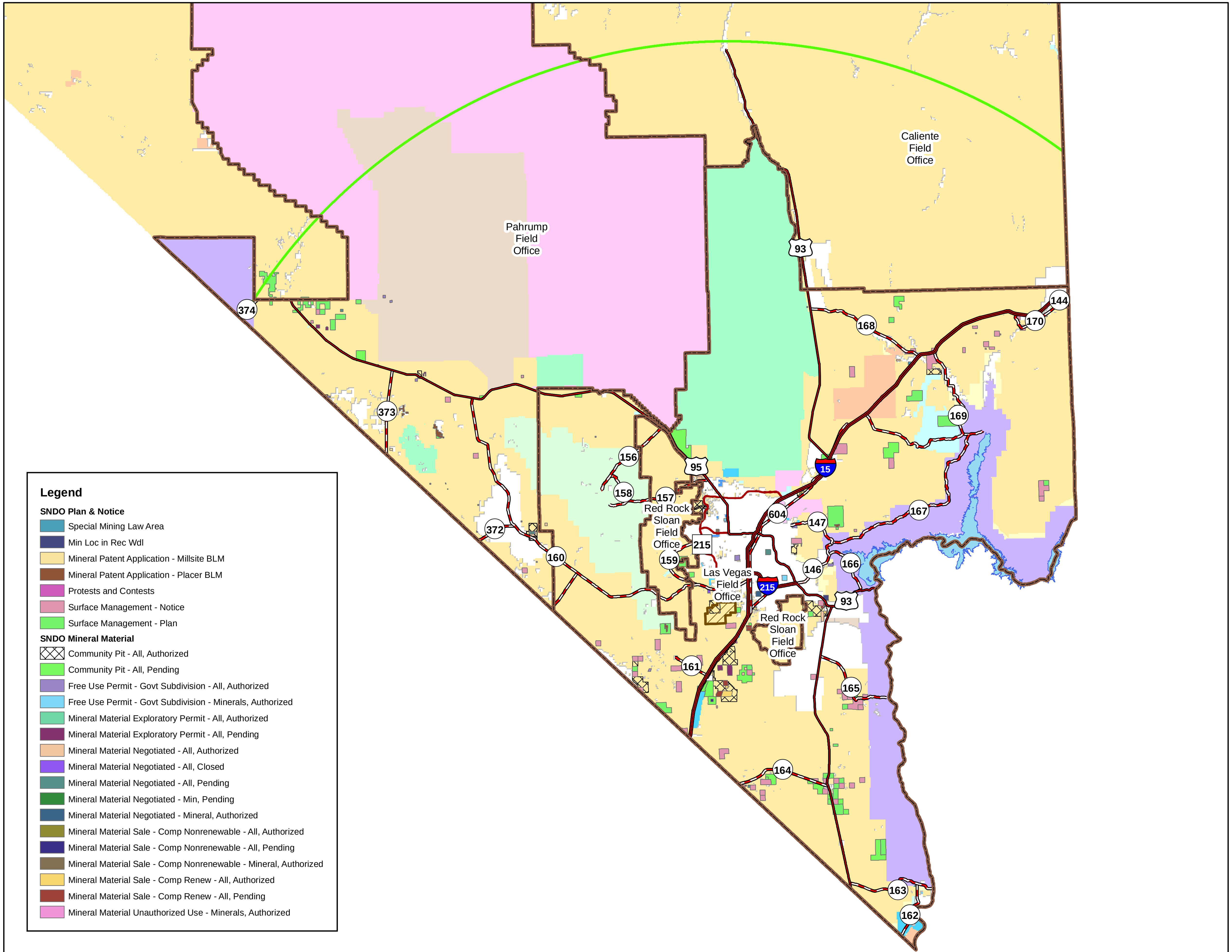
Figure 9

Avoidance Area: Mineral Development



Legend

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10 Appendix B: U.S. Fish and Wildlife Service, Desert Tortoise Recovery Office Guidance

handcarried 6/21/12 Rcvd.

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Nevada Fish and Wildlife Office
1340 Financial Blvd., Suite 234
Reno, Nevada 89502
Ph: (775) 861-6300 ~ Fax: (775) 861-6301

June 20, 2012

Memorandum

To: Raul Morales, Deputy State Director, Bureau of Land Management, Reno, Nevada

From: State Supervisor, Nevada Fish and Wildlife Office, Reno, Nevada

Subject: Guidance to Apply to an Environmental Assessment for Translocation of Mojave Desert Tortoises

This memo transmits guidance on various factors related to translocation for incorporation into the Environmental Assessment in development by the Bureau's Las Vegas Field Office. Specifically outlined below is guidance on addressing 1) genetic issues, 2) health and disease issues, 3) criteria for translocation sites, 4) pre-release survey needs, and 5) post-translocation monitoring. This memo generally is consistent with existing Service guidance on translocation of Mojave desert tortoises from project sites (most commonly applied to renewable energy development projects), but where deviations occur, this memo supersedes or otherwise clarifies prior guidance for reasons described herein.

Genetics of Translocated Tortoises

The Desert Tortoise Recovery Office (DTRO) completed an evaluation on minimizing genetic risks from translocating desert tortoises from the Desert Tortoise Conservation Center (DTCC). The technical paper was reviewed by three independent geneticists (noted in the paper's acknowledgements) and is attached. In summary, the assessment concluded that tortoises may be translocated from the DTCC to locations at distances up to 175 km without individual genetic screening. This guideline would ensure that the vast majority of tortoises would be moved within an equivalent genetic unit (with most moved much shorter distances from their actual population of origin). In addition, the risk of causing outbreeding depression by translocating Mojave desert tortoises is low.

Health and Disease of Translocated Tortoises
The previous Desert Tortoise Translocation Environmental Assessment (NV-050-2005-173) allows healthy tortoises of unknown genetic background that were brought to the DTCC from Clark County, Nevada, to be translocated to the Large-scale Translocation Site near Jean, Nevada. Since 2009, San Diego Zoo Global and the Conservation Centers for Species Survival have been directly involved in updating husbandry protocols, developing health assessment protocols, and managing the collection of tortoises at the DTCC. The pre-translocation screening protocols have become much more defined and rigorous than those applied in the past, and only tortoises determined to be in good overall health (as defined by numerous metrics) are recommended for translocation. Previously, the result of an ELISA for antibodies to *Mycoplasma agassizii* was used to determine the health of individuals in holding at the DTCC. In 2007, we formally recognized that the *Mycoplasma* ELISA result alone gave no indication of a tortoise's current health status, and we terminated the policy of euthanizing tortoises at the DTCC based on this single test result. A tortoise's health status is now assessed using protocols developed by wildlife veterinarians and pathologists that consider the tortoise's body condition, clinical signs of disease that are most likely to result in pathogen spread, medical history while at the DTCC, presence of ectoparasites, and other factors determined to be important in appropriately assessing the individual's current health and determining suitability for translocation. Importantly, ELISAs, indicate the presence of antibodies to a pathogen rather than actual health or infection status. Rather, these tests provide useful information about exposure to pathogens in the past.

As early as 1994, it was recommended that under some circumstances *Mycoplasma* ELISA-positive tortoises could be translocated into populations where other seropositive tortoises are located. Our goal now is to identify tortoises for release that have the greatest chance for survival in the wild and least chance of posing a significant risk to wild populations. To achieve this, the practice of releasing only ELISA-negative tortoises is no longer advised, and regardless of the ELISA status, tortoises deemed healthy under standards in place at the DTCC should be considered for translocation to the wild. Given that the state of health evaluations and diagnostic testing is in a state of flux and increasingly improving, translocation decisions should be based on the most recent health assessment guidance developed by the San Diego Zoo and DTRO.

Criteria for Translocation Sites
Numerous factors are involved in selecting appropriate recipient translocation sites. The most important are described below with associated recommendations:

- Translocation sites should contain appropriate desert tortoise habitat outside of known popular high–use, speed-based recreation areas, energy development areas, or other similar activities. Suitable translocation sites may be located within designated conservation areas; within linkages between conservation areas; or within any other appropriate habitat outside such areas, especially if the translocation is conducted in association with addressing site-specific questions that would further recovery. Such sites may include areas at the margin of the tortoise's distribution relative to questions about habitat constraints, limitations, or climate change.

- Most desert tortoises released at remote locations (>500 m) from their origin disperse long distances and settle within 6.5 km of their release point. Therefore, a radius of this distance should be considered relative to potential hazards to dispersing tortoises (e.g., unfenced highways) and topographic features that may constrain dispersal.
- Preferably, translocation sites would occur on lands where desert tortoise populations have been depleted or extirpated yet still support suitable habitat. We consider an area to be depleted if the density is below the 95-percent confidence limit of the density of its respective recovery unit (Table 1), ecologically appropriate habitat is present, and there is either a lack of desert tortoise sign or a preponderance of desert tortoise shells in the area. Depleted areas may include lands adjacent to highways. In any case, adult tortoise density within the site should be low enough to accommodate the addition of translocated tortoises, as defined in Table 1.

Table 1. Density thresholds for identifying "depleted areas" and maximum post-translocation densities within each recovery unit.

Recovery Unit	**Mean RU Density ($tortoises/km^2$)[1]**	**Maximum depleted-area density**	**Maximum recipient + translocatee density**
Eastern Mojave	4.2	2.19	5.77
Colorado Deserts	5.3	2.79	7.41
Northeastern Mojave	2.8	1.63	3.62

[1] Mean density from 2007-2010 surveys of designated critical habitat and other conservation areas.

- Evaluation of disease within wild populations, especially in relation to translocation, is an active area of investigation; selection of translocation sites should be based on the most recent scientific information and guidance. Currently, disease prevalence within the resident desert tortoise population at translocation sites should be less than 20 percent. Disease prevalence is defined as the separate proportions of tortoises within the population that are seropositive to *Mycoplasma agassizii* antibodies, those that are seropositive to *Mycoplasma testudineum* antibodies, or those that have other clinical signs that disqualify an individual from being translocated as per the most recent health assessment handbook developed by the San Diego Zoo and DTRO.

Pre-release Survey Needs

Pre-release surveys of the resident tortoise population are usually necessary for responsible translocations and can be important for documenting the context of each particular translocation for future evaluation. Surveys are most important in documenting resident-population densities relative to the criteria outlined in Table 1 and in minimizing risks of releasing healthy tortoises into a high-disease population.

- Evaluation of translocation sites that are most important for recovey and have limited background information should include surveys consistent with our most recent Pre-project Survey Protocol. Surveys should include visual health assessments and collection of biological samples based on the most recent health assessment guidelines. As mentioned above, selection of key translocation sites should be based on the most recent scientific information and guidance. Currently, target sample sizes for such sites would be those needed to detect 10-percent disease prevalence at the 95-percent confidence level and are based on the estimated population size within the expected dispersal radius at a particular translocation site (e.g., $n \approx 25$-40; Figure 1). At a minimum, sample sizes should be sufficient to detect 20-percent disease prevalence at the 95-percent confidence level (e.g., $n \approx 12$-20; Figure 1).
- Independent evidence that the population at a translocation site is depleted, as defined above, may be used to choose a site with minimal pre-release surveys. Nevertheless, confirmatory "spot" surveys, health assessments, and collection of biological samples should be conducted. With documented evidence that the population is depleted, the "maximum depleted-area density" can be used without additional surveys to determine the maximum number of adult tortoises that can be released into the population, according to Table 1. Likewise, the disease prevalence sampling goals, above, do not apply.
- When appropriate, biological sample collection should include blood samples from which ELISAs should be conducted for *Mycoplasma agassizii* and *Mycoplasma testudineum*; residual red blood cells and plasma samples should be archived for future analyses. Oral swabs and nasal lavages should also be collected for future reference.

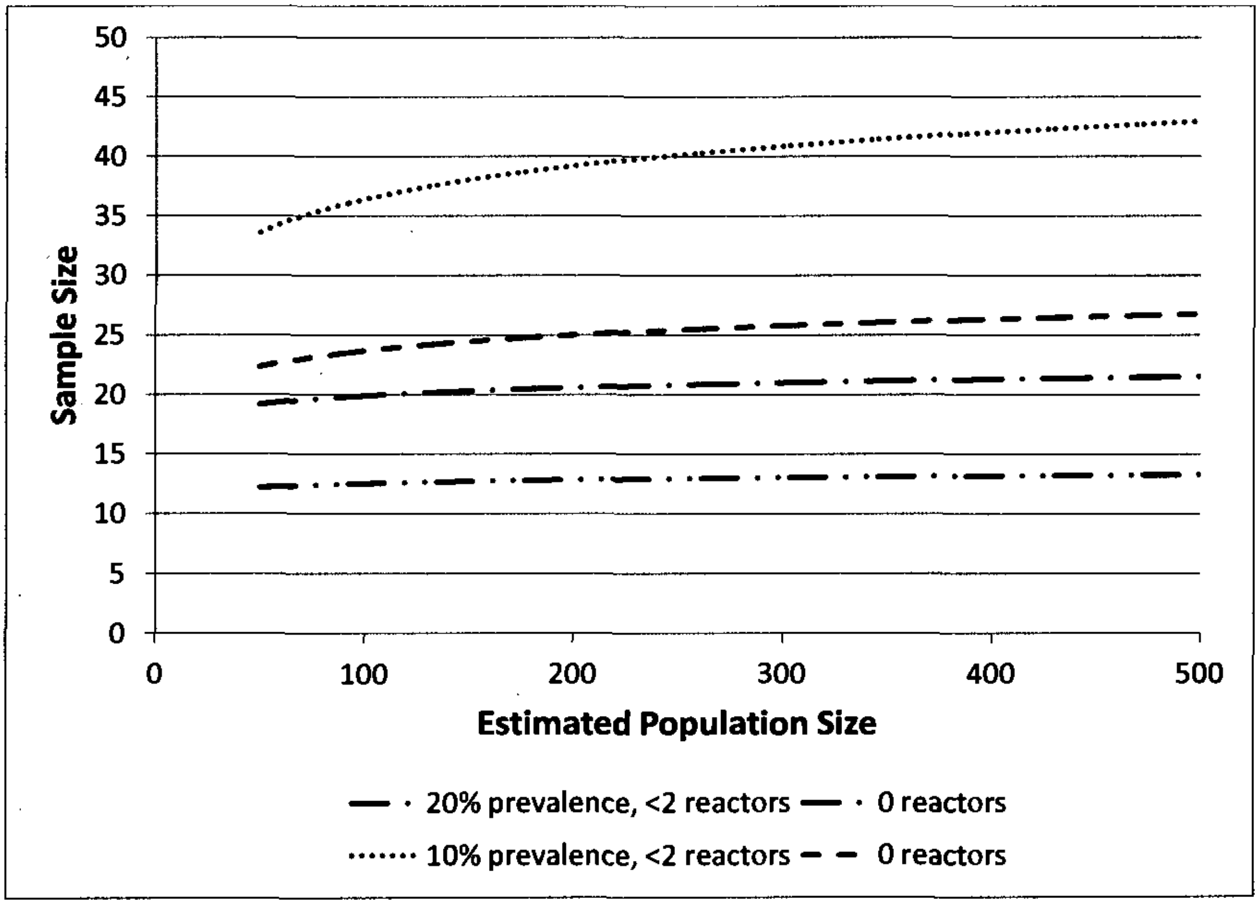

Figure 1. Sample sizes needed to detect 10-percent and 20-percent disease prevalence at the 95-percent confidence level.

Post-translocation Monitoring

Monitoring the effectiveness of translocation can be important to document the outcome of the effort and whether the translocation is achieving recovery-related goals. We do not expect that a single monitoring approach is necessary, or even desirable, for every translocation. Rather, monitoring plans should be developed based on site-specific conditions, questions, and availability of funding.

for Edward D. Koch

Enclosure: Technical paper on "Defining Spatial Scales for Translocation that are Consistent with Genetic Population Structure of Mojave Desert Tortoises" (June 2012)

U.S. Fish and Wildlife Service
DESERT TORTOISE RECOVERY OFFICE
1340 Financial Blvd., Suite 234
Reno, Nevada 89502
Ph: 775-861-6300 ~ Fax: 775-861-6301

DEFINING SPATIAL SCALES FOR TRANSLOCATION THAT ARE CONSISTENT WITH GENETIC POPULATION STRUCTURE OF MOJAVE DESERT TORTOISES

JUNE 2012

Summary

- Spatial autocorrelation analysis indicates that Mojave desert tortoise populations within a 200-276km straight-line radius of each other (249-308 km measured around topographic barriers) tend to be genetically correlated and may be considered single genetic units for management purposes.
- When planning translocations of wild populations, releasing tortoises at recipient sites within a straight-line distance of 200 km from the source population would most conservatively maintain historic genetic population structure.
- A translocation distance of 175 km from the Desert Tortoise Conservation Center (DTCC) would ensure that the vast majority of tortoises from the DTCC would be moved within an equivalent genetic unit, with most moved much shorter distances from their actual population of origin.
- In general, the risk of causing outbreeding depression by translocating Mojave desert tortoises is low.

Background

In the face of loss of biodiversity, inadequate resources, and a lack of will to make difficult socio-economic decisions necessary to protect existing biodiversity from effects of human population growth and development, translocation has become an important conservation tool that can be used to conserve evolutionary processes (Moritz 1999). Translocation of Mojave desert tortoises (*Gopherus agassizii*) has been recommended as a tool to augment depleted populations within a research-oriented framework (USFWS 2011), and it also has increasingly been applied as a "rescue" measure to minimize population impacts caused by development projects occurring within desert tortoise habitat. However, managers need to take precautions to ensure that movement of individuals will maintain the historic population structure (Hagerty 2008).

Although dispersal ecology of desert tortoises is not well understood (Morafka 1994), individuals have been known to move long distances (>30 km; Edwards et al. 2004). Historically, habitat of the Mojave desert tortoise was well connected, and gene flow among adjacent populations within the Mojave and Colorado Deserts was relatively high (Murphy et al. 2007, Hagerty and Tracy 2010, Hagerty et al. 2011). For example, Las Vegas Valley has been hypothesized to be a transitional corridor between the northern and southern reaches of the geographic range (Britten et al. 1997, Hagerty and Tracy 2010). Habitat in the southwestern portion of the range is more continuous than in the northeastern Mojave Desert and has few ‘‘pinch points’’ or restricted habitat corridors (Hagerty et al. 2011).

Even though advances in molecular techniques have improved the ability to describe genetic structure of wildlife populations, defining discrete units for conservation purposes has been problematic for species with continuous distributions (Diniz-Filho and Telles 2002). Such is the case for the Mojave desert tortoise. Even though various genetic groups have been identified (Murphy et al. 2007, Hagerty and Tracy 2010), these groups vary depending on sampling designs and locations, markers used, and resolution of analysis. In addition, high gene flow historically occurred between identified genetic groups, which are not defined by discrete boundaries (Hagerty 2008). Spatial autocorrelation analysis provides a useful technique to establish geographic distances within which continuously distributed populations may be considered a single genetic unit (Diniz-Filho and Telles 2002), thereby providing managers with guidance on the distance within which individual tortoises can be moved between populations consistent with historic genetic population structure. An evaluation of the risks of outbreeding depression would also inform managers relative to the risks of releasing tortoises of unknown genetic origin to the wild, such as from the Desert Tortoise Conservation Center (DTCC) in Las Vegas, Nevada.

Translocation between Wild Populations

We reanalyzed data from Hagerty and Tracy (2010) regarding microsatellite variation among 25 populations distributed across the range of the Mojave desert tortoise. Genetic and geographic distances among sampling locations were correlated strongly (Figure 1; Hagerty and Tracy 2010). We performed a Mantel spatial autocorrelation analysis of the pair-wise genetic distances ($F_{ST}/(1 - F_{ST})$; Rousset 1997) and Euclidian geographic distances using the computer program PASSaGE 2 (Rosenberg and Anderson 2011). We performed analyses using six, 10, and 15 distance classes with approximately equal numbers of pairs per distance class to ensure that choice of distance class size had no effect on analysis results (*cf.* Miller et al. 2006). We used a randomization procedure of 10,000 replicates to identify distance classes where average genetic distances were significantly different than expected. We repeated the analysis using pair-wise least-cost-path distances with data from a landscape genetics study by Hagerty et al. (2011), which takes into account habitat probability and barriers to gene flow (Nussear et al. 2009).

The multivariate correlograms indicated a clinal profile for the genetic variation for each of the distance-class analyses; Figure 2A shows this profile for the 6-class analysis based on Euclidian distances. The intercepts (conservatively reported as the minimum end of the non-significant distance class) were similar among all correlograms, ranging from 200 to 276 km. Therefore, we may consider local populations within the most conservative intercept distance of 200 km to be genetically correlated (genetic distance <0.12; Figure 1) and compatible for translocation. However, topographic features have played an important part in genetic structuring of Mojave desert tortoise populations (Hagerty et al. 2011). When using least-cost path distances, the correlograms indicated a more "stabilizing" profile, with intercepts ranging from 249 to 308 km (6-class analysis shown in Figure 2B); these intercepts are consistent with the Euclidian distance-based analysis, with larger intercept distances reflecting obstacles of natural topographic barriers on the landscape. Samples at geographic distances lower than the intercept, particularly in stabilizing correlograms, can be considered a single genetic unit for conservation (Diniz-Filho and Telles 2002). Therefore, an appropriate management guideline is to limit translocations from wild populations to straight-line distances $\leq$200 km. Taking historical barriers into account, this guideline is consistent with the “historical approach” to translocations recommended by Moritz (1999).

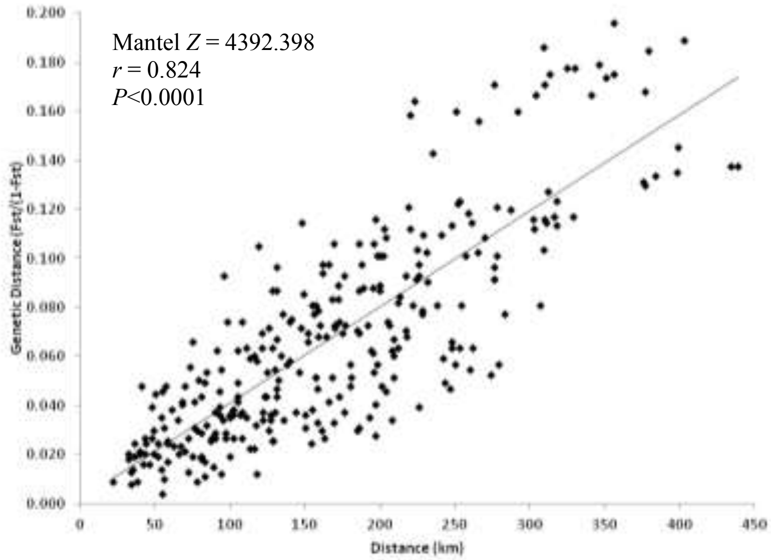

Figure 1. Genetic distance (Fst) versus geographic distance between sampling sites across the range of the Mojave desert tortoise (from Hagerty and Tracy 2010).

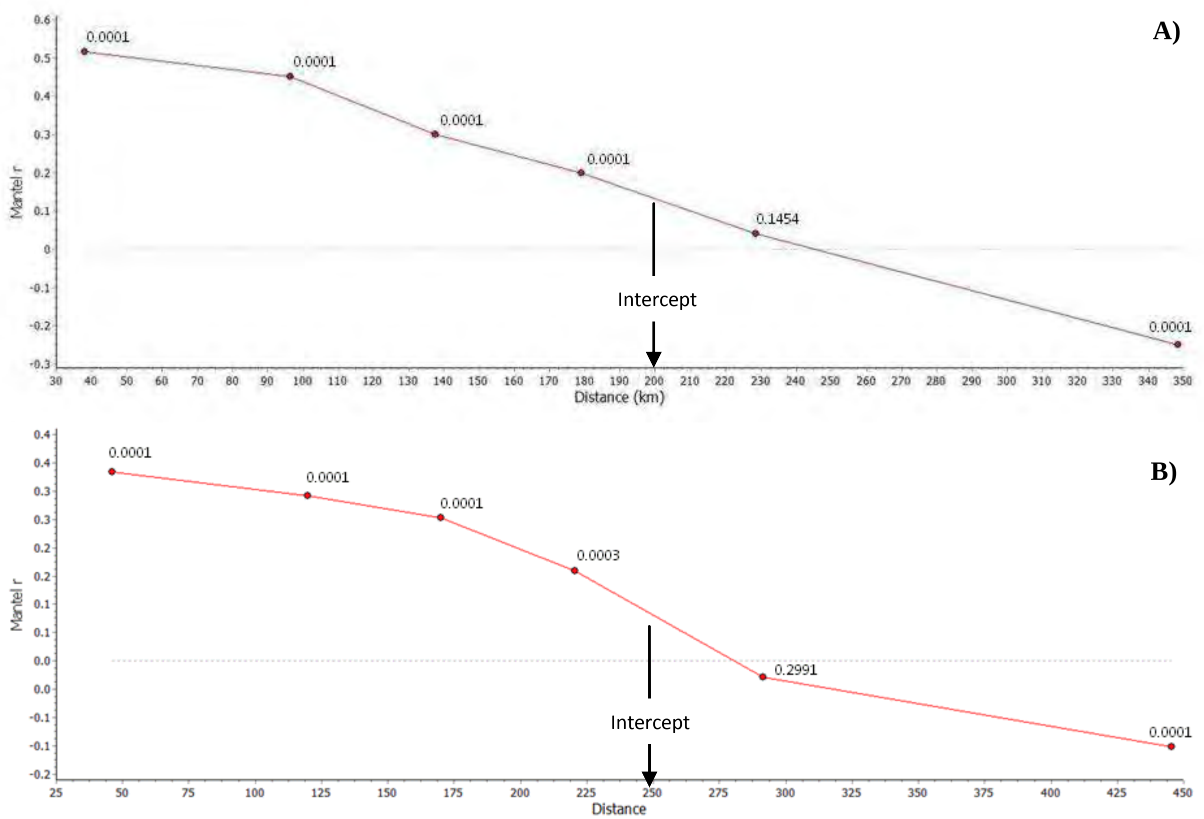

Figure 2. Mantel correlograms obtained after partitioning geographic distances into six connectivity matrices with an approximately equal number of pairs. Numbers above each point are the Type I error of matrix correlation (standardized Mantel’s Z) established after 10,000 random permutations. A) Euclidian distances between sample pairs (n = 48-51 pairs per distance category). B) Least-cost path distances (n = 49-51 pairs per distance category; data from Hagerty et al. 2011).

Repatriation from the Desert Tortoise Conservation Center

Translocating groups of tortoises up to 200 km between wild populations of known locations minimizes risks of disrupting historic genetic population structure. However, the DTCC has amassed hundreds of Mojave desert tortoises of uncertain geographic origin, most as unwanted or lost pets from local residents. Many of these tortoises, after health screening, are suitable for release to the wild and could contribute to recovery-oriented population augmentation programs (USFWS 2011). Unfortunately, genotyping every individual tortoise at the DTCC (approximately 2700 individuals) in order to assign it to the most closely related genetic population for repatriation is cost prohibitive under existing budgets, but if all tortoises at the DTCC had a high probability of originating within 100 km of the DTCC, this radius could be used to keep within the 200km translocation recommendation for wild populations.

Of 21 assignable tortoises Hagerty (2008) sampled in the Large-Scale Translocation Area south of Las Vegas that were released from the DTCC, 20 (95%) were assigned to populations centered within about 100 km of the DTCC (Table 1, Figures 3-4). An additional 39 tortoises at the DTCC have also been sampled and compared to a different database of genetic markers, with 16 (41%) assigned to the Ivanpah Valley, the location in this database most proximal to the DTCC; 22 individuals (56%) were from populations just outside the 100km radius from the DTCC, and one (3%) was assigned to the southern Colorado Desert approximately 270 km away (Table 1, Figures 3-4; Edwards and Berry, pers. comm., 2012). The assignment tests by Edwards and Berry were based on a database that did not include genetic samples from Nevada; therefore, it is likely that several of the samples assigned to more distant California populations actually may have originated within contiguous populations in Nevada.

Most of the tortoises that have been sampled from the DTCC come from populations within about 100 km of the DTCC, so release within 100 km would be consistent with the 200km distance recommendation to prevent altering historical genetic population structure in wild populations. The question remains, however, to determine what are the risks to wild populations of releasing a small percentage of tortoises of origin >100km from the DTCC.

Table 1. Population assignment of tortoises sampled from the Desert Tortoise Conservation Center. The DTCC occurs in the South Las Vegas/Ivanpah population. Assignment tests by Edwards and Berry were based on a database without samples from Nevada; several samples assigned to more distant populations likely originated within contiguous populations in Nevada (e.g., see footnote a).

	Hagerty (2008)		**Edwards and Berry (pers. comm.)**	
Population	N_{21} (%)	Distance (km)	N_{39} (%)	Distance (km)
South Las Vegas/Ivanpah	13 (62%)	0-55	16 (41%)	70
Eldorado	3 (14%)	30-40		
Amargosa	2 (10%)	60-130		
Muddy Mountains	1 (5%)	50-125		
Lower/Upper Virgin River	1 (5%)	120-155	11 (28%)	120-155[a]
Piute	1 (5%)	80		
Goffs-Fenner			10 (26%)	120
Central Mojave Desert			1 (3%)	140
Southern Colorado Desert			1 (3%)	270

[a] Hagerty and Tracy (2010) found no significant genetic difference between tortoises in the Upper Virgin River and Lower Virgin River regions. It is likely that most of the tortoises Edwards and Berry assigned to the Upper Virgin River originated closer to the DTCC in the Lower Virgin River area, so the distance here reflects this likelihood.

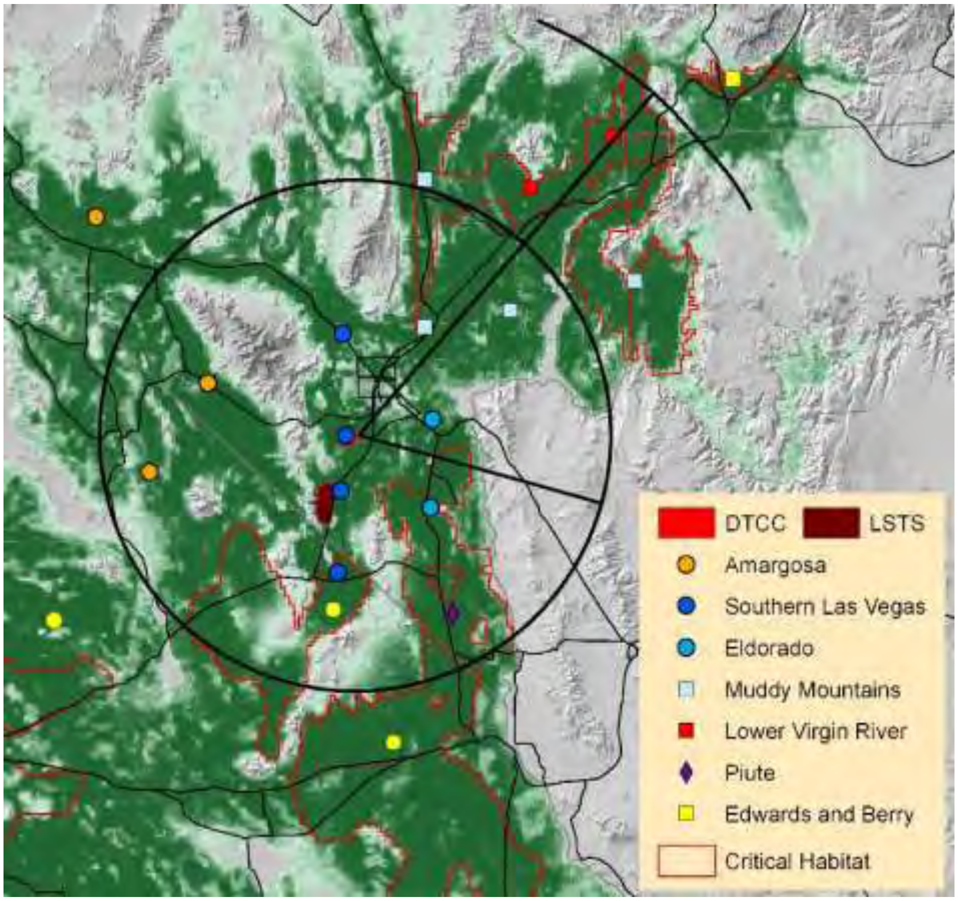

Figure 3. Populations to which tortoises sampled from the DTCC were assigned by Hagerty (2008) and Edwards and Berry (pers. comm., 2012) relative to a 100km radius. Outer arc is 175 km. Green shading is historic Mojave desert tortoise habitat (Nussear et al. 2009). Individual population symbols are from Hagerty (2008). Four populations from Edwards and Berry, clockwise from upper right, are Upper Virgin River, Goffs/Fenner, Ivanpah, central Mojave Desert (southern Colorado Desert not shown).

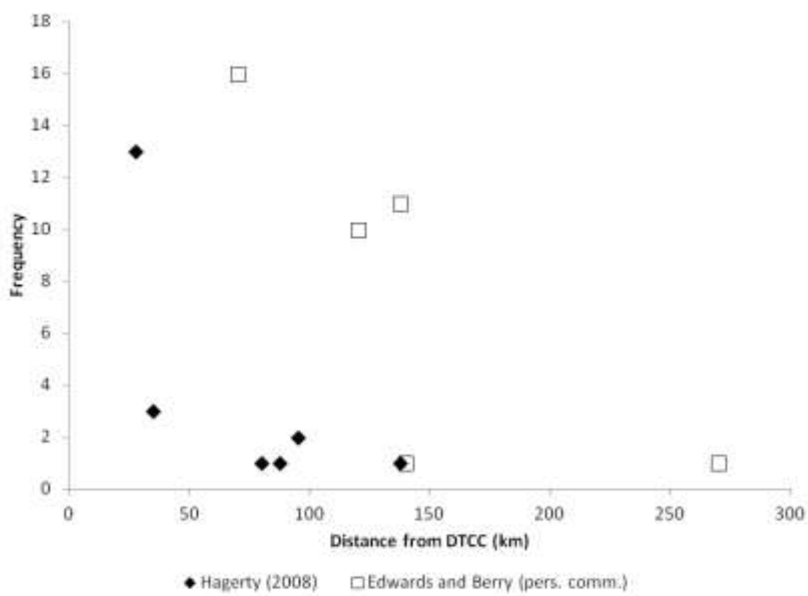

Figure 4. Frequency distribution of genetic samples from the DTCC relative to distance of population of origin. Midpoints are used where a range of distances were estimated for particular populations (Table 1).

The primary genetic risk associated with releasing tortoises of unknown origin to the wild is that of outbreeding depression, i.e., reduction in reproductive fitness following attempted crossing of populations (Storfer 1999; Frankham et al. 2011). Given an historic pattern of genetic population structure based on isolation-by-distance (Britten et al. 1997, Murphy et al. 2007, Hagerty and Tracy 2010), the most likely mechanism of outbreeding depression is adaptive differentiation of populations from different parts of the desert tortoise's range. In similar environments, thousands of generations of evolution in isolated populations of a species is required to initiate outbreeding depression, and dozens of generations are still required for populations in different natural environments (Frankham et al. 2011). For Mojave desert tortoises, with a generation time on the order of 25 years (USFWS 1994), the time scale in which outbreeding depression might occur is 600 or more years.

Frankham et al. (2011) provide a decision tree for assessing the probability of outbreeding depression between two populations, which may be applied to prospective releases of desert tortoises from the DTCC.

1. Is taxonomy resolved? Yes (Murphy et al. 2011).
2. Fixed chromosomal differences? No (continuous gene flow across range).
3. Gene flow between populations within last 500 years? Yes (continuous gene flow across range).
4. Substantial environmental differences? Maybe, depending on origin of individuals at DTCC.
    a. No
        - Low probability of outbreeding depression.
    b. Yes
        Populations separated >20 generations (i.e., ~500+ years)? No.
        - Low probability of outbreeding depression.

In general, the risk of initiating outbreeding depression by releasing tortoises from the DTCC to the wild, particularly to the surrounding eastern to northeastern Mojave Desert, is low. Consequences of occasionally releasing a tortoise of distant origin to a wild population would often be temporary, because natural selection will act on the enhanced genetic diversity to eliminate outbreeding depression (if the offspring from the introduced individual did not have actually enhanced fitness; Frankham et al. 2011). Based on the results of genetic samples from the DTCC, the low probability of outbreeding depression, and a recommendation for a more active approach to augmenting gene flow to minimize population extirpation (Frankham et al. 2011), comparing genotypes of every tortoise at the DTCC against a genetic database is unnecessary.

Most tortoises sampled from the DTCC originate from populations within 100 km (Table 1, Figures 3-4). Therefore, defining a translocation distance of 175 km from the DTCC would ensure that the vast majority of tortoises would be moved within 275 km of their population of origin, which is within the 276km correlogram intercept of the 15-class autocorrelation analysis and remains consistent with an historical approach to translocation (Moritz 1999). The vast majority of tortoises would be moved much shorter distances from their actual population of origin. Given the low risk of outbreeding depression, defining a maximum translocation distance of 175 km from the DTCC provides a practical management alternative to genotyping hundreds or thousands of individual tortoises while still minimizing impacts to the genetic population structure of wild populations.

Acknowledgements

B. Hagerty graciously provided the least-cost-path distance matrix from Hagerty et al. (2011). We thank T. Edwards and K. Berry for sharing results of their analyses from the DTCC. We appreciate comments and review from A. Diniz-Filho, K. Ralls, and O. Ryder.

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11 Appendix C: Forage Overlap information

Appendix C. Desert tortoise forage and cover plant species. Tortoise forage plants were identified through a literature review on desert tortoise ecology, while tortoise cover plants were identified through the literature review, as well as a characterization of plant growth forms in the field.

Desert Tortoise Forage Species

Abronia fragrans – ABFR2
Acacia greggii – AGCR
Achnatherum hymenoides – ACHY
Achnatherum speciosum – ACSP12
Aliciella leptomeria – ALLE7
Allionia incarnate – ALIN
Allium fimbriatum – ALFI2
Allium vineale – ALVI
Ambrosia dumosa – AMDU2
Amsinckia tessellata – AMTE3
Androstephium breviflorum – ANBR4
Antheropeas wallacei - ANWA
Argemone spp.
Argythamnia spp.
Aristida purpurea – ARPU9
Artemisia tridentata – ARTR2
Artemisia filifolia – ARFI2
Astragalus acutirostris – ASAC3
Astragalus didymocarpus – ASDI3
Astragalus layneae – ASLA8
Astragalus lentiginosus – ASLE8
Astragalus nuttallii – ASNU5
Atriplex canescens – ATCA2
Atriplex confertifolia – ATCO
Baileya multiradiata – BAMU
Baileya pleniradiata – BAPL3
Bouteloua aristidoides – BOAR
Bouteloua barbata – BOBA2
Bouteloua trifida – BOTR2
Bromus rubens – BRRU2
Bromus tectorum - BRTE
Bromus madritensis – BRMA3
Calochortus nuttallii – CANU3
Calochortus flexuosus – CAFL
Calycoseris parryi – CAPA7
Camissonia andina – CAAN14
Camissonia boothii – CABO7
Camissonia boothii ssp. decorticans - CABOD
Camissonia brevipes – CABR23
Camissonia claviformis – CACL4
Camissonia palmeri – CAPA37
Camissonia munzii – CAMU14
Carex spp.
Caulanthus inflatus – CAIN15
Centrostegia thurberi – CETH3
Chaenactis carphoclinia – CHCA
Chaenactis fremontii – CHFR
Chamaesyce albomarginata – CHAL11
Chamaesyce micromera – CHMI7
Chamaesyce parryi – CHPA28
Chamaesyce spp.
Chorizanthe brevicornu – CHBR
Chorizanthe rigida – CHRI
Chrysothamnus spp.
Cirsium spp.
Coleogyne ramosissima – CORA
Coreopsis bigelovii – COBI
Croton californicus – CRCA5
Cryptantha angustifolia – CRAN4
Cryptantha circumscissa – CRCI2
Cryptantha micrantha – CRMI
Cryptantha nevadensis – CRNE2
Cryptantha virginensis – CRVI5
Cryptantha pterocarya – CRPT
Cylindropuntia ramosissima – CYRA9
Cymopterus spp.
Dalea spp.
Dasyochloa pulchella – DAPU7
Delphinium nuttallianum – DENU2
Delphinium parishii ssp. *parishii* - DEPAP3
Descurainia pinnata – DEPI
Dichelostemma pulchellum – DIPU3
Dichelostemma capitatum – DICA14
Dimorphocarpa wislizeni – DIWI2
Draba cuneifolia – DRCU
Echinocactus polycephalus – ECPO2

Echinocereus engelmannii – ECEN
Elymus elymoides – ELEL5
Elymus spp.
Encelia frutescens – ENFR
Ephedra nevadensis – EPNE
Equisetum spp.
Eremalche exile – EREX3
Eriastrum diffusum – ERDI2
Eriastrum eremicum – ERER2
Erigeron spp.
Eriogonum deflexum – ERDE6
Eriogonum fasciculatum – ERFA2
Eriogonum gracillimum – ERGR6
Eriogonum inflatum – ERIN4
Eriogonum maculatum – ERMA2
Eriogonum pusillum – ERPU6
Eriogonum thomasii – ERTH
Erioneuron pilosum – ERPI5
Erodium cicutarium – ERCI6
Eschscholzia minutiflora – ESMI
Festuca octoflora – FEOC3
Fouquieria splendens – FOSP2
Gaura coccinea – GACO5
Gilia latiflora – GILA
Gilia minor – GIMI2
Gilia scopulorum – GISC
Glyptopleura setulosa – GLSE4
Grayia spinosa – GRSP
Gutierrezia sarothrae – GUSA2
Helianthus anomalus – HEAN4
Heterotheca villosa – HEVI4
Hymenoclea salsola – HYSA
Hymenopappus filifolius – HYFI
Janusia gracilis – JAGR
Kochia spp.
Krameria erecta – KRER
Krascheninnikovia lanata – KRLA2
Langloisia setosissima – LASE3
Larrea tridentata – LATR2
Lepidium flavum – LEFL2
Lepidium lasiocarpum – LELA
Lesquerella rectipes – LERE3
Lesquerella tenella – LETE3
Linanthus dichotomus – LIDI2
Linanthus parryae – LIPA4
Linanthus pungens – LIPU11
Loeseliastrum matthewsii – LOMA10
Loeseliastrum schottii – LOSC6
Lomatium mohavense – LOMO
Lotus humistratus – LOHU2
Lotus plebeius – LOPL2
Lotus salsuginosus var. brevivexillus - LOSAB
Lotus strigosus var. tomentellus - LOSTT
Lupinus arizonicus – LUAR4
Lupinus odoratus – LUOD
Lupinus concinnus – LUCO
Lupinus flavoculatus – LUFL
Lycium spp.
Lygodesmia spp.
Malacothrix coulteri – MACO3
Malacothrix glabrata – MAGL3
Malacothrix sonchoides – MASO
Malacothrix californica – MACA6
Mentzelia affinis – MEAF2
Mentzelia albicaulis – MEAL6
Mentzelia obscura – MEOB3
Mirabilis bigelovii – MIBI8
Mirabilis californica – MICA6
Mirabilis multiflora var. pubescens – MIMUP
Mohavea confertiflora – MOCO
Monoptilon bellioides – MOBE2
Muhlenbergia porteri – MUPO2
Nama demissum – NADE
Oenothera deltoides – OEDE2
Oenothera pallida – OEPA
Oenothera primiveris – OEPR
Opuntia basilaris – OPBA2
Opuntia engelmannii – OPEN3
Opuntia polyacantha var. erinacea – OPPOE
Oxytheca perfoliata - OXPE2
Oxytropis spp.
Pectis papposa – PEPA2
Pectocarya platycarpa – PEPL
Pectocarya recurvata – PERE
Phacelia bicolor – PHBI
Phacelia crenulata – PHCR
Phacelia ivesiana – PHIV
Phacelia tanacetifolia – PHTA

Phacelia fremontii – PHFR2
Pholistoma membranaceum – PHME3
Plagiobothrys arizonicus – PLAR
Plantago ovata – PLOV
Plantago patagonica – PLPA2
Pleuraphis rigida – PLRI3
Pleuraphis jamesii – PLJA
Potentilla spp.
Prenanthella exigua – PREX
Psilostrophe cooperi – PSCO2
Rafinesquia neomexicana – RANE
Salsola tragus – SATR12
Schismus arabicus – SCAR
Schismus barbatus – SCBA
Selinocarpus diffuses – SEDI3
Sida spp.
Solanum spp.
Sphaeralcea ambigua – SPAM2
Sphaeralcea grossulariifolia – SPGR2
Sporobolus flexuosus – SPFL2
Sporobolus cryptandrus – SPCR
Stephanomeria exigua – STEX
Stephanomeria parryi – STPA3
Stephanomeria pauciflora – STPA4
Stillingia spinulosa – STSP
Streptanthella longirostris – STLO4
Stylocline micropoides – STMI2
Thysanocarpus curvipes - THCU
Tidestromia spp.
Tiquilia plicata – TIPL2
Tridens muticus – TRMU
Tropidocarpum gracile – TRGR5
Vulpia octoflora – VUOC
Yucca elata – YUEL

Desert Tortoise forage species found at Lincoln County Study Sites (2008-2009)

Achnatherum hymenoides – ACHY
Achnatherum speciosum – ACSP12
Allionia incarnate – ALIN
Ambrosia dumosa – AMDU2
Amsinckia tessellata – AMTE3
Aristida purpurea – ARPU9
Astragalus lentiginosus – ASLE8
Atriplex canescens – ATCA2
Baileya multiradiata – BAMU
Baileya pleniradiata – BAPL3
Bouteloua barbata – BOBA2
Bromus tectorum - BRTE
Bromus madritensis – BRMA3
Calochortus flexuosus – CAFL
Camissonia brevipes – CABR23
Chaenactis fremontii – CHFR
Chamaesyce albomarginata – CHAL11
Chorizanthe brevicornu – CHBR
Chorizanthe rigida – CHRI
Coleogyne ramosissima – CORA
Cryptantha angustifolia – CRAN4
Cryptantha circumscissa – CRCI2
Cryptantha micrantha – CRMI
Cryptantha nevadensis – CRNE2
Cryptantha pterocarya – CRPT
Dasyochloa pulchella – DAPU7
Delphinium parishii - DEPA
Descurainia pinnata – DEPI
Dichelostemma capitatum – DICA14
Draba cuneifolia – DRCU
Echinocereus engelmannii – ECEN
Elymus elymoides – ELEL5
Encelia frutescens – ENFR
Ephedra nevadensis – EPNE
Eriastrum eremicum – ERER2
Eriogonum deflexum – ERDE6
Eriogonum fasciculatum – ERFA2
Eriogonum inflatum – ERIN4
Eriogonum inflatum var. *deflatum* – ERIND
Erodium cicutarium – ERCI6
Eschscholzia minutiflora – ESMI
Gaura coccinea – GACO5
Gilia latiflora – GILA
Grayia spinosa – GRSP
Gutierrezia sarothrae – GUSA2
Hymenoclea salsola – HYSA
Krameria erecta – KRER
Krascheninnikovia lanata – KRLA2

Langloisia setosissima – LASE3
Larrea tridentata – LATR2
Lepidium lasiocarpum – LELA
Lesquerella tenella – LETE3
Linanthus dichotomus – LIDI2
Linanthus pungens – LIPU11
Loeseliastrum schottii – LOSC6
Lotus humistratus – LOHU2
Lupinus concinnus – LUCO
Malacothrix glabrata – MAGL3
Mentzelia albicaulis – MEAL6
Mirabilis bigelovii – MIBI8
Mirabilis multiflora – MIMU
Muhlenbergia porteri – MUPO2
Nama demissum – NADE
Opuntia basilaris – OPBA2
Opuntia polyacantha – OPPO
Opuntia polyacantha var. erinacea – OPPOE
Oxytheca perfoliata - OXPE2
Pectis papposa – PEPA2
Pectocarya platycarpa – PEPL
Phacelia crenulata – PHCR
Phacelia fremontii – PHFR2
Plagiobothrys arizonicus – PLAR
Plantago ovata – PLOV
Pleuraphis rigida – PLRI3
Pleuraphis jamesii – PLJA
Psilostrophe cooperi – PSCO2
Rafinesquia neomexicana – RANE
Salsola tragus – SATR12
Schismus barbatus – SCBA
Sphaeralcea ambigua – SPAM2
Sporobolus cryptandrus – SPCR
Stephanomeria exigua – STEX
Stephanomeria parryi – STPA3
Stephanomeria pauciflora – STPA4
Thysanocarpus curvipes - THCU
Tridens muticus – TRMU
Vulpia octoflora – VUOC

Desert Tortoise Cover Species

Acacia greggii – ACGR
Acamptopappus sphaerocephalus – ACSP
Ambrosia dumosa – AMDU2
Artemisia filifolia – ARFI2
Artemisia tridentate – ARTR2
Atriplex canescens – ATCA2
Bebbia juncea – BEJU
Ceratoides spp.
Chrysothamnus viscidiflorus – CHVI8
Coleogyne ramosissima – CORA
Cylindropuntia acanthocarpa – CYAC8
Cylindropuntia echinocarpa – CYEC3
Encelia virginensis – ENVI
Ephedra nevadensis – EPNE
Ephedra viridis – EPVI
Eriogonum fasciculatum – ERFA2
Grayia spinosa – GRSP
Gutierrezia sarothrae – GUSA2
Hymenoclea salsola – HYSA
Juniperus scopulorum – JUSC2
Krameria grayi – KRGR
Krameria parvifolia – KRER
Krascheninnikovia lanata – KRLA2
Larrea tridentata – LATR2
Lepidium fremontii – LEFR2
Lycium andersonii – LYAN
Lycium cooperi – LYCO2
Mortonia utahensis – MOUT
Pleuraphis rigida – PLRI3
Prunus fasciculata – PRFA
Psorothamnus fremontii var. *fremontii* – PSFRF
Purshia mexicana – PUME
Quercus turbinella – QUTU2
Salazaria mexicana – SAME
Salvia dorrii – SADO4
Stanleya pinnata – STPI
Tetradymia spinosa – TESP2
Thamnosma Montana – THMO
Yucca baccata – YUBA
Yucca brevifolia – YUBR
Yucca schidigera – YUSC2

Desert Tortoise Cover Species Found at Lincoln County Study Sites (2008-2009)

Acamptopappus sphaerocephalus – ACSP
Ambrosia dumosa – AMDU2
Atriplex canescens – ATCA2
Bebbia juncea – BEJU
Chrysothamnus viscidiflorus – CHVI8
Coleogyne ramosissima – CORA
Cylindropuntia acanthocarpa – CYAC8
Cylindropuntia echinocarpa – CYEC3
Encelia virginensis – ENVI
Ephedra nevadensis – EPNE
Ephedra viridis – EPVI
Eriogonum fasciculatum – ERFA2
Grayia spinosa – GRSP
Gutierrezia sarothrae – GUSA2
Hymenoclea salsola – HYSA
Krameria grayi – KRGR
Krameria parvifolia – KRER
Krascheninnikovia lanata – KRLA2
Larrea tridentata – LATR2
Lepidium fremontii – LEFR2
Lycium andersonii – LYAN
Lycium cooperi – LYCO2
Mortonia utahensis – MOUT
Pleuraphis rigida – PLRI3
Prunus fasciculata – PRFA
Psorothamnus fremontii – PSFR
Salazaria mexicana – SAME
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