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EXPLORING REMNANT LANDSCAPES OF NEVADA'S ARROWHEAD TRAIL

JOE WEBER and MATTHEW LAFEVOR

ABSTRACT. The Arrowhead Trail was an early 20th century automobile highway, running 853 miles between Los Angeles and Salt Lake City via southern Nevada. While some of the road evolved into a modern highway, much of the original road was abandoned and parts even submerged underneath Lake Mead after construction of the Hoover Dam in the 1930s. This study examines the condition of two sections of the Arrowhead Trail in Nevada using Federal Trail Data Standards, which allows classification based on condition and location, and a zonal model of reservoirs developed by archaeologists that offers a guide to how immersion in a reservoir will affect artifacts. These were tested using a combination of archival data and fieldwork. The Federal Trail Data Standards provide a useful means for characterizing the condition of historic roads, while the reservoir-based approach offers insights into road survivability and may be of greater use in the future. *Keywords: Highway, reservoir, Nevada, underwater archaeology.*

Visitors to the beautiful Valley of Fire state park in Nevada may notice a historic marker calling attention to the Arrowhead Trail, the first automobile highway between Los Angeles, California, and Salt Lake City, Utah (Figure 1). Visitors who take the time to read the sign may wonder why the road passed through such a remote and rugged place, so far from any modern highway. The road does not appear on today's maps, and only the sign points to the remains of where it was. Much of the Arrowhead Trail eventually became U.S. 91 and later I-15, leaving the old road to fade away under the influence of weather, vegetation, and later use. But while old highways in the West face increasing threats from urbanization, military base expansion, and solar power projects (Weber 2019), part of the stretch through Nevada suffered a rare fate for a desert road by being submerged under the waters of Lake Mead, the nation's largest reservoir, following the construction of the Hoover Dam in the 1930s. Today, persistent drought and overextraction have dropped Lake Mead's water to record low levels, and the old Arrowhead Trail route has emerged.

Historic roads such as this one are an important part of cultural landscapes and heritages around the world, although efforts to identify and interpret them have been slow to develop (Jakle and Sculle 2011; Loren-Méndez and others 2016; Center for Preservation Education and Planning 2017). This is partly explained by the traditional research focus on roads largely for their economic and/or functional roles, especially in the context of historic landscape studies (Turner and Crow 2010; Johnson 2008). Cultural geographers, however, have long stressed issues of representation and interpretation in historic landscapes

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FIG. 1—Arrowhead Trail marker in Valley of Fire state park. Photo by authors.

(Olwig 1996, 2003; Cosgrove and others 1988) and, when combined with new empirical and field-based studies, are beginning to use more interdisciplinary and synthetic approaches to understanding historic roadways (Ruíz and others 2015), which include new methods of characterizing and classifying historic roads (Loren-Méndez and others 2016). Importantly, these studies serve to bridge the central tension between economic/functional and social/symbolic approaches to historic landscape research that has long been identified in archaeology (Johnson 2008), anthropology (Snead and others 2011), history, and geography (Widgren 2004; Cosgrove 2003).

Research on historic roads has also connected with newer disciplines. Environmental conservation, management, and engineering seek better understanding of historic roads as the imprints of past road construction, development, maintenance, and abandonment manifest today in a variety of natural and anthropogenic contexts (Spooner 2007). The timing, extent, and socio-environmental context of road development are also key to studies that measure, monitor, and model the long-term impacts of roads on soil erosion, sediment transport, and hydrologic connectivity (Ramos-Scharrón and LaFevor 2016). Research on historic roads and associated landscapes (corridors) is relevant to a wide range of socio-environmental, historic, and geographic subfields. New efforts to identify and manage the vestiges of historic roadways provide important foundations for geographical research into past and present landscapes, in all their economic/functional, socio-symbolic, and biophysical dimensions.

In the United States, the National Park Service (NPS) has played an active role in identifying and examining historic roadways within and outside its territories (Davis 2016; Davis, Croteau, and Marston 2004), a well-known example being the preservation and interpretation of the old Lincoln Highway and Route 66 (National Park Service 1994, 1995, 2005). Thanks to these and similar efforts, other historic roadways are incrementally being added to the National Register of Historic Places, a growing and living archive of the nation's historic landscapes (National Park Service 2020). While inclusion in the National Register does not guarantee roadway preservation, it does indicate a growing awareness that these places are important to the nation's heritage, especially if coupled with state efforts to recognize and mark these roads.

Marking an historic highway like the Arrowhead Trail at only a single location is insufficient for conveying its importance or meaning within a transport landscape. This paper examines several remaining sections of the historic road through a combination of fieldwork and mapping with the goal of better understanding the road's geography and survival. It applies a methodology for assessing the condition of each section, which is informed by a general model of how the location of historic features (such as roads) within reservoir lakes may impact survival over time. The Arrowhead Trail, and its flooding by Lake Mead, provide an ideal opportunity to develop an understanding of the region's cultural landscapes and heritages.

Background

The earliest attempts to develop long-distance automobile routes in the United States stemmed from the efforts of individuals and organizations. The first of these was the famous Lincoln Highway, founded in 1912 as a transcontinental road (Hokanson 1988). Hundreds of others followed in the next several years, each the result of efforts to connect adjacent towns (Jakle 2000). Campaigns to promote construction of the Arrowhead Trail began in 1916 by residents of Las Vegas, who had witnessed other auto trails being created across central and northern Nevada (Lyman 1999a, 1999b, 1999c). The new highway was named for a natural arrowhead-shaped feature on the side of California's San Bernardino Mountains (Lyman 1999a; Meek 2007). The 853-mile road connected Los Angeles with Salt Lake City via Las Vegas, and was promoted as being free of bad grades, high elevations, or sand (Figure 2) (Waddell 1917).

Between San Bernardino, California, and St. George, Utah, the road traveled through the Mojave Desert, crossing several empty valleys and low mountain ranges. Leaving the Las Vegas valley, the road passed through a gap between the Dry Lake Range and Sunrise Mountain and down California Wash before turning east to pass through a gap in the Muddy Mountains. From here the road descended into the Valley of Fire, a desert canyon with red sandstone hills and outcrops (Figure 3). The road continued eastwards into the Muddy River Valley, a mile-wide floodplain within which the Muddy River flowed throughout the year, fed by springs several miles upstream.

The abundant water made the valley a natural focal point for people and roads. Native American farmers first settled this valley, followed by Latter-day

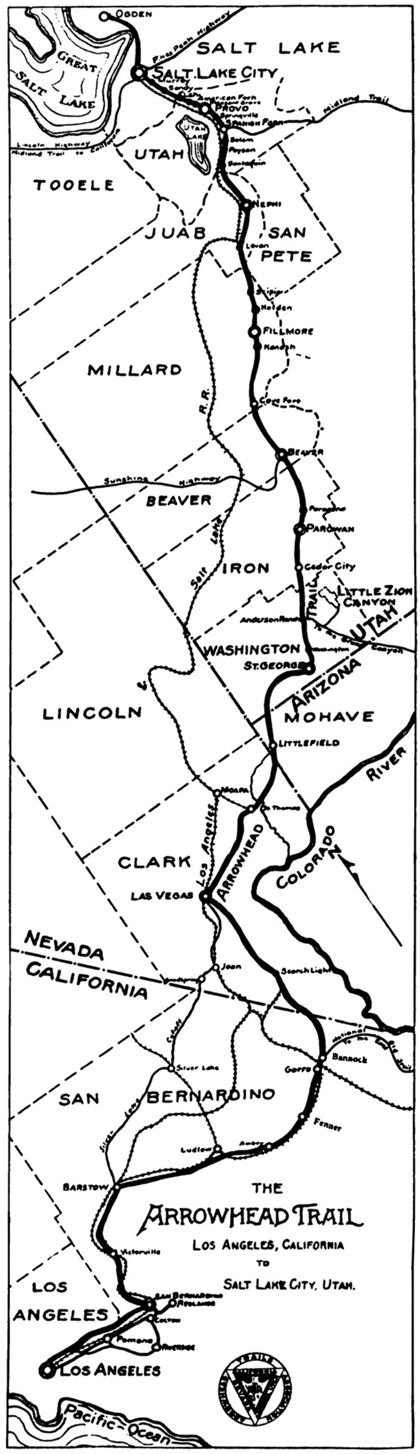

FIG. 2—Strip map of Arrowhead Trail, 1917. Source: Motor West Company (1917).

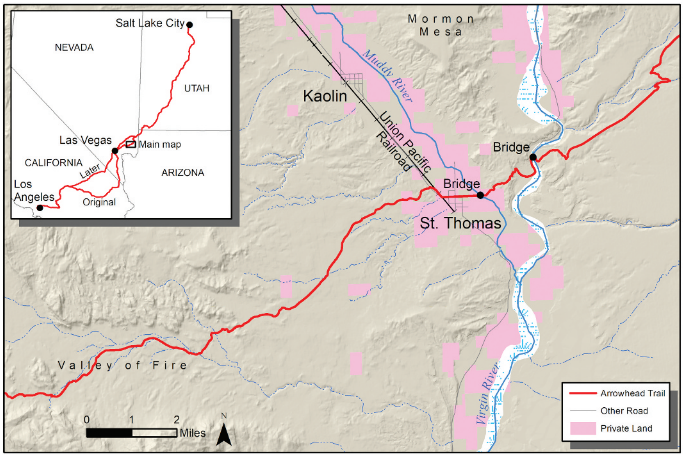

FIG. 3—Map of Arrowhead Trail in 1920. Map by authors.

Saint (more commonly known as Mormon) farmers who developed several small agricultural communities during the early twentieth century. The southernmost of these was St. Thomas. This small farm town along the Muddy River had been founded in 1865 and would hold the distinction of being the largest town in southern Nevada until Las Vegas was founded in 1905 (McArthur 2013). The valley remained isolated by difficult roads until 1912, when a small railroad line arrived and connected St. Thomas with the rest of the state (Myrick 1963). By 1918, the town had a garage, school, hotel, several grocery stores, restaurants, and other businesses located along its main street (McArthur 2013). Residents grew alfalfa, watermelons, and cantaloupe for local consumption and for export via the town's railroad spur. Some grazed cattle on surrounding hills, and many mined salt from nearby deposits for household use or sale. Because the town was a Mormon community, the Church allocated land to each farming family, and few bothered to seek ownership according to homestead laws. This changed in the 1930s once government appraisers arrived and began the process of providing compensation to farmers for lands that would be lost to Lake Mead; Figure 3 shows the extent of private lands at this time. The private farms and the town's streets were based on the Public Land Survey, apparent in the rectangular boundaries and cardinal directions of the town's streets (Weber 2018a).

The Arrowhead Trail passed through St. Thomas on its main street and over the Muddy River on a small wooden bridge, then ascended a wash to the crest of a narrow ridge separating the Muddy River from the Virgin River. The road crossed the Virgin River on a substantial truss bridge in an area known as the Narrows (or Upper Narrows), one of two places where the wide river valley narrowed to a small gap that could be bridged with a single span. The road continued northeastwards to a second Virgin River crossing at the town of

Mesquite, Nevada. Although normally a small, sluggish stream, the Virgin River was prone to flooding during storms (United States Department of Agriculture 1977), and as a result the bridges over it were frequently damaged. New bridges were planned for the Virgin and Muddy rivers after the Arrowhead Trail became Nevada State Highway 6 in 1920 (Nevada State Highway Commission 1919; Nevada Department of Highways 1921).

These plans, and other improvements to the road, were put on hold, however, by a bold new engineering plan developing in California's distant Imperial Valley. Floods there had led to calls for dams to prevent flooding and to store water during dry years. Engineers had identified Boulder Canyon in Nevada as the best location for a massive dam as early as 1920 (Bureau of Reclamation 1922). The Boulder Dam project proposed building a massive reservoir with an elevation of 1300 feet above sea level, which, once filled, would completely submerge St. Thomas, Kaolin, and Overton (Nevada Department of Highways 1923). The planned lake elevation was later reduced to 1221 feet, sparing Overton but not St. Thomas, Kaolin, and portions of the Arrowhead Trail. By 1924, Route 6 and the Arrowhead Trail had been relocated well to the north of the future reservoir, which also shortened the road (Nevada Department of Highways 1923, 1925). In the following year, the old road through the Valley of Fire was abandoned and the Virgin River bridge near St. Thomas was burned (Morrow and others 2010; McArthur 2013). In 1926, the relocated Arrowhead Trail became U.S. 91 when the United States adopted a national system of numbered highways, formally replacing the old system of named highways throughout the country.

The Boulder Dam Act was signed into law in 1928, although construction did not begin until 1930 (Bureau of Reclamation 1948; Hiltzik 2010). The lake began to fill behind the dam in 1935 and the rising waters reached St. Thomas in June 1938 (Bureau of Reclamation 2019). The town's buildings were demolished and its trees cut down, with the last resident driving through the lake's waters on the way out. By the time the lake surface reached its maximum elevation of 1221 feet above sea level the town was 56-feet underwater. Over the next 34 years, this maximum lake level was seldom reached, and the town was exposed at least briefly almost every winter until the end of 1972, when rising lake levels kept it underwater year-round until May 2002 (Bureau of Reclamation 2019). Since then, St. Thomas and stretches of the old Arrowhead Trail have reemerged, perhaps permanently.

Reconstructing Old Roads

Efforts to locate and reconstruct historic roadways and trails have used several approaches. Some studies have used geographic information systems (GIS) to identify the locations of pathways and vehicle routes across terrain (Raitz, Levy, and Gilbreath 2009; Howey 2007; Weber 2018b; Zohar 2019). Others studies have used aerial or satellite imagery to identify landscape features of historic routes, ground truth them, and map roadways using these features as references (Ur 2003; Lipo and Hunt 2005; Reynolds and others 2006). Without historical references, ancient road networks have been identified and mapped from space using satellite imagery (Ur 2003). An early example, Carl Lipo and Terry Hunt (2005) used satellite imagery to identify the roads on Easter Island used to move the massive statues. Subsequently, they verified these routes through fieldwork, measuring road dimensions and identifying other archaeological remains that supported their findings. Reynolds and others (2006) used a similar mixed methodology, but referenced old land-survey maps to plan fieldwork, which identified a section of Georgia's early nineteenth century Federal Road.

Although not as ancient as many roadways of the past, America's historic automobile roads are receiving growing interest as cultural landscapes worthy of preservation (Mariott 2010). The exact locations of many roads remain uncertain, a phenomenon especially common in the rural American West. The Desert Research Institute (2009) used aerial photography and fieldwork to identify intact sections of the Lincoln Highway in the Utah desert, and ultimately created a GIS database of these sections. Jeffrey Baker (2014) also used aerial imagery to identify probable historic segments of late nineteenth and early twentieth century roads in Nevada, and then carried out fieldwork to link these segments and classify them as wagon- or automobile-era routes. In these cases, the identification and mapping of historic roads required a multistep process that began with estimating roadway locations using historic and cartographic source data and aerial imagery, and ended with ground truthing these estimates with various field techniques.

The Federal Trail Data Standards (FTDS) describes trails using six categories, each based on route documentation, archaeological evidence, current condition, and the extent to which the trail location can be verified (Federal Geographic Data Committee 2011). National Historic Trail (NHT) Condition Category I describes routes that have been verified from documentary sources and fieldwork, and appear identical to when they were in use. "The visible trail remnant retains the essence of its original character" and "shows no evidence of having been either impacted by subsequent uses or altered by other improvements" (Federal Geographic Data Committee 2011, 51). NHT II describes a trail that is intact, but "shows minor evidence of alteration by subsequent use, development, or natural events" (Federal Geographic Data Committee 2011, 51). NHT III trails appear to have been largely erased by natural processes, which especially applies to trails passing through bedrock or sand substrates, as these do not easily preserve evidence of a trail. Other trails have been completely destroyed, as when a previously identified trail has been erased by a graded road, and in these cases are classified as NHT IV. Beyond this, the NHT V category is used for trails in which the location is only approximately known. This scenario is common where trails are incorporated into current roads or submerged by reservoirs. (Interestingly, the Standards do not take reemergence into account).

Finally, on the other end of the spectrum, the NHT VI category describes a trail that has been carefully restored to match the best approximation of its historical appearance. Although the six FTDS categories were originally designed for describing National Historic Trails (NHTs) such as the nineteenth-century California or Old Spanish Trail emigrant routes (Oregon-California Trails Association 2014; Bureau of Land Management and National Park Service 2017), they are broadly applicable to any unpaved, linear transport feature, including early automobile roads.

Reservoir flooding has complicated efforts to identify, map, and interpret many roads in the American West. Thousands of dams and reservoirs have been built in the region since 1900, often in the same preferred locations (e.g., river valleys and easy mountain passageways) that also attracted the earlier road builders. Decades ago, Donald Jewell (1961) recognized that one consequence of the growth in reservoir construction could be the loss of important archaeological and historic sites. However, a caveat to the prediction was also added that suggested, counterintuitively, that reservoir flooding may also serve as a means of site preservation, rather than destruction. Throughout the 1960s and 1970s, researchers held widely contrasting views on the impacts of reservoir flooding on site preservation, although there appears to have been little formal research on the topic.

The first formal attempt to examine what happens to historical artifacts when they are submerged under reservoirs was the National Reservoir Inundation Study that began in 1975. Among its findings (Lenihan and others 1981), the study emphasized the role of mechanical processes, especially waves along a shoreline, and how they impact landscapes as lake levels rise and fall over long vertical ranges of time. The potential energy of wave action varies with wind speed, duration, and the distance it blows over open water. Partly as a result, lakes that fill quickly and have little drawdown will often result in less landscape degradation. Additionally, lakes with steeper slopes will likely have greater wave impacts than those with lower slopes, as gravity and the vertical impacts of waves are greater. In newly filled reservoirs, underwater landslides are also a common feature, found often in areas of loose rock and sand. Gradually, sedimentation processes will fill the reservoir, with the highest rates of sedimentation occurring where flowing streams reach slack water, where deltas often form. In deeper parts of the reservoir, sediments will deposit near the former river channels, thereby burying many cultural resources along these features. Biochemical processes involving sedimentation, temperature, changing pH, and dissolved oxygen levels also can impact organic artifacts, but these processes are less relevant to transportation features.

The findings of this study have been reflected in several studies. Scott Carpenter and Laura Kirn (1988) surveyed a reservoir in Yosemite National Park that was filled in 1917, but was completely drained in 1985. They found that the original land surface was well preserved, although some localized degradation had been caused by creeks flowing into the reservoir. They also found a number of prehistoric and historic archaeological sites on the former lake bottom, including roads, bridge abutments, timbers, sawdust piles, and metal debris left from occupation and dam construction. The remains of a cabin yielded many small historic artifacts, and another site yielded evidence of a U.S. Army campsite. The lake was referred to as "a capsule sealed in time" (Carpenter and Kirn 1988, 210), and suggestions were made about what might be found in nearby Hetch Hetchy Reservoir and similar lakes. In a similar study, archaeological surveys were conducted in the drawdown zone of Amistad Reservoir in Texas during periods of low water (Dering 2002). Among the 5,172 acres surveyed, 102 new archaeological sites were found. The majority of these were prehistoric, but sites associated with railroads and roads that passed through the reservoir area before inundation were also identified. These included an army trail from 1875 and one of the first transcontinental railroads, built in 1883. In the case of Lake Mead, underwater survey work by Ron Reno and others (2009a, 2009b, 2009c) identified the remains of well-preserved roads from the 1930s, railroad lines, and building foundations.

A useful approach to understanding the impacts of reservoirs on submerged cultural resources is the zonal model of reservoirs (Lenihan and others 1981). This model divides the reservoir into five areas: 1) permanent storage zone, 2) the fluctuation or drawdown zone, 3) a higher zone of occasional flooding, 4) dry land above the high-water level, and 5) the area downstream from the dam. Under this model, historical landscapes within each zone likely reflect different impacts from natural and anthropogenic processes. Accounting for these impacts allows a type of relational characterization of those landscapes based on the different impacts in each zone.

In this model, Zone 1 describes the area below the dead pool, the body of water below the elevation of the lowest spillway or intake at the dam. The water below these outlets cannot be drained from the reservoir. Resources in this zone will remain underwater (and eventually be buried under sediment deposits) unless the dam is removed. In Zone 2 water levels can fluctuate and the wave or subsidence impacts on roads are likely to be greatest. Zone 3 includes areas above the normal water level that may be submerged during flood events. In western reservoirs, Zone 3 areas are likely small as these conditions on lakes are uncommon. Zone 4 is the above-water area and is likely to show impacts of heavy human activity. Off-road travel, vandalism, and lakeshore development have severe impacts on surviving resources in the above-water zone, leading to the possibility that submerged sites and artifacts may be better preserved. Finally, Zone 5 includes the riparian landscape downstream from the dam, where the survival of artifacts depends on water releases from the dam as well as later development.

The first goal of this paper is to test whether the Federal Trail Data Standards can be used to characterize the remains of the Arrowhead Trail. It is expected that this approach will provide a useful tool for classifying and visualizing the condition of historic roads. The second goal is to examine the effects of inundation on the trail by using the zonal reservoir model to subdivide the study area into two distinct sections: Zone 4 (never flooded) and Zone 2 (formerly flooded). The reservoir inundation model suggests that while the Zone 2 section is likely to be well preserved, roads in Zone 4 are likely to vary in their condition due to environmental processes and later reuse. This should be apparent when road conditions are mapped.

Methodology and Data

The Arrowhead Trail Association and commercial sources provided maps and guidebooks that were useful for establishing the general route location, but they did not help with field identification or ground truthing (Automobile Blue Book Publishing Company 1918). The authors drew a finer-resolution map using United States Geological Survey topographic maps and additional historic resources (Smith 1972; Belshaw and Peplow 1980; WESTEC Services, Inc 1980; Knight and Turner 1988; Nevada Department of Transportation 2019). The surrounding area has been mapped by the USGS since the 1890s as part of its topographic quadrangle series (Moffat 1985), and a number of additional topographic maps were created for the Hoover Dam project (USGS 1924). For this study, maps from the 1920s and 1950s were consulted that show the Arrowhead Trail, including much of the original route between Las Vegas and the Muddy River. Using these sources and aerial photos the Arrowhead Trail was mapped in GIS using ArcGIS software (Figure 3).

Two sections of the Arrowhead Trail were chosen for fieldwork. The first is a 4.69-mile stretch that includes the old road from Northshore Drive east to the Muddy River and the St. Thomas townsite. The second is a 6.64-mile section in Valley of Fire State Park (Figure 4). These sections were chosen for their ease of access; mapping indicated the Valley of Fire section is not in use and is separated from other sections by long paved stretches. The St. Thomas section begins where the pavement ends and runs to the Muddy River, which provides a physical barrier to further exploration on foot. These sections provide excellent opportunities to examine formerly submerged roads because a portion of the St. Thomas section was inundated for about 60 years (corresponding to Zone 2) while the adjacent lands and the Valley of Fire section were never submerged (Zone 4). The spatial extent of these zones was identified in GIS. A digital elevation model (DEM) was obtained from the USGS (2019) and reclassified in ArcGIS to create a zonal polygon based on appropriate elevations. Zone 2 represents the area between the dead pool (which at Lake Mead is 895 feet above sea level) and the maximum water-level elevation of 1221 feet, while

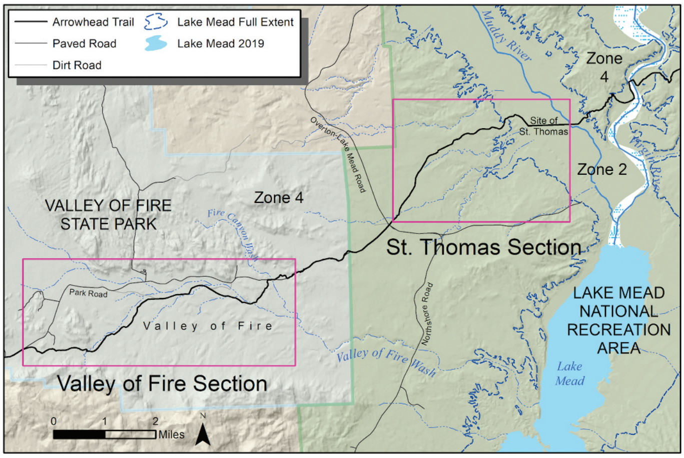

FIG. 4—Map of Study Locations. Map by authors.

Zone 4 is above this elevation. The boundary of the full lake extent in Figure 4, at 1221 feet, is therefore the boundary between Zones 2 and 4. Zone 3, the area covered when the lake is above maximum elevation, has only occurred twice, in 1941 and 1983, and in both cases for only brief periods. The highest elevation attained was 1225 feet above sea level in 1983, which was only four feet above the normal maximum lake level. Although this level was high enough to flood concession buildings at Overton Beach (Schweigert 2005), for purposes of this paper we determined the zone's extent and effects would be insignificant and did not incorporate it into the study. A polygon depicting Lake Mead at 1083 feet, its level in October 2019 (Bureau of Reclamation 2019), was also created from the DEM and is shown in Figures 4 and 5.

The lead author performed fieldwork to verify the locations mapped and to evaluate the conditions of the remains of the road using Federal Trail Data Standards. The results were mapped, illustrating the current condition of the road. Photographs of the road were taken. Although repeat photography studies of early highways have proven useful for understanding changing conditions (Vale and Vale 1983; Amundson 2013), in the current study the authors were unable to obtain the necessary historic imagery.

RESULTS

VALLEY OF FIRE SECTION

Most (4.71 miles, or 71 percent) of the old Arrowhead Trail through the Valley of Fire is classified NHT II, as the road is intact and does not appear to be substantially altered (Figure 5). On the ground it appears as two parallel tracks with an overall width of about eight to ten feet, partly overgrown by shrubs (Figure 6). The road

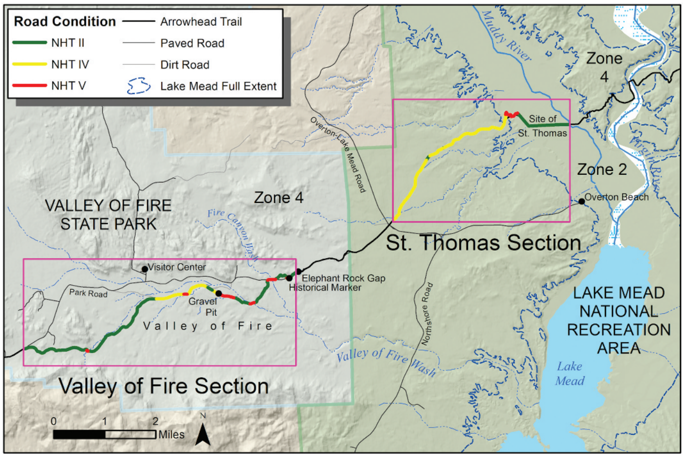

FIG. 5—Map of Arrowhead Trail, 2019. Map by authors.

FIG. 6—Arrowhead Trail in Valley of Fire. Photo by authors.

does not appear to have been graded as there is no distinct shoulder and a high center is present. Many substantial rocks have been exposed, the likely result of postabandonment aeolian erosion. The original road was not surfaced and today appears the same color as the surrounding ground, making some sections nearly invisible in aerial photographs. In other sections, the road's gravel surface appears lighter in color than the weathered, gravel surface of unaltered desert. There is no evidence of recent traffic as the road is now closed to motorized vehicles. Scattered desert shrubs now grow throughout many road sections, but creosote, an otherwise common desert shrub, is notably absent. Creosote (*larrea tridentata*) has been used in previous studies as an indicator species as it seldom grows in the compacted soils of abandoned roads, an effect that can persist for centuries (Webb and others 1986; Prose and Wilshire 2000; Brooks and Lair 2009).

Based on these observations, the Arrowhead Trail is a prime example of a folk road, built not to engineering standards but established with minimal work and maintained largely by users, if at all (Weber 2018b). To facilitate this traffic, the road generally runs along higher ground and avoids passing through dry washes, which present hazards in the form of soft sand and steep slopes (Thompson 1921). Where the road descends into shallow washes it often does so following the gentlest slope gradient.

The only available evidence of formal road construction is a rough, rock retaining wall near the Elephant Rock Gap in Valley of Fire (Figure 7). Braiding is evident along several sections in the Valley of Fire road where multiple alignments appear to have been used by drivers, especially as the road approaches and descends into washes. This is a common feature of folk roads, which lack physical road edges that clearly define road boundaries, allowing drivers to circumvent rough or sandy spots (Thompson 1921; Weber 2018b). However, more extensive deviations from the main road, in the form of turnouts or side roads, are lacking, except to the west of Elephant Rock gap where the remnants of a short spur road to the north are still present.

FIG. 7—Arrowhead Trail in Valley of Fire, looking east toward Elephant Rock Gap. Photo by authors.

The Valley of Fire was developed as Nevada's first state park in 1935, and about 1.17 miles of the Arrowhead Trail were incorporated into the Park's first road, which was built around 1940 (Nevada Department of Transportation 2019). This required grading the road to a width of 22 feet with distinct earthen berms, destroying the original road while preserving the location. These sections can therefore be classified as NHT IV (Figure 5).

Five short sections (totaling 0.56 miles) where the road crossed small drainages have been erased by flooding and are thus classified as NHT V. While normally dry, summer thunderstorms frequently damaged roads in southern Nevada before drainage structures were regularly provided (United States Department of Agriculture 1977). Traces of the road survive only in the smallest dry washes, as is common in the Mojave Desert (Hereford 2009). One of these NHT V stretches includes a section that became a gravel pit for park road construction after 1940. Two short sections near Elephant Rock Gap (totaling 0.20 miles) have been obliterated by the park's 1963 paved road.

St. Thomas section

Part of this section lies in Lake Mead's Zone 2 and was formerly underwater (Figure 5). The zone has been subjected to consistent wave action as the lake rose and fell between 1938 and 1972, depositing several inches of silt in the area (National Park Service 2019). The years underwater have covered much of St. Thomas's remains in silt, leaving a featureless mudflat (Figure 8). The valley bottom has been overgrown by tamarisk (or salt cedar), a fast-growing invasive shrub that has obscured most of the town remains and that made field exploration difficult.

Fig. 8—St. Thomas in 2019, looking east along the town's former main street and the Arrowhead Trail. Photo by authors.

The NPS has published a guide to the area that identifies the ruins of building foundations (National Park Service 2016). The map also identifies town streets and sections of the Arrowhead Trail that are visible in aerial photos. Fieldwork identified the route of the trail through town as a wide, cleared path; however, this is likely the result of visitor traffic and/or clearance action by the NPS. A row of stumps is visible, which may have at one time aligned the road. The NPS map brochure agrees with older maps, which show the Arrowhead Trail running straight and toward the east, to the far side of the valley, which also corresponds with the town's grid street pattern. This road section, and a northern extension along former railroad tracks, could be classified as NHT IV; while the route no longer exists, its course can be established with a high degree of accuracy. The section totals 1.14 miles.

West of St. Thomas, the Arrowhead Trail runs along a ridge in Zone 4, a never-inundated area. In this location, the road avoids the many small drainages found near the bluffs at the edge of the Muddy River Valley. It is within the boundaries of the Lake Mead National Recreation Area and is now a 3.25-mile, maintained, graded road that fits the description of the NHT IV classification (Figure 5). The ridgetop location would likely have preserved the route as an NHT II had it not also made it useful for modern travelers. The few wash crossings are regularly regraded, but two short pieces of old NHT II road (about 0.09 miles) can be identified where the graded road curves to cross a wash with more gradual slopes.

Neither reference to maps nor fieldwork were able to establish how the Arrowhead Trail descended from the ridge into the Muddy River Valley. The bluffs have been heavily eroded by wave action at different lake levels, leaving only coarse gravel and numerous strand lines, but no clues as to the location of the road (Figure 9). This section is classified as NHT V and is estimated at 0.21 miles (Figure 5).

Conclusions

The fluctuating water levels of Lake Mead, along with sedimentation and subsequent plant growth, have destroyed the Arrowhead Trail located within the reservoir's former extent. The buildings, roadside trees, agricultural fields, and roadside irrigation ditches that accompanied the trail have been replaced by thick tamarisk shrubbery and a uniform surface of clay and sand. In the adjacent Valley of Fire State Park, almost five miles of the road has survived largely intact, and now serves as a hiking trail. This section has remained intact not because the road was originally built to resist water erosion, but because it did not suffer the later reuse that other sections experienced; in 1940, an adjacent park road was built that carried visitors through valley, bypassing much of the original road section. The study areas examined in this paper are probably the best preserved and most easily visited sections of the road anywhere along its original route.

FIG. 9—View of bluffs above Muddy River Valley, showing strand lines from different lake elevations. Photo by authors.

Although they were intended for classifying trails and wagon roads, this work has shown that the Federal Trail Data Standards provide a useful framework for understanding the survival potential of early automobile roads. Early folk roads are likely to be severely impacted by environmental changes, including water and wind erosion, and related effects on soils and vegetation, all of which manifest through the different NHT classifications.

An interesting comparison with the Arrowhead Trail route exists in the form of the Overton-Lake Mead road, built in 1938 by the Civilian Conservation Corps (CCC) (Schweigert 2005). This road was built to connect the town of Overton, now the southernmost in the Muddy River Valley, with the new Overton Beach marina and swimming area, the northernmost constructed by the NPS on Lake Mead (Figure 5). The road was the first engineered automobile road built in the area and the CCC gave considerable attention to drainage, with 76 metal culverts and an array of diversion berms to protect it from flooding. It also took a circuitous route, adding almost five miles to the distance between town and marina, due to the need to stay out of the inundated Muddy River Valley and avoid the deep washes that emptied into it from the west. The road has been repaved and slightly widened, but today remains largely as it was when completed. While applying the Federal Trail Data Standards to a folk road such as the Arrowhead Trail is appropriate, the method would not be appropriate for examining an engineered road such as the Overton-Lake Mead road.

Several other limitations of the Federal Trail Data Standards are apparent. The first is related to scale and resolution. The scale at which the data is mapped will affect interpretation of results, as short NHT V sections (i.e., where the Arrowhead Trail crossed washes) may not be visible on maps due to their short length or low resolution. A second limitation is related to the descriptive structure of the NHT classifications. The Trail Data Standards are based on the road's current condition rather than use. For example, the NHT II road classification may describe either a trail, a backcountry road, or a trail that is closed to any use. Distinguishing among these may become important when evaluating management possibilities or in predicting future conditions of the road.

The classification method used here also focuses on the road itself, and does not attempt to fully reconstruct the historic landscape or the experiences early travelers would have had while driving the road. Sources on the Arrowhead Trail indicate that St. Thomas was a welcomed oasis of shade, flowing water, home-cooked meals, and even an ice cream parlor. Today, the site is an uninviting mudflat overgrown by tamarisk. Further integration and synthesis of these types of details could add fascinating cultural dimensions to future studies, making the road's history of greater interest to the public (Loren-Méndez and others 2016).

The reservoir-zonation model contributes little to understanding the survival of the Arrowhead Trail, as the road through the former lake has been destroyed. However, other studies suggest roads may survive at greater depths elsewhere in Lake Mead. Several roads and railroads were built along the Colorado River to support the construction of Hoover Dam, and like the Arrowhead Trail these were submerged under the reservoir, though in much deeper waters (Bureau of Reclamation 1948). Recent archaeological work has identified the submerged remains of old roads, railroad grades, and the foundations of a gravel plant used in Hoover Dam construction (Reno and Zeier 2009a, 2009b). The remains are located below the lowest-recorded, postinundation lake elevation (1071.64 feet in June 2016), which suggests that these have not yet been subject to wave action beyond the initial creation of Lake Mead. Should the waters of Lake Mead continue to drop (which appears likely), these remnants will experience wave and wind erosion, with the extent depending on whether the water levels drop precipitously (less degradation through fewer ebb and flow cycles) or drop slowly (more degradation from frequent cycles). Regardless, either scenario should provide ample opportunity for examining the survival of formerly inundated roads.

Further development of methods for identifying and examining formerly inundated roads is needed as ongoing droughts in western states continue to reveal historical roadways. Currently, there is little consensus over how these remains should be managed, either as cultural artifacts or heritage landscapes. Recently, drought in Northern California has lowered Shasta Lake's level to reveal portions of U.S. 99, complete with concrete bridges dating to the 1920s. The San Carlos Reservoir in Arizona is nearly empty, revealing old road and railroad routes, as well as the remains of an entire town. Lake Powell in Arizona and Utah, Abiquiu and Navajo reservoirs in New Mexico, Amistad Reservoir in Texas, and Pueblo Reservoir in Colorado also reflect this trend. As drought continues across western states, the numbers of historic roads that emerge from reservoirs are likely to grow. Appropriate classification methods that recognize their important role in cultural and heritage landscapes are needed.

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