

High-Speed Rail and Equine Issues



MTI Report WP 12-07



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REPORT WP 12-07

HIGH-SPEED RAIL AND EQUINE ISSUES

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EXECUTIVE SUMMARY

This paper reports the results of a review of existing scholarly and professional literature regarding the possible impacts of the creation of a high-speed rail (HSR) route in California on surrounding equine populations and equestrian recreation. Concerns have been voiced that a HSR route between Palmdale and Burbank could disrupt existing equestrian and equine facilities in that area; this research is intended to summarize and explain the possible conflicts known to exist. To identify relevant research, an extensive search of various electronic bibliographic databases was conducted.

Essentially, the results of the review suggest that very little scholarly and professional research has been conducted on the precise topic of potential or documented problems between HSR and equines. The lack of an established body of research in this specific area seems to reflect a concomitant lack of problems between HSR systems and equines. If such issues had been common, we would expect to find more documentation. However, it is also possible that the subject has somehow been overlooked by researchers.

The review indicates that, although aesthetic conflicts between HSR and the boarding and use of equines may be a concern, it is not one that is documented in existing research. Rather, the primary potential conflict between HSR routing and equines that has been touched upon is the potential for noise from the trains harming or bothering horses. However, the small amount of existing research does not address this potential conflict in a definitive matter.

Generally, the existing literature has the following shortfalls or gaps:

1. Research has most commonly focused on noise from jet aircraft passing overhead, and not from trains. Whereas the two have some similarities, they are not identical.
2. Research has typically been more concerned with the effect of noise on wildlife and not domestic animals.
3. One piece of research that has focused on horses specifically looked at the effect of prolonged exposure to loud, live music, and not trains.

What is known can be summarized as follows:

- Noises levels of 100 dBA SEL (Sound Exposure Level, a cumulative measure of noise) have the potential – at least in theory, as this is not documented -- to harm horses, and existing FRA (Federal Railway Administration) guidelines state that such levels must be screened for possible conflicts. However, existing HSR lines operate below that level, and damage to horses has not been documented.
- Loud noises, however, are known to have the potential to startle horses, which may have various detrimental effects to the well-being of horses and their

riders. There are no precise criteria for the amount of noise required to create a startling effect. Only rough estimates of the amount of noise that might serve to startle horses are available, and virtually no systematic research has been conducted to establish such criteria.

- The very few studies that seem the most relevant – i.e., those that explicitly seek to address the link between noise and a response from equines – uniformly conclude that horses tend to “habituate” to the regularly repeated noises. However, this response pattern appears not to have been subject to systemic testing with respect to the noise produced by trains.
- Perhaps most definitively, in commenting on a HSR proposal in the UK, the International League for the Protection of Horses has stated that “horses usually became habituated to repeated noise including that from passing trains, although it is acknowledged that there may be a short period of adjustment.”¹ The extent to which this statement is supported by specific scientific research, however, is unknown.

RESEARCH OBJECTIVES

The primary objective of this project will be to: (1) using existing research, systematically evaluate the known conflicts and challenges posed by the potential proximity of HSR trains and known areas of equine and equestrian land use and populations, and (2) create a database, illustrated with maps that help illustrate where equine facilities such as trails, ranches, and boarding farms are located with respect to identified HSR route options.

GENERAL METHODOLOGY

Primarily a “desktop” study, this project is based upon review of existing research and other systematically recorded information concerning interaction between equine populations and HSR systems, with a focus on horses. The literature review included searches on relevant terms in a wide and diverse range of databases, including (but not limited to) the Transport Research International Documentation (TRID), Google Scholar, various Transportation Research Board resources (including ACRP, TCRP, and TRB conference websites), veterinary medicine resources, domestic and international rail agency websites, and multiple electronic library databases, including the Social Science Citation Index, ScienceDirect, AGRIS, BIOSIS, Academic Search Premier (which itself encompasses multiple databases). Due to the apparent paucity of information from such sources, limited contact with individuals with experience with HSR projects and/or equines was used to help corroborate findings from the research literature.

The mapping portion of the project entailed (1) searching for relevant databases and other potential sources of indicators of equine populations and activity and appropriate GIS technologies, in order to create a straightforward, easily interpretable map or maps that reflects both the density and specific locales of equine populations and activities in the relevant areas of the state. Among the data sources tapped for this effort were: (1) equestrian trails, (2) equestrian trail access points, and (3) equestrian boarding facilities.

Additional data were assembled from phone calls to equestrian facilities identified from online resources, although some facilities could not be reached, and not necessarily every facility was contacted, due to the lack of a reference database.

**PART ONE: INTRODUCTION AND REVIEW OF LITERATURE
ON HSR AND EQUINE ISSUES**

I. INTRODUCTION

The goal of this paper is to develop a synthesis and literature review of current academic and professional research regarding the interface of California's planned high-speed rail routes, and equines (specifically, horses). Some residents of areas near the Palmdale-to-Burbank section of the planned HSR route have voiced concerns that the service would negatively impact their horse populations and riding activities. This study will identify and explore known conflicts and associated challenges. To further inform this discussion, the authors consulted a database and created a map of known concentrations of horses, equine facilities, and associated recreational areas in the Palmdale–Burbank segment of the planned California High-Speed Rail (HSR) system.

Whereas the problems created by aircraft for wild and domestic animals are well known and the subject of strategic mitigation efforts, less is known about the potential for HSR (or other rail) service to harm or denigrate equine populations. In the case of airports and aircraft, problems exist for both the affected wildlife and the air transportation system. For example, collisions with birds create \$187 million in damages to airplanes on an annual basis (though collisions are not the focus of interest here). Airports typically establish wildlife management plans to protect wildlife from aircraft (and vice versa). SeaTac airport in Washington was the first to hire a full-time biologist, as a part of “an ecological approach to maintaining aviation safety and protecting wildlife.”

Collisions between animals and high-speed trains, however, are not known to be a problem because rail routes are generally constructed within fenced areas or above grade, or both. The primary concern regarding high-speed trains and animals – and horses, specifically – is the potential for the animals to be detrimentally affected by noise associated with HSR construction and operation. Of secondary concern are the possible aesthetic impacts of train routes near pathways preferred by equestrians. Moreover, the development associated with HSR routes and stations may also have impacts on equines. However, none of the literature identified for this study addressed the general issues of aesthetics and increased development. That does not preclude the need for planners to consider possible aesthetic concerns from equestrians, but it does place such concerns outside of the bounds of this study for practical purposes.

The dearth of systematic research into the possible conflicts between horses and HSR trains is itself a significant finding. Although this apparent gap may simply mean that researchers are behind the curve, it may also mean that relatively few problems have been reported. When asked whether European HSR systems had encountered any such difficulties, an official of the International Union of Railways responded, “No, frankly, never.”²

Nearly all of the available literature on the impact of noise focuses on the operation rather than construction of HSR. Whereas there is little doubt that construction causes considerable disruption, including noise, there is apparently no accessible information concerning any particularly harmful or lasting impacts with respect to horses and equestrian activities. Guidelines developed by the Federal Railroad Administration (FRA) in 2012 do not address animals specifically but do seem to suggest that noise from construction is generally no greater than that associated with HSR operations (i.e., the sound of running trains).³ The

guidelines include suggestions for mitigating noise associated with construction, but these are oriented toward residential and commercial areas.⁴ The bulk of the available literature focuses on the possible impact of noise on animals in general, from endangered species to livestock.

II. HIGH-SPEED TRAIN NOISE AND EQUINES

As stated earlier, there is a paucity of published research or reports concerning the potential impact of HSR systems on horses (or any animals). In 2008, Carl Hanson – apparently the most visible applied researcher in this area – said, “[S]o far nothing has been reported on the potential effects of high-speed train noise on wild or domestic animals.”⁵ One challenge to potential research is that there is no ready metric for determining harm to animals. “For humans, annoyance is considered to be the primary environmental noise effect; thresholds for annoyance in terms of sound exposure have been determined by surveys ... [h]owever, for animals, the effects are not easily determined.”⁶

Existing studies of noise on animals have been based on exposing them to a specific stimulus (such as a jet flying overhead) and observing the response. The potential responses to experimental stimuli range from “no reaction or mild responses such as slight changes in body position to extreme responses such as panic and attempts to escape.”⁷ Unfortunately for researchers, longer-term effects could easily be confused with other external stimuli, such as weather. Therefore, this line of research is limited to producing only “preliminary indications of the appropriate descriptor, rough estimates of threshold levels for observed animal disturbance, and habituation characteristics of only a few species.”⁸ Horses are among the many species that have not been experimentally subjected to systematic effects of noise levels produced by trains.

III. EXISTING GUIDELINES FOR HSR AND ANIMALS

The Federal Railroad Administration (FRA) has established guidelines (with Hanson listed as the primary author) for noise levels that are potentially of concern with respect to animals, although these guidelines fall quite short of specific criteria.⁹ Essentially, because human beings react negatively to high levels of noise, such as those produced by trains, the assumption is that animals experience a similar effect. “Some characteristics of high-speed train noise are similar to low overflights of aircraft, and researchers generally agree that high noise levels from aircraft overflights can have a disturbing effect on both domestic livestock and wildlife.”¹⁰

Table 1. Interim Criteria for High-Speed Train Noise Effects on Animals

Animal Category	Class	Noise Metric	Noise Level (dBA)
Domestic	Mammals (Livestock)	SEL	100 dBA
	Birds (Poultry)	SEL	100 dBA
Wild	Mammals	SEL	100 dBA
	Birds	SEL	100 dBA

Source: Hanson, Ross and Towers, High-Speed Ground Transportation Noise and Vibration Impact Assessment, 3-5.

The guidelines (known as “Interim Criteria”) are listed in Table 1. They indicate that for all types of animals that have been subject to testing (wild or domestic) , a noise level of 100 dBA (Sound Exposure Level, or “SEL”) is an appropriate basis for “screening” the potential impact: It is based on “the assumption that impact occurs when a noise event is sufficiently loud to generate an observable effect in domestic livestock or wildlife.”¹¹ SEL is known as “the primary descriptor of high-speed rail noise emission.”¹² It “describes a receiver’s cumulative noise exposure from a single noise event.”¹³ The SEL is used because it essentially represents the accumulated noise associated with exposure, not simply the onset of a noise event. Thus, if a train passes by, the SEL associated with that event is a measure of the net impact of the acoustic event – expressed in decibels – over the duration of the entire passage, not only the loudest moment.¹⁴ However, little or no research has actually applied measures of SEL to animal responses.¹⁵

IV. KNOWN NOISE CHARACTERISTICS OF HSR TRAINS AND POSSIBLE EQUINE RESPONSES

Existing HSR European and Asian trainsets are generally known to produce SEL levels of between 83 and 91 dBA, meaning that they uniformly operate at below the 100-dBA threshold for possible impacts on animals (including horses).¹⁶ The actual noise generated by a specific train on a given route will vary according to several factors, including (1) speed, (2) length of the train, (3) distance from the track to the receptor, and (4) noise mitigation measures.¹⁷ The estimates for HSR trainsets are based on average or reference values, including a distance of 50 feet. As the distance from the train to the receptor (a horse, in this case) increases, the SEL decreases by a known factor.

The fact that HSR trains generally do not exceed the criteria suggested by the FRA (via Hanson et al) does not necessarily mean that the noise they generate won't create problems for equines and equestrians. For humans, it is not so much the noise produced by the train they find annoying but its rapid onset rate. "Onset rate" refers to how quickly a loud noise is produced and is measured in decibels per second. When onset rates exceed 30 dB per second, "people tend to be startled, or surprised, by the sudden onset of the sound. FRA guidelines suggest that the potential "startle effect" be considered as "additional information" and not added to measurements of high-speed train noise."¹⁸

This effect is known to occur primarily at spots that are close (50 feet or less) from the track. Nevertheless, some environmentalists have noted that loud noises frighten domestic animals and may elicit a "fight or flight" response.¹⁹ It is reasonable to assume that some horses – and perhaps their riders – may be startled by a suddenly approaching HSR train.

However, there is considerable reason to believe that many animals – including horses – simply adjust to recurring noise events: "There is evidence that some animals demonstrate reduced response to noise after prior exposure but that a few species never become accustomed to, or *habituate*, to high noise levels. Researchers found that for turkeys, previous exposure to sound levels below the 100 dB threshold was sufficient to eliminate panic responses to higher level sounds."²⁰

A US Forest Service study of the effects of aircraft noise on wildlife areas found that "Aircraft overflights are startling, but animals can adapt to them very well under most circumstances. Effects of overflights are subtle because animals adapt by habituating behaviorally and psychologically to the challenge."²¹

In this regard, the International League for the Protection of Horses has stated to the train authority of the UK: "[H]orses usually became habituated to repeated noise including that from passing trains, although it is acknowledged that there may be a short period of adjustment."²² This pattern may help account for the fact that little has been written about any lasting impact of rail on equine populations. However, it bears repeating that few existing studies have actually measured and scientifically verified the habituation process, and even fewer appeared to have focused on equines.

One such study that attempted to measure the effect of noise on horses did confirm the

habituation response. A 2008 study of the effects of “excessive music noise” concluded that loud music (in the range of average levels from 65 to 90 dBA) “would not be associated with any danger [to horses] and if there is any startle responses, habituation may occur quickly.”²³ However, the sound pattern of continuous loud music is obviously different from that associated with HSR trains, so the relevance of this study may be limited.

Finally, Huybregts (citing Greenberg and Haraway) states that horses have a 10 -15 dB higher hearing threshold than do humans, concluding: “...horses are somewhat deaf compared to us.”²⁴ This implies that the same amount of noise is likely to be less startling to a horse than it is to a human being. However, it is unclear if – and how – this difference translates into “startled” behaviors.

V. SUMMARY AND CONCLUSIONS

This review of existing scholarly and professional literature concerning equines and HSR systems has determined that relatively little has been written about possible conflicts. The lack of scientific research and associated literature may stem from either a lack of emergent issues or the inattention of researchers, or perhaps some of each. In any event, little has been established about how the creation and operation of HSR routes may affect equine populations and equestrians. Generally, the existing literature has the following shortfalls or gaps:

1. Existing research has most commonly focused on noise from overhead jet aircraft, and not from trains. Whereas the two share some similarities, they are not identical.
2. The research has typically been more concerned with the effect of noise on wildlife, not on domestic animals.
3. One piece of research that focused on horses specifically looked at the effect of prolonged exposure to loud, live music, and not trains.

What is known can be summarized as follows:

- Noises levels of 100 dBA SEL (Sound Exposure Level, a cumulative measure of noise) have the potential – at least in theory, as this is not documented – to harm horses, and existing Federal Railway Administration (FRA) guidelines state that such levels must be screened for possible conflicts. However, existing HSR lines operate below that level, and damage to horses has not been documented at that or any level of noise.
- Loud noises are known to have the potential to startle horses, which may have various detrimental effects to their well-being and that of their riders. There are no precise criteria for the amount of noise required to create a startling effect, only rough estimates of the amount of noise that *may* startle them. Virtually no systematic research has been conducted to establish such criteria.
- The very few studies that seem most relevant – i.e., those that explicitly seek to address the link between noise and a response from equines – uniformly conclude that horses tend to “habituate” to regularly repeated noises. However, this response pattern appears not to have been subject to systemic testing with respect to the specific noise patterns produced by trains.

Perhaps most definitively, in commenting on a HSR proposal in the UK, the International League for the Protection of Horses has stated that “horses usually became habituated to repeated noise including that from passing trains, although it is acknowledged that there may be a short period of adjustment.”²⁵ The extent to which this statement is supported by specific scientific research, however, is unknown.

PART TWO: CREATION OF MAPS

I. HIGH SPEED RAIL/EQUESTRIAN MAP

(FIGURES 1–7)

MAP CREATION PROCESS

To create the High Speed Rail/Equestrian map, the following data were obtained:

- Geodatabase of proposed California High Speed Rail alignment from Parsons Brinckerhoff
- Trails shapefile from Los Angeles County Department of Parks and Recreation via the LA County GIS Data Portal
- Roads shapefile of 2010 TIGER roads via the LA County GIS Data Portal
- Search engine results related to equestrian boarding facilities
- California Rail Network via the Caltrans GIS Data Library

Each shapefile was imported into ArcGIS and overlaid onto a topographic basemap. Because some records in the Department of Parks and Recreation Trails shapefile were missing, equestrian designations, online information from the Pacific Crest Trail Association, and the LA County Department of Parks and Recreation Trails website were used to modify the “equestrian” field of several trails whose equestrian designation was not provided. Trails with a “proposed” designation were removed from the map so as to reflect only existing trails.

Data on equestrian boarding facilities were obtained via an Internet search for equestrian facilities in the Palmdale and Burbank areas. The authors contacted each facility by phone to determine its acreage, equestrian boarding capacity, and current occupancy, however, some facility contacts could not be reached or were unwilling to provide this data. Ultimately, usable data were collected for 10 of the 37 facilities. The data were compiled into a spreadsheet and then geocoded into ArcGIS using the Los Angeles County Countywide Address Management System (CAMS) Address Locator.

Several sub-maps were created at a different scale (1:69,350) to provide greater detail within the area. These maps are displayed in figures 2 through 7.

DESCRIPTION OF MAP

As shown in the legend, this map features: (1) the four proposed California High Speed Rail lines between the Palmdale and Burbank stations and their track elevations, (2) LA County Department of Parks and Recreation trails and their equestrian permissions, (3) highways, freeways, and roads, and (4) equestrian boarding facilities within the area. The four HSR alignments pass through the San Gabriel Mountains and are mostly below grade through the Angeles National Forest. The map is overlaid onto a topographic basemap of the area.

MAP IMPLICATIONS

Though the map implies that there may be some potential at-grade conflicts with some existing boarding facilities, the majority of the Palmdale-Burbank stretch avoids most potential conflicts through below-grade development. The map also illustrates that a substantial amount of activity currently coexists with equestrian use, including the highway system, existing rail, surface streets, and development. Many of the existing equestrian boarding facilities and trails exist within or adjacent to areas that are already developed.

LIMITATIONS

As mentioned earlier, information on the capacity of equestrian boarding facilities was obtained through individual telephone calls to facility owners and operators, many of whom either could not be reached or declined to provide the information. Therefore, this map shows data for only 10 of the 37 facilities that were identified within the area. Further, this map does not represent all equestrian facilities in the area. Private ranch owners whose Internet presence does not identify them as offering equestrian boarding will not appear on this map, although they may have multiple equines.

This map offers a broad-brush level of detail and should not be relied upon to provide information about any particular potential conflicts between HSR and any other land use. The HSR alignments are currently in a conceptual planning stage and are undergoing environmental review. However, this map provides a look at what is currently in the Palmdale-Burbank area and provides a general look at what equestrian facilities are currently present.

SOURCES

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LA County Department of Parks and Recreation. “Marshall Canyon Trail.” <https://trails.lacounty.gov/Trail/36/marshall-canyon-trail?mobile=1>

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LA County GIS Data Portal. “2010 TIGER Roads.” <http://egis3.lacounty.gov/dataportal/2011/04/25/2010-tiger-roads/>

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Pacific Crest Trail Association. <http://www.pcta.org/discover-the-trail/equestrian-center/>

Parsons Brinckerhoff. Personal geodatabase. High Speed Rail alignment.

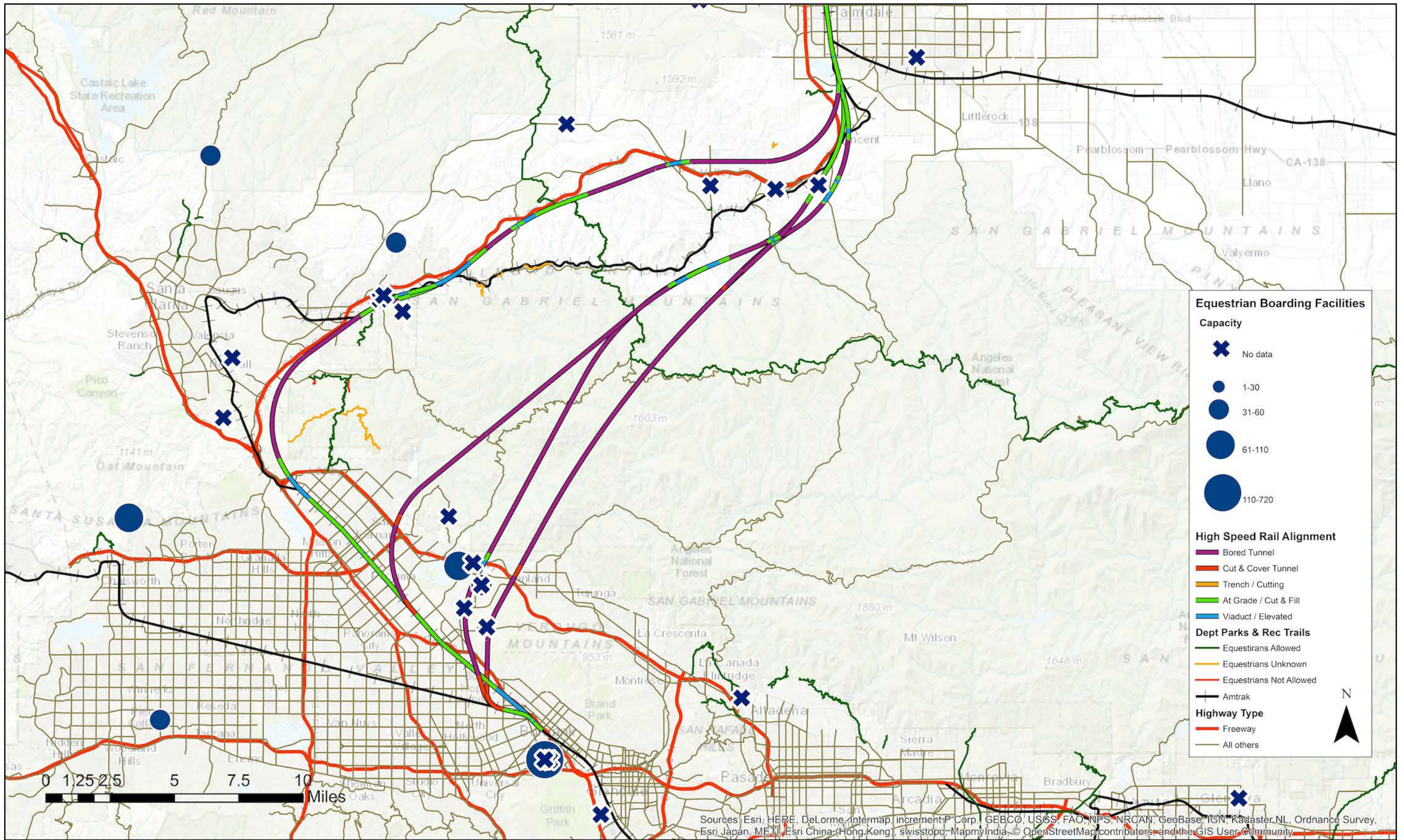


Figure 1. Palmdale-Burbank High Speed Rail and Equestrians



Figure 2. Palmdale-Burbank High Speed Rail and Equestrians at 1:69,350

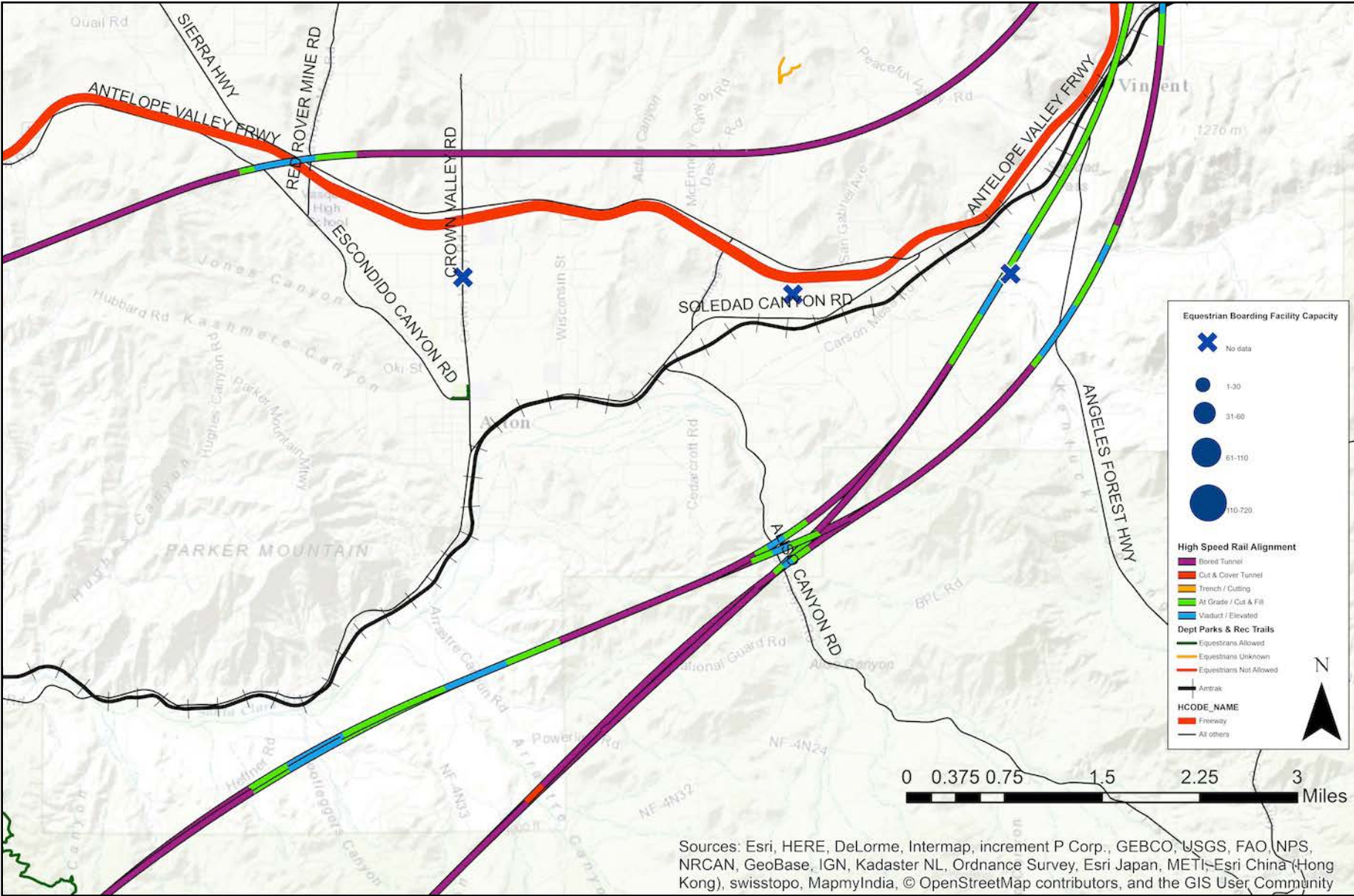


Figure 3. Palmdale-Burbank High Speed Rail and Equestrians at 1:69,350

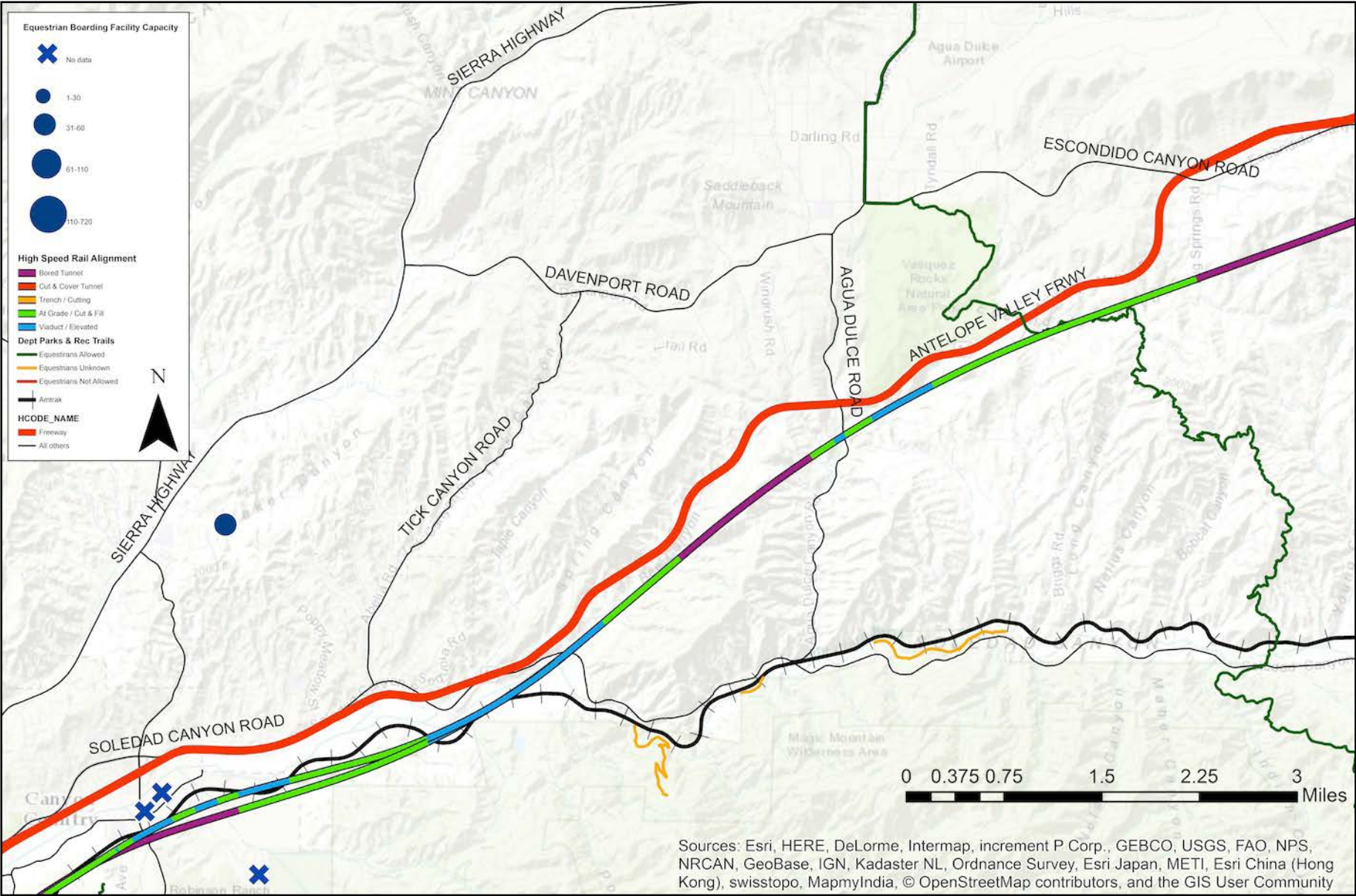


Figure 4a. Palmdale-Burbank High Speed Rail and Equestrians at 1:69,350

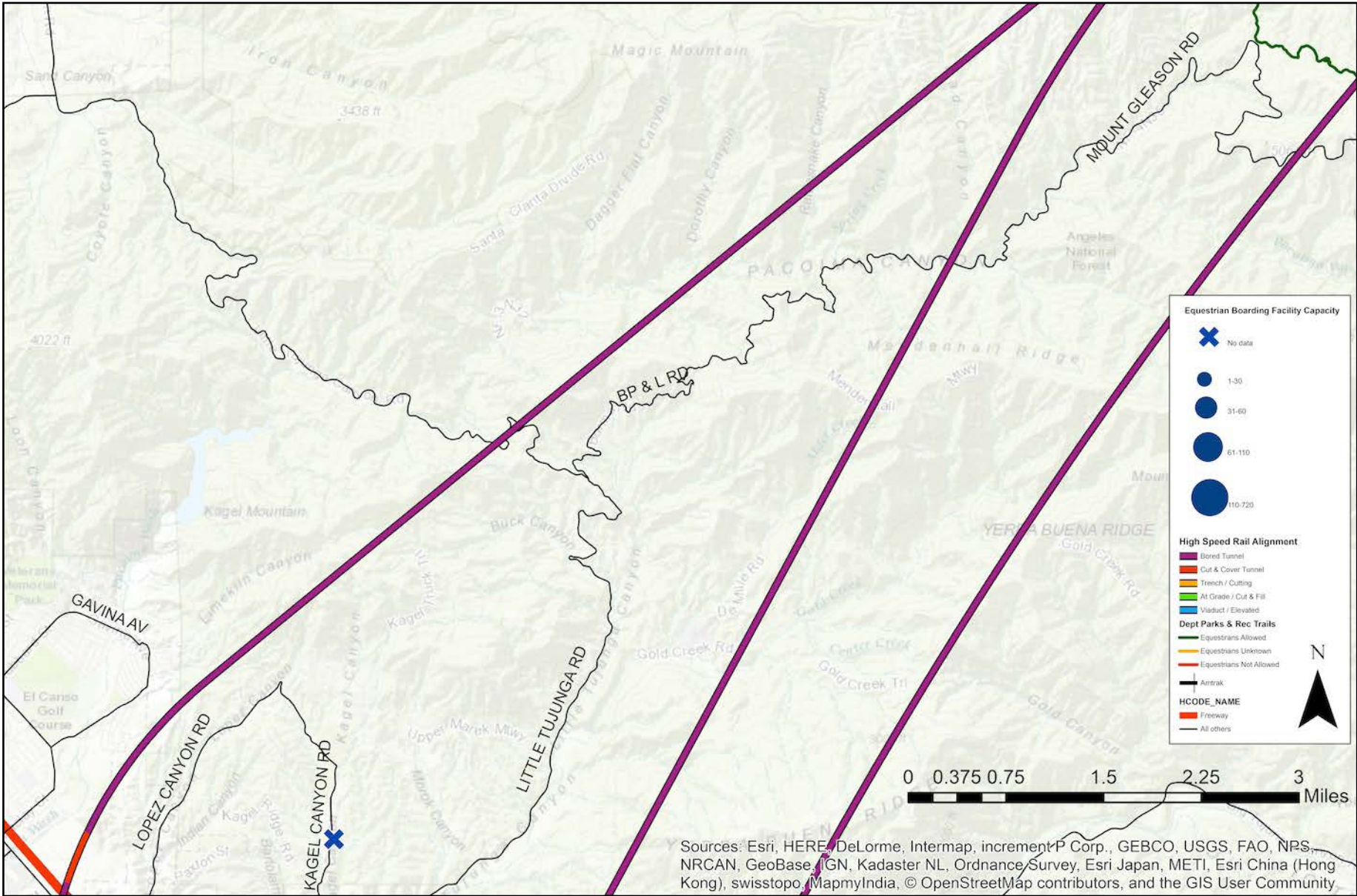


Figure 4b. Palmdale-Burbank High Speed Rail and Equestrians at 1:69,350

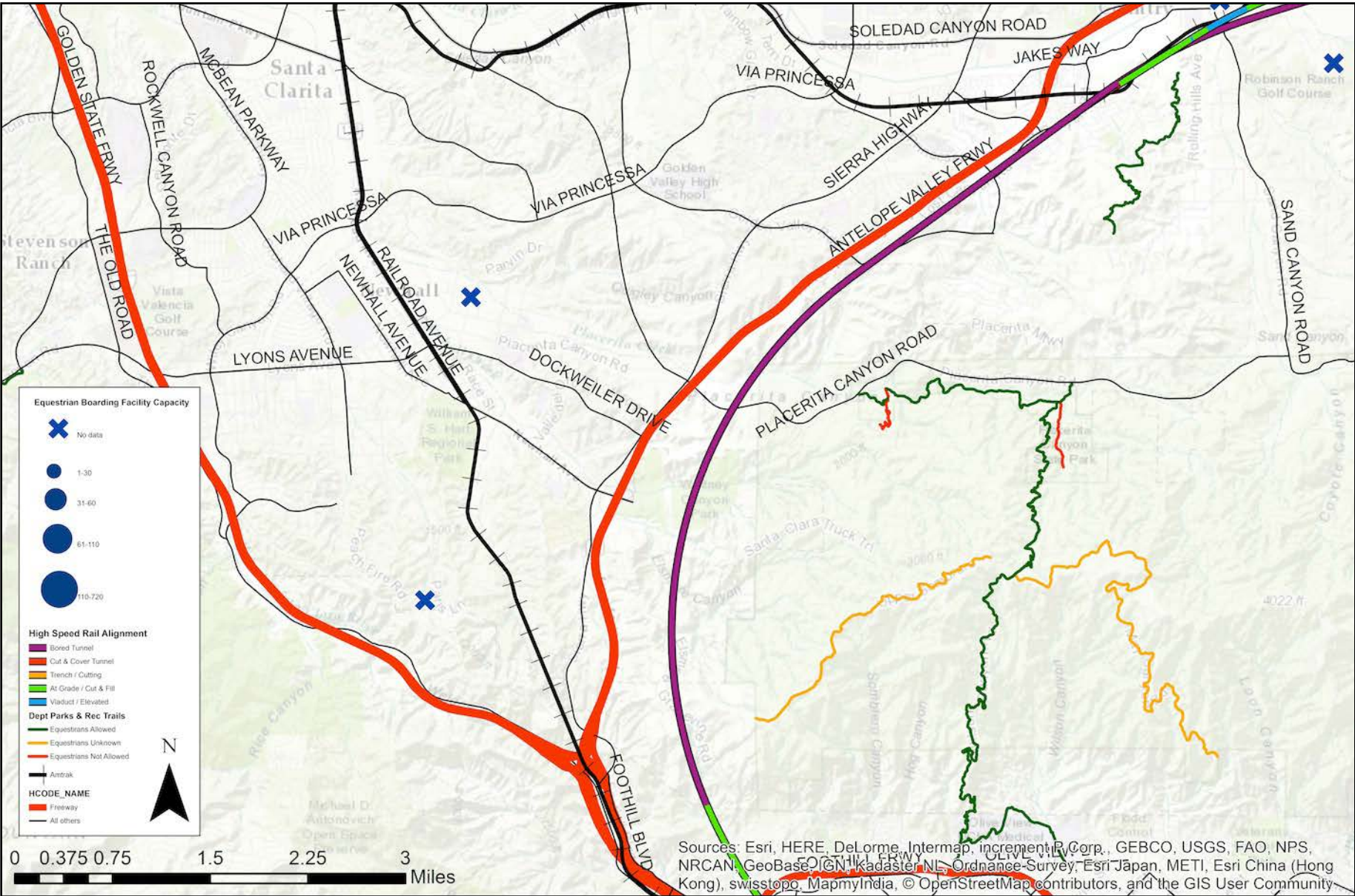


Figure 5a. Palmdale-Burbank High Speed Rail and Equestrians at 1:69,350

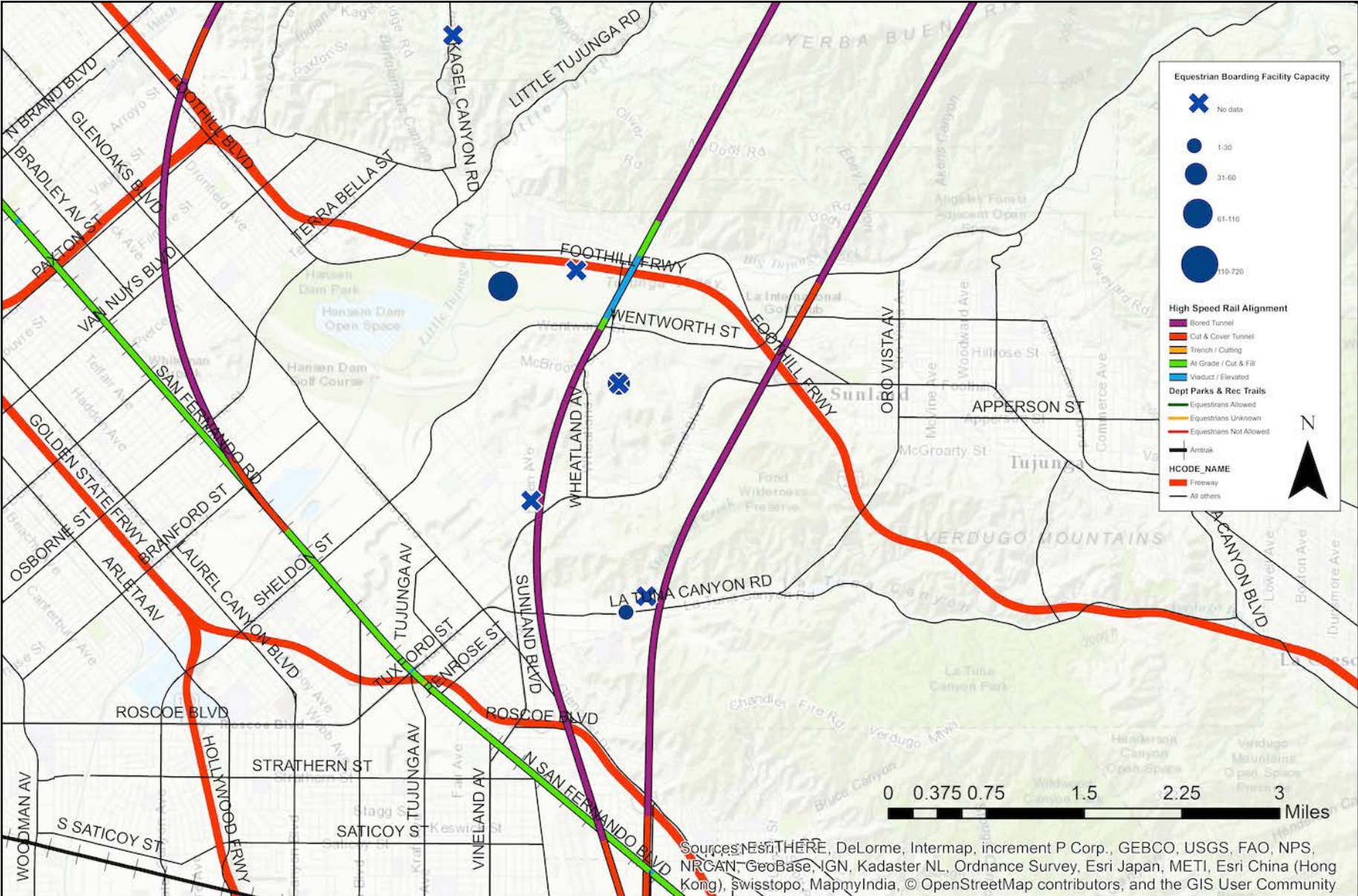


Figure 5b. Palmdale-Burbank High Speed Rail and Equestrians at 1:69,350

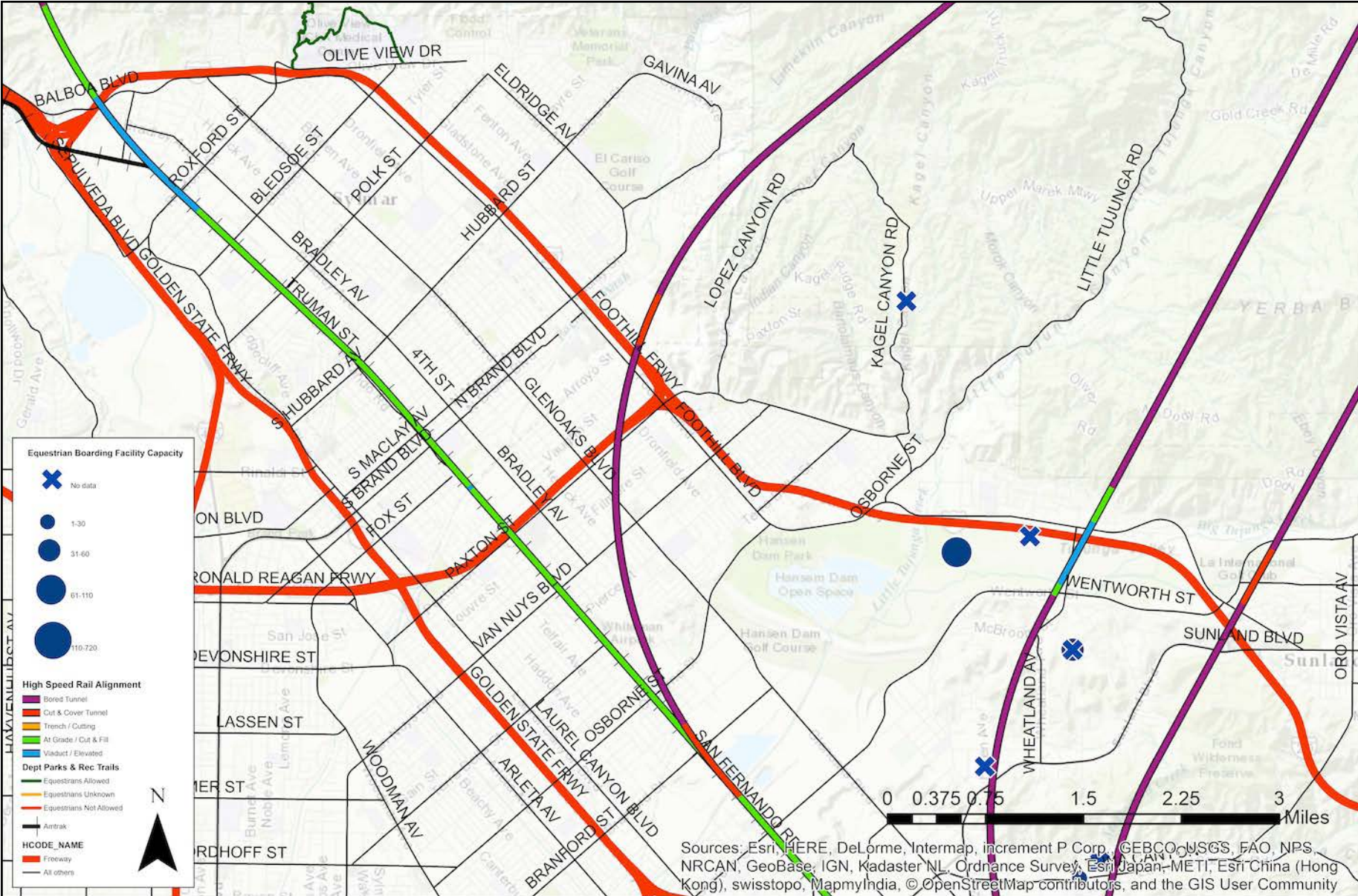


Figure 6. Palmdale-Burbank High Speed Rail and Equestrians at 1:69,350

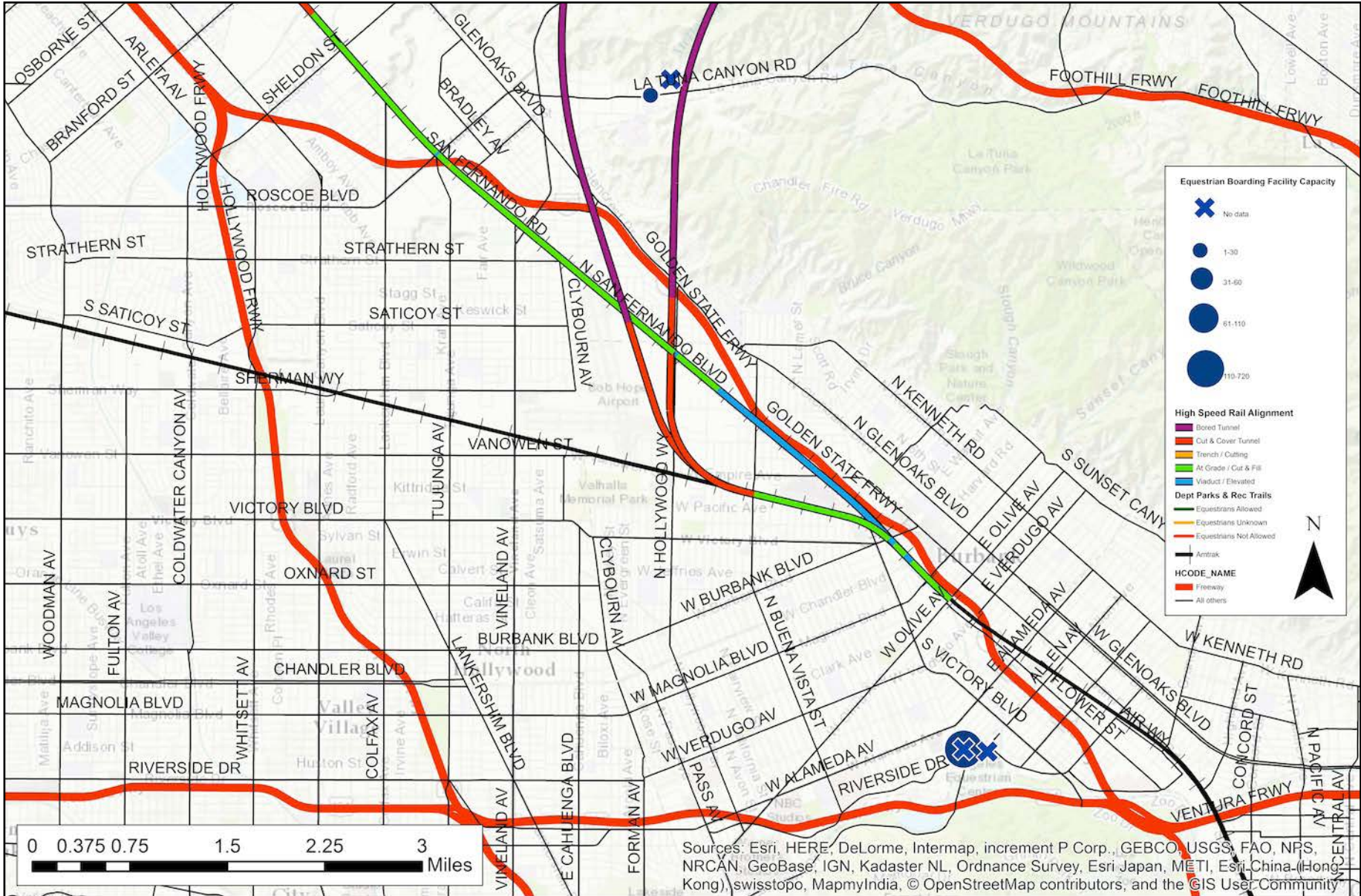


Figure 7. Palmdale-Burbank High Speed Rail and Equestrians at 1:69,350

II. RAIL/EQUESTRIAN DENSITY MAP

(FIGURES 8–9)

MAP CREATION PROCESS

To create the rail and equestrian density map, the authors obtained the following data:

- 2012 Agricultural Census data from the United States Department of Agriculture
- A National Railway Network shapefile from the USDOT Bureau of Transportation Statistics' National Transportation Atlas Database
- County boundaries from the US Census Bureau

To create this map, the authors downloaded agricultural census data from the US Department of Agriculture. The data are in tabular format and include indicators for average horse and pony count per 100 acres of farmland, per United States county. To enable a spatial format view, the agricultural census table was imported into ArcGIS and joined to a county layer for the United States by county code. A national railway network and a topographic basemap were then imported, with the agricultural census data visually represented as a dot density map to provide a broad look at equestrian density.

DESCRIPTION OF MAP

This map overlays the national railroad network onto a density display of the average number of horses and ponies per 100 acres of farmland. The map is overlaid onto a topographic basemap of the area.

MAP IMPLICATIONS

This map was created to provide a broad look at the current equestrian/rail coexistence. Although HSR is a new element in California, it is not, as the map illustrates, entering this area of California without precedent. Areas with high equestrian density appear to occur in each of California's highest population centers; for example, Sacramento, the Bay Area, and the Los Angeles areas, as well as rail network hubs, all appear to currently have high equestrian densities.

This map was created using agricultural census data. The dataset specifically quantifies the average number of horses and ponies per 100 acres of farmland, and can therefore only provide implications with regard to farmland equestrian density, and does not provide any measure of any other type of equestrian ownership density. With regard to farmland, the map seems to imply that there is some advantage to owning and operating a farm with equestrians in a relatively urban region (counter to the idea that equestrian use should be avoided in areas with higher population density); otherwise, one might expect to see a higher density of equestrian facilities in counties with lower population density. However, the use of USDA data may skew these findings since it's possible that farm owners would prefer locations near rail lines for distribution purposes.

LIMITATIONS

This map is intended to provide a rough look at the possible relationship between rail and equestrian density; however, spatial equestrian data are rare, and this dataset has several limitations for our purposes. First, the average equestrian counts from the Census of Agriculture do not actually represent total average equestrian ownership for the United States; they account only for equestrians affiliated with farmland. Other equestrian owners, ranch owners, or even small or family-owned farms may not necessarily report their equestrian ownership, as it may not be associated with any farming operations. As the data represent horses and ponies, the extent to which it actually represents equestrians is unknown. Finally, the data represent density only at the county level, which is necessarily imprecise.

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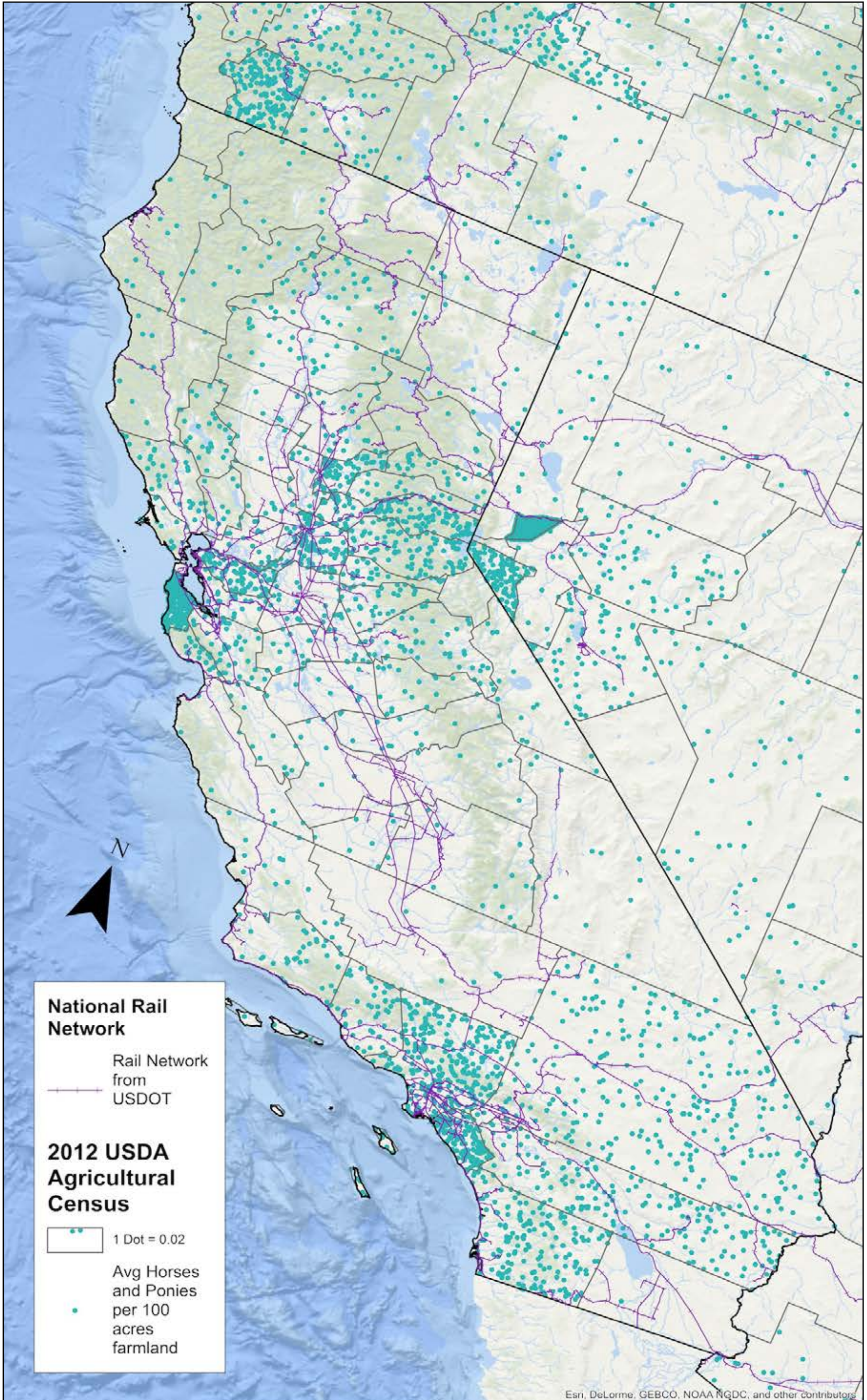


Figure 8. Rail and Equestrian Density (Two-Page View)

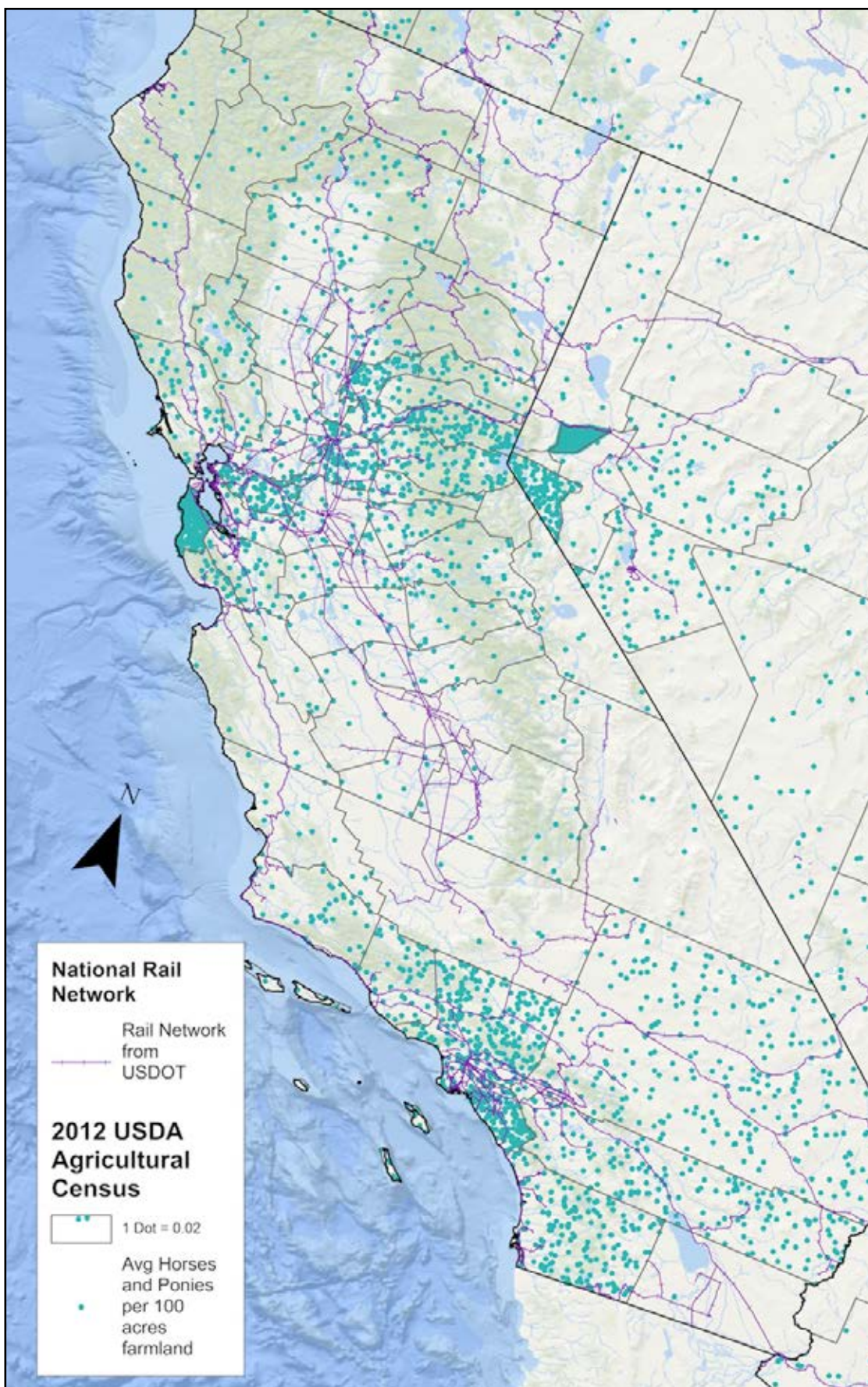


Figure 9. Rail and Equestrian Density (Single-Page View)

ENDNOTES

1. Arup/URS, *London-West Midlands Environmental Statement, Volume 5: Technical Appendices* (London: Department for Transport, 2013), 8.
2. Ignacio Barron de Angoiti, email message to author, August 31, 2015.
3. Carl E. Hanson, Jason C. Ross, and David A. Towers. *High-Speed Ground Transportation Noise and Vibration Impact Assessment*. (Washington, DC: Federal Railroad Administration, 2012), 10-1 to 10-15.
4. *Ibid.*, 10-9 to 10-11.
5. Carl E. Hanson, "High Speed Train Noise Effects on Wildlife and Domestic Livestock," in *Noise and Vibration Mitigation for Rail Transportation Systems* (New York: Springer, 2008), 26.
6. Hanson, Ross and Towers, *High-Speed Ground Transportation Noise*, A-19.
7. *Ibid.*, A-19.
8. *Ibid.*, A-19.
9. *Ibid.*, 3-2.
10. *Ibid.*, 3-2.
11. *Ibid.*, 3-9.
12. *Ibid.*, 2-4.
13. *Ibid.*, 2-4.
14. "Sound exposure level is a composite metric which represents both the intensity of a sound and its duration. Mathematically, the mean square sound pressure is computed over the duration of the event, then multiplied by the duration in seconds, and the resultant product is turned into a sound level. It does not directly represent the sound level heard at any given time, but rather provides a measure of the net impact of the entire acoustic event. It has been well established in the scientific community that Sound Exposure Level measures this impact much more reliably than just the maximum sound level." Department of the Air Force, *Realistic Bomber Training Initiative: Final Environmental Impact Statement* (Langley AFB, VA: United States Air Force, 2000), G-3.
15. *Ibid.*, A-20.
16. *Ibid.*, 5-11.

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17. Ibid., 5-12.
 18. Ibid., A-19.
 19. Hanson, "High Speed Train Noise Effects," 27.
 20. Hanson, Ross and Towers, *High-Speed Ground Transportation Noise*, A-21.
 21. Lawrence Hartmann, Robin T. Harrison, and William Makel, *Potential Impacts of Aircraft Overflights of National Forest System Wildernesses*. (Washington, DC: US Department of Agriculture, 1992), 45.
 22. Arup/URS, *London-West Midlands Environmental Statement*, 8.
 23. Cornelius Huybregts, "Protecting Horses from Excessive Music Noise - A Case Study." in *Animals: 9th International Congress on Noise as a Public Health Problem*. (Foxwoods, CT: International Commission on the Biological Effects of Noise, 2008), 7.
 24. Ibid., 3. Greenberg, Gary and Maury M. Haraway (Eds.), *Comparative Psychology: A Handbook 1st Edition*. New York: Routledge, 1998.
 25. Arup/URS, *London-West Midlands Environmental Statement*, 8.

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