Preliminary Groundwater Availability Assessment for Brownlee Ranch Burnet County, Texas

Prepared for

Asterra Properties

Prepared by

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Geoscientist Seal

This report documents the work of the following licensed professional geoscientist with Advanced Groundwater Solutions, LLC (License No. 50639), a licensed geoscientist firm in the State of Texas.

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Mr. Beach was responsible for developing the study approach, aquifer modeling, and overseeing development of well maps and hydrogeologic descriptions in the report.

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1. Executive Summary

The Brownlee Ranch is located about 6 miles north of Marble Falls on Highway 281. Burnet County and this area is one of the most geologically complex areas in Texas and the region is known as the Llano Uplift. There are several geologic strata containing groundwater on the Ranch and in the vicinity. Some of the aquifers on the Ranch and in the vicinity include the Ellenburger-San Saba, Marble Falls, Welge-Lion Mountain, and Hickory; all of which are very old rocks that are locally or regionally recharged from precipitation. The assessment of hydrogeologic and well data in the area indicate that depth of wells and well capacity is variable due to the complex geology. A preliminary groundwater availability assessment indicates that sufficient groundwater is available for typical large tract development and small tract development experiencing typical usage patterns for residential properties if the wells are drilled to sufficient depth to provide appropriate available drawdown in wells. Some wells may have reduced capacity due to geologic conditions and therefore require a larger storage tank to ensure water availability for high usage periods. This approach is not uncommon for some residential or small commercial developments in the area.

2. Introduction

Advanced Groundwater Solutions, LLC (AGS) has completed a preliminary hydrogeologic assessment and groundwater availability study for Brownlee Ranch (Ranch), which is located about 6 miles north of Marble Falls on Highway 281. The ranch is located on the southwest corner of the intersection of Highway 281 and Park Road 4. The objective of this study was to assess potential aquifers on the property and estimate groundwater availability for two development scenarios. The first scenario was for large tracts of about 100 acres and the second scenario was for smaller tracts of about 10 acres. This report describes the hydrogeology of the area, the aquifers that may be productive on the ranch, and the general groundwater availability based on aquifer and hydrogeologic assumptions from published reports from the area. AGS did not test wells on the ranch to complete this preliminary assessment. We used available data from public databases, which include the Texas Water Development Board (TWDB) well database and other published scientific literature to complete this desktop analysis.

3. Hydrogeology and Aquifers

Burnet County is one of the most geologically complex areas of the State. The region is known as the Llano Uplift, where much older basement rocks are exposed at the surface. The strata ranges from igneous intrusives that are over 1.1 billion years old through a series of stratigraphic units that span much of geologic time up to about 100 million years ago during the early Cretaceous. Additionally, a few recent alluvial deposits exist along surface water drainages. Table 1 shows the stratigraphy and hydrogeologic classification of geologic units in the Llano Uplift area (after Shi and others, 2016). Table 1 is a comprehensive table for a larger region, and not all the geologic units and aquifers shown in the table are present at the Ranch.

The older strata in the region have a variety of lithologies. The stratigraphic units that are composed of permeable sands or limestones with secondary porosity form the best aquifers in the area. Some additional structural faulting has occurred that further complicates the geology and acts to compartmentalize some of the zones between faults from one another.

Three units form minor aquifers in the area as defined by the Texas Water Development Board. From oldest to youngest, those units are the Hickory Sandstone, Ellenburger-San Saba Dolomitic Limestone and the Marble Falls Limestone, which is not available in the vicinity of the Ranch. The surface geology in the area of interest is shown in Figure 1.

The Hickory Sandstone is Cambrian-age and is the lower most unit of the Riley Formation. It is sediment eroded from and deposited in terrestrial and shallow marine environment on the irregular basement rocks in the area. Generally, the bottom portion of the Hickory is composed of coarser sand and conglomerates, which results in the best water production potential. Thickness of the Hickory can vary greatly from near zero in the outcrop areas to 400 to 500 feet in some areas in the subsurface areas.

The Ellenburger-San Saba Aquifer is composed of the San Saba, which is the lower most member of the Wilberns Formation, and where present is in hydraulic connection with the Ellenburger. The Ellenburger Group is a dolomitic limestone of Ordovician Age and composed from bottom to top of the Tanyard, Gorman and Honeycut Formations. The total thickness for all these aquifer subunits can collectively range from 0 to over 2,000 feet thick. The Ellenburger has had varying episodes of erosion, faulting and karstification since originally deposited. This secondary porosity is key for aquifer production capabilities with reports of wells that can produce over 1,000 gallons per minute (gpm) in some locals.

The aquifer likely to be utilized most in the property is the Ellenburger-San Saba in the northern portion of property. The Ellenburger portion of the aquifer is not available on the ranch, but the San Saba is the geologic unit at the surface in the northern half of the property. The San Saba is not present in the southern portion of the property (Figure 1).

The geologic unit, Point Peak member, which is stratigraphically below the San Saba limestone is found in outcrop in the southern portion of the property. Looking at domestic wells in the area, some domestic wells appear to be completed into the Point Peak member. These geologic units below the San Saba are not particularly known to be an aquifer in the region. However, some usable volume of water might be obtained from these units between the San Saba limestone and the Hickory Sand. If utilizing large enough storage, a domestic well producing a few gallons per minute could provide enough volume of water for a family. Based on available data on wells in the area, the expected depth of wells in the northern area is about 400 feet or less. If the San Saba is too thin, lacks water or is not present in any portion of the property, then the Hickory might be considered for water at deeper depth below the San Saba.

4. Wells on the Brownlee Ranch

Public records contain data for two wells on the Ranch, as shown in Figure 2. The older well in the records (BT-57-22-601) shown in Figure 2 was drilled in 1925 to a depth of 860 feet. The drill cuttings describing green glauconitic sands indicate that the well bottoms into the Riley Formation, which is stratigraphically located above the Hickory. As a result, the Hickory Sand may be deeper than 1,000 feet in the central portion of the property and likely shallower moving to the south. The older well (BT-57-22-601) is described as a test well, and it is unclear why it was drilled to 860 feet deep.

Another well record (#392878) shown in Figure 2 in the southeast portion of the property was drilled to a depth of 105 feet that was reported as “dry”. However, another well (#392882) shown in Figure 2 was drilled nearby to a depth of 225 feet and had a reported yield of 80 to 90 gallons per minute. This indicates that the geology and hydrology are somewhat unpredictable and site specific well conditions may vary significantly across the property.

Figure 2 also shows the locations and depths of various wells around the Ranch. Most of the wells are reported as domestic wells and while some are relatively shallow (40 feet), most wells are 400-800 feet deep. For planning purposes, it would be prudent to anticipate that domestic wells may range from 400-800 feet deep, knowing that there may be some locations where productive wells may be obtained at shallower depths.

5. Preliminary Groundwater Availability Assessment

To assess general groundwater availability on the Ranch, AGS completed aquifer drawdown analysis based on Theis drawdown equation for confined aquifers. The Theis drawdown analysis is a well-recognized method for assessing the impacts (water level decline) caused by well production of various volumes in aquifers. Because we did not test the wells on the property, we used aquifer properties that have been documented for the aquifers on the Ranch by Shi and others (2016). Based on reported data, hydraulic conductivity in the Ellenburger-San Saba ranges from 1 to 5 feet/day and the storativity averages about $2x10^{-5}$. Likewise, the Hickory aquifer hydraulic conductivity ranges from about 1.5 to 5 feet/day hydraulic conductivity and exhibits a storativity of about $6x10^{-5}$. Assuming an average hydraulic conductivity of 3 feet/day and aquifer saturated thickness of 100 feet yields a transmissivity of about 2,200 gal/day/ft. AGS assumed a storativity of $3x10^{-5}$ for these assessments. Results are presented as water level decline contours from the original water levels in the well. Water level declines inside a well when a pump is operating will likely be somewhat higher than the contours indicate, and thus, these water level declines indicate the general availability of groundwater in the aquifer. The “cone of depression” near a well while the pump is operating will be determined by local hydraulic properties, well completion details, and other factors.

AGS assessed two development scenarios. The first scenario was for large tracts of about 100 acres (10 wells) and the second conceptual scenario was for smaller tracts of about 10 acres (96 wells). For the first development scenario (Scenario 1), we assumed two different production scenarios: 1) 600 gallons per day (gpd) per well, and 2) 25,000 gpd per well. For the second development scenario (Scenario 2), we assumed only one production scenario, which was 600 gpd per well. 600 gpd per well is considered a reasonable typical volume for a family residence. 25,000 gpd per well is the maximum that can be used per well on the property.

Large Tract Development – 600 gpd per well

Figures 3 and 4 show the simulated locations of wells for the large acreage development and the estimated groundwater level decline after 1 and 30 years respectively, with each well pumping 600 gpd. Estimated water level declines after 1 year are generally less than 2 feet and less than 3 feet after 30 years. This level of water level decline is relatively small if wells are drilled to an appropriate depth and pumps are set to provide a significant depth of water above the pump under static (non-operating) conditions.

Large Tract Development – 25,000 gpd per well

Figures 5 and 6 show the simulated locations of wells for the large acreage development and the estimated groundwater level decline after 1 and 30 years respectively, with each well pumping 25,000 gpd. Estimated water level declines after 1 year are generally about 60 feet and about 90 feet after 30 years. If wells are drilled to an appropriate depth and pumps are set to provide a significant depth of water above the pump under static (non-operating) conditions, this level of water level decline should not be problematic.

Small Tract Development – 600 gpd per well

Figure 7 shows the simulated locations of wells for the small acreage development and the estimated water level decline after 1 year with each well pumping 600 gpd. Estimated water level declines after 1 year are about 15 feet and about 22 feet after 30 years. This level of water level decline is manageable for the usage scenario depicted.

6. Limitations of this Evaluation

This assessment is preliminary and is based only on general and publicly available data in published reports. AGS has not tested wells on the property to corroborate findings from the property with the assumptions in this report. While the Theis analysis is a widely used and accepted methodology in the hydrogeologic profession, it employs limiting assumptions that may not be applicable in all aquifers. A very critical assumption in this assessment is that production from nearby wells is limited and does not compete with the pumping at Brownlee Ranch. This assumption may not be appropriate if there is significant development at the perimeter of the ranch. This study is meant to provide a basic assessment of potential groundwater availability and does not ensure that groundwater will be available on any particular tract or that any well will produce a certain amount of water.

Table 1. Stratigraphy and hydrogeologic classification of geologic units in Llano Uplift area (after Shi and others, 2016).

Geologic Units									Hydrogeologic Units
Era	System	North and East of Study Area				South and West of Study Area			
		Group	Formation		Member	Formation		Member	
Cenozoic	Quaternary	Loose sediments at river valley bottoms							Cretaceous Aquifer
Mesozoic	Cretaceous	Washita	Buda, Del Rio						
			Georgetown			Edwards Group	Segovia		
			Kiamichi						
		Fredericksburg	Edwards				Fort Terrett		
			Comanche Peak						
			Walnut						
		Trinity	Antlers	Paluxy		Absent			
				Glen Rose		Glen Rose			
				Travis Peak	Hensell	Travis Peak		Hensell	
					Cow Creek/Hammett			Cow Creek/Hammett	
					Sycamore/Hosston			Sycamore/Hosston	
	Jurassic	Absent							
	Triassic	Absent							
Paleozoic	Permian	Wichita Albany	Undivided			Absent			
		Cisco	Undivided			Absent			
	Pennsylvanian					Undivided			Confining Layer
		Canyon	Undivided			Undivided			
		Strawn	Undivided			Undivided			
		Bend	Smithwick		Undivided	Smithwick		Undivided	
			Marble Falls		Undivided	Marble Falls		Undivided	Marble Falls Aquifer
	Mississippian		Barnett			Barnett			Confining Layer
			Chappel			Chappel			
	Devonian	Exists in collapses only							
	Silurian	Absent							
	Ordovician	Burnam	Exists in collapses only						
		Ellenburger	Honeycut		Undivided	Honeycut		Undivided	Ellenburger-San Saba Aquifer
			Gorman		Undivided	Gorman		Undivided	
			Tanyard		Staendebach	Tanyard		Staendebach	
					Threadgill			Threadgill	
	Cambrian	Moore Hollow	Wilberns		San Saba	Wilberns		San Saba	
					Point Peak			Point Peak	Confining Layer
					Morgan Creek			Morgan Creek	
					Welge			Welge	Welge-Lion Mountain Aquifer
			Riley		Lion Mountain	Riley		Lion Mountain	
					Cap Mountain			Cap Mountain	Confining Layer
					Hickory			Hickory	Hickory Aquifer
Precambrian	Metamorphic (gneisses, amphibolites, and schists) and intrusive igneous (granites) rocks								Confining Layer

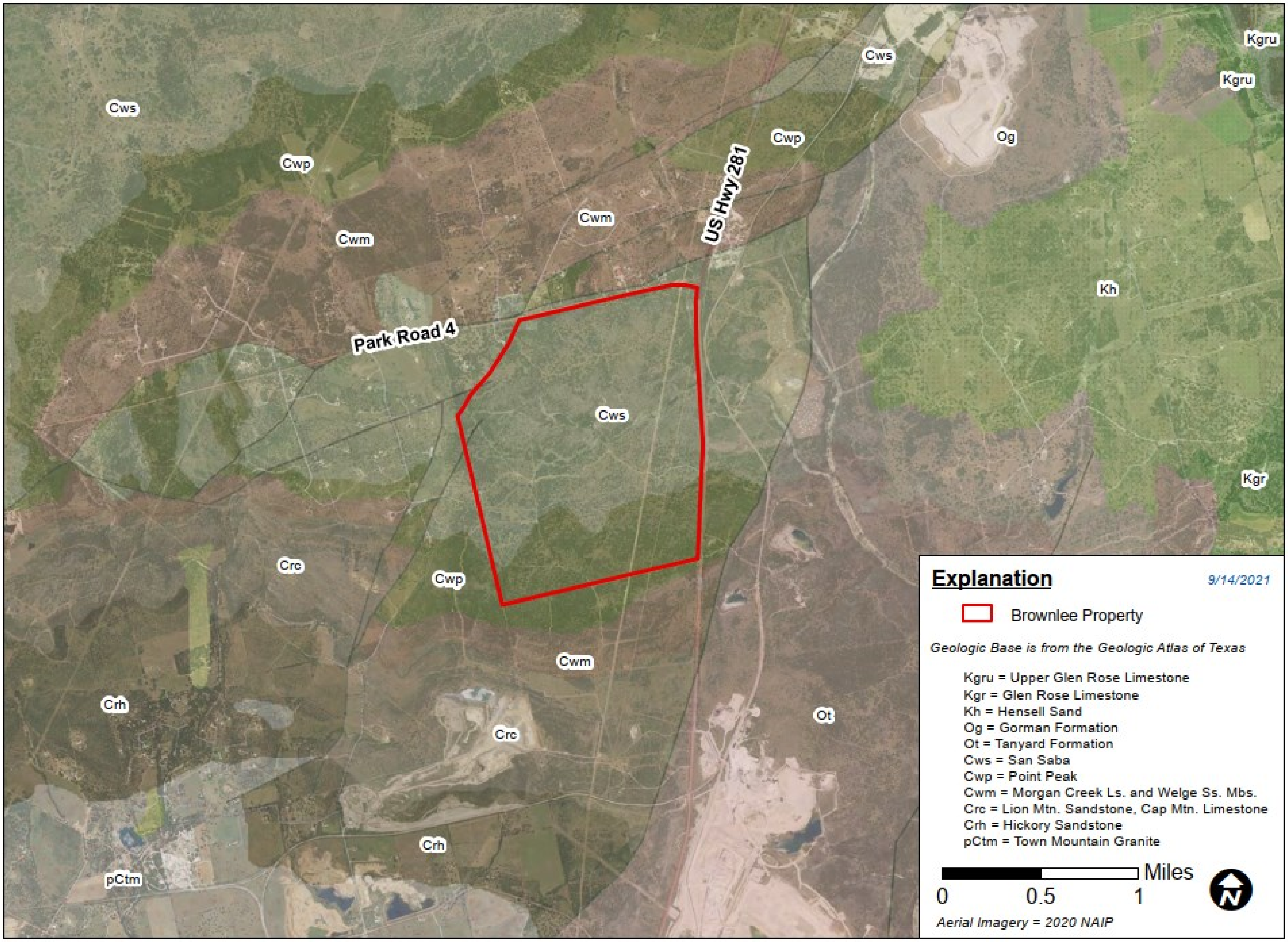

Figure 1. Surface geology in the vicinity of the Brownlee Ranch.

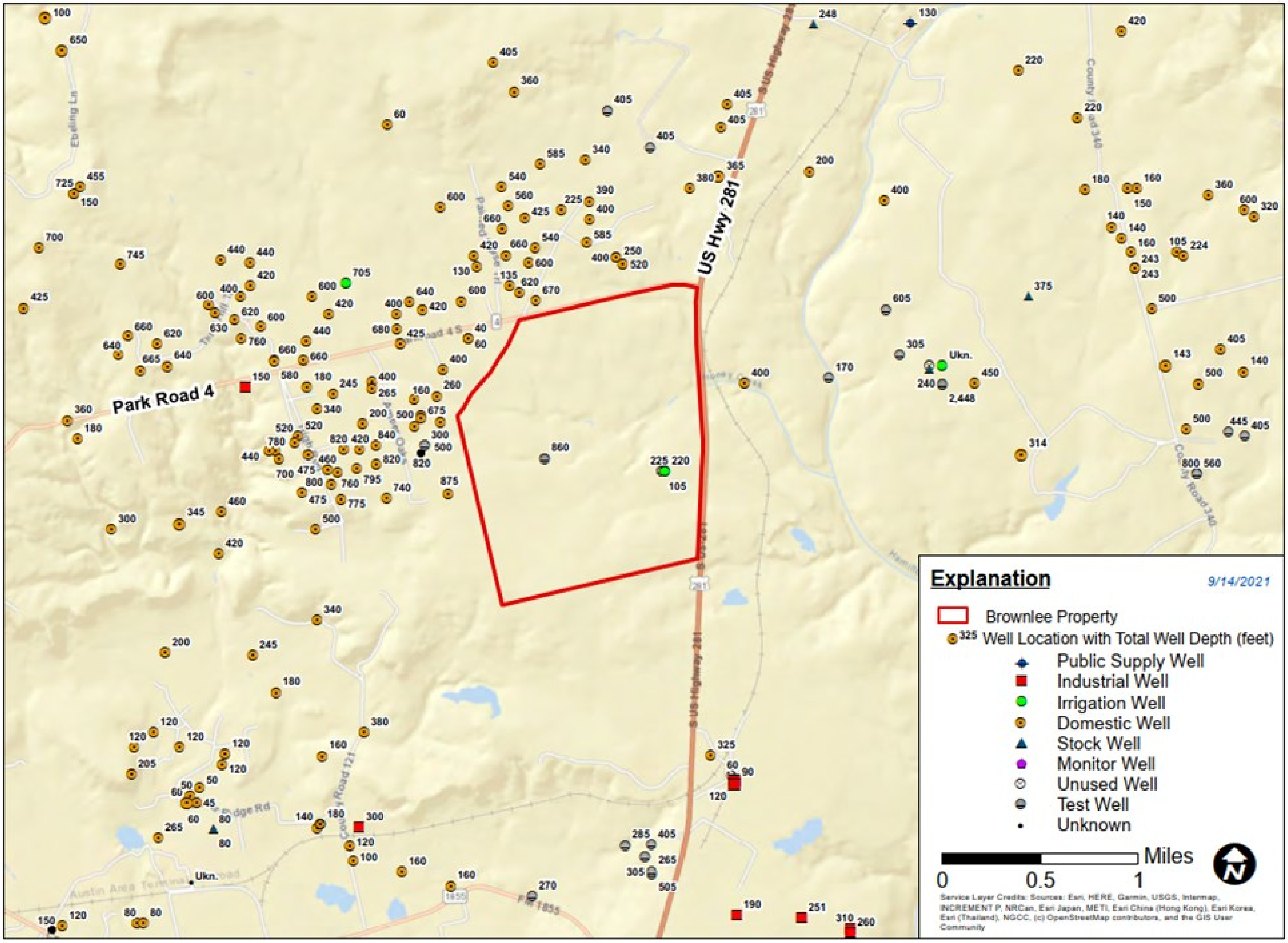

Figure 2. Water well locations on and near Brownlee Ranch

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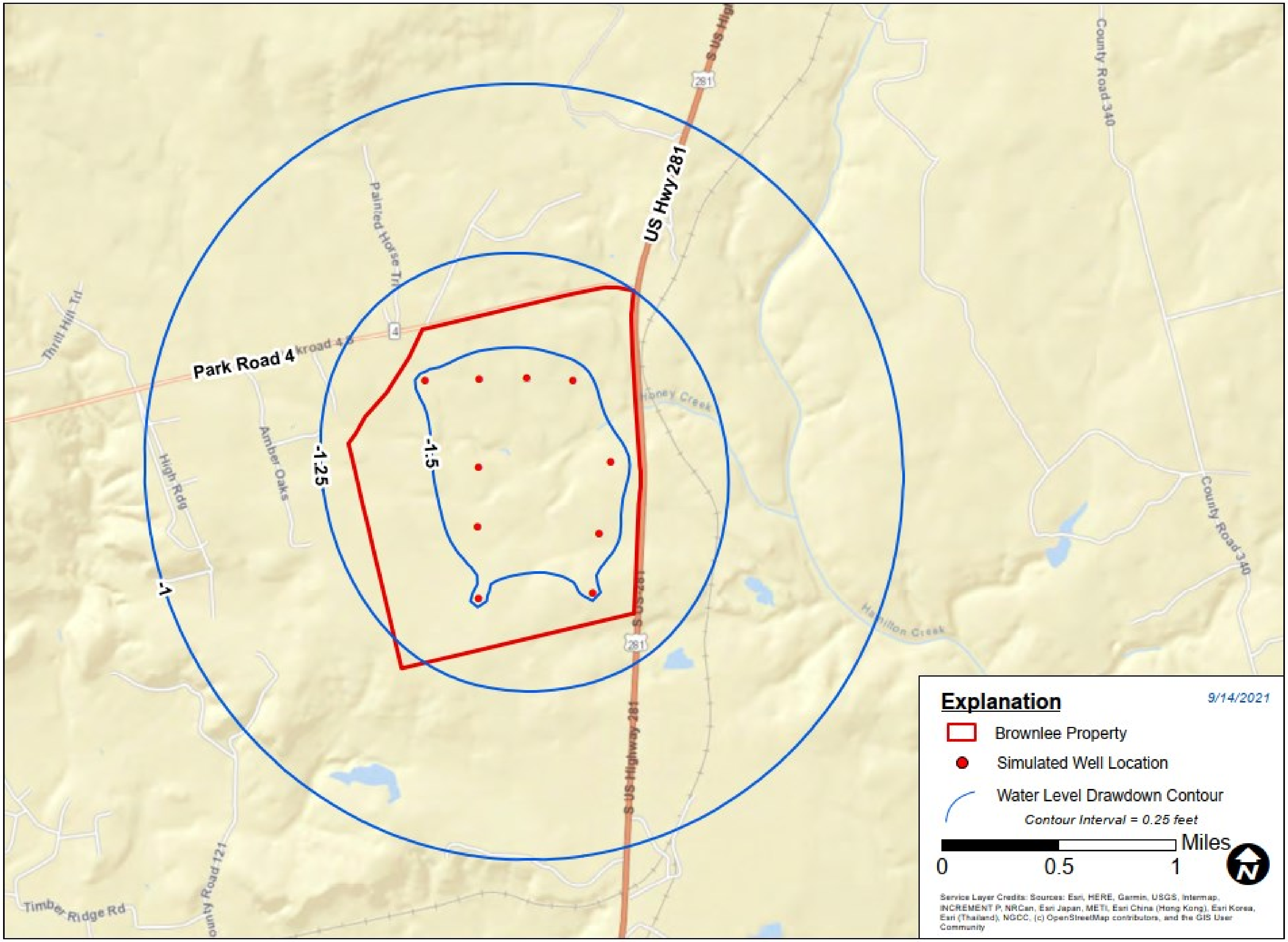

Figure 3. Simulated well locations (large tract) and aquifer drawdown after 1 year with each well pumping 600 gallons per day.

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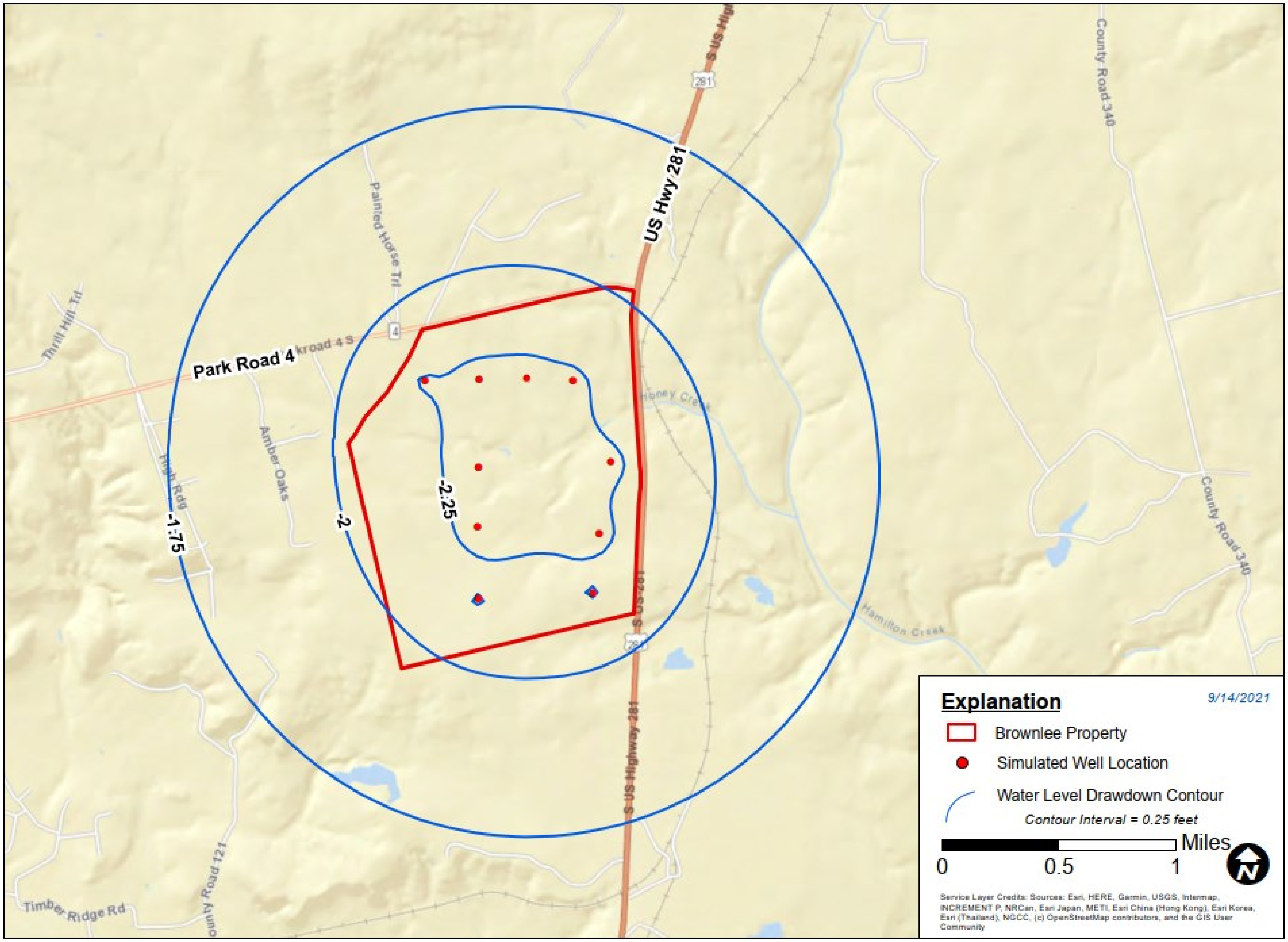

Figure 4. Simulated well locations (large tract) and aquifer drawdown after 30 years with each well pumping 600 gallons per day.

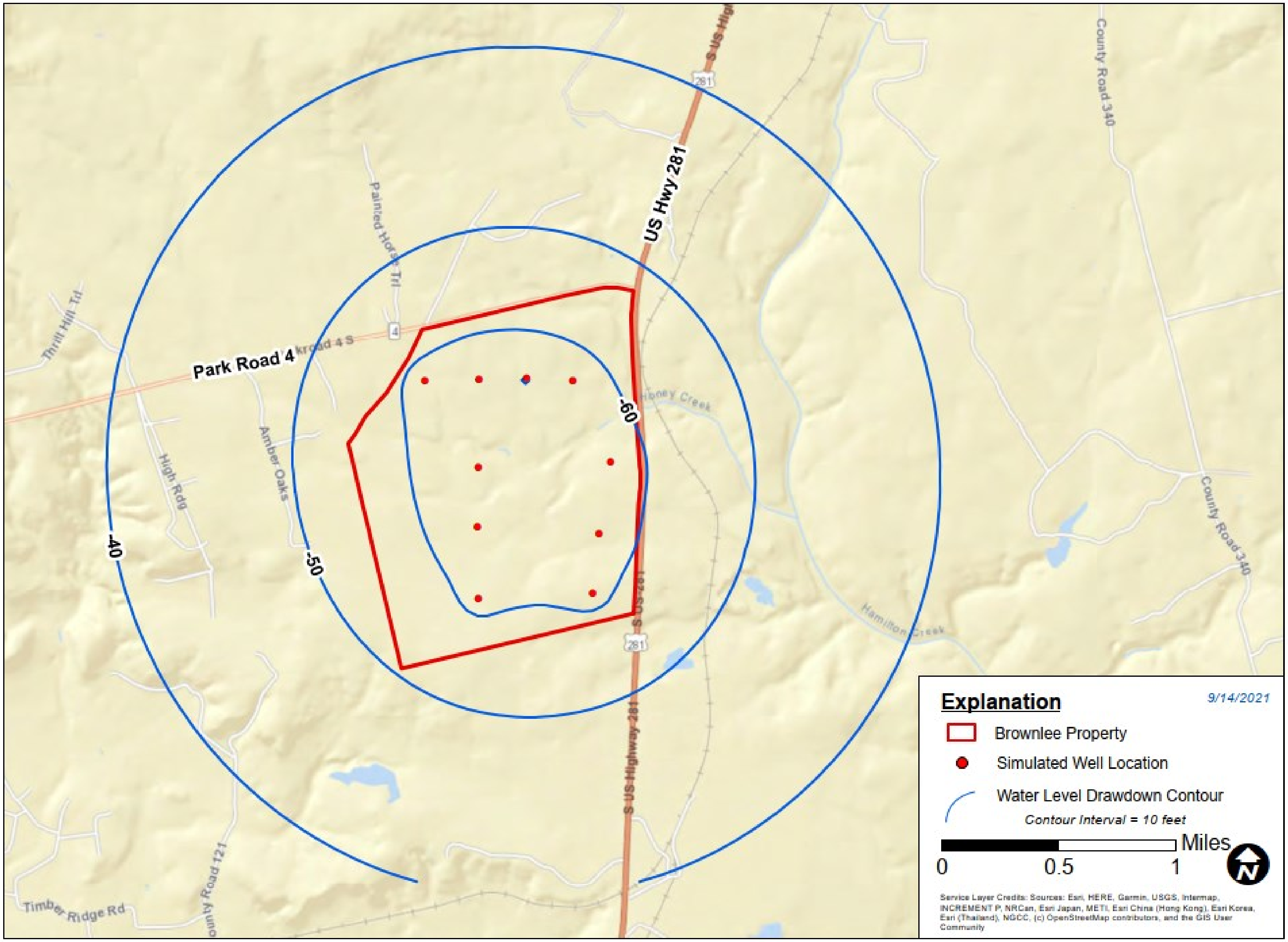

Figure 5. Simulated well locations (large tract) and aquifer drawdown after 1 year with each well pumping 25,000 gallons per day.

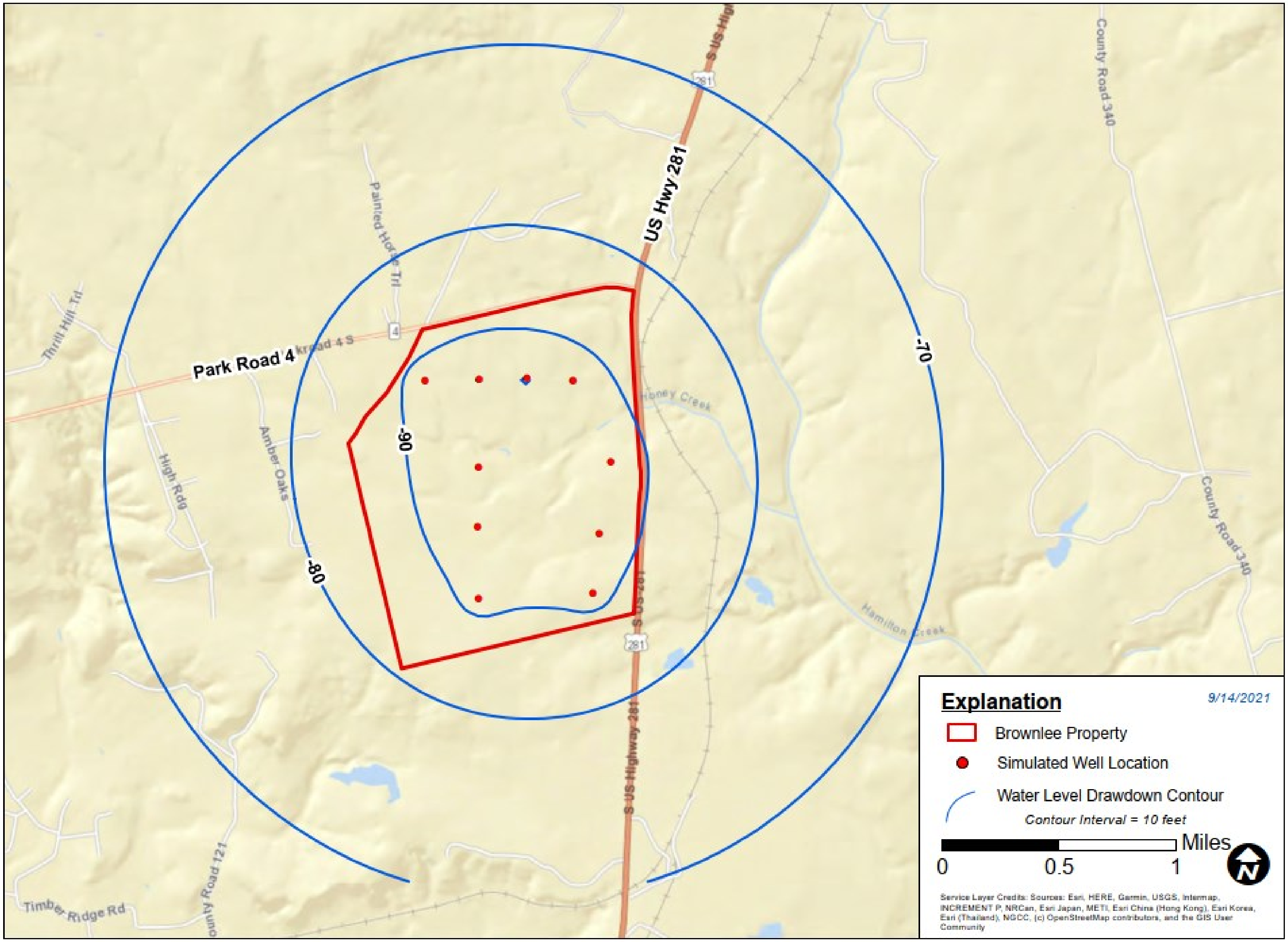

Figure 6. Simulated well locations (large tract) and aquifer drawdown after 30 years with each well pumping 25,000 gallons per day.

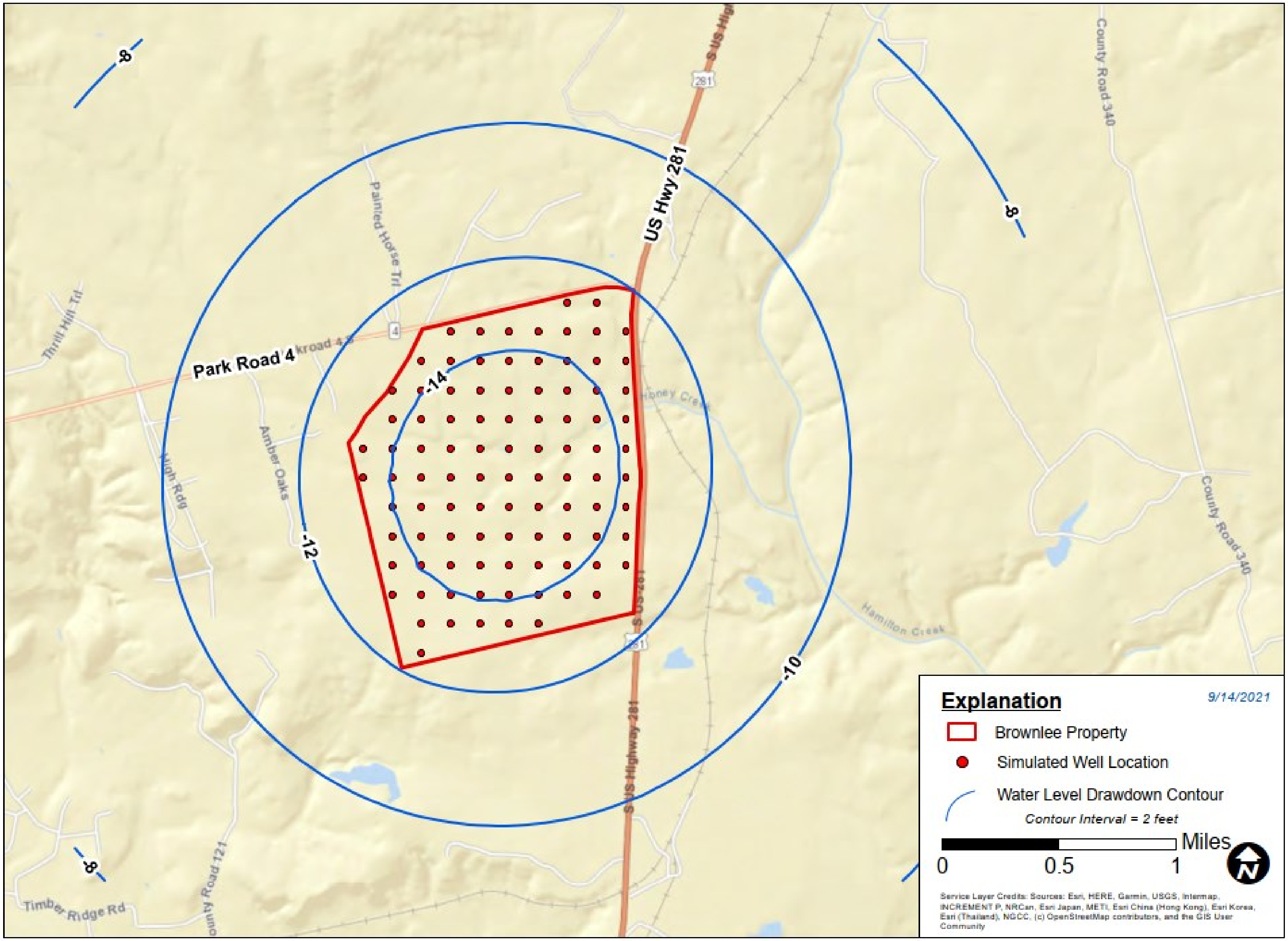

Figure 7. Simulated well locations (small tract) and aquifer drawdown after 1 year with each well pumping 600 gallons per day.

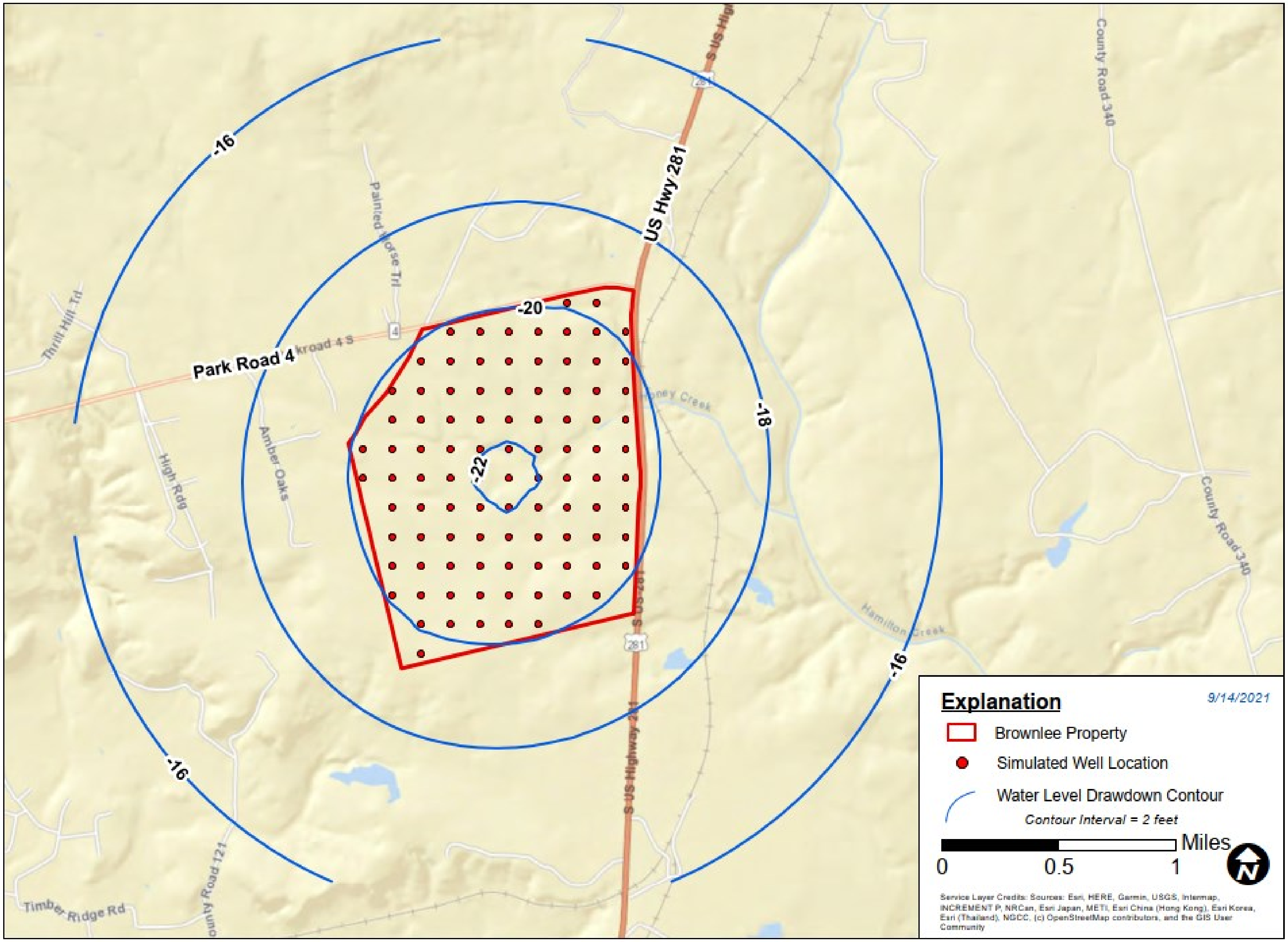

Figure 8. Simulated well locations (small tract) and aquifer drawdown after 30 years with each well pumping 600 gallons per day.