Central New Mexico Climate Change Scenario Planning Project

Task 3.2 Memo: Preliminary Scenario Evaluation and Resiliency

January 12, 2015

Prepared by the University of New Mexico and Ecosystem Management, Inc.

Dr. Gregory Rowangould
Mohammad Tayarani
Amir Poorfakhraei
Stephanie Lee
Mike Tremble
Justine Vaivai

TABLE OF CONTENTS

1 Introduction 1
2 Scenarios 2
3 Scenario Evaluation and Comparisons 2
3.1 Accessibility 2
3.2 Land-Use 2
3.3 Mobility 4
3.3.1 Roadways 4
3.3.2 Transit 4
3.3.3 Rio Grande River Crossings 6
3.4 Economic Competitiveness 6
3.5 Safety 7
3.6 Sustainability 7
3.6.1 Greenhouse Gas Emissions 7
3.6.2 Water Consumption 7
3.6.3 Flood Risk 8
3.6.4 Forest Fire Risk 14
3.6.5 Crucial Habitat Areas 21
3.7 Resiliency 29
3.7.1 Urban Heat 30
3.7.2 Drought 31
3.7.3 Flooding 31
3.7.4 Wildfire 32
3.7.5 Crucial Habitat 32
4 Summary and Conclusions 34
5 Appendix 35

Table of Figures

Figure 1. Accessibility Performance Measures – Comparison with Base Year. 3
Figure 2. Accessibility Performance Measures – Comparison with Allowable Use Scenario. 3
Figure 3. Land-Use Performance Measures. 4
Figure 4. Highway Performance Measures. 5
Figure 5. Transit Performance Measures. 6
Figure 6. River Crossing Performance Measures. 6
Figure 7. Regional Economic Growth. 7
Figure 8. Change in GHG Emissions. 8
Figure 9. Change in Residential Water Consumption. 9
Figure 10. 100-Year Floodplain and Emerging Lifestyles Population Change. 10
Figure 11. 100-Year Floodplains and Emerging Lifestyles Scenario Population Change Overview. 11
Figure 12. 100-Year Floodplains and Jobs/Housing Scenario Population Change. 12
Figure 13. 100-Year Floodplains and Jobs/Housing Scenario Population Change Overview. 13
Figure 14. Development in 100-year Floodpain by Scenario. 14
Figure 15. Wildfire Intermix Risk Climate Scenario Analysis. 15
Figure 16. Wildfire Interface Risk Climate Scenario Analysis. 16
Figure 17. Wildfire Total Risk Climate Scenario Analysis. 16
Figure 18. Wildland Urban Interface and Emerging Lifestyles Scenario Population Change. 17
Figure 19. Wildland Urban Interface and Emerging Lifestyles Scenario Population Change Overview. 18
Figure 20. Wildland Urban Interface and Jobs-Housing Scenario Population Change. 19
Figure 21. Wildland Urban Interface and Jobs-Housing Scenario Population Change Overview. 20
Figure 22. Development in Crucial Habitat Area by Scenario Rank 1. 22
Figure 23. Development in Crucial Habitat Area by Scenario Rank 2. 22
Figure 24. Development in Crucial Habitat Area by Scenario Rank 3. 23
Figure 25. Development in Crucial Habitat Area by Scenario Rank 4. 23
Figure 26. Development in Crucial Habitat Area by Scenario Rank 5. 24
Figure 27. Development in Crucial Habitat Area by Scenario Rank 6. 24
Figure 28. Crucial Habitat and Emerging Lifestyles Scenario Population Change. 25
Figure 29. Crucial Habitat and Emerging Lifestyles Scenario Population Change Overview. 26
Figure 30. Crucial Habitat and Jobs-Housing Scenario Population Change. 27
Figure 31. Crucial Habitat and Jobs-Housing Scenario Population Change Overview. 28
Figure 32. Summary of Global Climate Model Runs for the Year 2040 for Central New Mexico. 29
Figure 33. Urban Heat and Public Health. 30

1 INTRODUCTION

This memo evaluates three preliminary regional land-use planning scenarios developed by the Mid-Region Council of Governments (MRCOG) for the Central New Mexico Climate Change Scenario Planning Project. The scenarios include two alternative scenarios, one aimed at balancing jobs and housing (the "jobs/housing balance" scenario) and the other aimed at increasing mixed use development (the "emerging lifestyles" scenario). A third scenario represents a simplified version of the existing zoning to allow for more direct comparison among the scenarios (the "allowable uses" scenarios). Each of the alternative scenarios and the allowable uses scenario were modeled using the UrbanSim agent-based land-use simulation model. Each scenario was specified in UrbanSim by defining different zoning layers that indicate the allowable uses and intensity of use for each parcel in the region. Additionally, for the emerging lifestyles scenario, major transit stations were defined by MRCOG within which the probability of development was modestly increased in the UrbanSim model. The increased probabilities were designed to capture factors not accounted for in UrbanSim that may increase the development potential of certain areas. Despite this adjustment, the major driver for future development patterns in each scenario was zoning.

UrbanSim provides parcel level output that includes basic socio-economic data and land-use attributes. These data provide information about the type and extent of development within the metropolitan area. To determine how different development patterns will affect travel and greenhouse gas (GHG) emissions, the UrbanSim output are also used as input to MRCOG's regional travel demand model. The regional travel demand model estimates the production and attraction of trips to and from 900 travel analysis zones (TAZs) across the metropolitan area. The trip production and attraction rates for each TAZ depend on output from UrbanSim including population, household size, income, employment, and presence of a school. The travel demand model matches trips produced by a TAZ with trips attracted to other TAZs, and then determines the likely mode for these trips and which routes through the transportation network they will take. The travel demand model provides output that includes the number of vehicle and transit trips and their speed along each roadway link in the regional transportation network. These data are used to estimate common transportations system performance metrics and also used for estimating GHG emissions.

The preliminary scenarios considered in this phase of the Central New Mexico Climate Change Scenario Planning Project only considered changes in land-use, each of the three future scenarios have the same street and transit networks from the 2035 long-range transportation plan. The output of the travel demand model vary because of the different TAZ-level population and land-use data provided by the three scenarios which were modeled in UrbanSim and differentiated by defining different land-use zoning layers.

The output from the travel demand model is also used to estimate the quantity of greenhouse gas emissions produced from each scenario. Vehicle emissions are estimated with U.S. Environmental Protection Agency's Motor Vehicle Emission Simulator (MOVES) emission model. The main factors affecting vehicle emission rates are traffic volume and speed as well as the type of vehicles that make up the regional vehicle fleet. Traffic volume and speed data are provided by the travel demand model output. Currently, there is no local information to define a regional vehicle fleet for the MRCOG region or New Mexico. As a substitute for this local information the Austin, Texas, metropolitan area vehicle fleet is used. The Austin vehicle fleet was chosen based on consultation with the City of Albuquerque's Environmental Health Department, which has used this dataset in its previous regional air quality studies. The dataset was created by Sonoma Tech for the city to evaluate the air quality impact of its vehicle inspection and maintenance program[1]. The MOVES model was run to provide output that includes the

[1] Sonoma Tech Inc. (February 18, 2014) Technical Memorandum, Re: Inspection and Maintenance (I/M) Program Analysis. Prepared by Yuan Du and Stephen Reid, Sonoma Tech for Fabian Macias, Albuquerque Environmental Health Department.

gram per mile emission rate for carbon dioxide (CO_2), methane (CH_4), nitrogen dioxide (N_2O), and black carbon (BC) for a range of speeds for each roadway type (limited access/unrestricted access rural and urban roadways) for typical winter and summer weather conditions. The summer and winter modeling results were averaged to estimate annual average emission rates. The MOVES model output was formatted into a lookup table. Based on roadway type and average speed, emission rates from the lookup table were matched to each roadway link in the travel demand model output and multiplied by link's traffic volume to calculate the total daily quantity of emissions for each roadway link. Finally, the link level emissions were summed up to calculate a regional emission inventory.

2 SCENARIOS

Within the central New Mexico region, population is expected to grow by 460,000 to 1,362,000 (a 52 percent increase) by the year 2040. MRCOG created three future land-use scenarios to accommodate this growth: the allowable uses, emerging lifestyles, and jobs/housing balance scenarios. The scenarios are primarily differentiated from each other based on different patterns of zoning. The allowable uses scenario keeps current zoning in place and represents a business as usual scenario. The emerging lifestyles scenario focuses on increasing mixed use density near high frequency transit stops. This scenario is accomplished by zoning areas within a vicinity of existing and future transit stops as either medium-density or high-density mixed use. The attractiveness of developing near major transit stops was also enhanced by applying a "shifter" which increased the probability that UrbanSim would allocate development near transit stops. MRCOG adopted the shifters to account for factors that make these areas attractive but are not included in UrbanSim's logic. The jobs/housing balance scenario focused on addressing the lack of employment on the west side of the Rio Grande. Zoning was changed to allow higher intensity commercial in several locations on the west side where commercial development is expected or where it already exists, as well as higher intensity residential development near existing activity centers east of the Rio Grande.

UrbanSim was used to forecast the type and intensity of development on each parcel in the metropolitan area for each of the three future scenarios. For each scenario UrbanSim assumed the same 2012 base year transportation network and traffic conditions and the same population and employment growth. The only difference between the scenarios was zoning and the application of the shifter in the emerging lifestyles scenario. UrbanSim output were also used to run MRCOG's regional travel demand model to forecast how changes in land-use, population, and employment patters may affect traffic and GHG emissions. The travel demand model was run with the same 2035 transportation network for each of the three land-use scenarios. The only difference between the travel demand modeling runs were the location of different land-uses, population, and employment.

3 SCENARIO EVALUATION AND COMPARISONS

Each scenario was evaluated against a wide range of performance measures (see Appendix). The change in each performance measure was evaluated against the base year (2012) and the baseline future scenario (allowable uses) to illustrate how the region is expected to change from today and to highlight the differences between the future scenarios. The following sections discuss the main findings for each category of performance measure defined by MRCOG and several additional performance measures developed by the University of New Mexico (UNM). A complete listing of performance measures and their values is provided in the appendix.

3.1 Accessibility

Accessibility was measured as the proximity of households to various amenities including activity centers, bicycle paths, transit, and schools; the jobs to housing ratio within activity centers; and the non-motorized mode share. Figure 1 compares five of these performance measures with the 2012 baseline. There are generally only small differences in accessibility between the scenarios. Not included in Figure 1a is the difference in the number of households located near premium transit which increases 600 to 850

percent. The large increase in households located near transit is due to the expected expansion of the transit network in the future. Figure 2 shows differences in these indicators relative to the allowable use scenario to highlight the differences between the future scenarios.

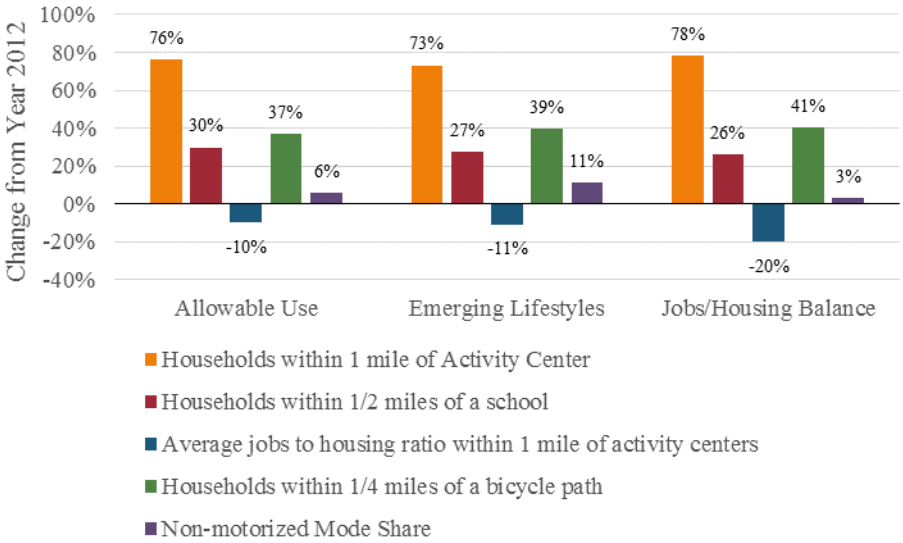


Figure 1. Accessibility Performance Measures – Comparison with Base Year.

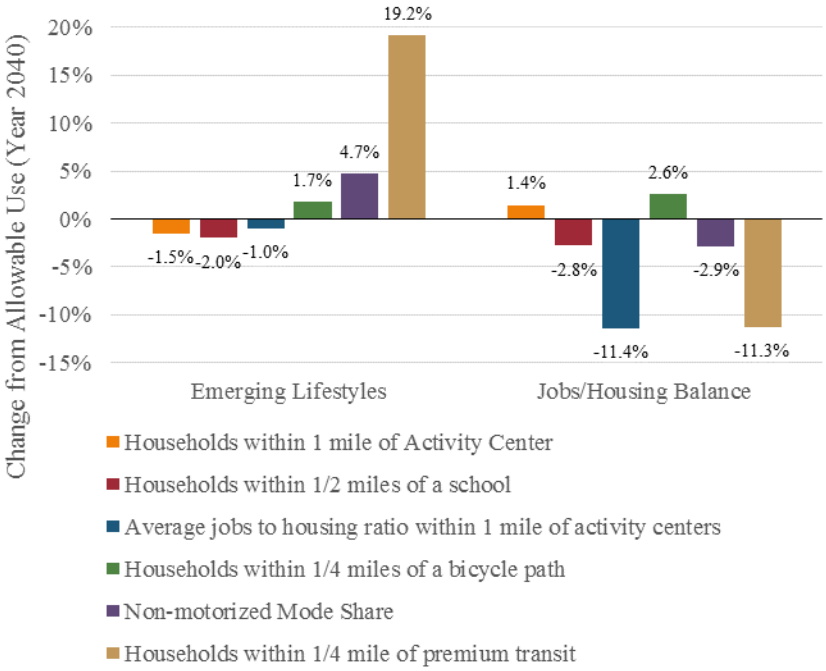


Figure 2. Accessibility Performance Measures – Comparison with Allowable Use Scenario.

None of the future scenarios performs best on all of the performance criteria. The jobs/housing balance scenario provides the most equitable jobs to housing balance and the most number of households located near activity centers, though this difference is very small. The emerging lifestyles scenario has a greater

non-motorized mode share (indicating greater accessibility since these trips are usually short) and the largest number of households located near premium transit stops but the least number of households located near activity centers. The allowable use scenario locates the most households near schools.

3.2 Land-Use

Land-use was measured by the change in roadway lane miles and the acres of land developed. As Figure 3 indicates, there is little difference between the scenarios with regard to these performance measures. Since each scenario has the same future transportation system, they all have the same number of lane-miles, which are expected to grow by 13 percent over today's network. The land-use models also forecast a large increase in the region's development footprint. While the emerging lifestyles scenario results in about 2 percent less land developed than either of the other scenarios; this is a relatively small difference compared with the expected 50 percent increase in land development over 2012 levels. One limitation of this analysis is that these data do not indicate what amount of this development occurs on currently undeveloped land and what amount may be redevelopment. While the development footprint will grow substantially, the population density of new land developed will increase notably for the emerging lifestyle scenario to 5.9 persons per developed acre, which is 7 percent greater than today's average of 5.5 persons per developed acre. The overall increase in average density is about 2 percent for the emerging lifestyles scenario and there is no notable change for the other scenarios.

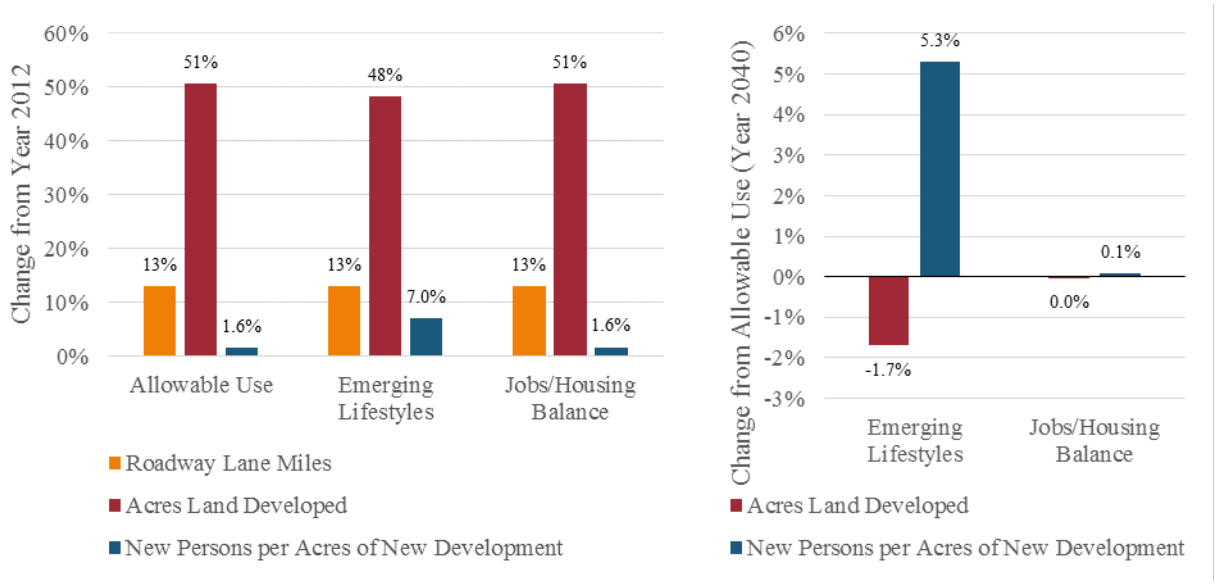


Figure 3. Land-Use Performance Measures.

3.3 Mobility

Mobility was measured by three categories of performance measures: roadway performance, transit ridership, and river crossings. Each is discussed in turn below.

3.3.1 Roadways

Roadway performance was evaluated based on congestion levels and amount of driving. Seven roadway performance measures were estimated; however, the three shown in Figure 4 summarize the differences between each scenario and the 2012 baseline (full set of performance measures are available in the appendix). Each scenario indicates a large increase in the amount of driving and congestion over the 2012 baseline. This is expected given a 52 percent increase in population, no change in the transit network, a very small (0.5 percent–2.3 percent) increase in average population density, and modest 13 percent increase in roadway lane-miles. The emerging lifestyles scenario performs the best out of the future year

scenarios. It is the only scenario where the average person will drive less than they do today and as a result there is slightly less congestion.

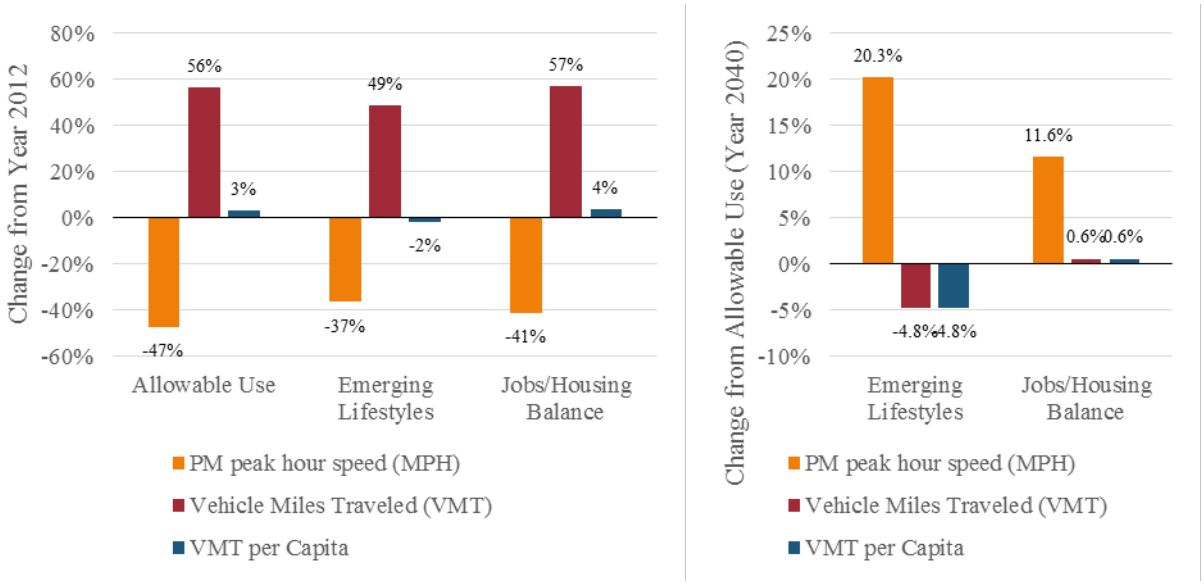


Figure 4. Highway Performance Measures.

3.3.2 Transit

Transit performance was evaluated based on transit ridership, transit passenger miles traveled, and transit mode share (the percentage of trips made using transit). In each scenario, transit ridership and passenger miles traveled increased substantially over year 2012 levels; however, transit mode share declined (Figure 5). The increase in transit ridership fails to keep pace with growth in vehicle travel and the population. Transit passenger miles traveled grows significantly and transit mode share declines for each of the future scenarios. After completing the modeling for each scenarios, the project team determined that there was an error in the transit forecasts caused by an error in the definition of the base year transit network. The project team corrected the problem for the next round of modeling, which will include an expanded future year transit network. The transit system may also be reaching capacity. Again, the reason for the decline in transit mode share has not yet been investigated. It should also be noted that the apparent large decline in transit mode share is due to a very small baseline transit mode share of just 1.1 percent in the year 2012 modeling results. Overall, the emerging lifestyles scenario performs the best for each transit performance measure.

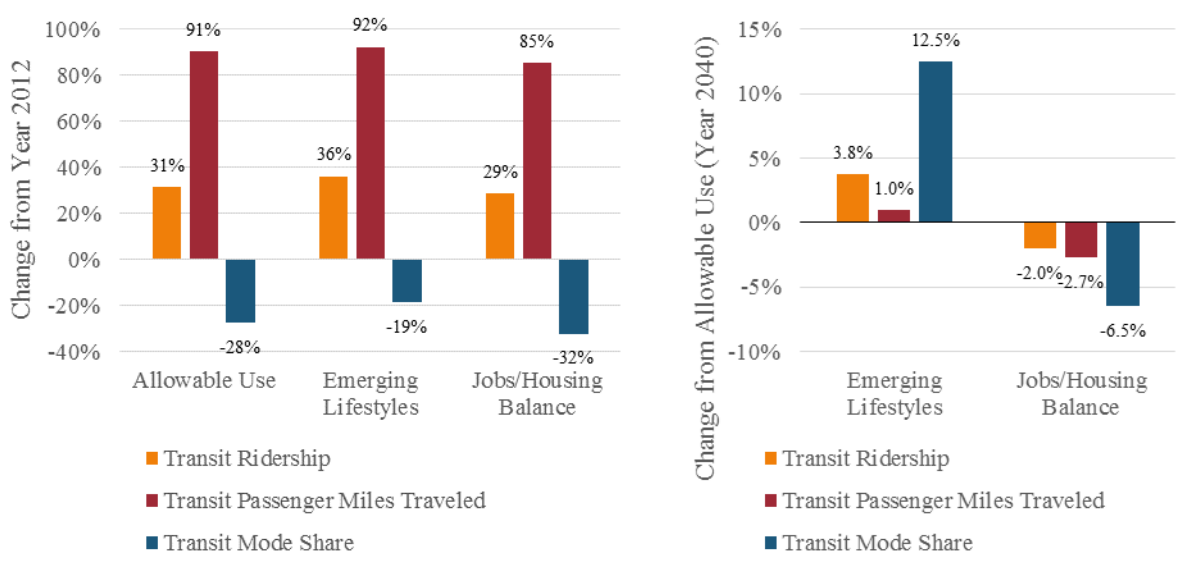


Figure 5. Transit Performance Measures.

3.3.3 Rio Grande River Crossings

The number of trips crossing the Rio Grande, a major bottle neck due to a limited number of bridges, is expected to increase by approximately 225,000 to 280,000 trips per day, a 38 percent to 47 percent increase over year 2012 crossings (Figure 6). This increase in river crossings will result in a large increase in congestion on the river crossings with average volume to capacity ratios (v/c ratios) exceeding 1 for each future scenario. The jobs/housing balance scenario is expected to hold the increase in river crossings to a lower level than the other scenarios with about 6 percent fewer trips than the allowable use scenario and 5 percent fewer trips than the emerging lifestyles scenario.

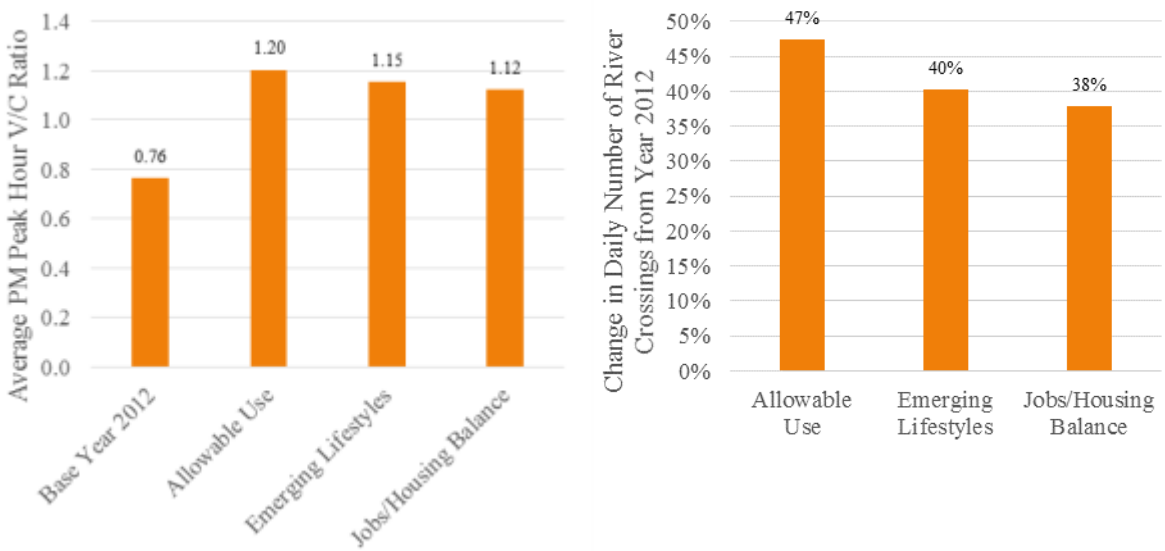


Figure 6. River Crossing Performance Measures.

3.4 Economic Competitiveness

The economic competitiveness of the region was measured by MRCOG using the Regional Economics Modeling, Inc. (REMI) regional macro-economic forecasting model. The model considers changes in congestion levels, among other non-transportation system factors, when forecasting changes in economic growth. Prior research indicates that high levels of regional congestion can slow employment and economic growth[1, 2]. The gross regional product (GRP) per capita, a general measure of the region's wealth, is expected to grow by about 25 percent over current levels (Figure 7). There is no difference in GRP per capita among the three future scenarios in the region, which indicates that the potential drag on economic growth expected from increasing congestion is relatively small compared with other factors driving economic growth in the REMI model.

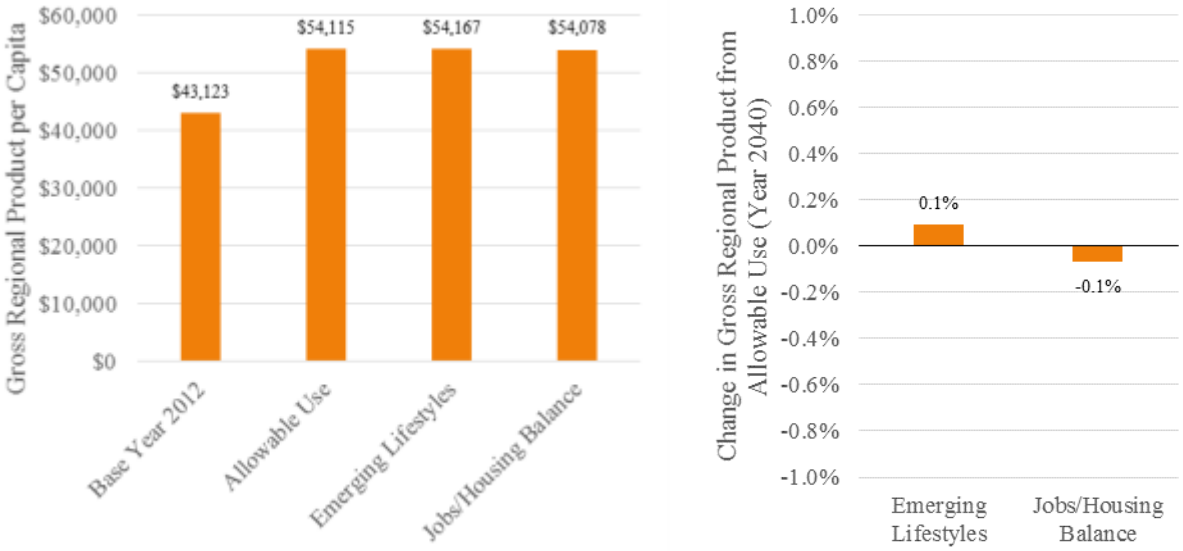


Figure 7. Regional Economic Growth.

3.5 Safety

Safety was evaluated as the crash rate (crashes per 100 million VMT). The crash rate is expected to increase by 87 percent from a crash rate of 550 in 2012 to approximately 1,020 in 2040. There is no significant difference in the crash rate between future year scenarios. MRCOG's crash prediction model does not distinguish between the severity or the type of crashes.

3.6 Sustainability

Several categories of performance measures were evaluated related to environmental sustainability. These are discussed in turn below.

3.6.1 Greenhouse Gas Emissions

Emissions of GHGs, (CO_2, CH_4, and N_2O) were modeled for each scenario. CH_4 and N_2O emissions were then converted to CO_2 equivalents (CO_2-eq) using 100 year global warming potentials (GWP) from the United Nations Framework Convention on Climate Change[3]. BC emissions were also modeled; however, GWPs do not exist for these relatively short lived particles and there is still uncertainty about their net climate forcing affect[4]. Given these uncertainties about black carbon emissions, the project team does not consider them in this analysis. There is a large increase in GHGs from current levels for each of the future scenarios. Increases range from 31 percent to 43 percent (Figure 8). While the total quantity of GHGs increases, GHG per capita declines in each scenario. The decline in per capita GHG emissions is driven almost entirely by the expected increase in average vehicle fleet fuel efficiency over the next 28 years since each scenario results in slower average vehicle speeds (less fuel efficiency and higher emission

rates) and all but the emerging lifestyles scenario cause greater VMT per capita. While still representing a large increase in GHG emissions, the emerging lifestyles scenario results in the lowest amount of GHG emission among the future scenarios (9 percent less than the allowable use scenario).

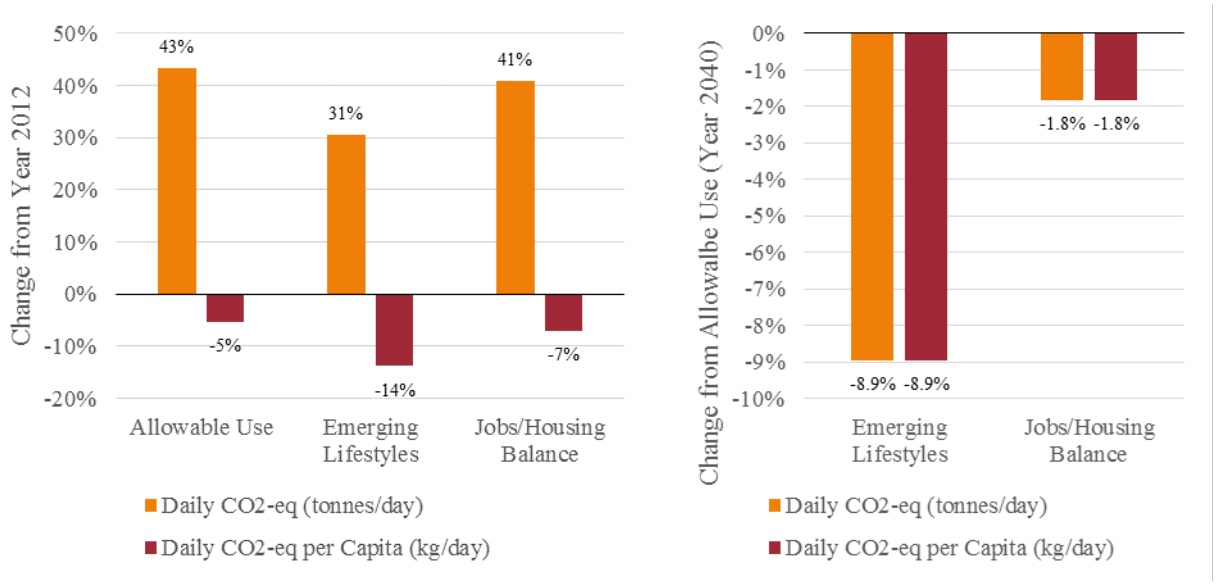


Figure 8. Change in GHG Emissions.

3.6.2 Water Consumption

Water consumption is expected to be influenced by changes in land-use; however, the project team currently only has data from UrbanSim that provides the number of multi-family and single-family dwelling units. The project team does not have information about the change in the extent of commercial, industrial, and agricultural land-use. Furthermore, while the project team has information about the type and number of residential dwelling units, two important factors in determining residential water consumption: the project team does not have consistent information about the size of each residential parcel or any information about the size of the undeveloped, and presumably landscaped and irrigated, area of each residential parcel. The project team has conducted some preliminary analysis of residential water consumption based only on changes in the number of single family and residential dwelling units (see Figure 9). The project team has assumed that water consumption rates do not change from year 2013 levels and the project team has not accounted for any net changes in water consumption that would occur when a parcel is converted from an existing land-use that consumes water to a residential land-use (e.g., from agriculture to single family). Single-family and multi-family water consumption rates are based on the project team's analysis of the Albuquerque Bernalillo County Water Utility Authority (ABCWUA) year 2013 water use calculator that was provided to us by MRCOG. The project team's analysis, considering these limitations, finds that residential water use will increase by about 48 percent over year 2012 levels and that there is virtually no difference in water consumption between the different future year scenarios. If the project team assumes, as the ABCWUA has in their 2024 Water Conservation Plan[5], that per capita water use will decline by 8.9 percent between 2012 and 2024 and that after 2024 per capita water use remains steady, the residential water use would increase by about 36 percent over 2012 levels.

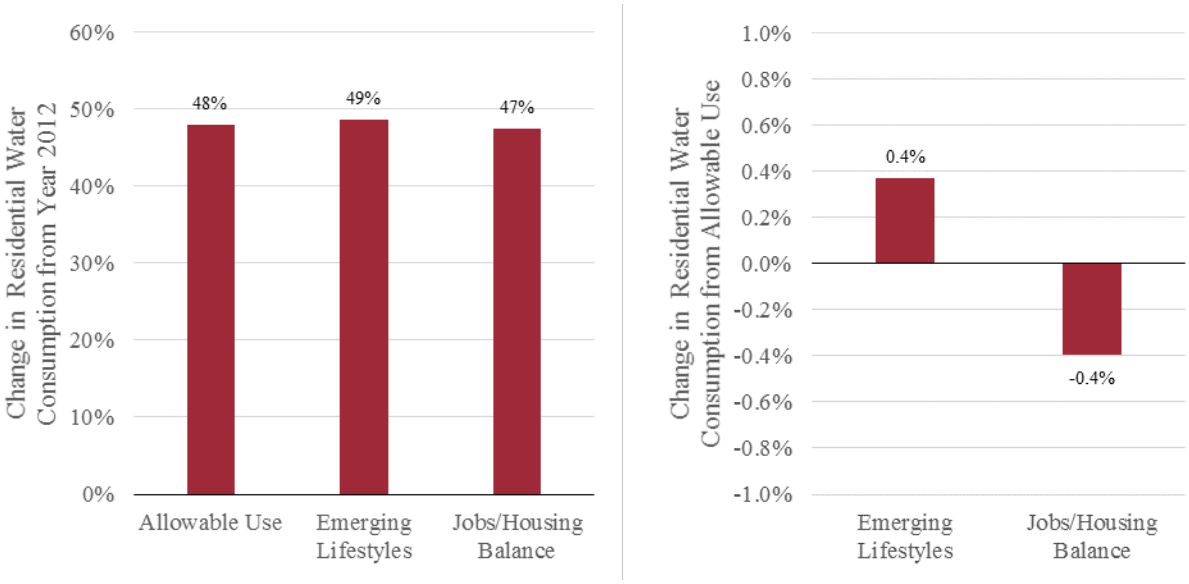


Figure 9. Change in Residential Water Consumption.

3.6.3 Flood Risk

Flood risk was evaluated by mapping areas of FEMA 100 year floodplains in areas of development in each scenario. To create the developed lands layer, the outputs tabulated from each scenario (Allowable Uses, Emerging Lifestyles, and Jobs-Housing) were joined to the parcel layer using the parcel identification field. Once joined, the parcel layer was exported to create a new parcel layer with each scenario. To produce the maps, the parcel data was aggregated up to a 1 km grid to show differences between the modeled scenarios. The figures show the change in 2040 population for the jobs/housing balance and emerging lifestyles scenarios where the allowable use scenario is the baseline for comparison (Figures 10–13). For the emerging lifestyles scenario, development in floodplains appears to increase, but development would occur in already developed floodplain areas and outside the Rio Grande floodplain (Figure 10). For the jobs/housing scenario, there is more sprawl that could occur in undeveloped floodplain areas (Figure 13).

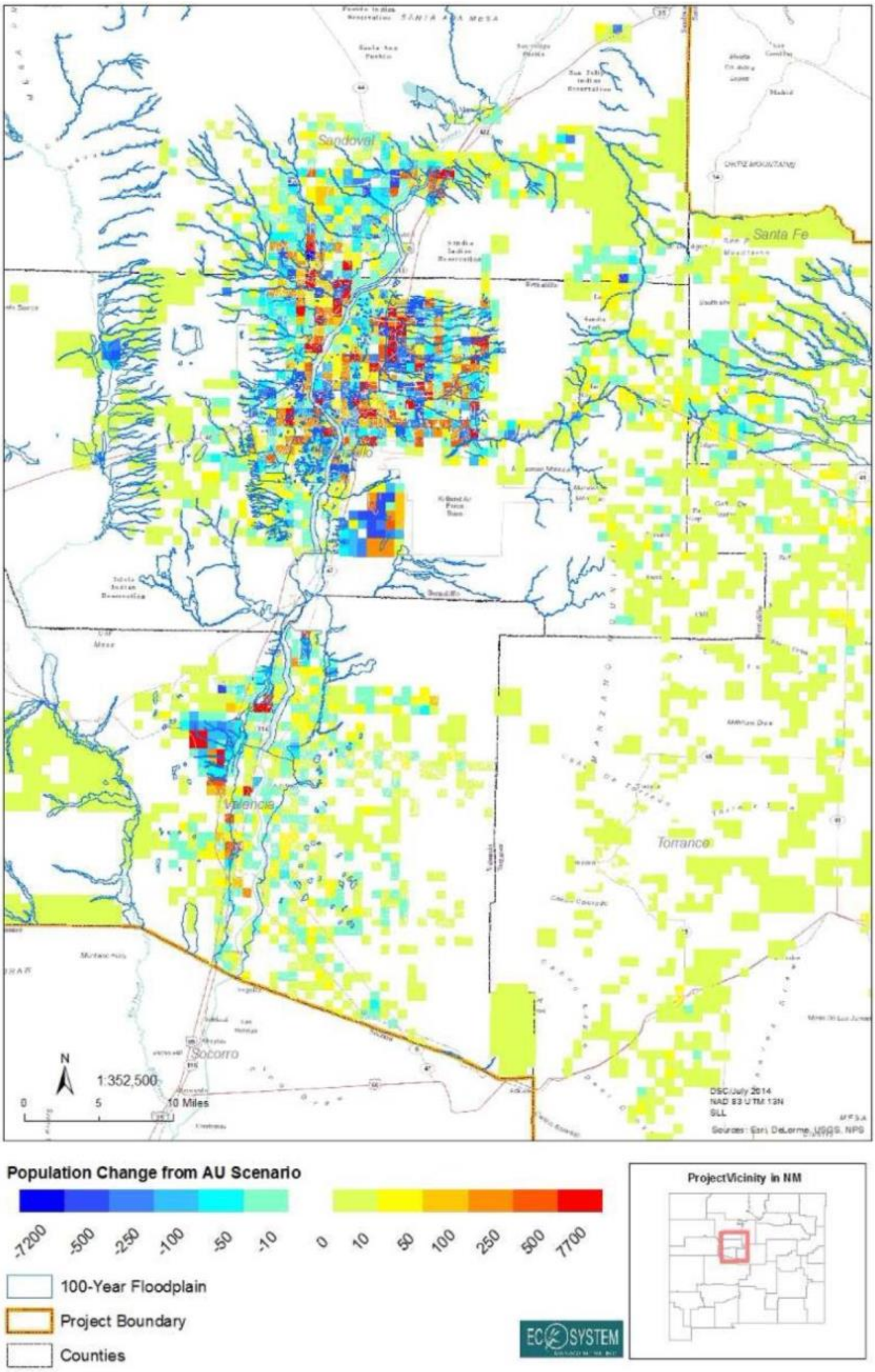


Figure 10. 100-Year Floodplain and Emerging Lifestyles Population Change.

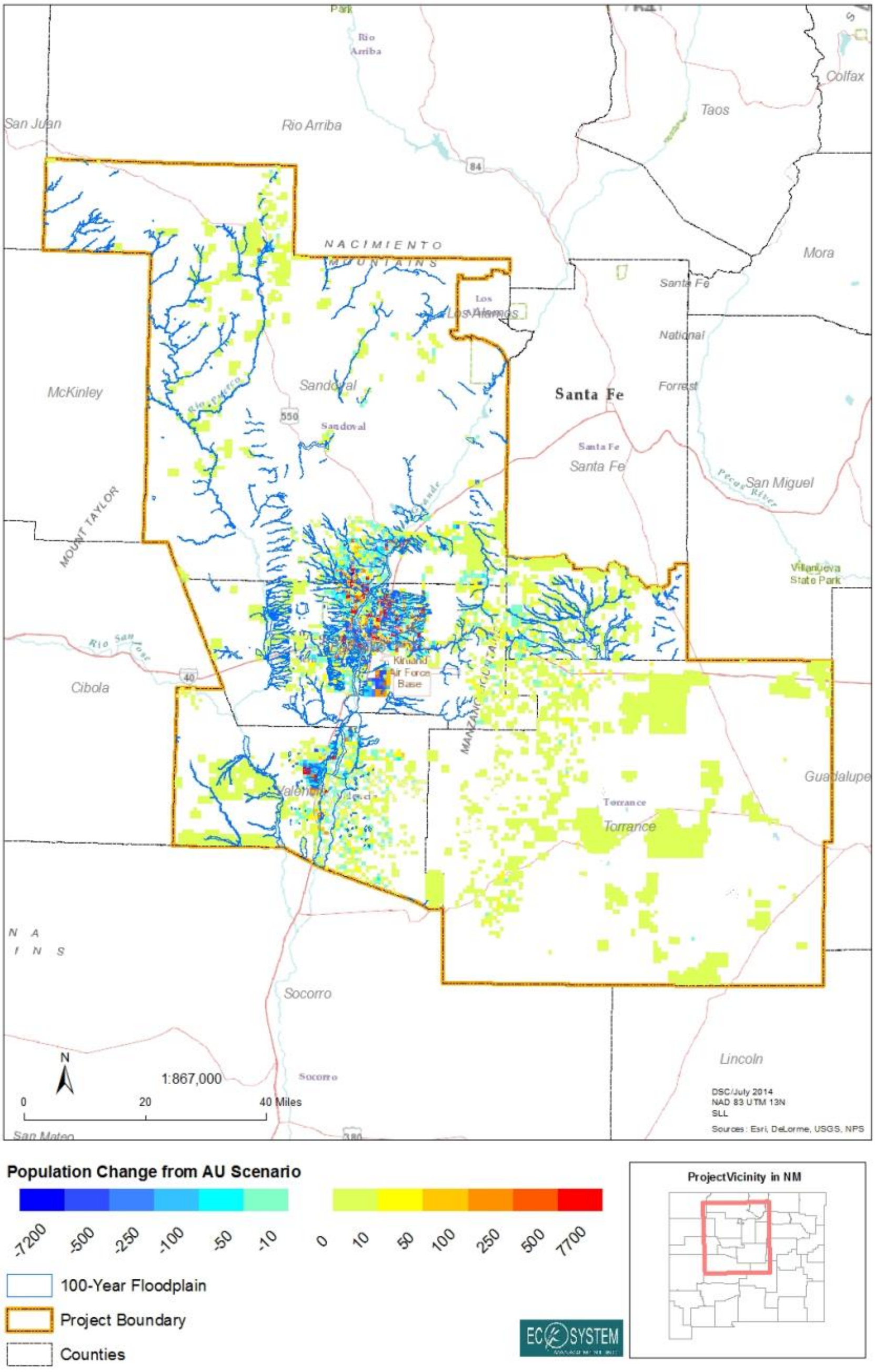


Figure 11. 100-Year Floodplains and Emerging Lifestyles Scenario Population Change Overview.

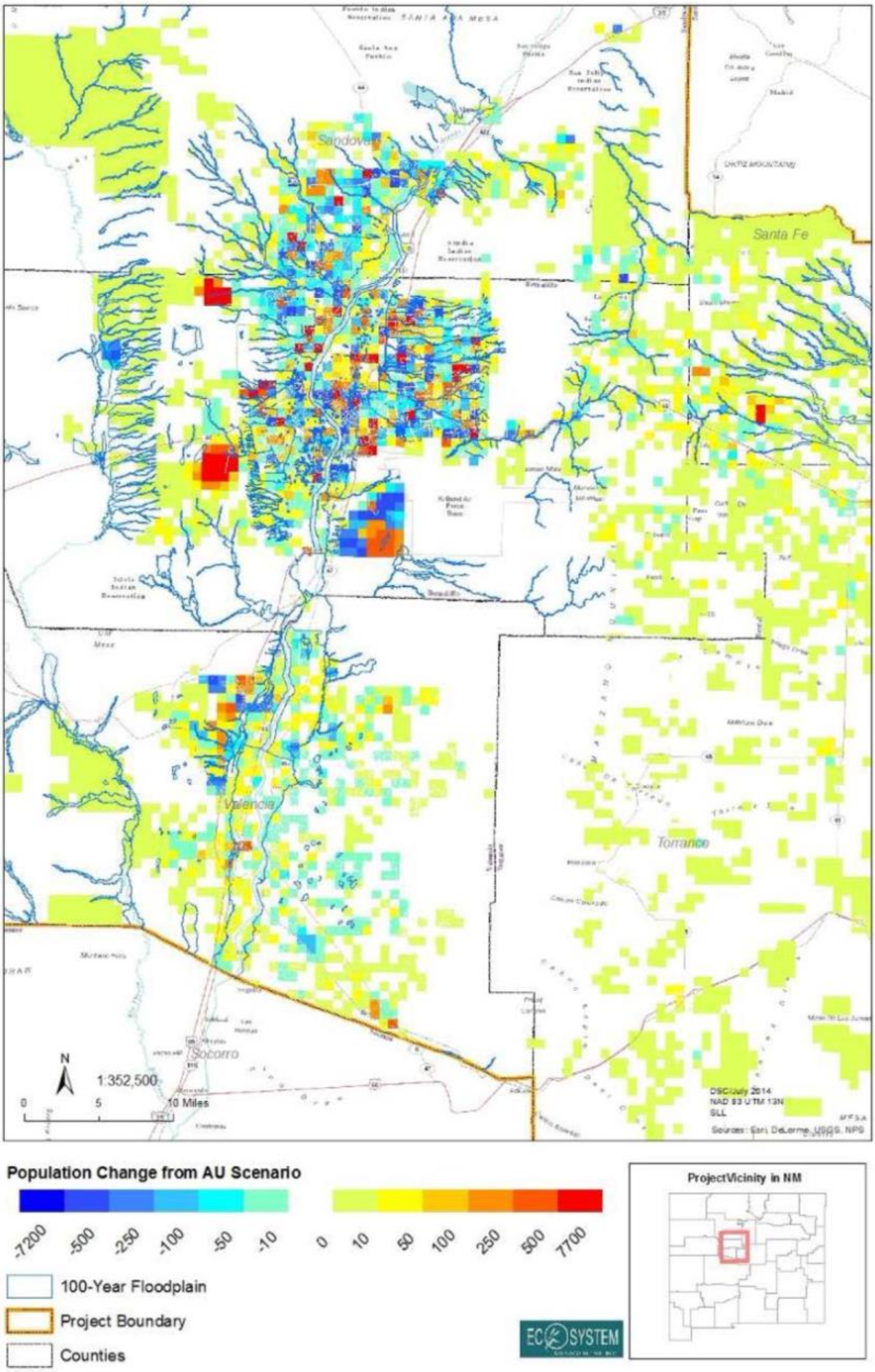


Figure 12. 100-Year Floodplains and Jobs/Housing Scenario Population Change.

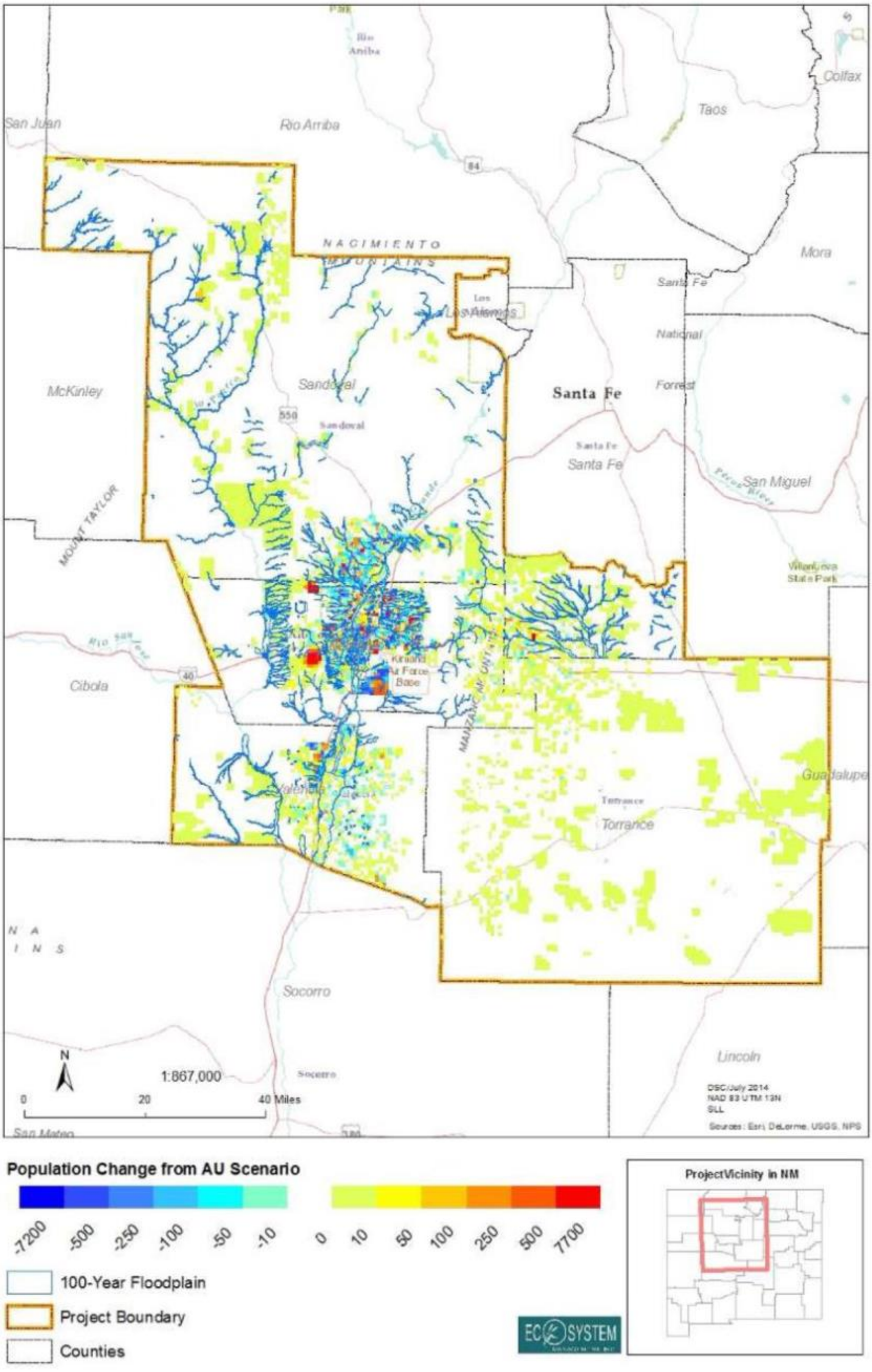


Figure 13. 100-Year Floodplains and Jobs/Housing Scenario Population Change Overview.

The households, household populations, employment, single-family units, multi-family units, and buildings in floodplains in each scenario are shown in Figure 14. This figure shows the percent change between the allowable use scenario compared to the emerging lifestyles and jobs/housing scenarios. The table for the calculation in percent change is in Appendix B Flood Tables.

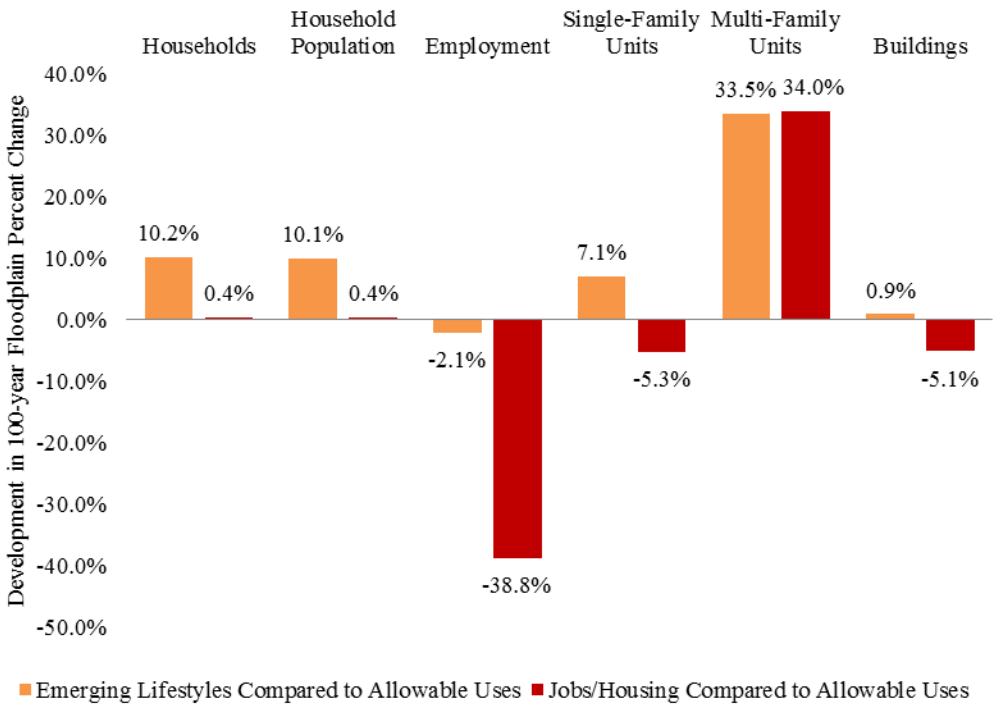


Figure 14. Development in 100-year Floodpain by Scenario.

3.6.4 Wildfire Risk

Wildfire risks was developed by using three modeled fire behavior parameters (rate of spread, flame length, crown fire potential) and one modeled ecological health measure (fire regime condition class) with wildland urban interface areas and ignition probability. Fire behavior parameters were modeled using FlamMap, fire regime condition class was modeled using the Fire Regime Condition Class tool, wildland urban interface areas were delineated using spatial data from the county level community wildfire protection plans within the state, and ignition probabilities were derived using fire history locations from 1987–2008. For a detailed description of each parameter, refer to the data atlas found at All about Watersheds Information Clearinghouse[2]. This data layer identifies areas with a relatively high risk of destructive wildfire. The intent of this layer is to identify areas where forest management is most likely to reduce the risk of wildfire damage (or reduce the impact of wildfire on natural resources, and human infrastructure and development). Areas at risk for wildfire for each scenario were categorized into: 1) wildland urban intermix areas where housing is more than one per 40 acres and 2) wildland urban interface areas with housing and low-density vegetation within fire's reach (1.5 miles) of a large, contiguous block of wildland vegetation. The households, household populations, employment, single-family units, multi-family units, and buildings in areas at risk for wildfire in each scenario are shown in Figures 15 to 17. The graphs compare the emerging lifestyles and jobs/housing scenarios to the allowable uses scenario. These graphs show the percent change in wildfire intermix areas, wildfire interface areas, and the total area. The tables that were used in these calculations can be found in Appendix C Wildfire

[2] "Data Atlas." *All About Watersheds*. New Mexico Forest and Watershed Restoration Institute-New Mexico Highlands University, n.d. Web. 15 Aug. 2014.

Tables. Areas at risk for wildfires for each scenario are show in Figures 18–21. For the jobs/housing scenario, more development would occur more in intermix areas and therefore be at more wildfire risk, where houses and wildland vegetation intermingle, due to more sprawl compared to the emerging lifestyles scenario (Figure 18 and Figure 20).

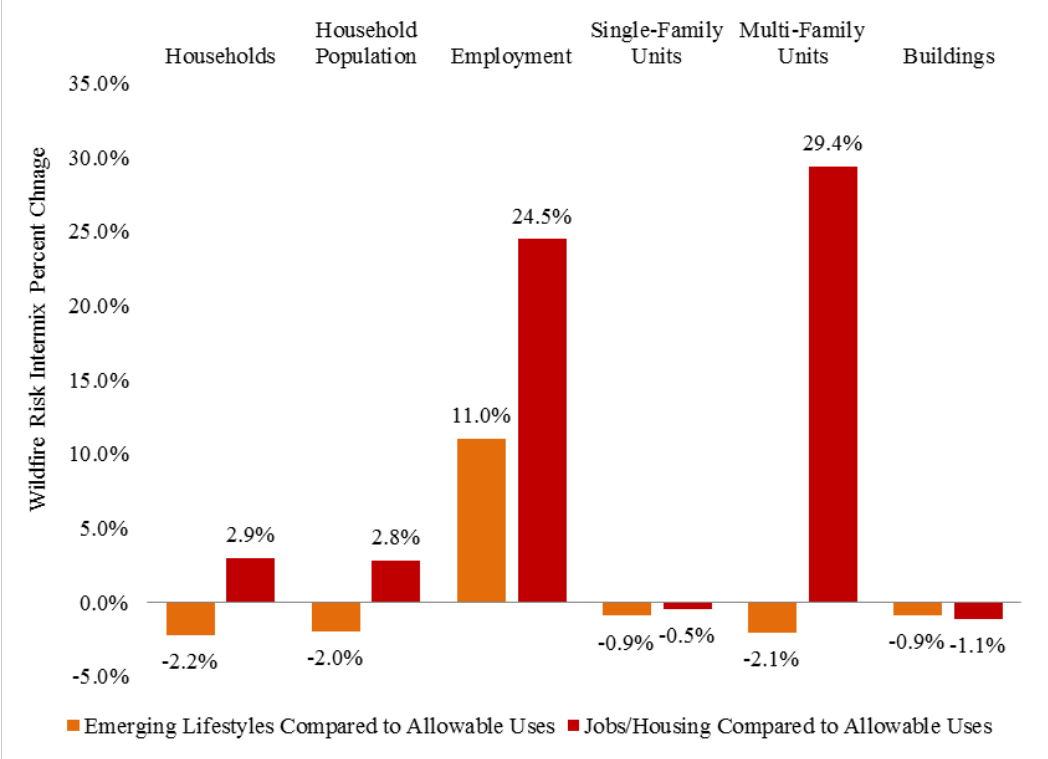


Figure 15. Wildfire Intermix Risk Climate Scenario Analysis.

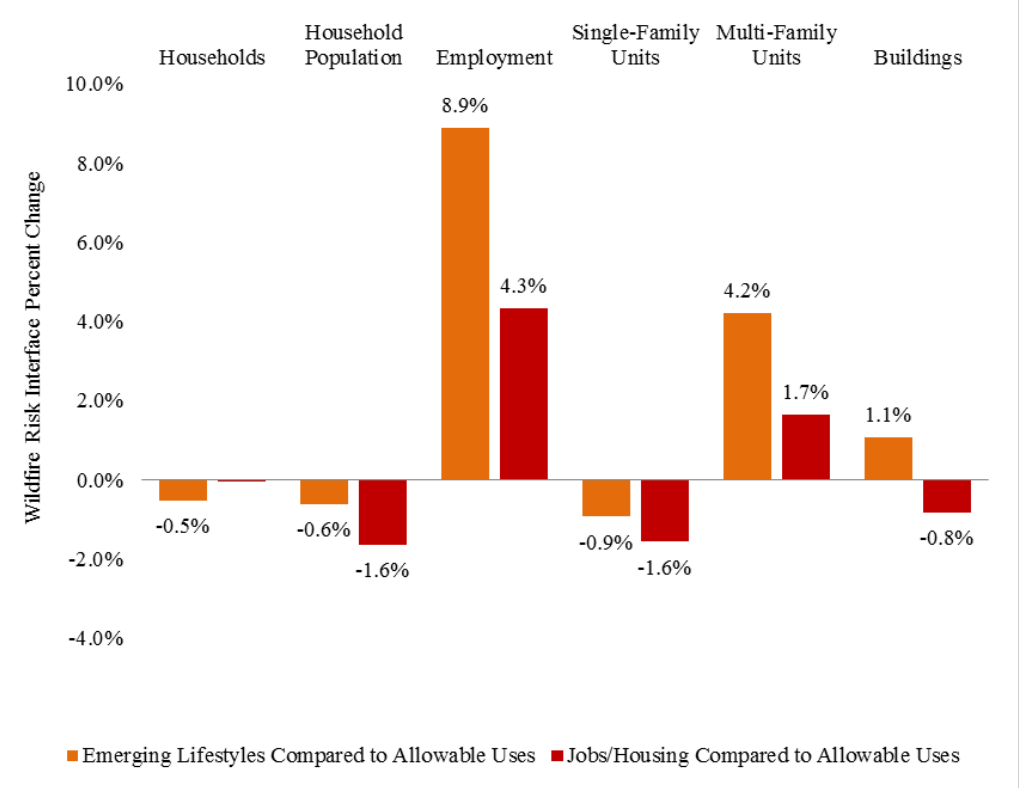


Figure 16. Wildfire Interface Risk Climate Scenario Analysis.

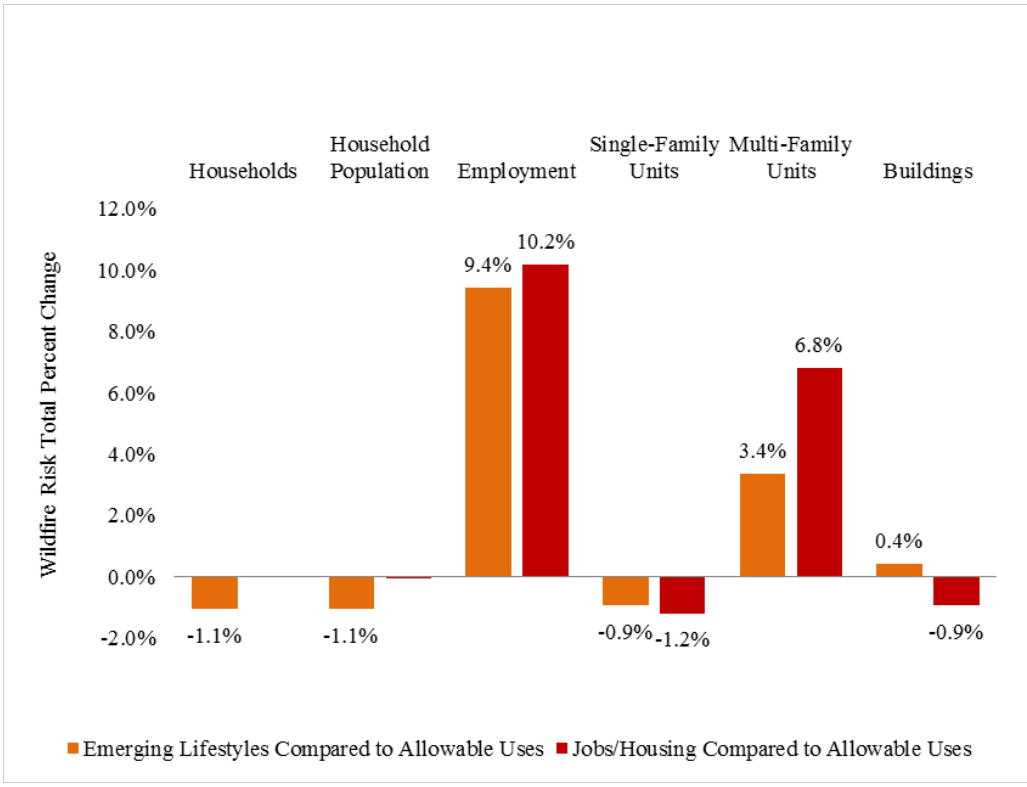


Figure 17. Wildfire Total Risk Climate Scenario Analysis.

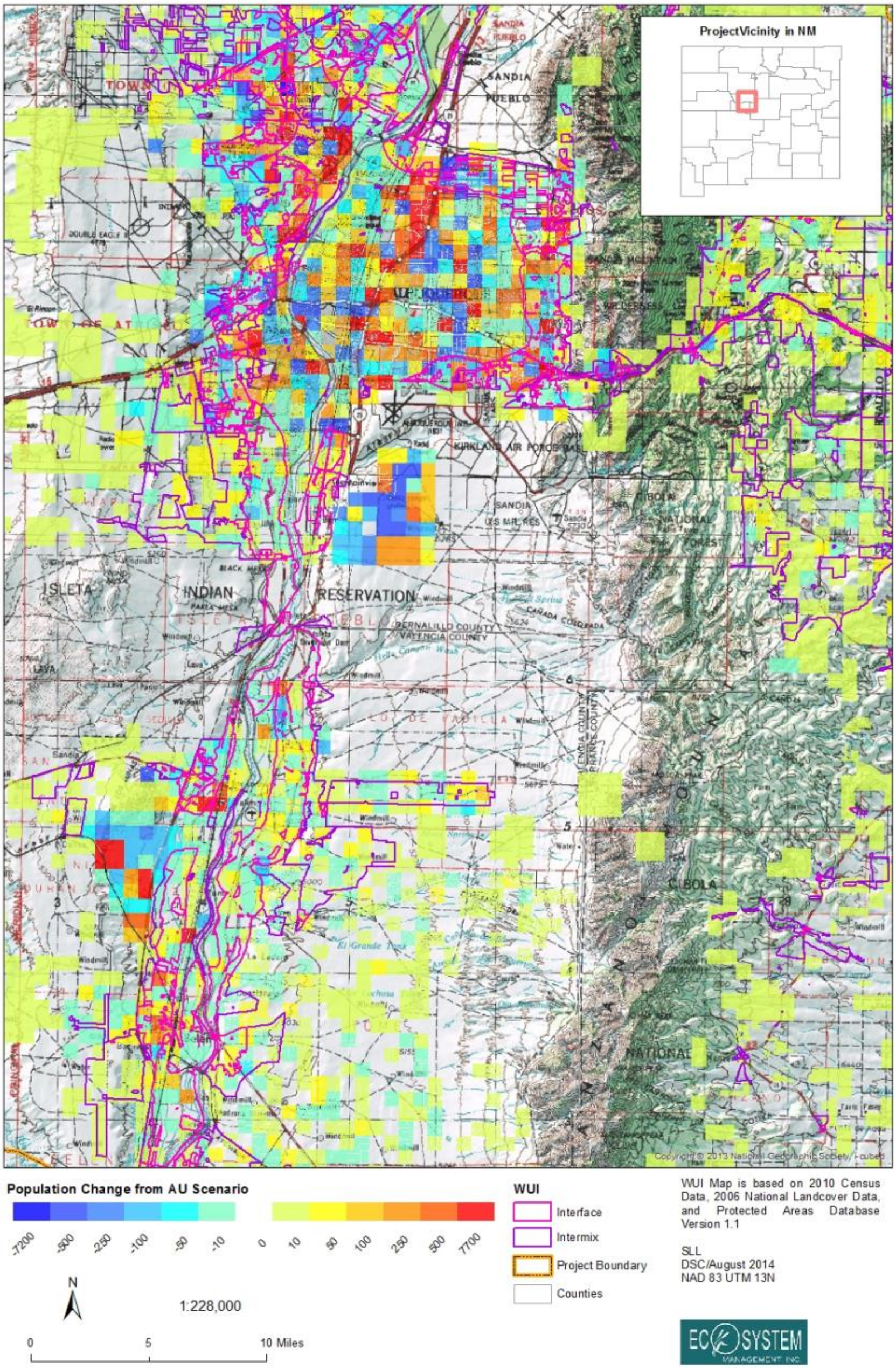


Figure 18. Wildland Urban Interface and Emerging Lifestyles Scenario Population Change.

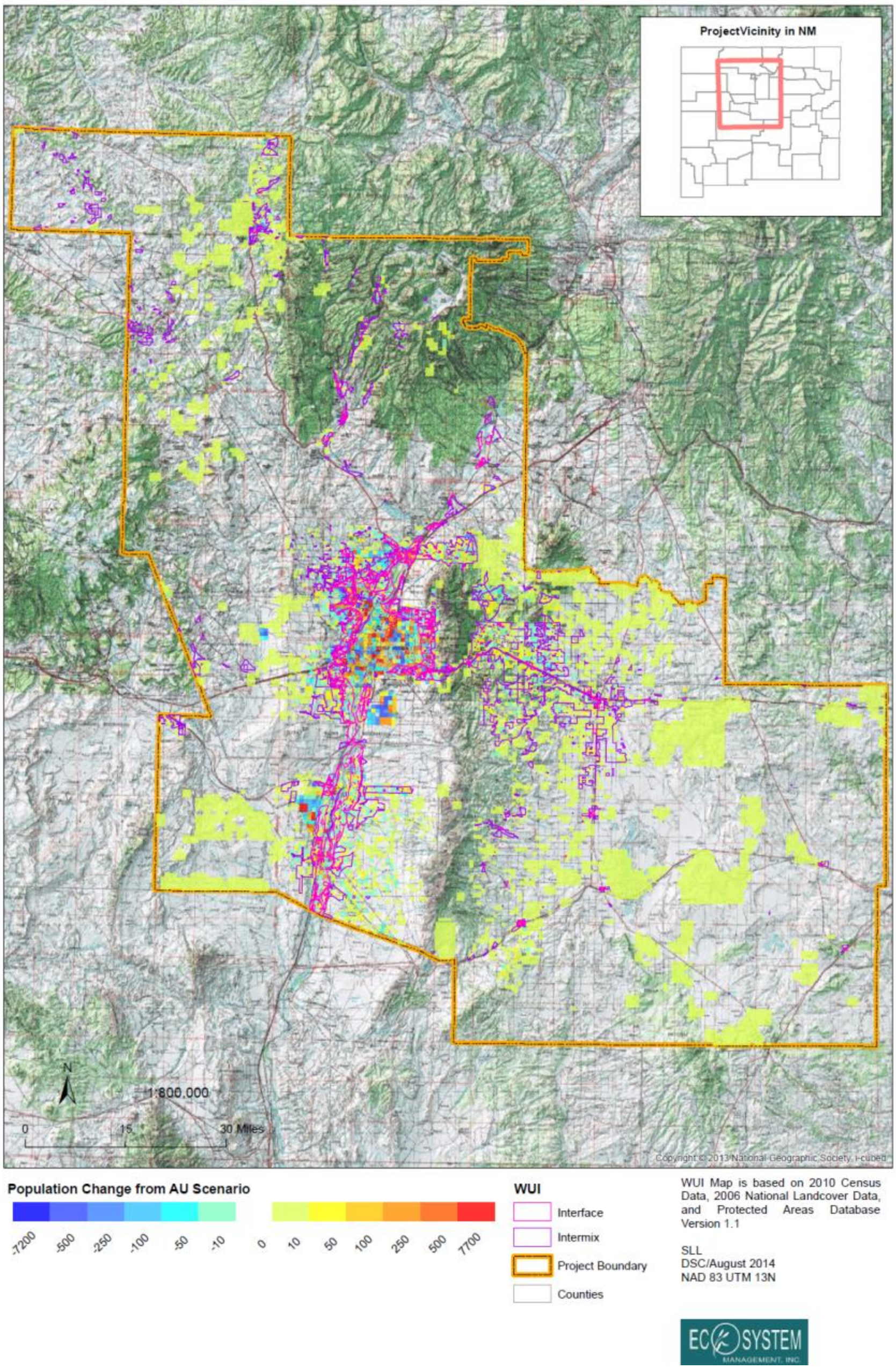


Figure 19. Wildland Urban Interface and Emerging Lifestyles Scenario Population Change Overview.

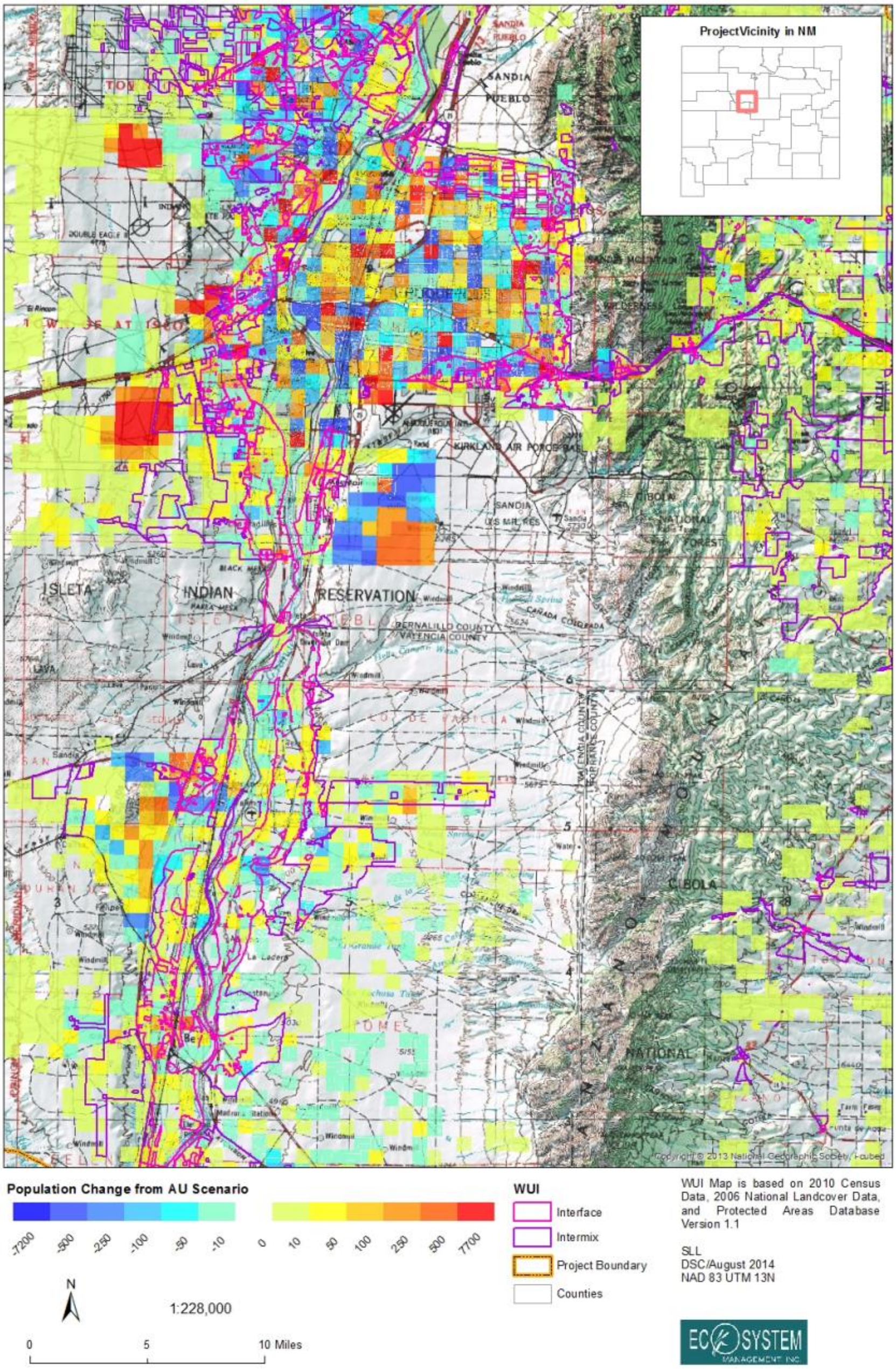


Figure 20. Wildland Urban Interface and Jobs-Housing Scenario Population Change.

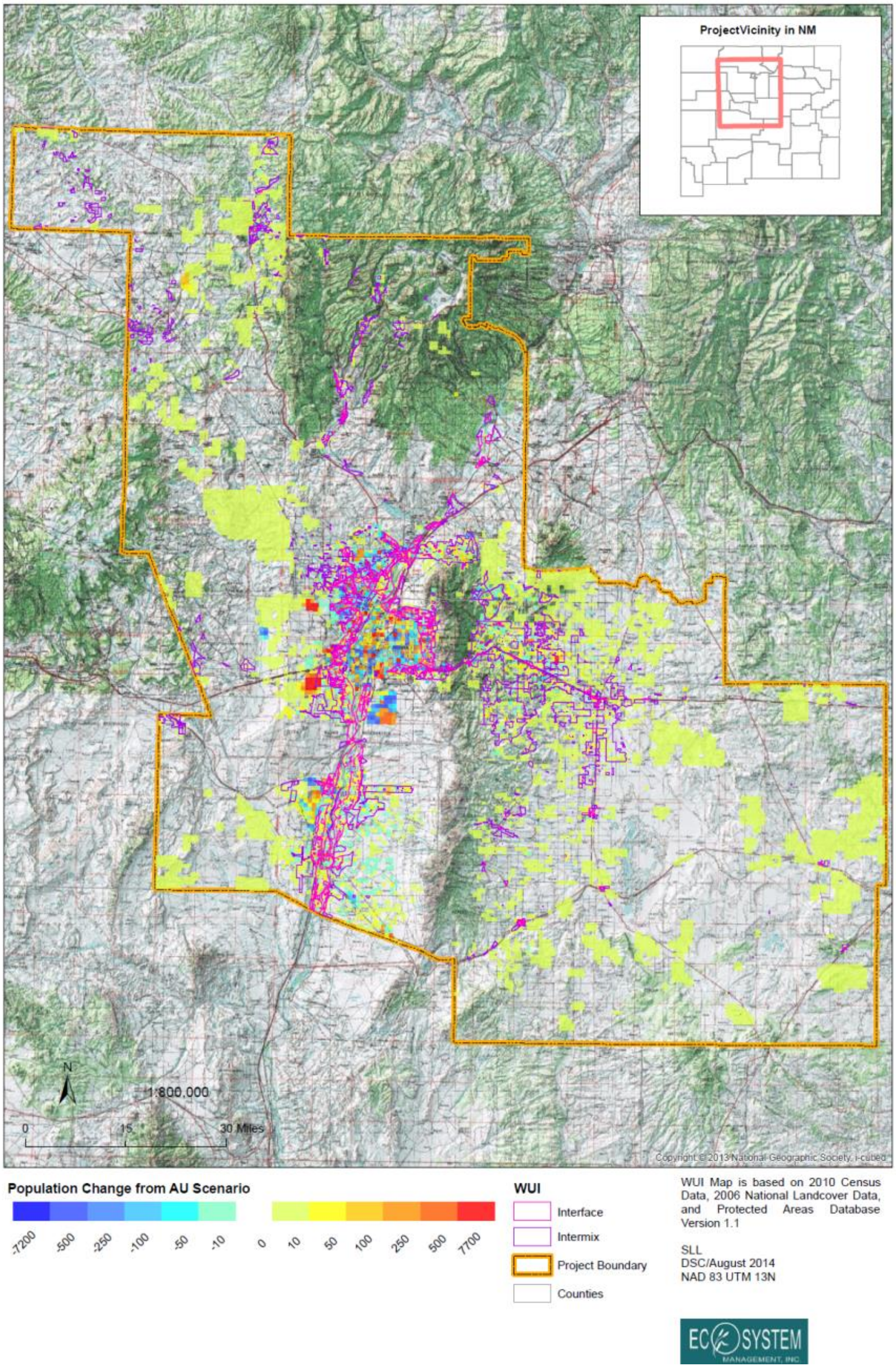


Figure 21. Wildland Urban Interface and Jobs-Housing Scenario Population Change Overview.

3.6.5 Crucial Habitat Areas

Crucial habitat is ranked on a relative scale of 1–6; areas most likely to contain natural resources that contribute to crucial habitat are ranked 1 on the scale with 6 representing areas considered least likely to contain those resources. A weighted score was created by taking the sum of the households and population in each category for ranks 1–3 and multiplying the sum by a value (3x for rank 1; 2x for rank 2; 1x for rank 3). A crucial habitat rank at a square-mile scale is based on:

- Species of concern (animals and plants)
- Wildlife corridors
- Terrestrial species of economic and recreational importance
- Aquatic species of economic and recreational importance
- Freshwater integrity (watershed status)
- Large natural areas
- Natural vegetation communities of concern

The percent change in development by rank is shown in Figures 22–27. Tables showing the numbers for the graphs are in Appendix D Crucial Habitat Tables. Another set of graphs was created to show the percent change of development in the emerging lifestyles and jobs/housing scenarios to development in the allowable use scenario by county (Bernalillo, Sandoval, Santa Fe, Torrance and Valencia counties) and rank; these can be found in Appendix E Crucial Habitats Percent Change by County Graphs. The tables for these calculations can be found in Appendix D Crucial Habitat Tables. Data layers of crucial habitat, obtained from the Western Governors' Association, were overlaid with the developed land layer. Areas of crucial habitat at risk for each scenario are shown in Figures 28 to 31. Development in crucial habitat areas under the allowable use scenario was compared to the emerging lifestyles and jobs/housing scenarios and the percent change was calculated. The emerging lifestyles scenario has more development in crucial habitat compared to the jobs/housing scenario. However, this development would mainly occur in already developed areas, such as Albuquerque and the Town of Alameda (Figure 29).

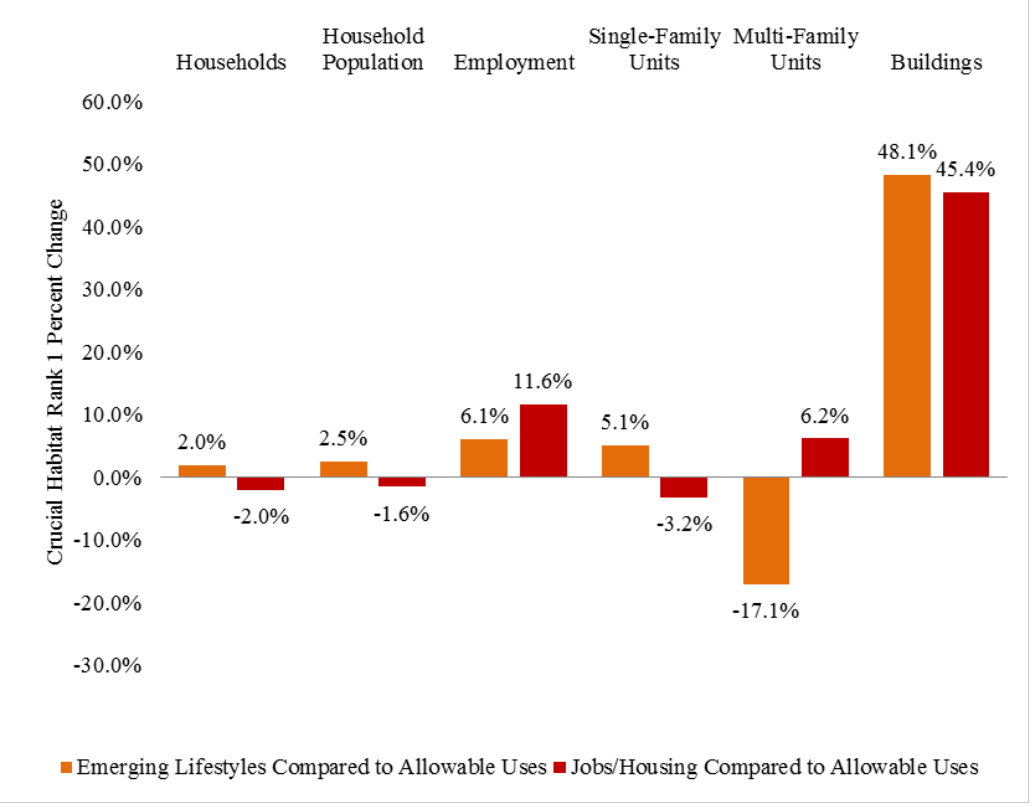


Figure 22. Development in Crucial Habitat Area by Scenario Rank 1.

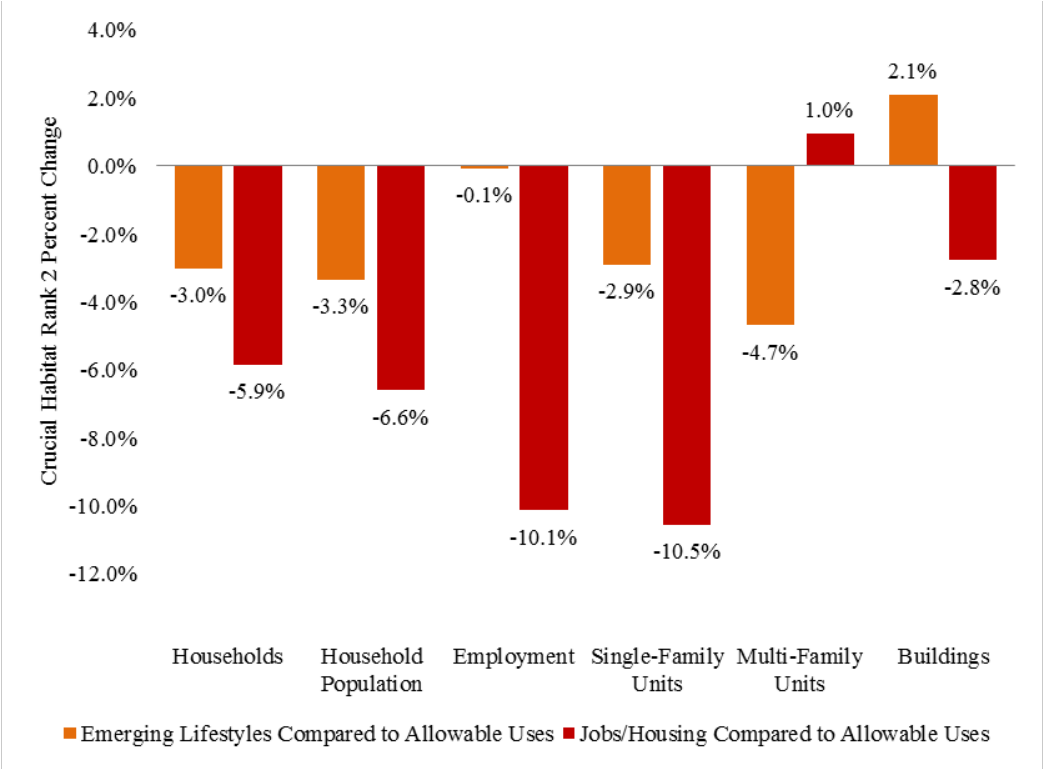


Figure 23. Development in Crucial Habitat Area by Scenario Rank 2.

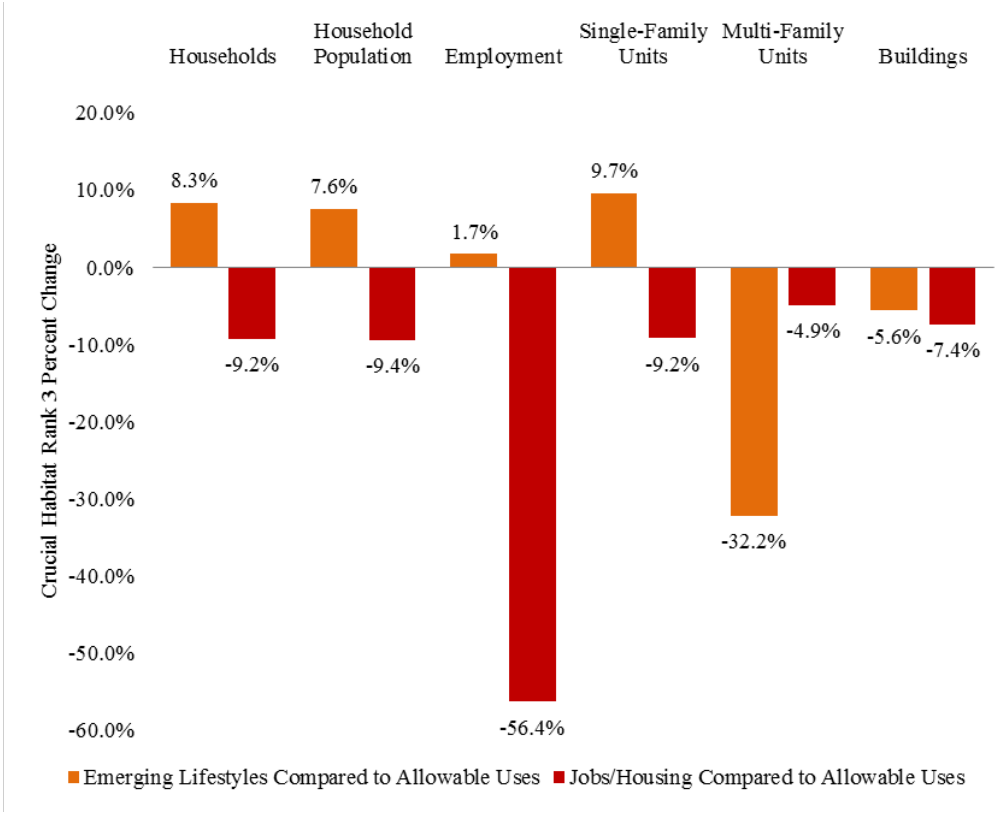


Figure 24. Development in Crucial Habitat Area by Scenario Rank 3.

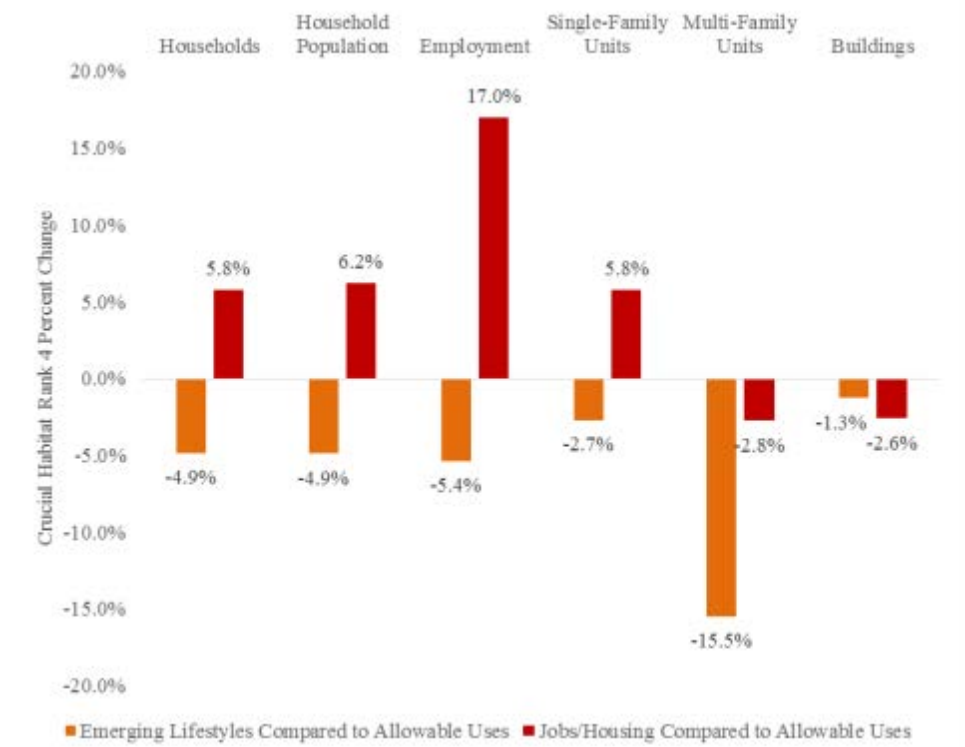


Figure 25. Development in Crucial Habitat Area by Scenario Rank 4.

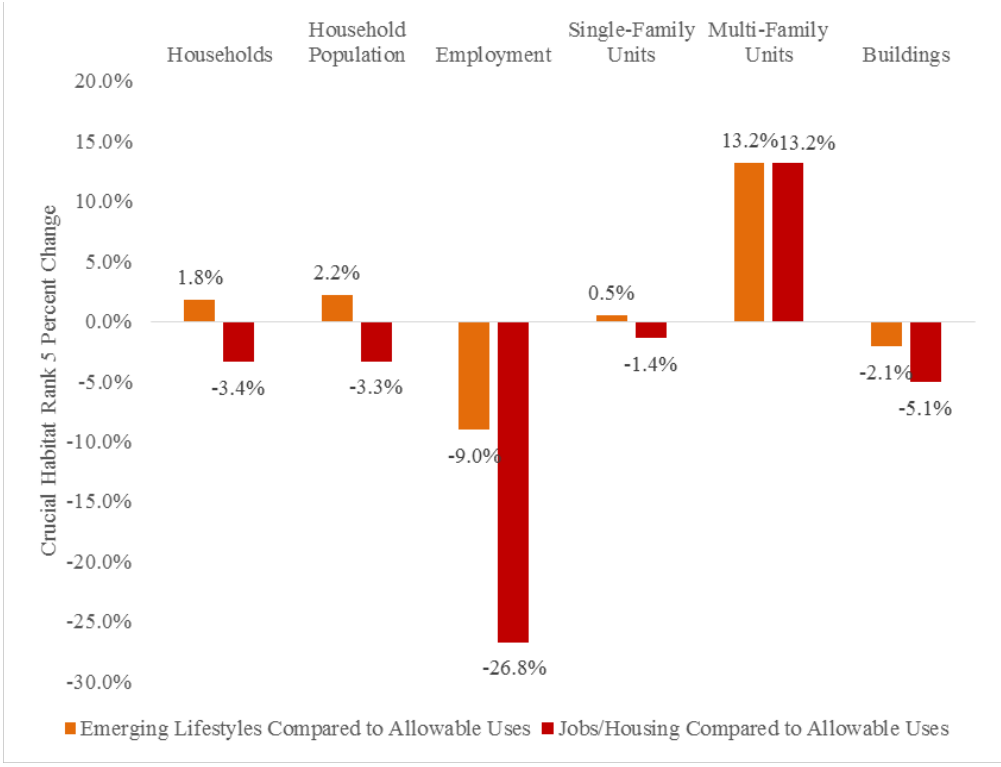


Figure 26. Development in Crucial Habitat Area by Scenario Rank 5.

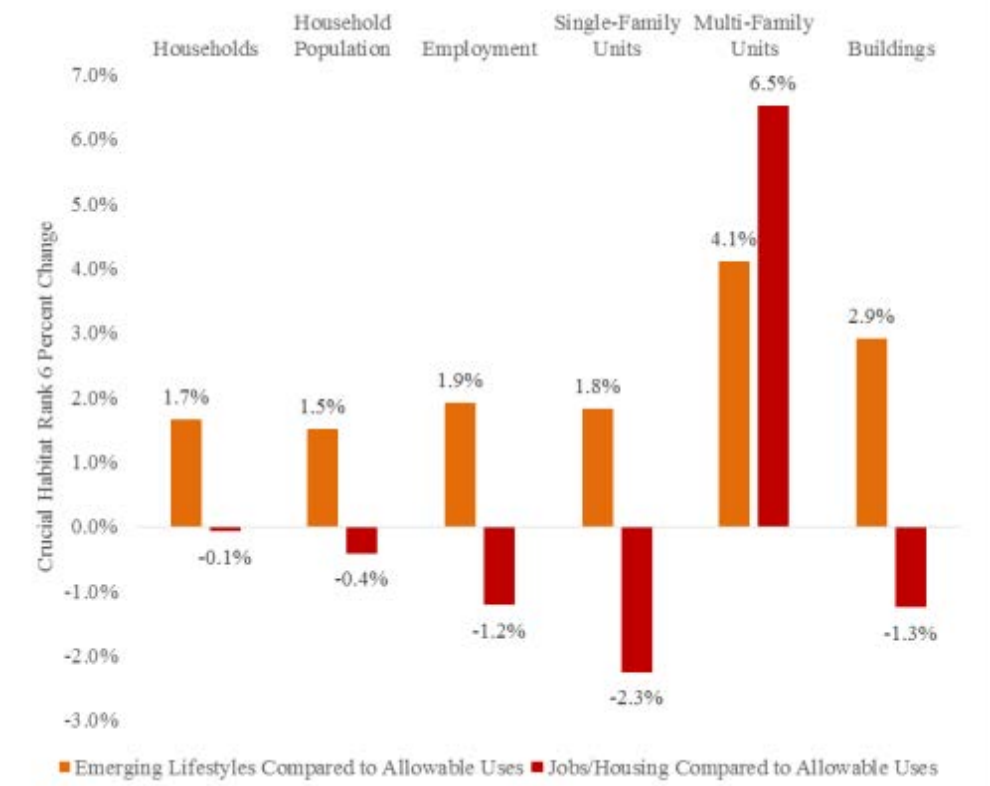


Figure 27. Development in Crucial Habitat Area by Scenario Rank 6.

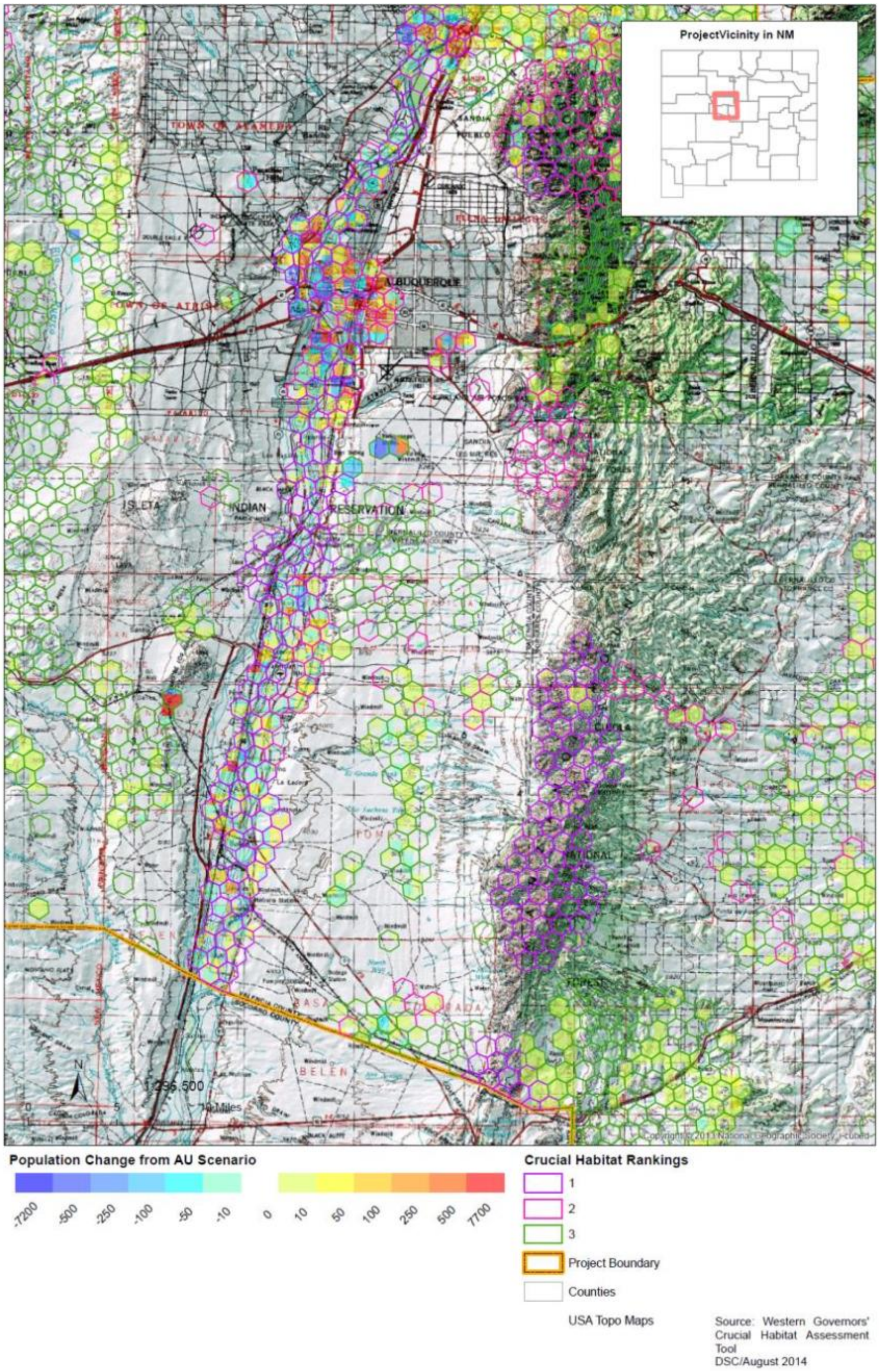


Figure 28. Crucial Habitat and Emerging Lifestyles Scenario Population Change.

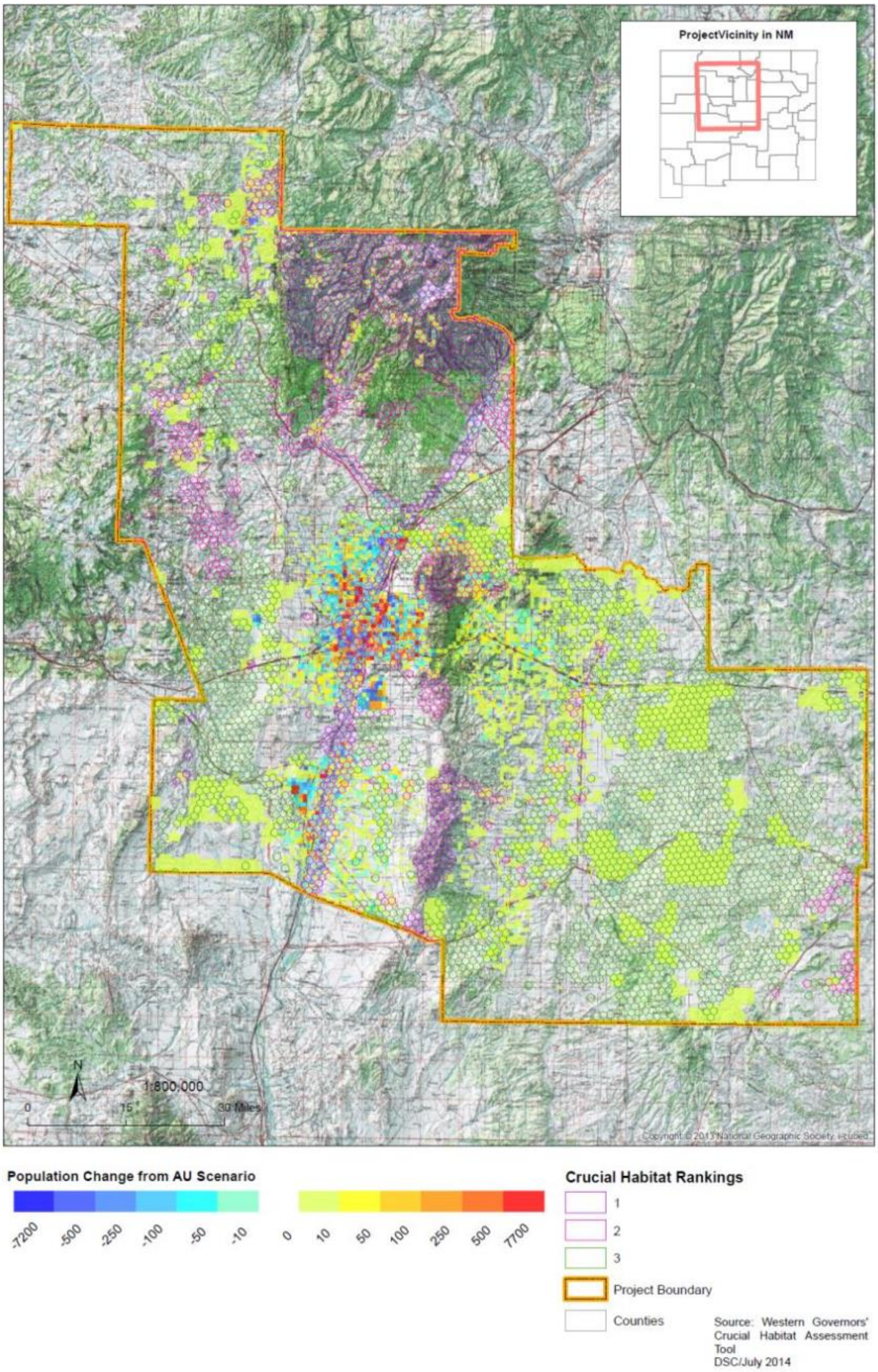


Figure 29. Crucial Habitat and Emerging Lifestyles Scenario Population Change Overview.

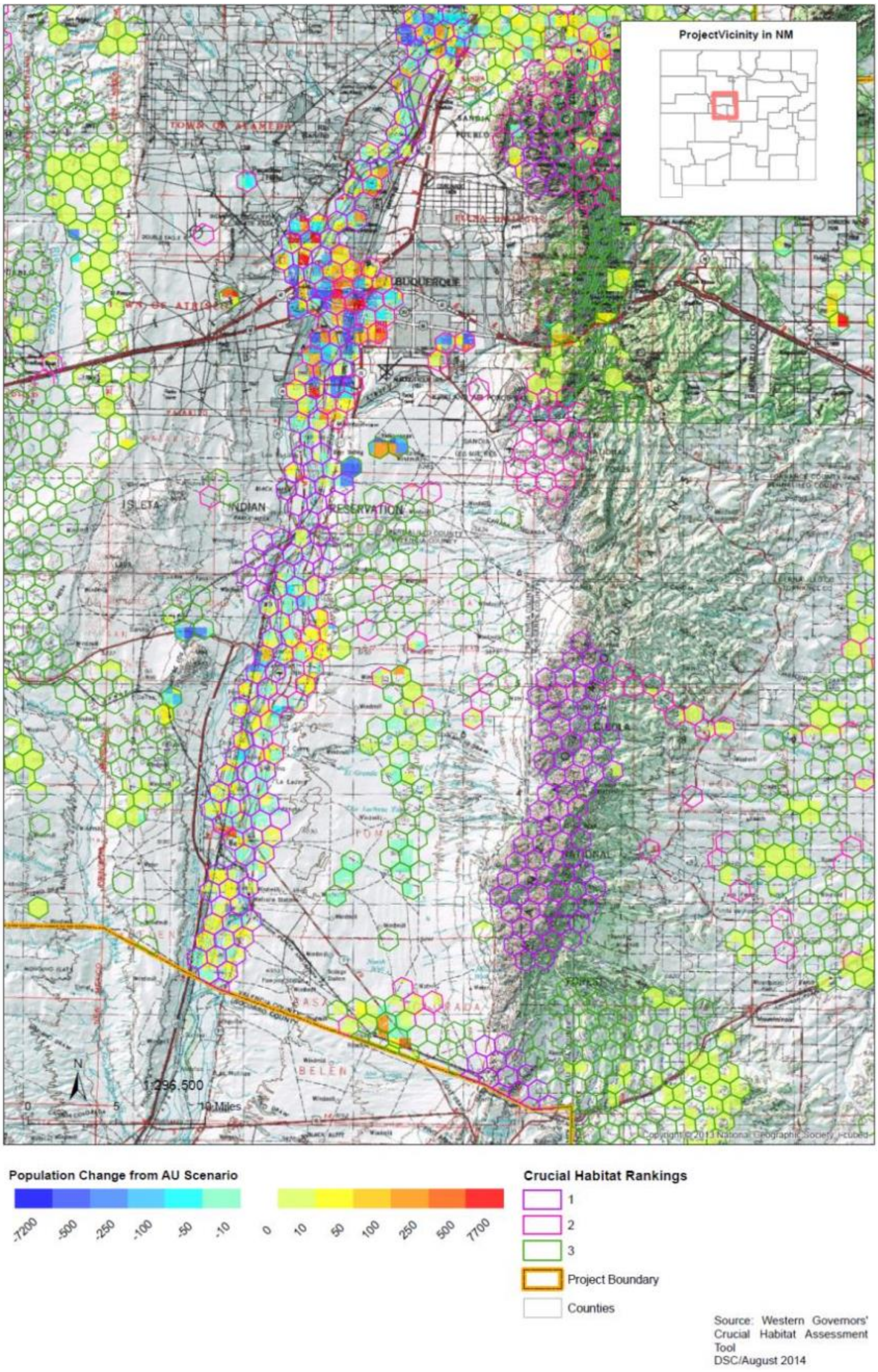


Figure 30. Crucial Habitat and Jobs-Housing Scenario Population Change.

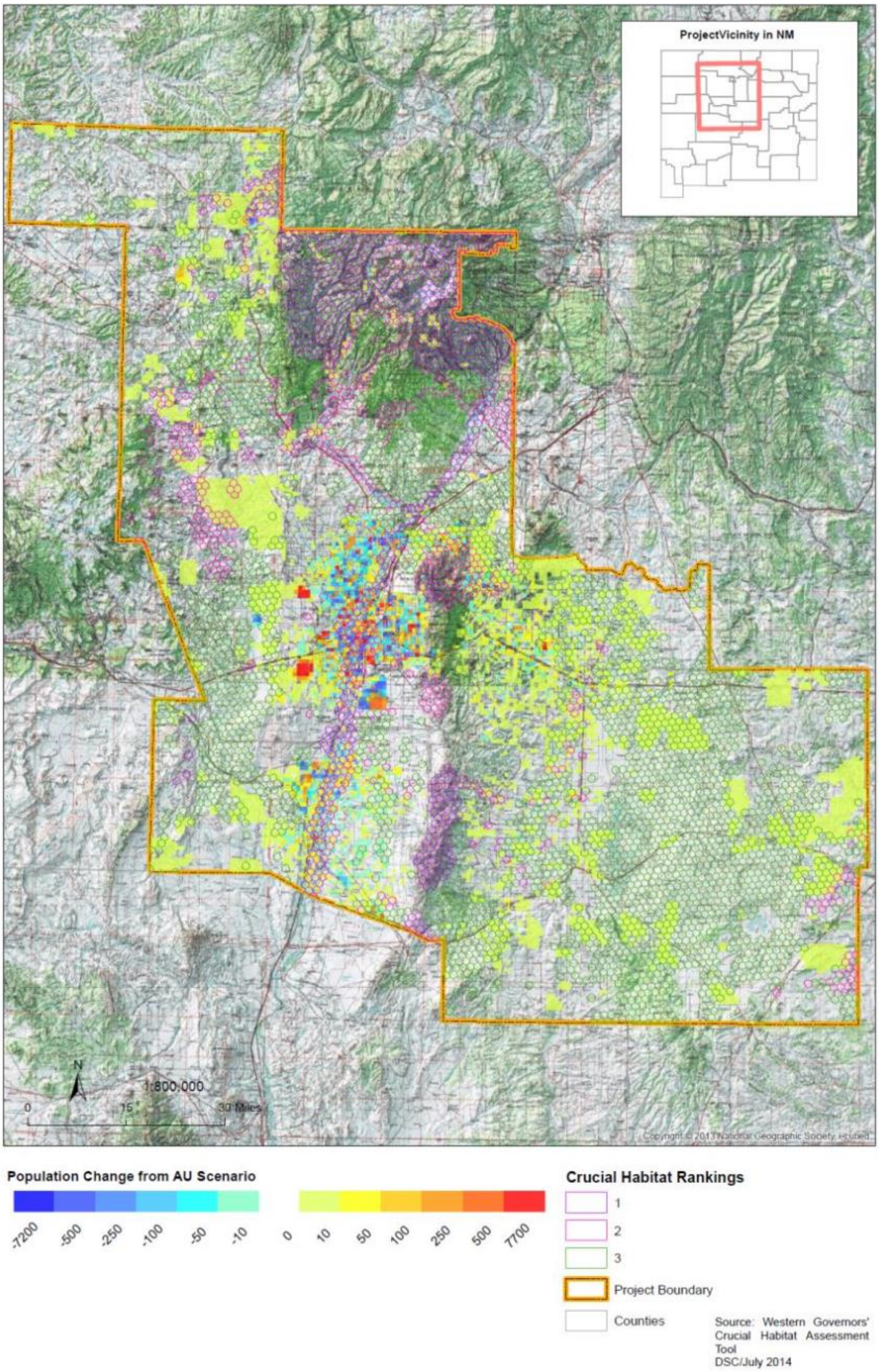


Figure 31. Crucial Habitat and Jobs-Housing Scenario Population Change Overview.

3.7 Resiliency

Resiliency refers to the ability of a system to withstand a shock. A recent executive order defines resiliency to climate change more specifically as the "…ability to anticipate, prepare for, and adapt to changing conditions and withstand, respond to, and recover rapidly from disruptions."[3] The task 1.1 and 1.2 memos discuss the various threats posed by a changing climate and the resiliency of various natural and engineered systems. For this task, the relative resiliency of each future land-use scenario was analyzed. While the task 1.2 memo provides a long list of resiliency considerations, only a subset are considered here. The reason for this limited assessment of resiliency is that the three scenarios are largely conceptual and do not provide detail about specific design considerations that may make particular scenarios more or less resilient to climate change. For example, the scenarios do not indicate if permeable pavements will be used to reduce runoff and improve ground water recharge or if new bridges may be designed to withstand larger floods. The resiliency analysis in this section only considers changes in the performance measures discussed above or included in the appendix.

The resiliency of each scenario is considered with respect to the expected change in the metropolitan area's climate. The Volpe Center provided analysis based on downscaled coupled model intercomparison project phase 3 (CMIP3) climate data that indicates the region is likely to become warmer with more frequent and longer heat waves. The modeling was less certain about precipitation. The region is slightly more likely to receive less precipitation but also expected to become drier even if there is more precipitation because of higher temperatures, which will increase evapotranspiration. Greater precipitation could, however, still increase flood risk even if it does not increase water supply. Figure 32 shows five potential climate futures based on global climate model runs for the region.

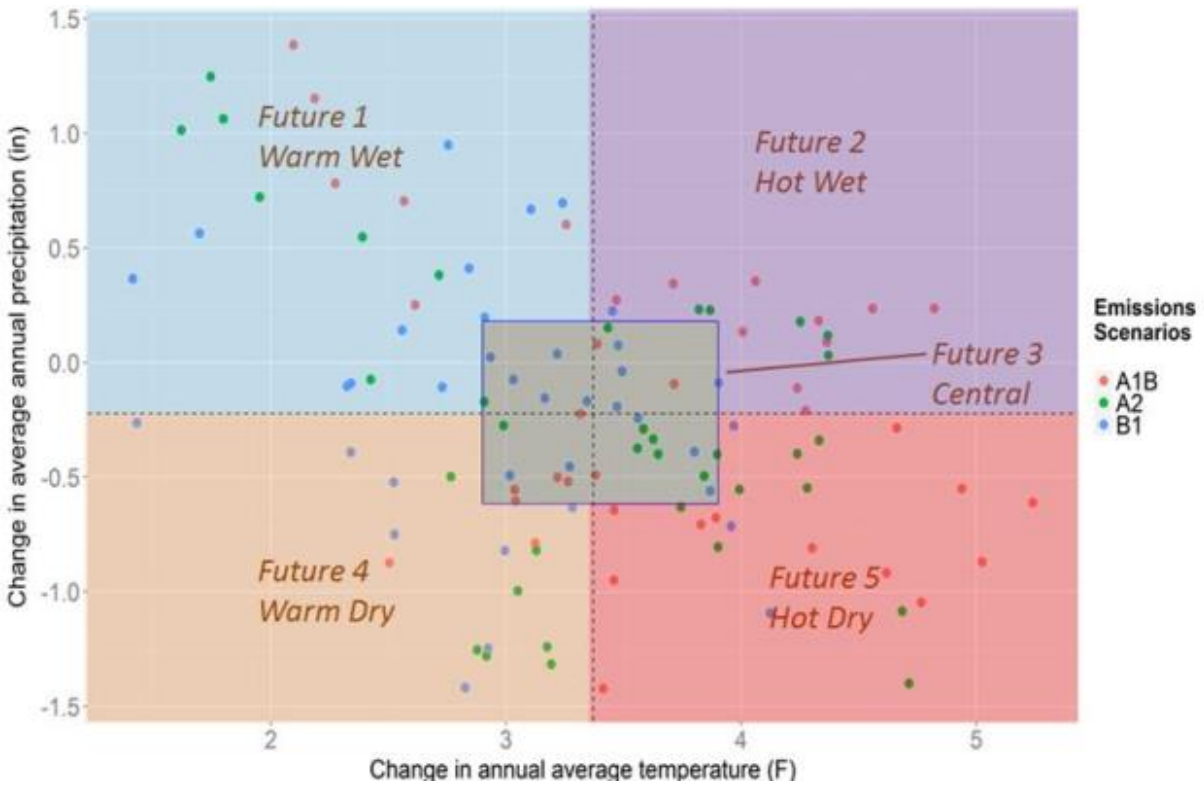


Figure 32. Summary of Global Climate Model Runs for the Year 2040 for Central New Mexico.

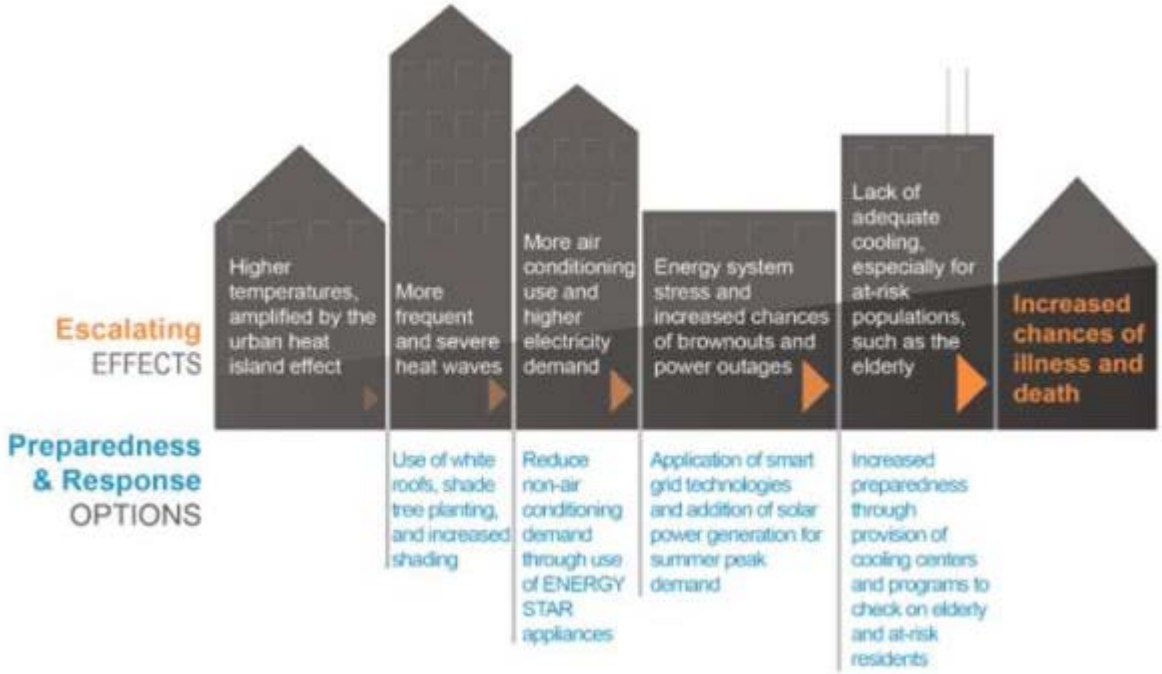
[3] 11/1/2013 Executive Order --Preparing the United States for the Impacts of Climate Change

Each land-use scenario was evaluated for its resiliency to an expected increase in temperature and the potential for a drier climate where there will be prolonged drought and also the potential for greater precipitation, which could increase flood risk. The Volpe Center modeled climate future plots for MRCOG-identified priority cells. The analysis found that maximum 24-hour precipitation events are predicted to increase more at higher elevations and that total days over 100 degrees Fahrenheit are predicted to increase more at lower elevations. Resiliency was considered along five dimensions: urban heat, drought, flooding, wildfire, crucial wildlife habitat.

3.7.1 Urban Heat

Two factors are expected to drive increasing temperatures: climate change driven by increasing concentrations of GHGs and an increasing urban heat island driven by development of currently undeveloped land. Each of the future scenarios will increased the region's development footprint by 48 percent to 50 percent over year 2012 levels and each scenario also includes a 12 percent increase in roadway land miles. This represents a large increase in development and is likely to lead to a larger and more intense urban heat island in the greater Albuquerque area. The small differences in land development between the three scenarios will not cause much change in the urban heat island unless other mitigating actions are taken (see task 1.2 memo). Additionally, each scenario will result in a large increase in GHG emissions over year 2012 levels as shown in Figure 8.

One of the main threats of increasing urban heat is public health (Figure 33). Extreme temperatures and prolonged heat waves are associated with an increase in deaths and other negative health outcomes[4]. Each of the scenarios will result in increased urban heat and therefore an increased threat to public health. Since each scenario is expected to experience similar increases in urban heat and each scenario has the same population, there is no significant difference in the population's resiliency to urban heat health impacts between the conceptual scenarios.



Graphic courtesy of National Climate Assessment

Figure 33. Urban Heat and Public Health.

[4] http://www.bt.cdc.gov/disasters/extremeheat/heat_guide.asp

The other main threat of urban heat is damage to transportation infrastructure. Increasing temperatures can cause failure (buckling) of railway tracks and accelerate the deterioration of roadway and parking lot pavements. The failure of railway tracks and deterioration of pavements represents an increase in transportation infrastructure maintenance costs. Since each of the future scenarios are expected to increase urban heat, transportation system maintenance costs are expected to increase over today's level. Since each scenario is expected to experience similar increases in heat and each has the same transportation infrastructure, there is no significant difference in their infrastructure resiliency to urban heat impacts.

3.7.2 Drought

While less precipitation is slightly more likely than more, increasing temperatures are likely to increase drought conditions and limit water availability under any of the potential climate futures. This occurs since higher temperatures will increase evaporation which can offset water gained by an increase in precipitation. Each of the future land-use scenarios can be evaluated for their resiliency to drought in two ways, their effect on water supply and their effect on water consumption. The main factor affecting water supply is the development footprint of the metropolitan area. Impervious surfaces such as buildings and paved roadways decrease the amount of land-area available for rain water to penetrate the surface and replenish ground water resources. As discussed in section 3.2 and shown in Figure 4, the amount of paved roadways and developed land increases for all future scenarios. This will reduce the amount of land area available for rain water to recharge ground water resources.

The main factor affecting water consumption is land-use. Commercial, industrial, agricultural, and residential land-uses consume more water than unirrigated range lands and undeveloped land. As discussed in section 3.6.2, the necessary data to fully evaluate how each scenario will affect water consumption is currently not available. The preliminary analysis of residential water consumption indicates a 48 percent increase in residential water consumption that is approximately equal for each of the three scenarios (see Figure 9).

Since water consumption is expected to increase and water supply is expected to decrease, the metropolitan region under any of the scenarios will be less resilient to drought in the future. The three future scenarios are very similar regarding performance metrics related to drought resilience; however, the emerging lifestyles scenario consumes slightly less land (see Figure 4) and would therefore be the most resilient. A more detailed analysis of water consumption would provide a more robust drought resilience analysis. The current analysis does not consider the amount of irrigable land (undeveloped land) on each lot or what type of land-use occurs on non-residential lots.

3.7.3 Flooding

As the probability of extreme precipitation events may increase with climate change, the risk of floods may also increase. Since the footprint of development in the 100-year floodplains increases in all scenarios, the metropolitan region under any of the scenarios will be less resilient to floods in the future.

Decisions about the location of development and the design of transportation facilities and buildings in addition to the density of development will affect flood damages and therefore flood resilience. Flooding in Albuquerque, the most populous part of the region, originates from the Rio Grande and/or from high-intensity short-duration thunderstorms which create relatively high peak flows but low volumes of water (New Mexico Floodplain Managers Association 2003). Flood risks in Sandoval and Torrance Counties are also generally related to extreme rainfall events. Valencia County had historical problems caused by the Rio Grande, but these have been resolved following levee construction. Development and infrastructure in the existing floodplains may be at greater risk from flooding where there is no protection from levees.

Locating (or relocating) transportation infrastructure outside of or above high flood-risk areas (as feasible) can reduce damages to transportation infrastructure. This strategy may be particularly important for facilities that are crucial for evacuation, safety, or economic purposes. Several transportation practices

can reduce the potential for localized flooding, thereby reducing damages to both transportation infrastructure and other facilities in a community (buildings, vehicles, etc.). These include rain gardens, stormwater ponds, trees, native plans, pervious pavements, and native vegetation buffers along roadways. In combination with direct mitigation of stormwater volumes, bus transit operators such as ABQ Ride and Rio Metro should consider the location of their bus storage facilities in relation to areas of increased flood risk (e.g., the Rio Grande floodplain and other areas of elevated flood risk). Bridge assets are also at particular risk under increasingly severe climate scenarios due to "bridge scour" where high velocity flows can remove soil at bridge piers resulting in weakened supports. Culverts are at risk of being washed out, exceeding capacity, or being plugged by debris and vegetation during large storm events, resulting in localized flooding. According to the New Mexico Floodplain Managers Association, "many bridges and culverts are not designed to carry the 100-year frequency flood flows, which causes raised water levels upstream whenever their capacities are exceeded. Overflow of channels and flooding results" (New Mexico Floodplain Managers Association 2003). Under-design for some structures has resulted in flooding events in the past, indicating that in the future even larger culvert designs may be needed to accommodate the larger storm events predicted to result from climate change. Drainage infrastructure initially designed for a one in 20 year storm or a one in 50 year storm (based on risk tolerance, type of roadway [interstate versus county road], and other factors) may not accommodate more frequent and intense storms.

3.7.4 Wildfire

The frequency, intensity, and intensity of wildfires will increase under all scenarios. With warmer weather and extended growing seasons, there will likely be a continuing increase of combustible biomass, including invasive species. The change in vegetation patterns will likely alter the occurrence, severity, and distribution of wildfires. As seen over the past several years, there will likely continue to be a great increase in the size, severity, and frequency of wildfires. The large increase in development under all scenarios is likely to put more people, structures, and transportation facilities at greater risk. Future development in Central New Mexico will place homes or businesses in the wildland urban interface; consequently, the region will be less resilient to wildfires under all scenarios. In general, proper management of "non-developed" lands can help protect both residences and businesses in the vicinity and the lands themselves from wildfire. Fuel breaks can be created in the WUI to reduce fire behavior and severity. Vegetation may be mechanically thinned, treated with herbicide, or prescribed burns may be set to create the fuel breaks. Defensible space can be created around homes and other structures at risk.

Wildfires can greatly increase runoff and erosion rates. Wildfires increase the risk of debris flows, flooding, and impaired water quality. The cities of Albuquerque and Santa Fe stopped using river water for municipal needs for 40 and 20 days respectively due to debris flows and flooding resulting from the 2011 Las Conchas wildfire in the Jemez Mountains, demonstrating the significant impact of wildfire and post-fire debris flow on municipal water users. Post-fire rehabilitation treatments, such as seeding and mulching, are commonly applied to severely-burned areas to reduce post-fire runoff and erosion.

3.7.5 Crucial Habitat

With increasing development in crucial habitat under all scenarios, places of food, water, cover, and corridors for wildlife will be less resilient to climate change. Climate change itself will further fragment habitat and wildlife corridors and will result in an increasing demand for water, timing of precipitation, and decreased supplies. Experts predict decreasing availability of riparian habitat, including the loss of mature trees due to fire, insects, and disease, which would directly and indirectly affect many species of birds and mammals. Climate change may also lower the water table and will likely increase the risk of fire, which favors invasive species over native riparian species. Perhaps most notably, as the climate changes, the invasive species, tamarisk, is likely to spread, while outcompeting cottonwood species.

Climate change under all scenarios jeopardizes populations of endangered and threatened species. For example, climate change impacts will likely affect the endangered Rio Grande silvery minnow by

reducing its food supply, modifying its preferred habitat, preventing dispersal, and providing a continual supply of non-native fish that may compete with or prey upon the species. Young silvery minnows occupy shallow, low-velocity areas associated with backwaters and secondary channels. Large non-native fish prey upon the minnows in deeper water. The endangered Southwestern Willow Flycatcher, which nests in riparian vegetation, is very vulnerable to climate change as it is restricted to a local food source during nesting season and its primary food source, insects, depends on water for some phase of their lifecycle. Climate change will cause changes in fire regime and forest structure that will constrict the distribution of the flycatcher and will likely genetically isolate populations of the endangered Jemez Mountains salamander. The endangered New Mexico jumping meadow mouse is vulnerable to climate change as its wet meadow habitat could constrict due to loss of riparian vegetation. The threatened Mexican spotted owl is vulnerable to increased temperatures because it has a narrow and low thermal neutral zone. Increased wildfires may also jeopardize Mexican spotted owl habitat, which consist of high canopy closure, high stand density, a multi-layered canopy, uneven-aged stands, numerous snags, and downed woody matter. The threatened Pecos sunflower is vulnerable to climate change due to decreased groundwater and increased groundwater pumping as periods of drought increase.

Strategies that can be undertaken to increase the resilience of crucial habitat to climate change include the following:

- Coordinate Rio Grande water management activities to support and improve the bosque's riverine and terrestrial habitats, with special emphasis on mimicking typical natural hydrographs.
- Implement measures to allow fluvial processes to occur within the river channel and the adjacent bosque to the extent possible.
- Protect, extend, and enhance the structure of aquatic habitat to the benefit of native communities.
- Integrate management of nonnative and native fish species in all aquatic environments in the Middle Rio Grande riparian ecosystem including wetlands, canals, and drains.
- Protect the geographic extent of the Rio Grande bosque and avoid further fragmentation of the riparian ecosystem and component habitats.
- Protect, extend, and enhance riparian vegetation in noncontiguous areas in the floodplain.
- Manage the buffer zone of the contiguous bosque to protect ecosystem processes, enhance wildlife habitat values, and maintain rural and semirural conditions.
- Prevent unmanaged fires in all reaches of the bosque.
- Use native plant species and local genetic stock in vegetation establishment and management efforts throughout the bosque.
- Protect, enhance, and extend (create) wetlands throughout the Middle Rio Grande riparian zone.
- Sustain and enhance existing cottonwood communities, and create new native cottonwood communities wherever possible throughout the Middle Rio Grande riparian zone.
- Contain the expansion of existing large stands of nonnative vegetation in the Middle Rio Grande riparian zone.
- Modify storm water outfalls to function as wetlands, increasing diversity of habitat.
- Install moist soil willow swales that would serve a dual purpose of reestablishing connectivity between the bosque and the river, as well as providing shrub, mid-canopy habitat.
- Clear exotic species in the bosque and replant areas with native species of cottonwood riparian gallery forest.
- Reduce fuel loads and develop wildfire fuel breaks to reduce risk of severe wildfires.
- Remove debris from floods and wildfires from streams and arroyos.
- Create refugia for species such as the Rio Grande silvery minnow.
- Preserve and protect wildlife corridors

4 SUMMARY AND CONCLUSIONS

The three land-use scenario developed by MRCOG generally result in similar outcomes. Driven by significant population growth (52 percent) in the region by the year 2040, a large amount of new land is consumed by development and traffic congestion and GHG emissions increases significantly (see Figure 4 and Figure 8). While the differences between scenarios are small, the emerging lifestyles scenario performs the best overall. This scenario is the only one where VMT per capita actually decreases from today's level and it performs slightly better than the other scenarios on most performance metrics (see Figure 8). Each scenario, however, has certain strengths. The allowable uses scenario places more households near schools and has the least development in wildfire risk areas. The jobs/housing balance scenario results in the fewest river crossings, the most equitable jobs to housing distribution, and the least development in flood plains and crucial habitat areas.[5]

The results indicate that each scenario is less resilient than today, mainly because more land and infrastructure are developed. Increasing land development increases urban heat, reduces water supply while increasing water demand, and pushes more development into inappropriate places at higher risk for floods and wildfire and where crucial habitat is encroached upon. If one future scenario is to be selected as the most resilient it would be emerging lifestyles. The emerging lifestyles scenario has the smallest development foot print and least amount of vehicle traffic. The emerging lifestyles scenario could be further improved by controlling the amount of development in high fire and flood risk areas and crucial habitat areas. This could be accomplished with more restrictive zoning. The emerging lifestyles scenario could also be improved by finding a way to reduce river crossings without creating more fringe development, which was seen in the jobs/housing balance scenario.

[5] It should be noted that UrbanSim and the travel demand model each produce point estimates. While there is likely a great deal of imprecision and inaccuracy in each model and the data supplied to them, this has not been evaluated in the current modeling analysis. Such an evaluation would require a lengthy investigation which is outside the scope of the current work. However, these uncertainties should be kept in mind when comparing relatively small differences in performance measured calculated from these model output.

5 APPENDIX A PERFORMANCE MEASURE SUMMARY TABLE

			Absolute Value				% Change from 2012			% Change from AU	
Performance Measure Category	**Performance Measure**	**Unit of Analysis**	**2012**	**AU**	**EL**	**JH**	**AU**	**EL**	**JH**	**EL**	**JH**
Accessibility	Proximity to Recreation Sites	Households within 5 miles		48,600	47,756	47,215					
	Proximity to Activity Centers	Households within 1 mile of Activity Center	50,616	89,053	87,679	90,338	76%	73%	78%	-1.5%	1.4%
	Proximity to Transit	Households within 1/4 mile of premium transit	1,358	10,800	12,876	9,579	695%	848%	605%	19.2%	-11.3%
	Proximity to Bicycle Facilities	Households within 1/4 miles of a bicycle path	110,421	151,309	153,955	155,286	37%	39%	41%	1.7%	2.6%
	Proximity to Schools	Households within 1/2 miles of a school	129,487	168,253	164,939	163,565	30%	27%	26%	-2.0%	-2.8%
	Non-motorized Mode Share	% Trips bike or walk	5.6%	5.9%	6.2%	5.7%	6%	11%	3%	4.7%	-2.9%
	Jobs/Housing Mix in Activity Centers	Average jobs to housing ratio within 1 mile of activity centers	2.76	2.49	2.46	2.21	-10%	-11%	-20%	-1.0%	-11.4%
Land Use	Proximity to Key Corridors	Employment within 500 feet of key corridors	46,705	54,520	56,699	60,377	17%	21%	29%	4.0%	10.7%
	Lane Miles	Roadway Lane Miles	4,169	4,713	4,713	4,713	13%	13%	13%	0.0%	0.0%
	Land Developed	Acres Land Developed	162,788	245,378	241,224	245,321	51%	48%	51%	-1.7%	0.0%
	Population Density	Persons per Acre of Developed Land	5.5	5.5	5.6	5.5	0.5%	2.3%	0.6%	1.7%	0.0%
	Population Density of New Development	New Persons per Acres of New Development		5.6	5.9	5.6	1.6%	7.0%	1.6%	5.3%	0.1%
Mobility: Highway	System wide Speed	PM peak hour speed (MPH)	36.4	19.2	23.1	21.4	-47%	-37%	-41%	20.3%	11.6%
	Vehicle Hours of Delay (VHD)	PM peak hour: congested travel time - free flow travel time (hours)	12,927	88,264	59,664	72,450	583%	362%	460%	-32.4%	-17.9%
	Vehicle Hours Traveled (VHT)	PM peak hour: total travel time (hours)	50,778	149,555	118,007	133,254	195%	132%	162%	-21.1%	-10.9%
	Vehicle Miles Traveled (VMT)	Total vehicle miles traveled per day	20,335,265	31,807,335	30,295,936	31,984,758	56%	49%	57%	-4.8%	0.6%
	VMT per Capita	Average vehicle miles traveled per person	22.8	23.6	22.4	23.7	3%	-2%	4%	-4.8%	0.6%
	Percentage of Network in Congested Conditions	PM peak hour: % of network exceeding capacity (v/c > 1)	2.1%	9.1%	7.9%	8.5%	344%	286%	312%	-13.0%	-7.1%
	Congested Conditions along Freight Corridors	PM peak hour: % of freight network exceeding capacity (v/c > 1)	0.6%	16.2%	15.6%	15.3%	2439%	2335%	2302%	-4.1%	-5.4%
Mobility: Transit	Transit Ridership	Daily boardings	56,291	73,871	76,658	72,369	31%	36%	29%	3.8%	-2.0%
	Transit Passenger Miles Traveled	Daily passenger miles traveled	194,679	370,908	374,590	360,819	91%	92%	85%	1.0%	-2.7%
	Transit Mode Share	% Trips by Transit	1.1%	0.8%	0.9%	0.8%	-28%	-19%	-32%	12.5%	-6.5%
Mobility: River Crossings	River Crossing - Congested Conditions	PM peak hour: average volume to capacity ratio (v/c ratio)	0.76	1.20	1.15	1.12	58%	51%	47%	-4.1%	-6.8%
	River Crossings	Daily number of vehicle trips	592,609	873,122	831,338	817,189	47%	40%	38%	-4.8%	-6.4%
Economic Competitiveness	Proximity to Employment Sites	Households within 1 mile of employment	33,729	46,998	53,711	47,870	39%	59%	42%	14.3%	1.9%
	Average Commute Time	Minutes	17.43	35.32	25.03	28.38	103%	44%	63%	-29.1%	-19.6%
	Economic Value of Network Efficiency	Gross Regional Product (billion dollars*)	$38.4	$73.0	$73.1	$73.0	90%	90%	90%	0.1%	-0.1%
	Economic Value of Network Efficiency	GRP per Capita	$43,123	$54,115	$54,167	$54,078	25%	26%	25%	0.1%	-0.1%
Safety	Safety - High Crash Risk Locations Crash Rate	Crashes per 100 million VMT	550	1,023	1,031	1,026	86%	88%	87%	0.7%	0.2%
Sustainability & Resiliency	GHG Emissions	Daily CO2-eq (tonnes/day)	11,313	16,226	14,774	15,930	43%	31%	41%	-8.9%	-1.8%
	GHG Emissions per Capita	Daily CO2-eq per Capita (kg/day)	12.7	12.0	10.9	11.8	-5%	-14%	-7%	-8.9%	-1.8%
	Residential Water Consumption	Million gallons per year	30,027	44,450	44,615	44,275	48%	49%	47%	0.4%	-0.4%
	Development in High Flood-Risk Areas	Employment + Dwelling Units in 100 year Flood Plains	34,190	66,924	69,770	53,321	96%	104%	56%	4.3%	-20.3%
	Development in Forest Fire Risk Areas	Weighted value based on emp + housing in wildland-urban interface areas	3.11	4.47	4.55	4.68	44%	46%	50%	1.9%	4.7%
	Development in Crucial Habitat Areas	Weighted value based on emp + housing in priority ranking areas	5.73	7.46	7.57	7.30	30%	32%	27%	1.4%	-2.1%

6 APPENDIX B FLOOD TABLES

Development in 100-year Floodpain by Scenario Table.

Scenario	Households	Household Population	Employment	SF Units	MF Units	Buildings
Emerging Lifestyles Compared to Allowable Uses	10.2%	10.1%	-2.1%	7.1%	33.5%	0.9%
Jobs/Housing Compared to Allowable Uses	0.4%	0.4%	-38.8%	-5.3%	34.0%	-5.1%

7 APPENDIX C WILDFIRE TABLES

Wildfire Risk Climate Scenario Analysis Table.

Scenario	Households	Household Populations	Employment	SF Units	MF Units	Buildings
Allowable Uses	79,632	204,673	23,357	81,762	5,071	75,623
Emerging Lifestyles	77,886	200,667	26,253	81,002	4,967	74,946
Jobs/Housing	82,044	210,606	30,929	81,379	7,184	74,783
Scenario	**Households**	**Household Populations**	**Employment**	**SF Units**	**MF Units**	**Buildings**
Allowable Uses	168,844	431,456	72,134	147,584	31,017	147,994
Emerging Lifestyles	167,965	428,789	79,177	146,213	32,381	149,604
Jobs/Housing	166,511	424,402	75,393	145,276	31,539	146,763
Scenario	**Households**	**Household Populations**	**Employment**	**SF Units**	**MF Units**	**Buildings**
Allowable Uses	248,476	636,129	95,491	229,346	36,088	223,617
Emerging Lifestyles	245,851	629,456	105,430	227,215	37,348	224,550
Jobs/Housing	248,555	635,008	106,322	226,655	38,723	221,546

Wildfire Risk Intermix Percent Change Table.

Scenario	Households	Household Population	Employment	SF Units	MF Units	Buildings
Emerging Lifestyles Compared to Allowable Uses	-2.2%	-2.0%	11.0%	-0.9%	-2.1%	-0.9%
Jobs/Housing Compared to Allowable Uses	2.9%	2.8%	24.5%	-0.5%	29.4%	-1.1%

Wildfire Risk Interface Percent Change Table.

Scenario	Households	Household Population	Employment	SF Units	MF Units	Buildings
Emerging Lifestyles Compared to Allowable Uses	-0.5%	-0.6%	8.9%	-0.9%	4.2%	1.1%
Jobs/Housing Compared to Allowable Uses	0.0%	-1.6%	4.3%	-1.6%	1.7%	-0.8%

Wildfire Risk Total Percent Change Table.

Scenario	Households	Household Population	Employment	SF Units	MF Units	Buildings
Emerging Lifestyles Compared to Allowable Uses	-1.1%	-1.1%	9.4%	-0.9%	3.4%	0.4%
Jobs/Housing Compared to Allowable Uses	0.0%	0.0%	10.2%	-1.2%	6.8%	-0.9%

8 APPENDIX D CRUCIAL HABITAT TABLES

Development in Crucial Habitat Areas by Scenario Table.

	Rank 1					
Scenarios	**Households**	**Household Populations**	**Employment**	**SF Units**	**MF Units**	**Buildings**
Allowable Uses	69,788	176,230	49,781	63,936	10,980	35,315
Emerging Lifestyles	71,185	180,682	53,000	67,368	9,379	68,084
Jobs/Housing	68,418	173,526	56,344	61,977	11,700	64,642
	Rank 2					
Scenarios	**Households**	**Household Populations**	**Employment**	**SF Units**	**MF Units**	**Buildings**
Allowable Uses	54,977	132,662	138,738	39,307	19,786	42,442
Emerging Lifestyles	53,372	128,362	138,644	38,197	18,901	43,355
Jobs/Housing	51,938	124,448	125,989	35,557	19,977	41,299
	Rank 3					
Scenarios	**Households**	**Household Populations**	**Employment**	**SF Units**	**MF Units**	**Buildings**
Allowable Uses	15,125	38,812	13,645	14,641	3,234	13,676
Emerging Lifestyles	16,494	41,993	13,882	16,205	2,446	12,952
Jobs/Housing	13,845	35,475	5,948	13,406	3,082	12,734

Crucial Habitat Rank 1 Percent Change Table.

Scenario	Households	Household Population	Employment	SF Units	MF Units	Buildings
Emerging Lifestyles Compared to Allowable Uses	2.0%	2.5%	6.1%	5.1%	-17.1%	48.1%
Jobs/Housing Compared to Allowable Uses	-2.0%	-1.6%	11.6%	-3.2%	6.2%	45.4%

Crucial Habitat Rank 2 Percent Change Table.

Scenario	Households	Household Population	Employment	SF Units	MF Units	Buildings
Emerging Lifestyles Compared to Allowable Uses	-3.0%	-3.3%	-0.1%	-2.9%	-4.7%	2.1%
Jobs/Housing Compared to Allowable Uses	-5.9%	-6.6%	-10.1%	-10.5%	1.0%	-2.8%

Crucial Habitat Rank 3 Percent Change Table.

Scenario	Households	Household Population	Employment	SF Units	MF Units	Buildings
Emerging Lifestyles Compared to Allowable Uses	8.3%	7.6%	1.7%	9.7%	-32.2%	-5.6%
Jobs/Housing Compared to Allowable Uses	-9.2%	-9.4%	-56.4%	-9.2%	-4.9%	-7.4%

Crucial Habitat Rank 4 Percent Change Table.

Scenario	Households	Household Population	Employment	SF Units	MF Units	Buildings
Emerging Lifestyles Compared to Allowable Uses	-4.9%	-4.9%	-5.4%	-2.7%	-15.5%	-1.3%
Jobs/Housing Compared to Allowable Uses	5.8%	6.2%	17.0%	5.8%	-2.8%	-2.6%

Crucial Habitat Rank 5 Percent Change Table.

Scenario	Households	Household Population	Employment	SF Units	MF Units	Buildings
Emerging Lifestyles Compared to Allowable Uses	1.8%	2.2%	-9.0%	0.5%	13.2%	-2.1%
Jobs/Housing Compared to Allowable Uses	-3.4%	-3.3%	-26.8%	-1.4%	13.2%	-5.1%

Crucial Habitat Rank 6 Percent Change Table.

Scenario	Households	Household Population	Employment	SF Units	MF Units	Buildings
Emerging Lifestyles Compared to Allowable Uses	1.7%	1.5%	1.9%	1.8%	4.1%	2.9%
Jobs/Housing Compared to Allowable Uses	-0.1%	-0.4%	-1.2%	-2.3%	6.5%	-1.3%

Rank 1 Crucial Habitats Percent Change by County Emerging Lifestyles Table.

County	Households	Household Population	Employment	SF Units	MF Units	Buildings
Bernalillo	0.3%	1.3%	2.0%	7.4%	-29.7%	5.1%
Sandoval	2.5%	2.8%	16.8%	-1.4%	29.5%	4.1%
Santa Fe	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Torrance	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Valencia	5.7%	5.2%	-0.4%	6.6%	3.2%	1.8%

Rank 2 Crucial Habitats Percent Change by County Emerging Lifestyles Table.

County	Households	Household Population	Employment	SF Units	MF Units	Buildings
Bernalillo	-2.0%	-2.3%	-0.1%	-0.2%	-4.7%	4.0%
Sandoval	-15.0%	-16.0%	1.5%	-19.6%	0.0%	-5.8%
Santa Fe	23.1%	27.3%	50.0%	23.1%	0.0%	20.0%
Torrance	0.6%	2.5%	-1.1%	-0.2%	0.0%	-1.0%
Valencia	1.0%	1.3%	1.5%	0.8%	0.0%	-2.4%

Rank 3 Crucial Habitats Percent Change by County Emerging Lifestyles Table.

County	Households	Household Population	Employment	SF Units	MF Units	Buildings
Bernalillo	-12.8%	-15.1%	0.1%	-15.0%	-36.6%	-6.0%
Sandoval	-3.7%	-4.1%	7.6%	-3.7%	2.2%	-1.8%
Santa Fe	-4.8%	-5.5%	15.1%	-5.0%	0.0%	-4.1%
Torrance	-1.1%	1.0%	-3.1%	-0.8%	0.0%	-0.3%
Valencia	37.2%	36.0%	6.0%	33.7%	0.0%	-17.4%

Rank 4 Crucial Habitats Percent Change by County Emerging Lifestyles Table.

County	Households	Household Population	Employment	SF Units	MF Units	Buildings
Bernalillo	-4.7%	-4.9%	-11.4%	-4.3%	-15.7%	-1.0%
Sandoval	-4.1%	-4.0%	21.9%	1.5%	1.5%	-0.3%
Santa Fe	-5.8%	-7.5%	-29.9%	-5.8%	0.0%	-6.3%
Torrance	1.9%	1.5%	2.5%	-0.8%	0.0%	-0.1%
Valencia	-11.1%	-9.1%	-25.3%	-10.7%	0.0%	-9.6%

Rank 5 Crucial Habitats Percent Change by County Emerging Lifestyles Table.

County	Households	Household Population	Employment	SF Units	MF Units	Buildings
Bernalillo	6.3%	6.3%	-6.7%	4.0%	16.3%	0.5%
Sandoval	-24.3%	-25.4%	-85.9%	-29.3%	0.0%	-4.9%
Santa Fe	-7.2%	-6.7%	-26.5%	-8.0%	0.0%	-5.0%
Torrance	-1.0%	0.2%	-0.5%	-1.0%	0.0%	-0.8%
Valencia	0.3%	1.0%	-14.0%	0.4%	-17.2%	-4.5%

Rank 6 Crucial Habitats Percent Change by County Emerging Lifestyles Table.

County	Households	Household Population	Employment	SF Units	MF Units	Buildings
Bernalillo	3.0%	3.0%	0.1%	3.8%	3.7%	3.6%
Sandoval	-6.6%	-7.5%	14.3%	-7.5%	11.7%	-0.1%
Santa Fe	-4.4%	1.8%	11.8%	-4.1%	0.0%	-3.5%
Torrance	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Valencia	4.7%	4.9%	0.5%	4.7%	0.0%	2.1%

Rank 1 Crucial Habitats Percent Change by County Jobs/Housing Table.

County	Households	Household Population	Employment	SF Units	MF Units	Buildings
Bernalillo	-0.7%	0.1%	-22.1%	-1.5%	6.4%	-2.5%
Sandoval	-6.2%	-5.5%	49.2%	-8.5%	6.0%	3.0%
Santa Fe	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Torrance	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Valencia	-1.1%	-1.9%	-15.4%	-1.3%	3.8%	-2.0%

Rank 2 Crucial Habitats Percent Change by County Jobs/Housing Table.

County	Households	Household Population	Employment	SF Units	MF Units	Buildings
Bernalillo	-5.5%	-6.3%	-10.3%	-11.5%	1.0%	-3.2%
Sandoval	-14.2%	-14.6%	-1.3%	-18.6%	0.0%	-2.5%
Santa Fe	0.0%	14.3%	-100.0%	9.1%	0.0%	0.0%
Torrance	-1.0%	-1.3%	3.8%	-0.8%	0.0%	0.0%
Valencia	0.7%	0.4%	-8.3%	4.8%	0.0%	-0.4%

Rank 3 Crucial Habitats Percent Change by County Jobs/Housing Table.

County	Households	Household Population	Employment	SF Units	MF Units	Buildings
Bernalillo	-26.5%	-25.8%	-90.7%	-57.6%	-5.3%	-65.3%
Sandoval	-3.0%	-4.5%	46.1%	-2.9%	-1.1%	4.5%
Santa Fe	33.5%	34.1%	9.4%	33.5%	0.0%	-1.5%
Torrance	-0.5%	2.0%	0.7%	-1.2%	0.0%	-0.6%
Valencia	-30.3%	-31.3%	-13.5%	-21.5%	0.0%	-1.5%

Rank 4 Crucial Habitats Percent Change by County Jobs/Housing Table.

County	Households	Household Population	Employment	SF Units	MF Units	Buildings
Bernalillo	8.5%	9.2%	-6.0%	10.6%	-3.6%	-6.2%
Sandoval	0.7%	0.6%	65.5%	-0.9%	0.0%	2.2%
Santa Fe	3.8%	4.3%	-39.2%	3.6%	0.0%	-0.5%
Torrance	-2.1%	-1.1%	2.2%	-0.9%	0.0%	0.6%
Valencia	-1.4%	-0.5%	-71.6%	-1.7%	0.0%	0.8%

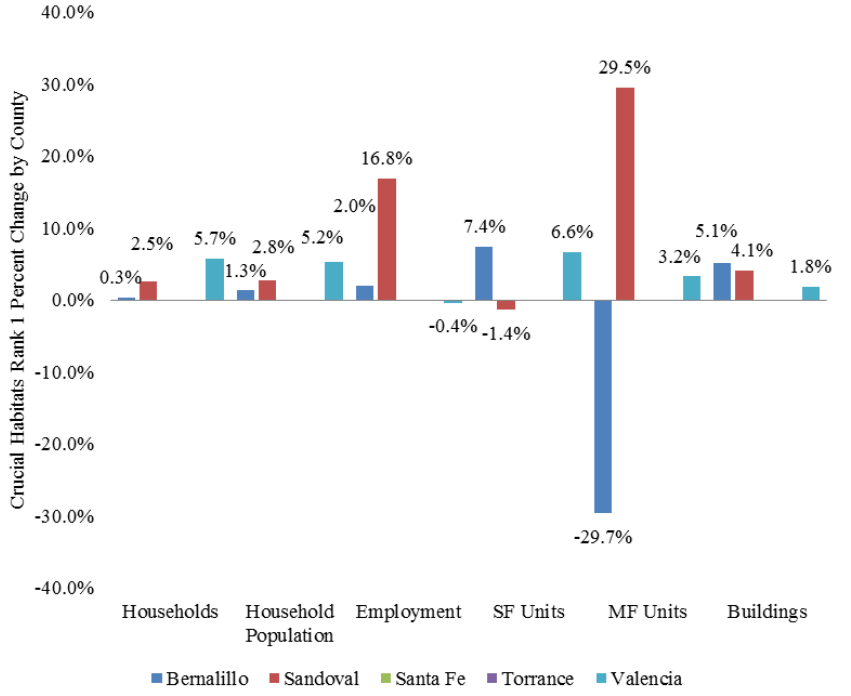
Rank 5 Crucial Habitats Percent Change by County Jobs/Housing Table.

County	Households	Household Population	Employment	SF Units	MF Units	Buildings
Bernalillo	-0.3%	-0.4%	-24.5%	-6.5%	17.7%	-6.8%
Sandoval	-5.4%	-4.6%	-50.8%	57.9%	0.0%	-3.6%
Santa Fe	0.7%	1.4%	-38.0%	1.1%	0.0%	0.0%
Torrance	-1.4%	-0.1%	-1.4%	-1.2%	0.0%	-1.0%
Valencia	-8.0%	-8.0%	-48.7%	-8.2%	-118.0%	-5.3%

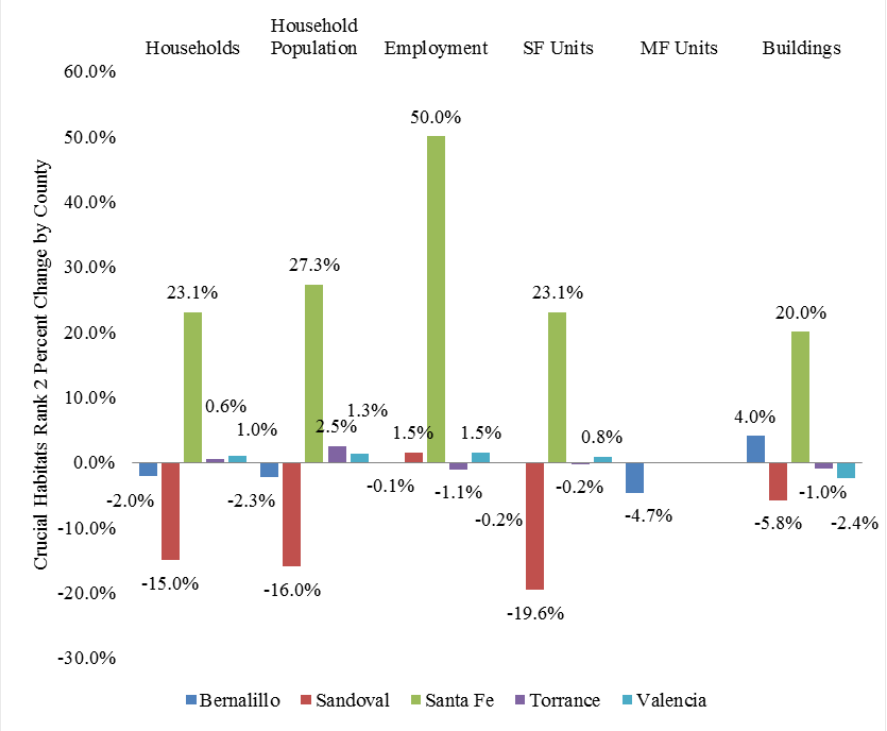
Rank 6 Crucial Habitats Percent Change by County Jobs/Housing Table.

County	Households	Household Population	Employment	SF Units	MF Units	Buildings
Bernalillo	0.5%	0.2%	-10.4%	-2.4%	6.9%	-1.2%
Sandoval	-4.4%	-4.7%	38.7%	-3.2%	1.6%	-2.1%
Santa Fe	0.6%	2.5%	8.9%	1.9%	0.0%	0.0%
Torrance	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Valencia	3.7%	3.2%	-10.8%	3.9%	0.0%	1.7%

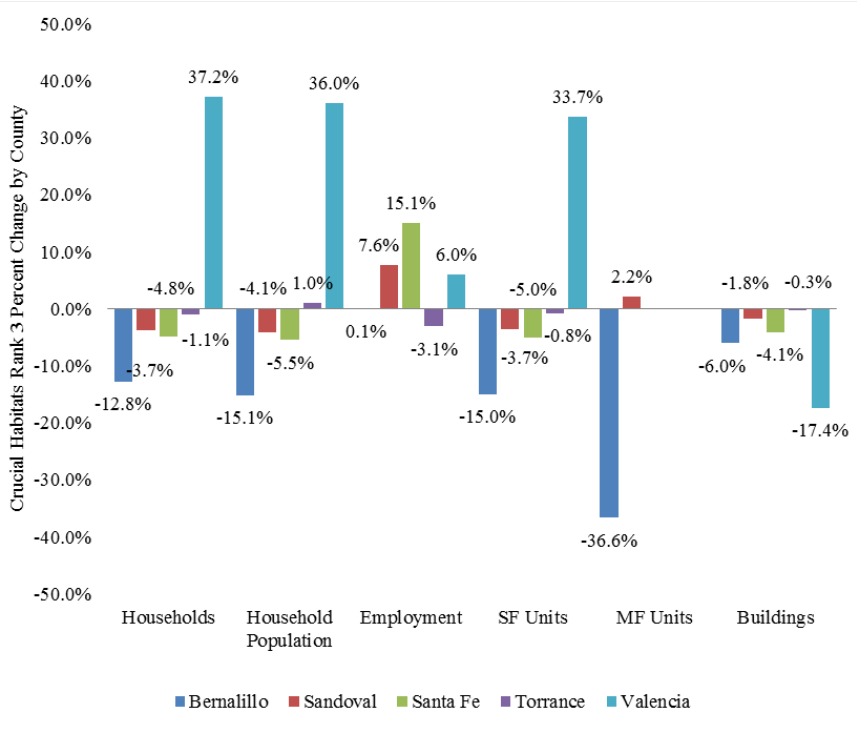
9 APPENDIX E CRUCIAL HABITATS PERCENT CHANGE BY COUNTY GRAPHS



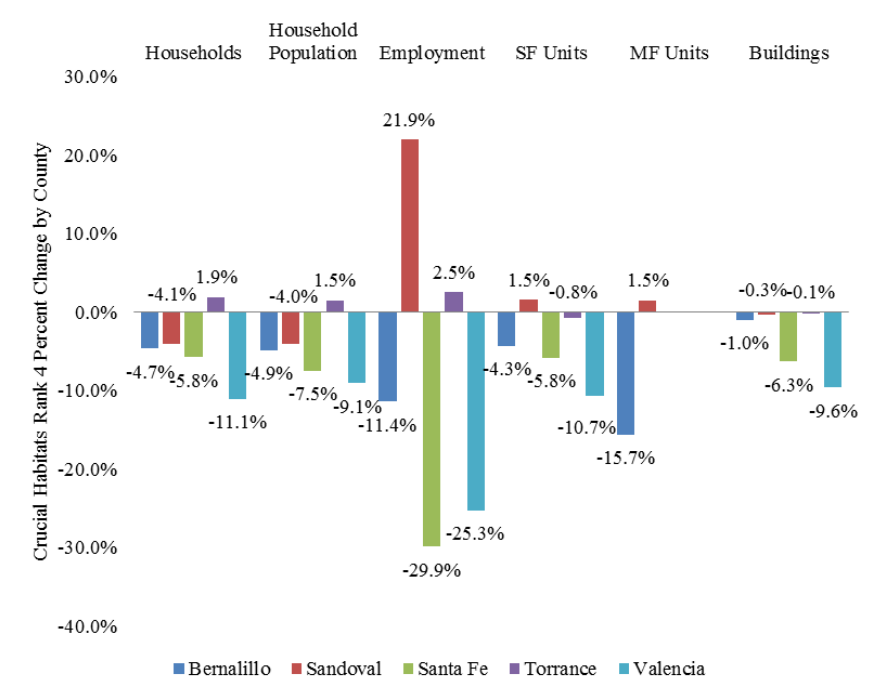
Crucial Habitats Rank 1 Percent Change Emerging Lifestyles Comparison to Allowable Use by County.



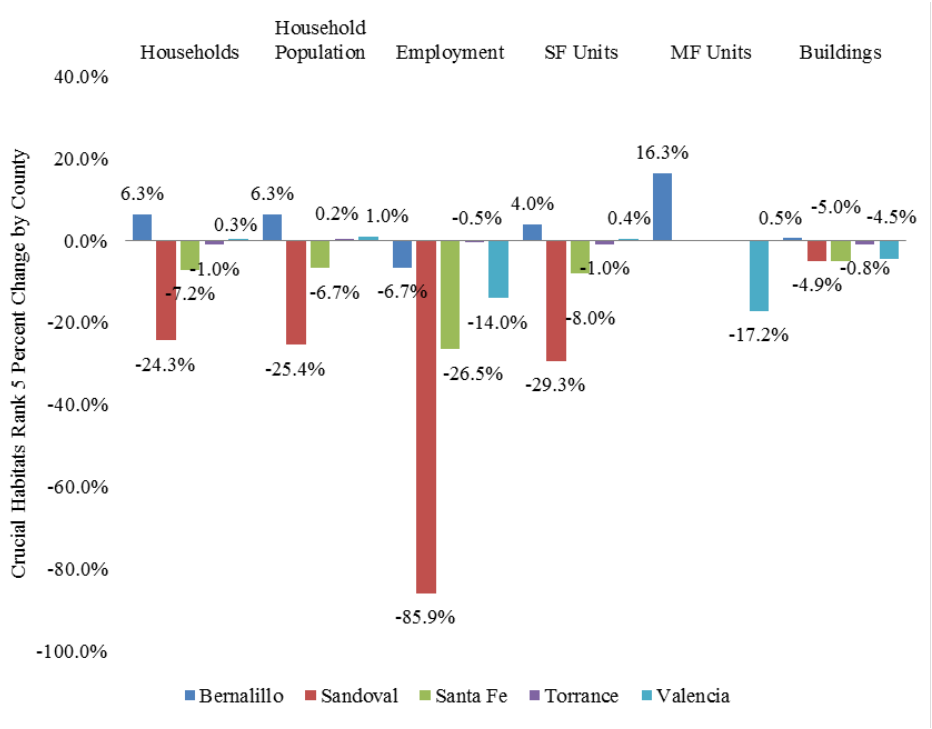
Crucial Habitats Rank 2 Percent Change Emerging Lifestyles Comparison to Allowable Use by County.



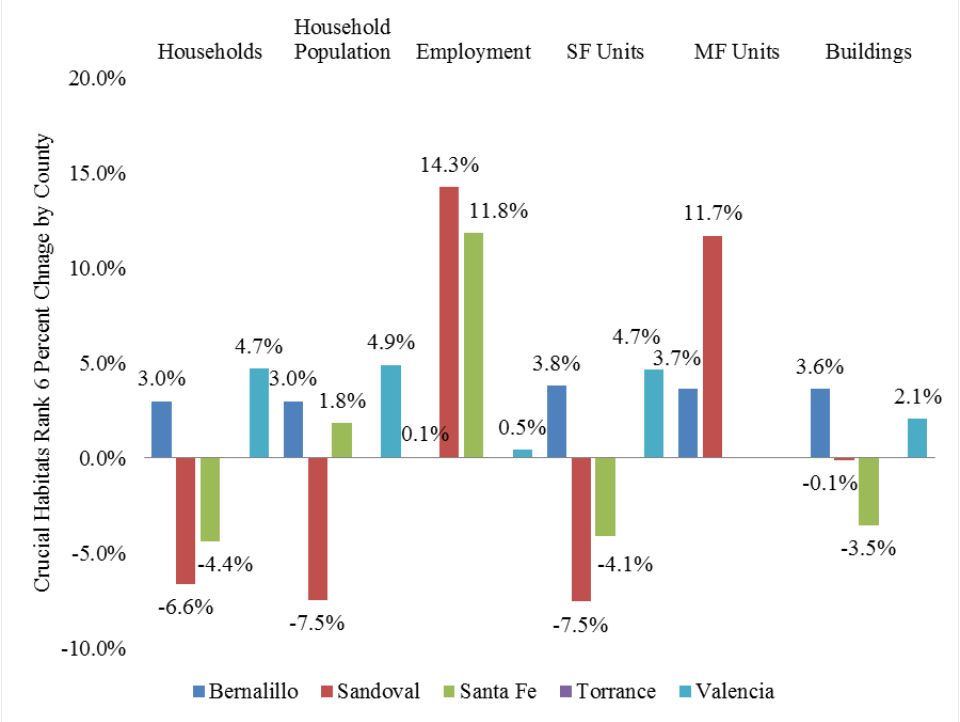
Crucial Habitats Rank 3 Percent Change Emerging Lifestyles Comparison to Allowable Use by County.



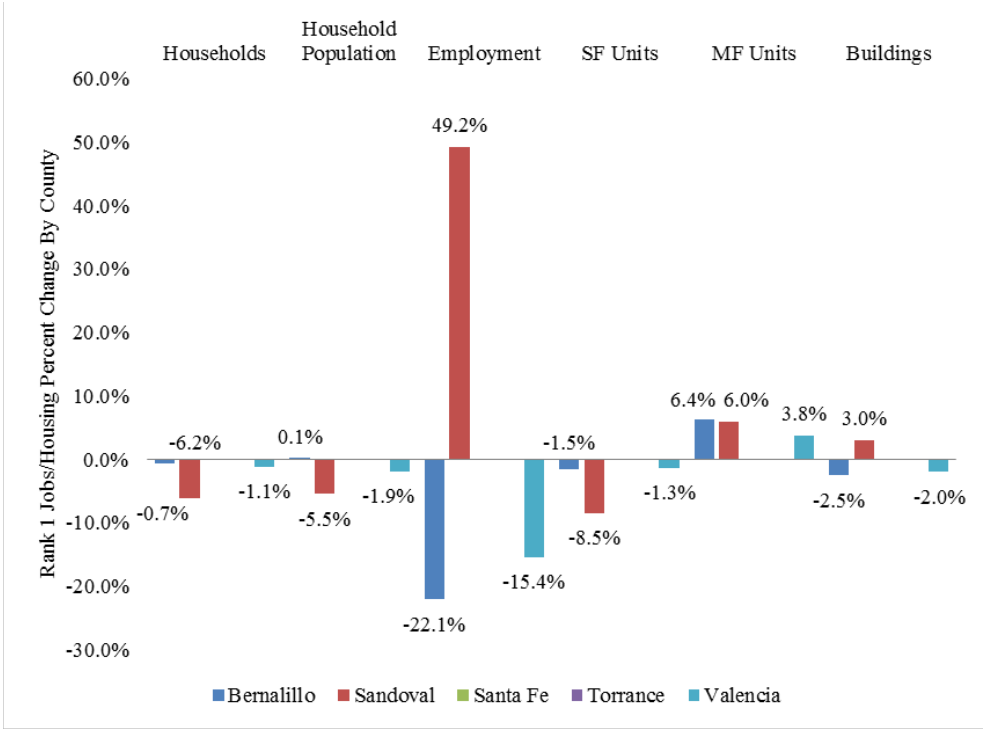
Crucial Habitats Rank 4 Percent Change Emerging Lifestyles Comparison to Allowable Use by County.



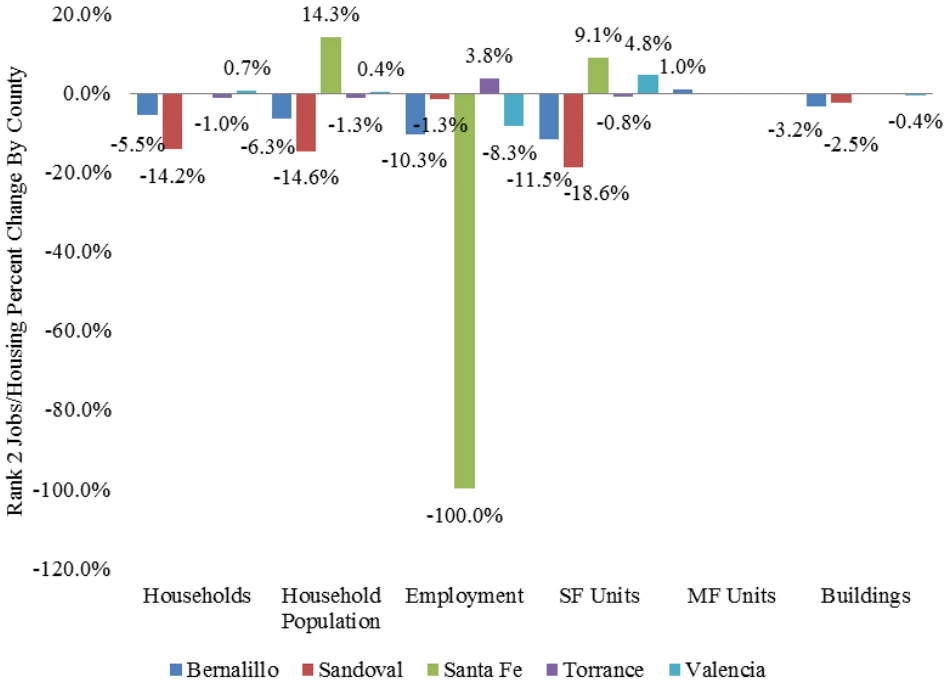
Crucial Habitats Rank 5 Percent Change Emerging Lifestyles Comparison to Allowable Use by County.



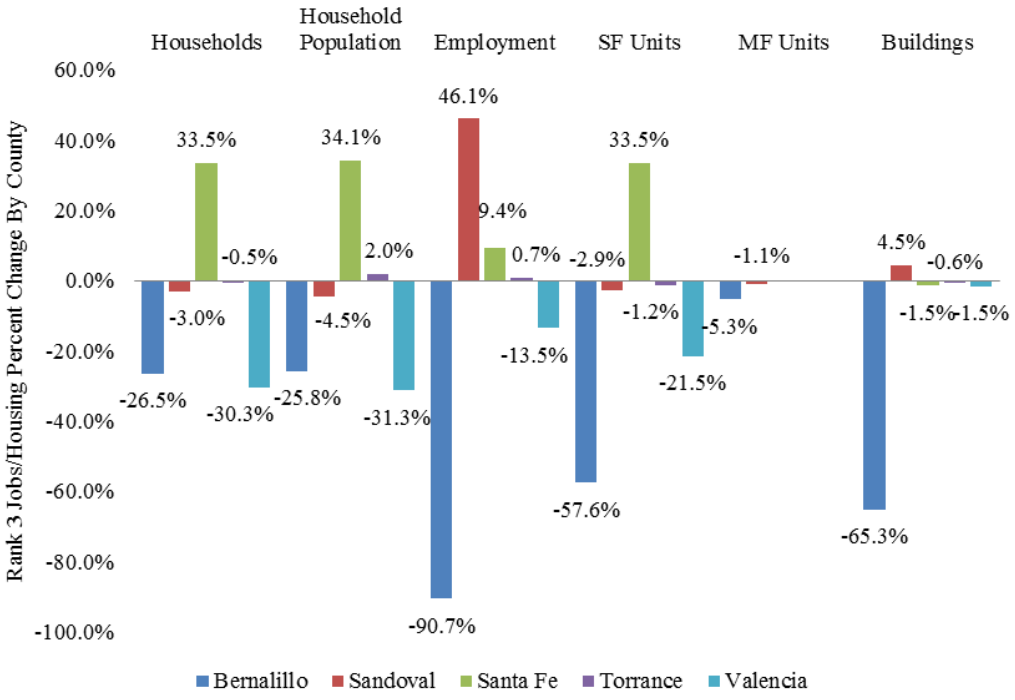
Crucial Habitats Rank 6 Percent Change Emerging Lifestyles Comparison to Allowable Use by County.



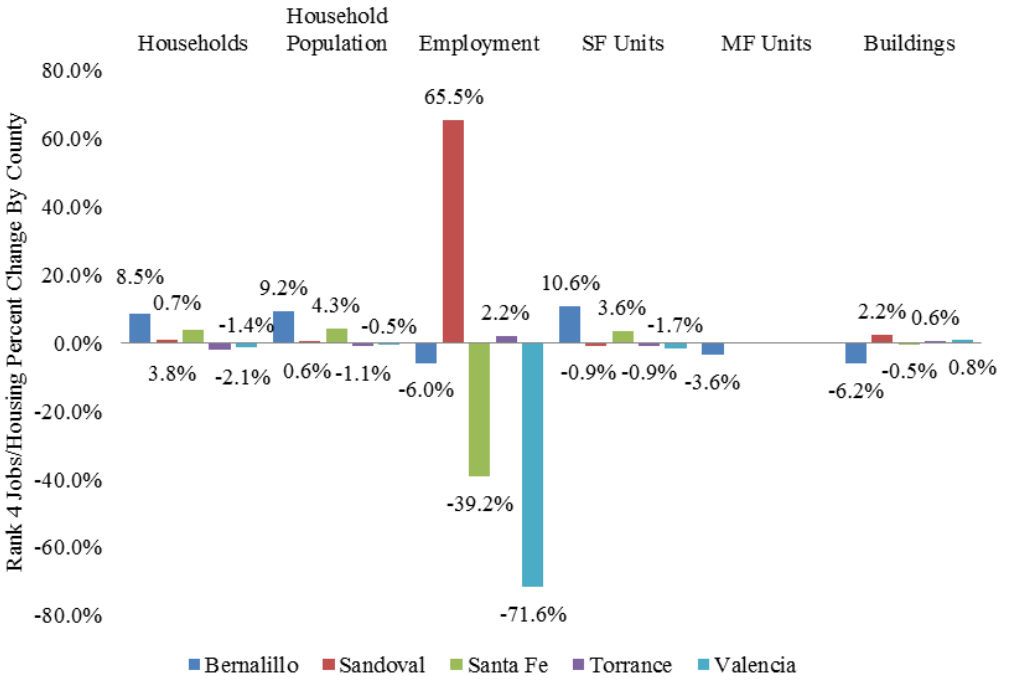
Crucial Habitats Rank 1 Percent Change Jobs/Housing Comparison to Allowable Use by County.



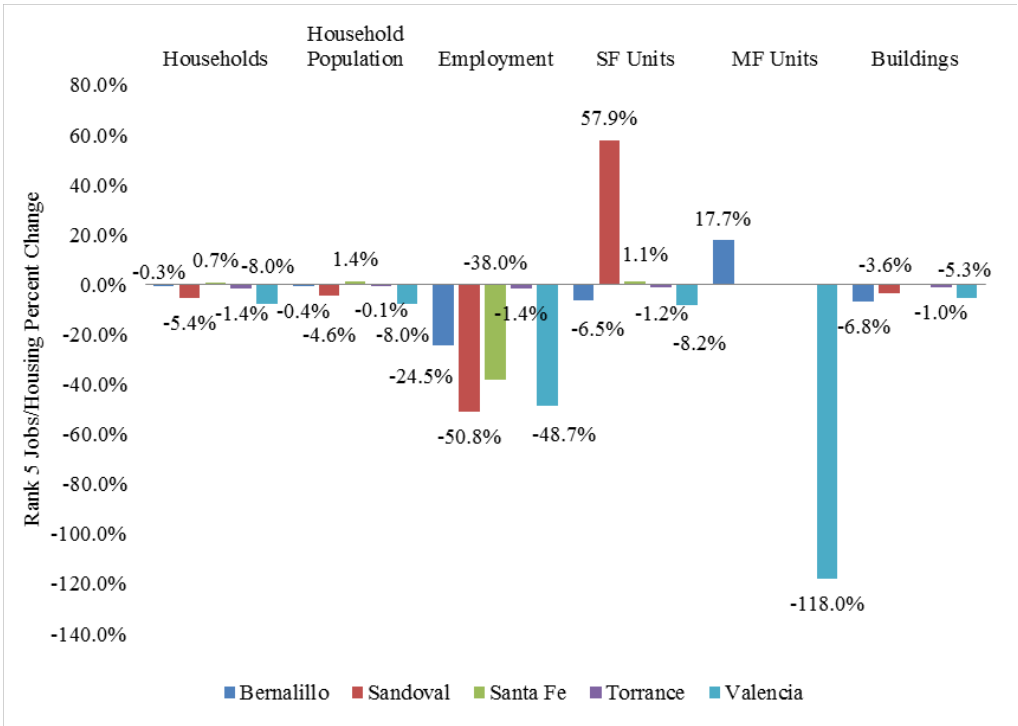
Crucial Habitats Rank 2 Percent Change Jobs/Housing Comparison to Allowable Use by County.



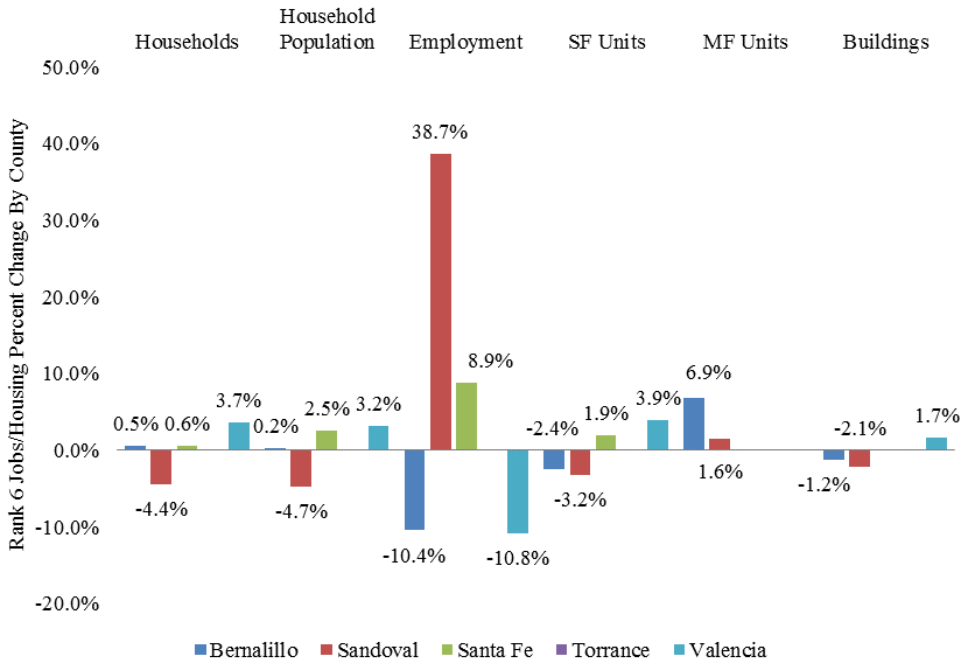
Crucial Habitats Rank 3 Percent Change Jobs/Housing Comparison to Allowable Use by County.



Crucial Habitats Rank 4 Percent Change Jobs/Housing Comparison to Allowable Use by County.



Crucial Habitats Rank 5 Percent Change Jobs/Housing Comparison to Allowable Use by County.



Crucial Habitats Rank 6 Percent Change Jobs/Housing Comparison to Allowable Use by County.