NEVADA DEPARTMENT OF TRANSPORTATION
RESEARCH PROBLEM STATEMENT

Internal Submission Form (not to exceed 3 pages with font size 11)

SPECIAL NOTICE: This Problem Statement requires that a Nevada licensed professional engineer (in accordance with NRS 625) be part of the research team. Due to this requirement and to align with 40 USC Ch. 11, proposers must exclude cost information and not respond to Item 10 of the Research Proposal Guidelines FFY24 when developing their research proposal. Cost will be negotiated after selection of the research proposal. This only applies to Problem Statement 23-03-E2.

I. PROBLEM TITLE: Development of Alternative Desert Tortoise Crossing Criteria and Designs

II. PROBLEM DESCRIPTION: While roadways have many effects on ecological resources, two primary concerns are fragmentation of suitable habitat for plants and wildlife and road-related mortality of wildlife species, specifically those whose populations are listed as threatened or endangered under the Endangered Species Act (ESA), such as the Mojave desert tortoise. The Nevada Department of Transportation (NDOT) maintains many hundreds of miles of highway in the habitat of the Mojave desert tortoise, 450 miles of which are protected by tortoise exclusionary fencing. While the exclusionary fencing protects desert tortoises from highway mortality, it does not address the issue of habitat fragmentation, and in fact may add to the problem. Since exclusionary fencing restricts desert tortoise movement even further than the highway itself, it can inhibit or prevent access to seasonal resources, alter tortoise behavior, and can be detrimental to the larger population through reduced gene flow.

In some areas, drainage culverts that pass under roadways have been retrofitted into desert tortoise crossings by connecting tortoise exclusionary fencing to the culvert wingwalls. Desert tortoises have been documented using some of these crossings. However, it appears that the design requirements of these drainage features, especially those in high-flow areas, commonly conflict with the movement abilities of the desert tortoise. Many of these culverts have large rocks (rip rap) placed at the openings to minimize the potential for erosion, but the large voids within the rip rap are a major obstacle for tortoise movement, an entrapment hazard, and have been known to cause mortality. NDOT maintenance has attempted to mitigate this issue by backfilling the rip rap with a mix of native gravel and soil. This has limited utility as it does well on flat terrain but is regularly carried away in steeper areas by the voluminous water flows commonly observed in desert flood events. The native soil must be replaced often, which is a burden for NDOT maintenance. **Therefore, there is a need to develop criteria and plans for retrofitting culverts into desert tortoise crossings that can withstand multiple large hydraulic events while also being easily navigated by desert tortoises.**

The United States Fish and Wildlife Service is requiring NDOT and other transportation agencies to retrofit drainage culverts into tortoise crossings on federally funded projects as frequently as every two miles, even in high-flow areas where rip rap is suggested as a means of erosion control. These crossings are expensive to install and require inspection and maintenance after every major storm event, putting a strain on both NDOT biologists and maintenance crews. Currently, no research is being done within the range of the desert tortoise on developing

alternative crossing designs to make maintenance easier and more cost-effective for the transportation agencies. It is imperative that NDOT find alternative crossing designs that can withstand multiple hydraulic events without requiring extensive maintenance, while also providing effective crossing opportunities for desert tortoises. If alternative designs can be developed through this research, NDOT can reduce construction and maintenance costs, save tax-payer money, reduce habitat fragmentation, and increase population viability for the desert tortoise.

III. **OBJECTIVE:** The goal of this research is to develop creative designs, including engineering plans, to retrofit at least four hydraulic culverts along Nevada State Route 160 (SR 160) into desert tortoise crossings with low maintenance requirements. The selected culverts should be a grade 4 or 5 (utilizing the Clark County Desert Conservation Program's Culvert Inspection for the Purposes of Desert Tortoise Passage project rating system) and would otherwise require rip rap as an erosion control measure. It would be preferred that at least one selected culvert have steep entrance and/or steep outlet conditions, as these tend to present the greatest challenges in providing a stable design that does not pose risks to desert tortoises.

The designs would preferably utilize common, non-proprietary materials that are durable against the harsh desert environment, expected hydraulic flow energy, and high impact potential from abrasion and debris. The designs must also be durable against and tolerant of typical maintenance activities, not unreasonably hinder maintenance of the structure, and must not depend on the establishment of vegetation (i.e., turf reinforcement mats). It is anticipated that any proposed designs will go through three review cycles, as necessary. While it is ideal for the project to be completed within a year of initiation, quality of ideas and designs are more important than a speedy project completion.

A report for each of the four selected culverts must be submitted with engineering plans detailing at least one design alternative and text which should outline culvert flow rates, topography, existing infrastructure, and other features. This research will study the strengths and weaknesses of new erosion control designs compared to the rip rap currently used in many high-flow tortoise crossings in District 1.

The final deliverable for this project, is a final report detailing the research performed, including background, methodology, evaluations of current and past crossing designs, lessons learned during the research process, and, if applicable, criteria for successful tortoise crossings, recommendations, and an implementation plan.

IV. **CURRENT PRACTICE and RELATED RESEARCH:** Gene flow connectivity of the Mojave desert tortoise is a top priority for the U.S. Fish and Wildlife Service (Service) in the recovery of the species. As such, the Service is requesting that NDOT and other transportation agencies install tortoise crossings on Federal projects as frequently as every 2 miles. NDOT has considered alternative erosion control designs, such as turf reinforcement mats, but these types of systems come with too many downsides to implement. Some of these downsides are the use of plastic materials that break down over time due to UV degradation; materials that are easily torn apart from hydraulic forces, debris, and maintenance activities; materials that don't tolerate abrasion well; and systems that rely on vegetation to help anchor the material, which is limited in the Mojave Desert. With no viable alternative designs on hand, most of the tortoise crossings incorporate backfilled rip rap. With storms, the soil and gravel wash away, the tortoise walkways get undercut, and in the most extreme circumstances, a tortoise may get trapped in the exposed

rip rap. The NDOT biologists inspect the crossings regularly and report the deficiencies to the area's maintenance crew. The crews are overburdened with public safety priorities, and it often takes several months to repair the tortoise crossings, leaving them both useless and dangerous to desert tortoises for most of the year.

Since connectivity is such a priority for the recovery of the species, there is an abundance of research on how to connect desert tortoise populations with crossings. Most of this research in Utah, California, Arizona, and Nevada is focused on identifying areas that would most benefit from tortoise crossings and how tortoises are using crossings. Clark County Desert Conservation Program completed their Culvert Inspection for the Purposes of Desert Tortoise Passage project in 2021, which gave a grade of 1 through 5 to each culvert tied into tortoise exclusionary fence in Clark County, based on the ability for a tortoise to pass through. This data will be useful in future research and project planning. Additionally, the NDOT research project for the Development for Dual-Purpose Desert Tortoise Crossings yielded a thorough literature review and monthly monitoring reports. The publications and data from these two projects may prove valuable to this Development of Alternative Desert Tortoise Crossing Criteria and Designs project.

V. IMPLEMENTATION POTENTIAL: The proposed research falls under the research deployment stage 3, Controlled Field Demonstration. The research will result in a final document containing design criteria for ideal desert tortoise crossings and engineering plans for at least four tortoise crossings that will be ready for implementation upon receipt. No institutional, political, or socio-economic barriers were identified that would interfere with implementation of the anticipated research results and products.

VI. URGENCY and PAYOFF POTENTIAL: It is extremely urgent to facilitate safe crossings for desert tortoises now in order to minimize the potential for inbreeding depression cause by habitat fragmentation. Without designs and design criteria that can guide NDOT to retrofit culverts into tortoise crossings that function well with minimal maintenance intervention, NDOT will continue to face challenges associated with project needs as well as commitments made through the Endangered Species Act consultations. It is imperative that this research be done as soon as possible, as the United States Fish and Wildlife Service is requesting tortoise crossings every two miles on new projects. These crossings are being installed even in high-flow areas where the suggested erosion control measure for culverts is rip rap which requires frequent maintenance. The result is hundreds of thousands of dollars spent on less-than-ideal designs that have limited function and put tortoises in danger. The sooner this research can be completed, the sooner NDOT can begin to save money by implementing more efficient tortoise crossing designs.

VII. DATE and SUBMITTED BY: April 6, 2023

Kristi Holcomb
Environmental Scientist IV, Environmental Services, (702) 385-6524, kholcomb@dot.nv.gov

VIII. ADDITIONAL CHAMPIONS:

Eric Yount
Manager 1, Hydraulics, (775) 888-7531, eyount@dot.nv.gov

FIVE STAGES OF RESEARCH DEPLOYMENT

Based on Caltrans Research and Innovation Stages

1. Concept Stage

- First steps following Problem Statement and Proposal Development
- Includes detailed literature search
- Involves experimental design, data collection, analysis, and reporting
- Assesses results of research
- Defines barriers to implementation (e.g., policies, specifications, standards)
- Submits a Final Report and outlines a recommended implementation plan
- Includes collaboration with outside agencies or other state DOTs and US DOT (Applies to all Stages of Deployment)

2. Laboratory Prototype Stage

- Develops breadboard circuit or computer system modeling
- Demonstrates operation in laboratory setting
- May incorporate customized or one-of-a kind components
- Assesses results
- Submits Final Report and recommends design of full-scale demonstration
- Potential end users are enlisted to support the field pilot stage

3. Controlled Field Demonstration Stage

- Prepares for full scale testing of demonstration project
- Controlled tests at specialized facilities are observed and supported by cooperating agencies, industry, and technical associations
- Potential end users are enlisted to support the field pilot stage
- Assesses results
- Submits Final Report and recommends site/conditions for first application pilot stage

4. First Application (Contract) Field Pilot Stage

- Works with potential end users to select site and to conduct pilot testing under real world operating conditions
- Test specifications and standards are developed
- Research assistance given to assure proper installation and operation
- Problems are corrected and adjustments made, as necessary, to complete pilot testing
- To the extent possible, potential end users operate the project under careful research surveillance
- Assesses results
- Submits Final Report and recommends initial sites for full corporate deployment
- Potential end users are enlisted to support the field pilot stage

5. Specification & Standards with Full Corporate Deployment Stage

- End users select site(s) and deploy the method/process/equipment using resident management, supervision, staff, and contracting forces (where applicable)
- Deployment is without research supervision or direction
- On call assistance is available upon request
- Assesses results

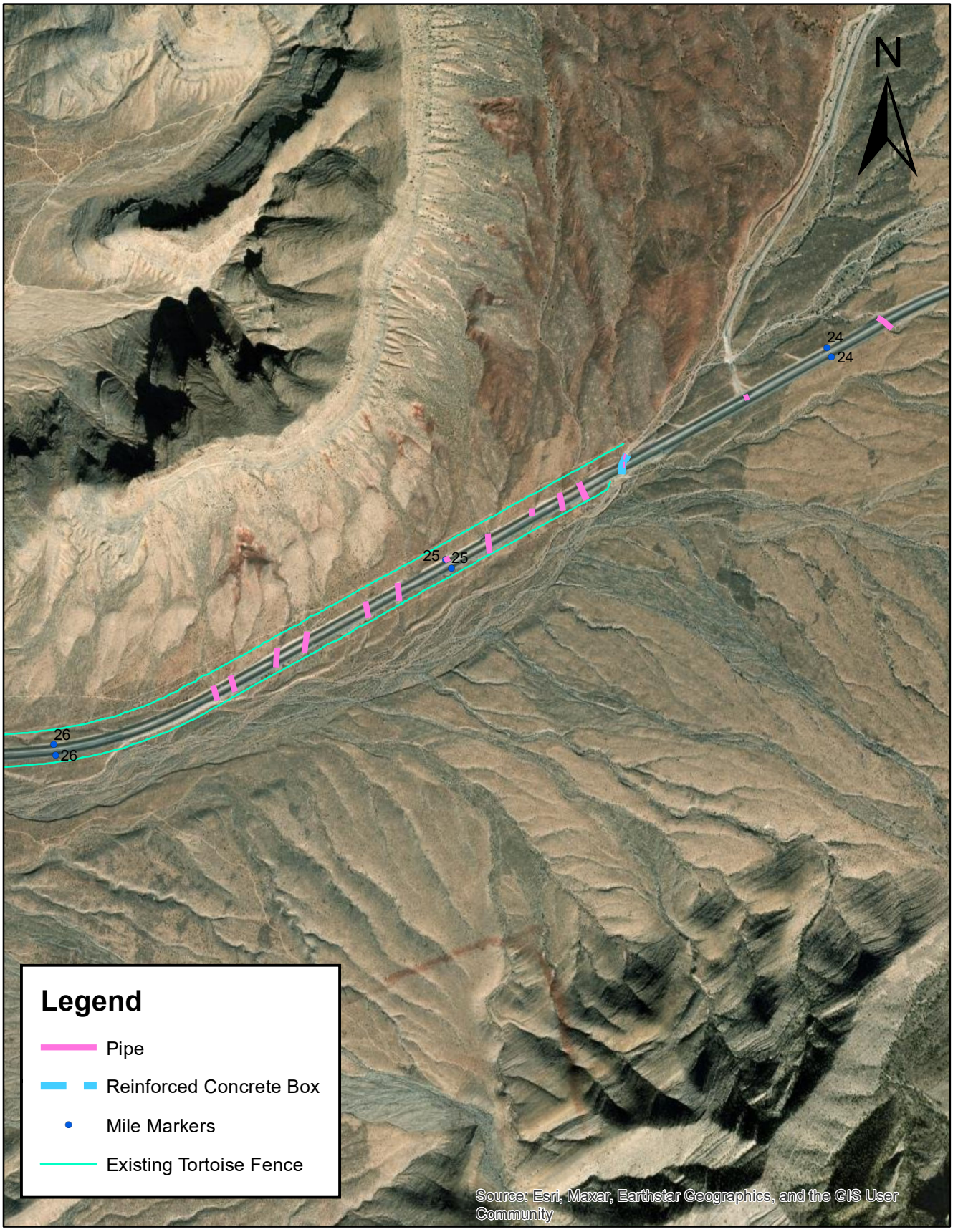
SR 160

Culvert Maps

with

Milepost Identifiers

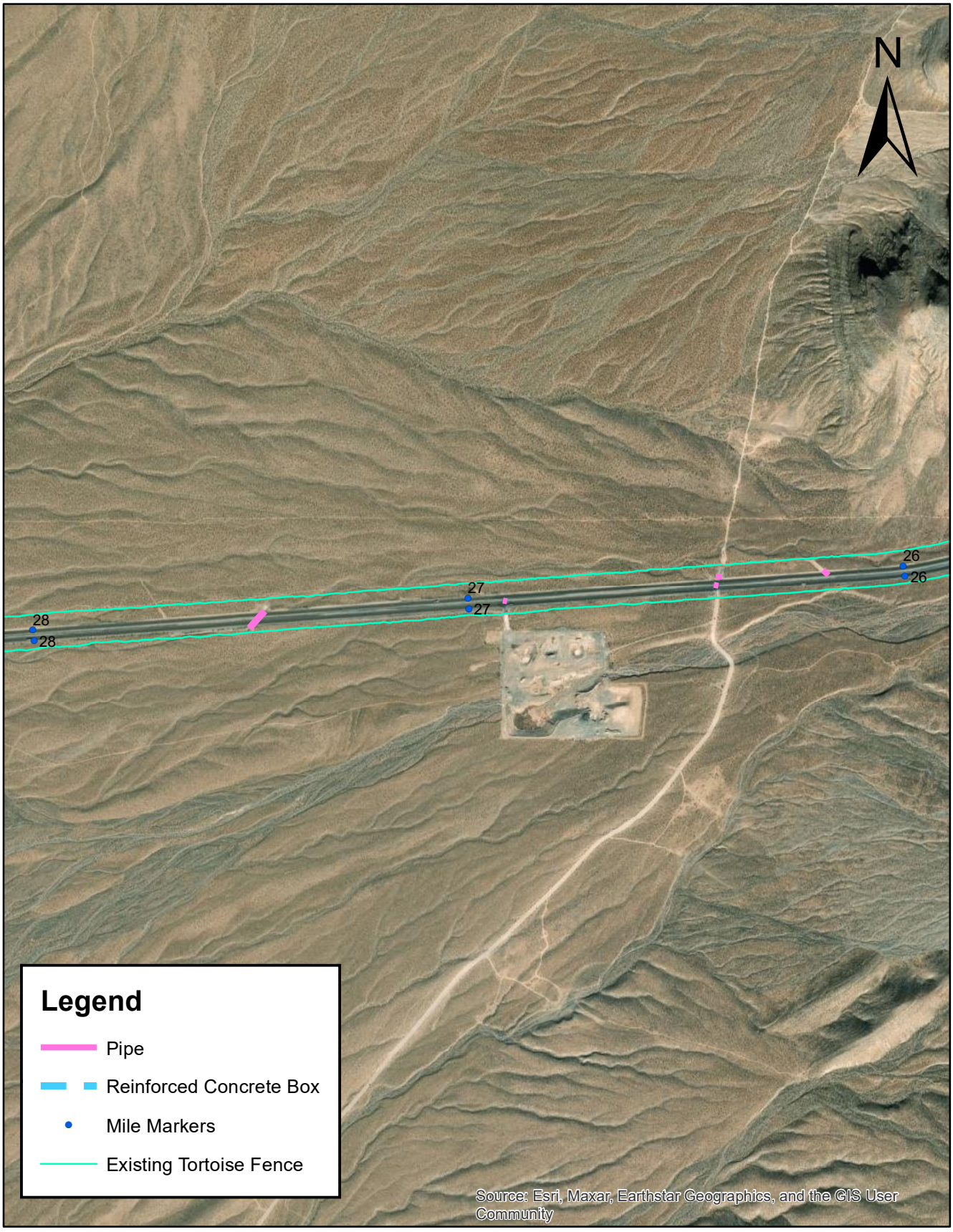
Culvert Map
SR 160
MP 24-26



Created by V. Furutani 6/20/23

0 0.1 0.2 0.4 0.6 0.8 Miles

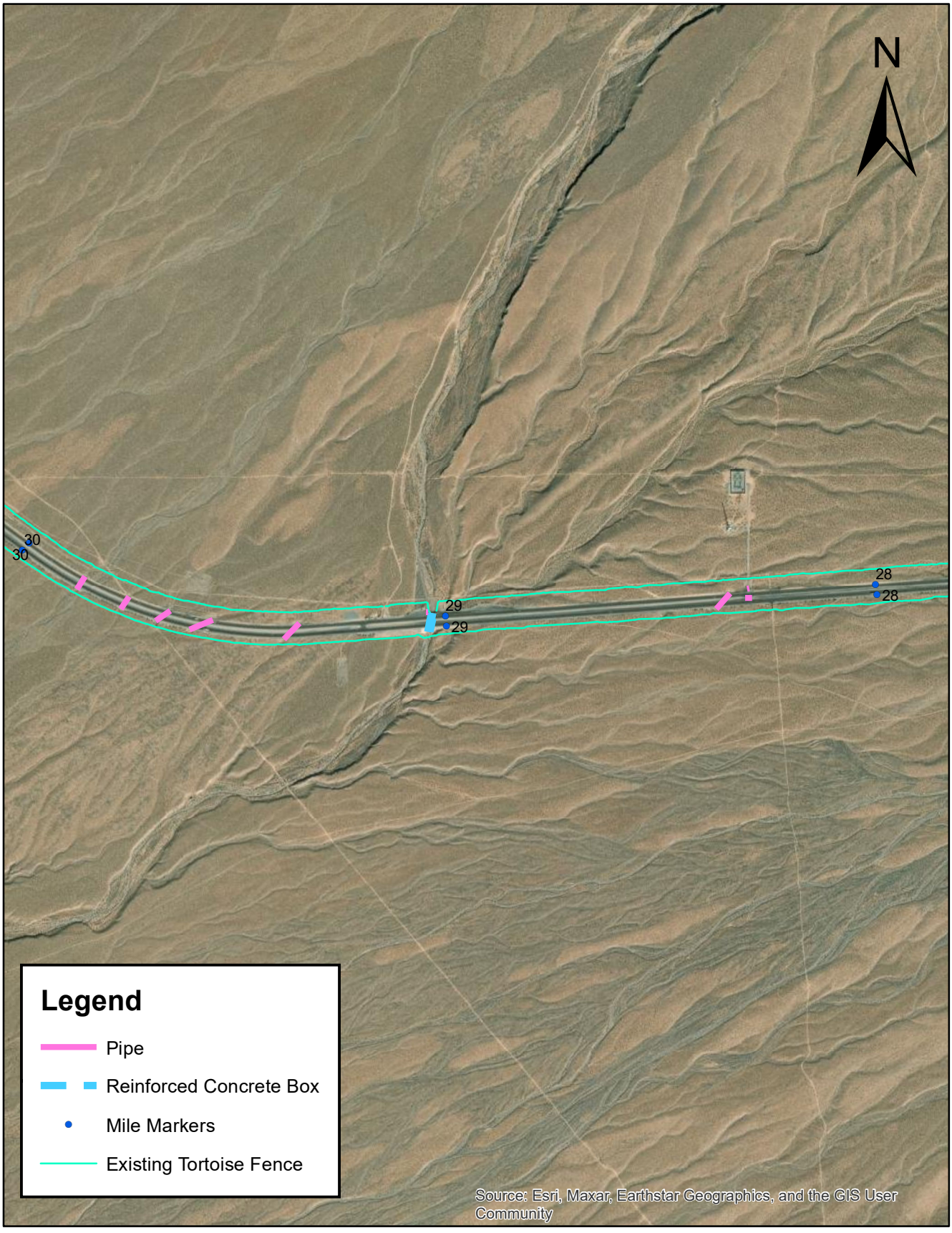
Culvert Map
SR 160
MP 26-28



Created by V. Furutani 6/20/23

0 0.1 0.2 0.4 0.6 0.8 Miles

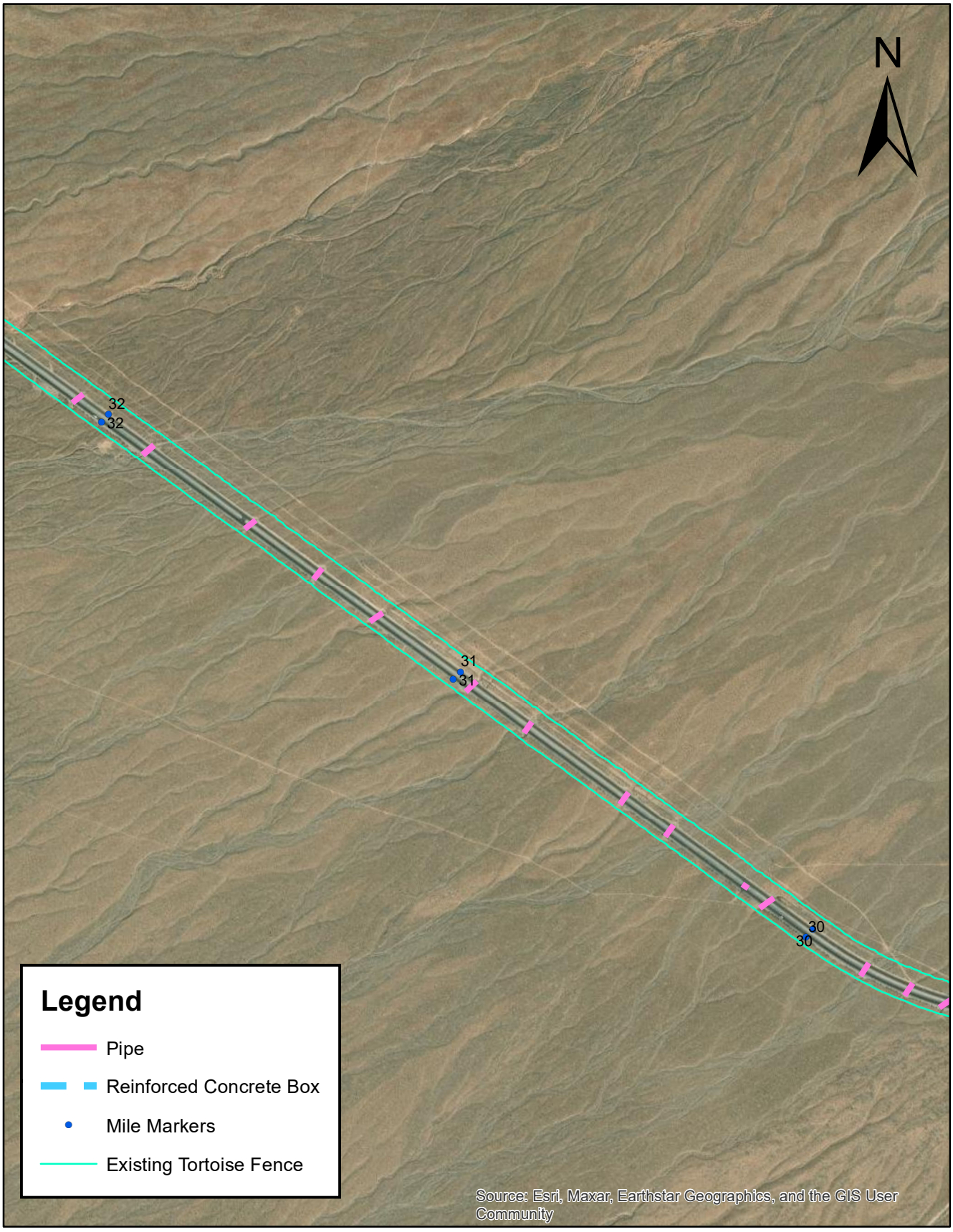
Culvert Map
SR 160
MP 28-30



Created by V. Furutani 6/20/23

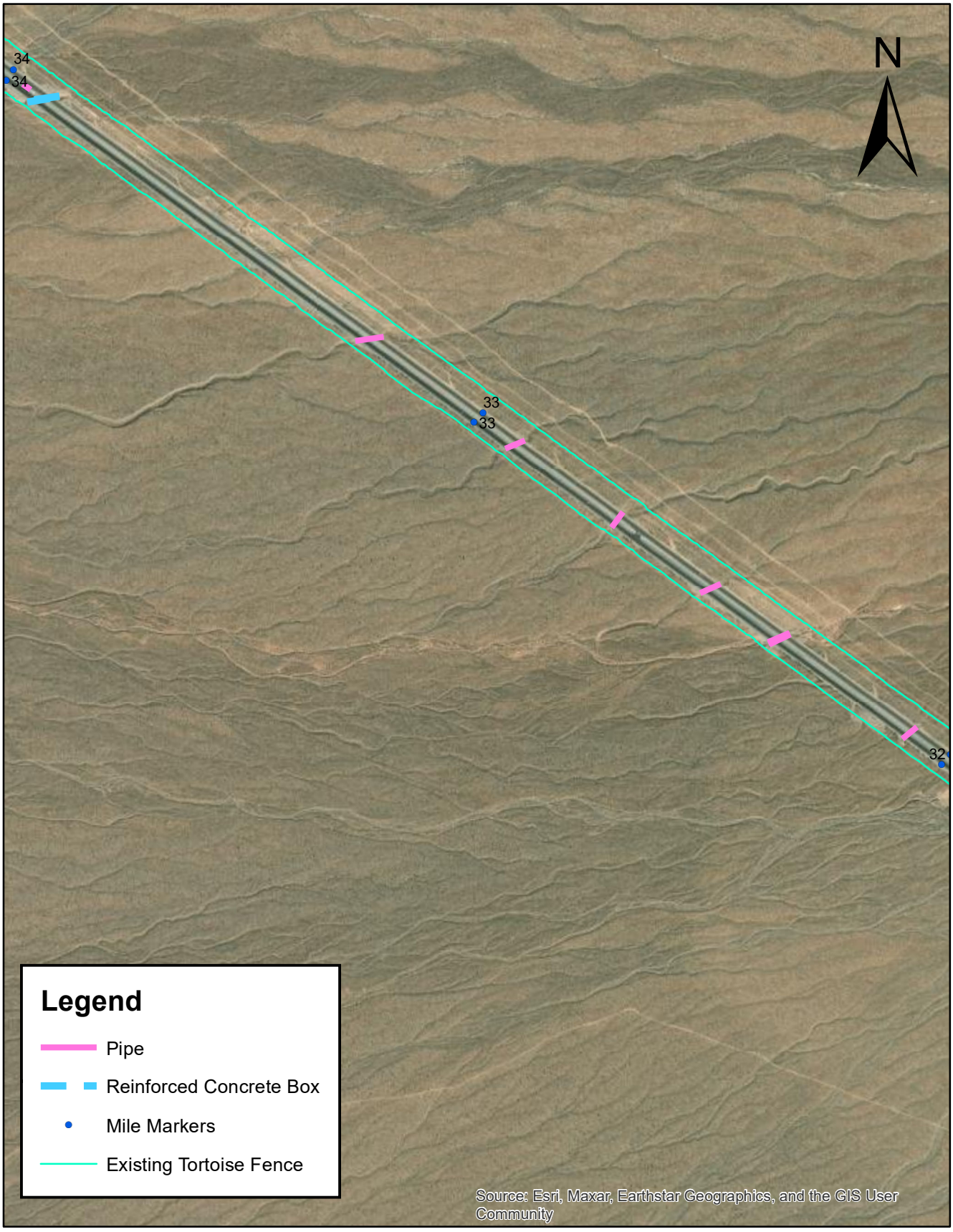
0 0.1 0.2 0.4 0.6 0.8 Miles

Culvert Map
SR 160
MP 30-32



Created by V. Furutani 6/20/23

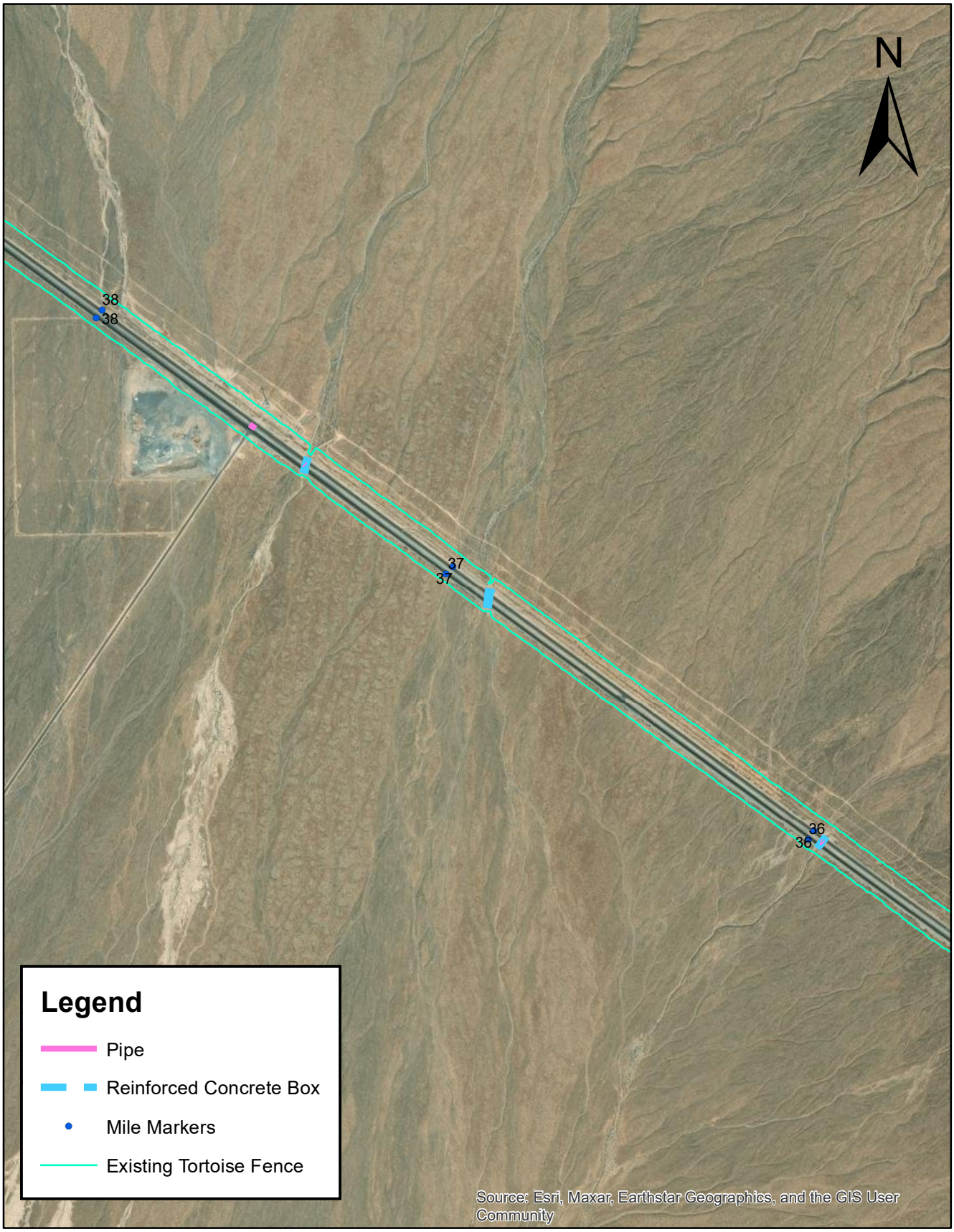
Culvert Map
SR 160
MP 32-34



Created by V. Furutani 6/20/23

0 0.0750.15 0.3 0.45 0.6
Miles

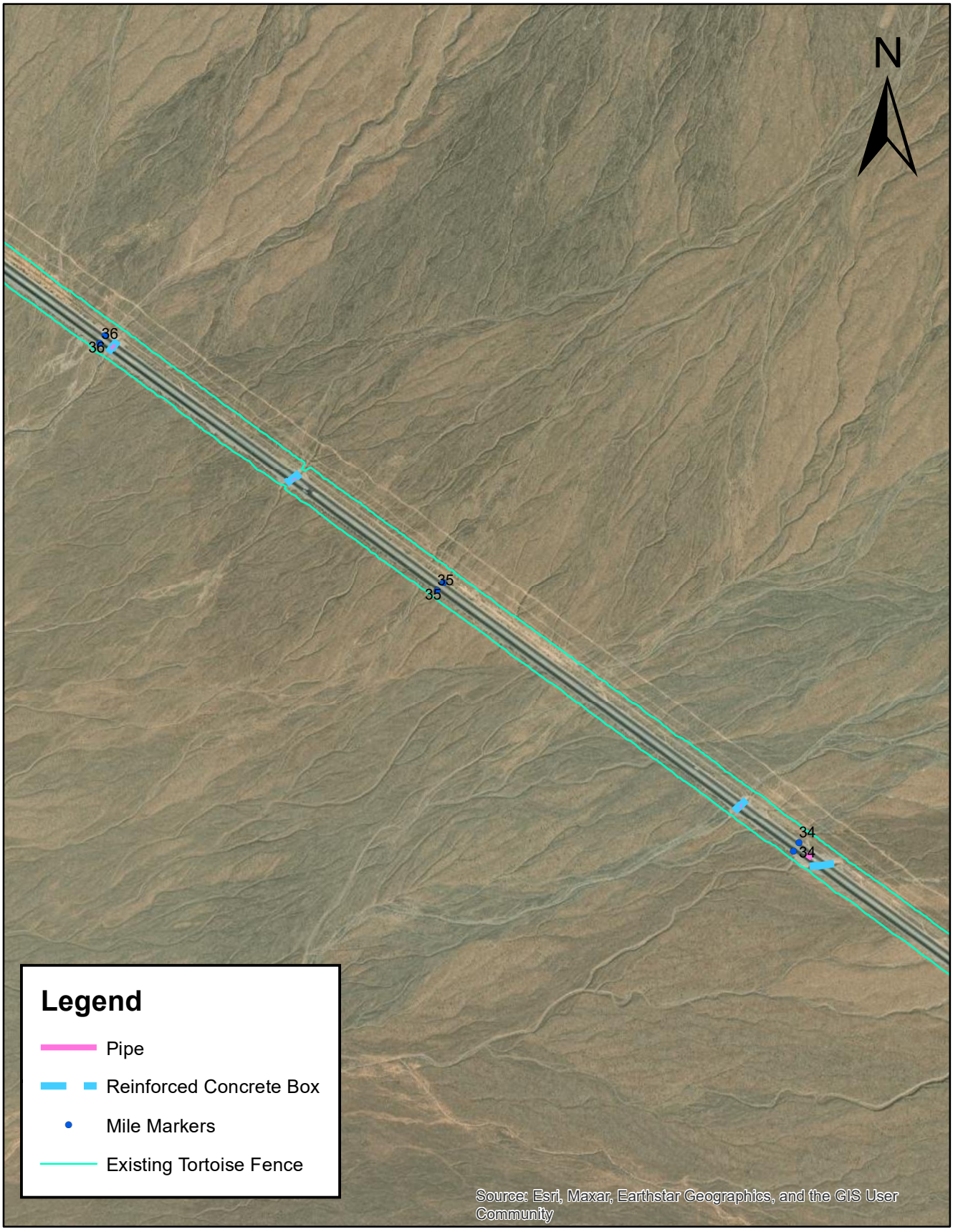
Culvert Map
SR 160
MP 36-38



0 0.1 0.2 0.4 0.6 0.8 Miles

Created by V. Furutani 6/20/23

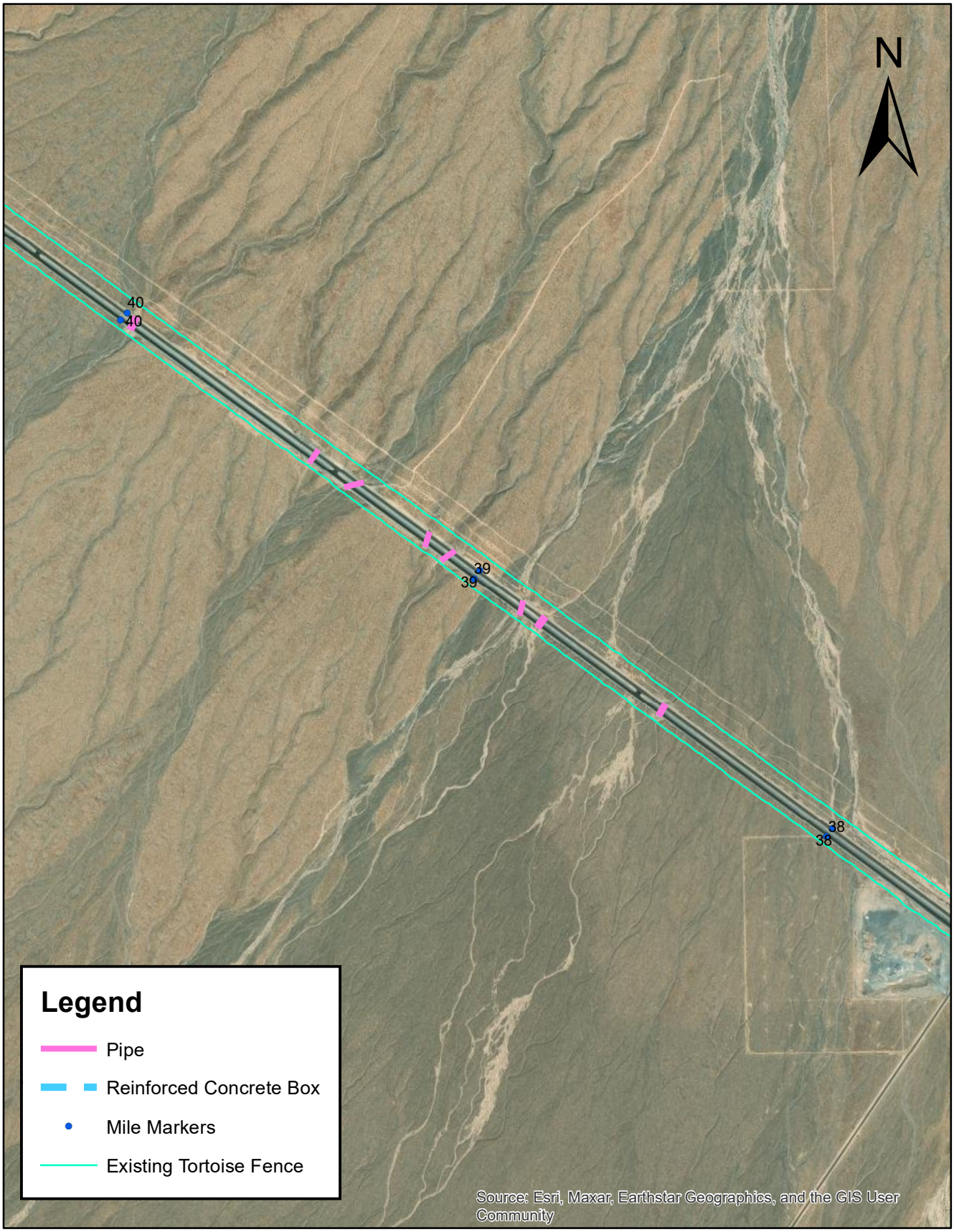
Culvert Map
SR 160
MP 34-36



0 0.1 0.2 0.4 0.6 0.8 Miles

Created by V. Furutani 6/20/23

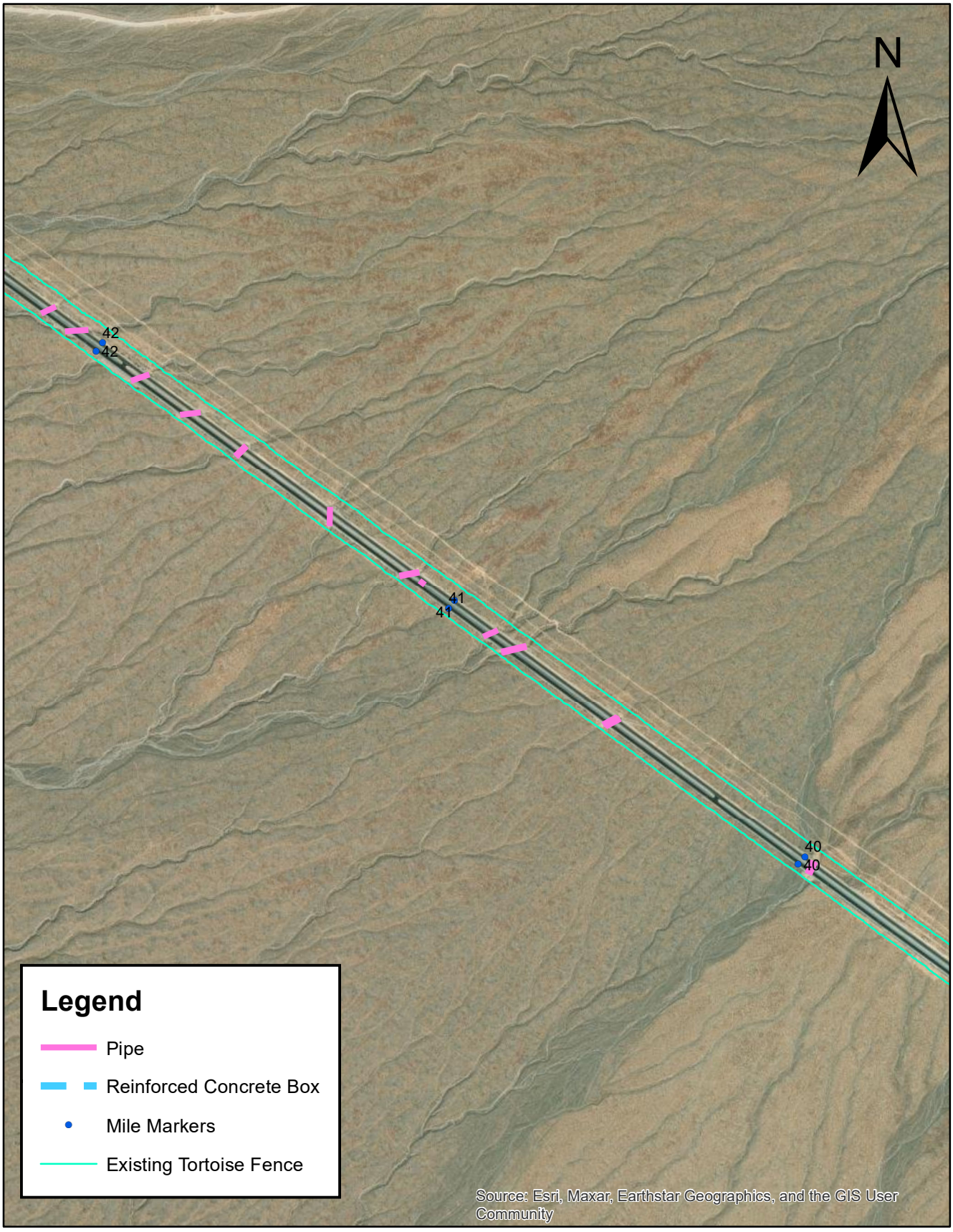
Culvert Map
SR 160
MP 38-40



0 0.1 0.2 0.4 0.6 0.8 Miles

Created by V. Furutani 6/20/23

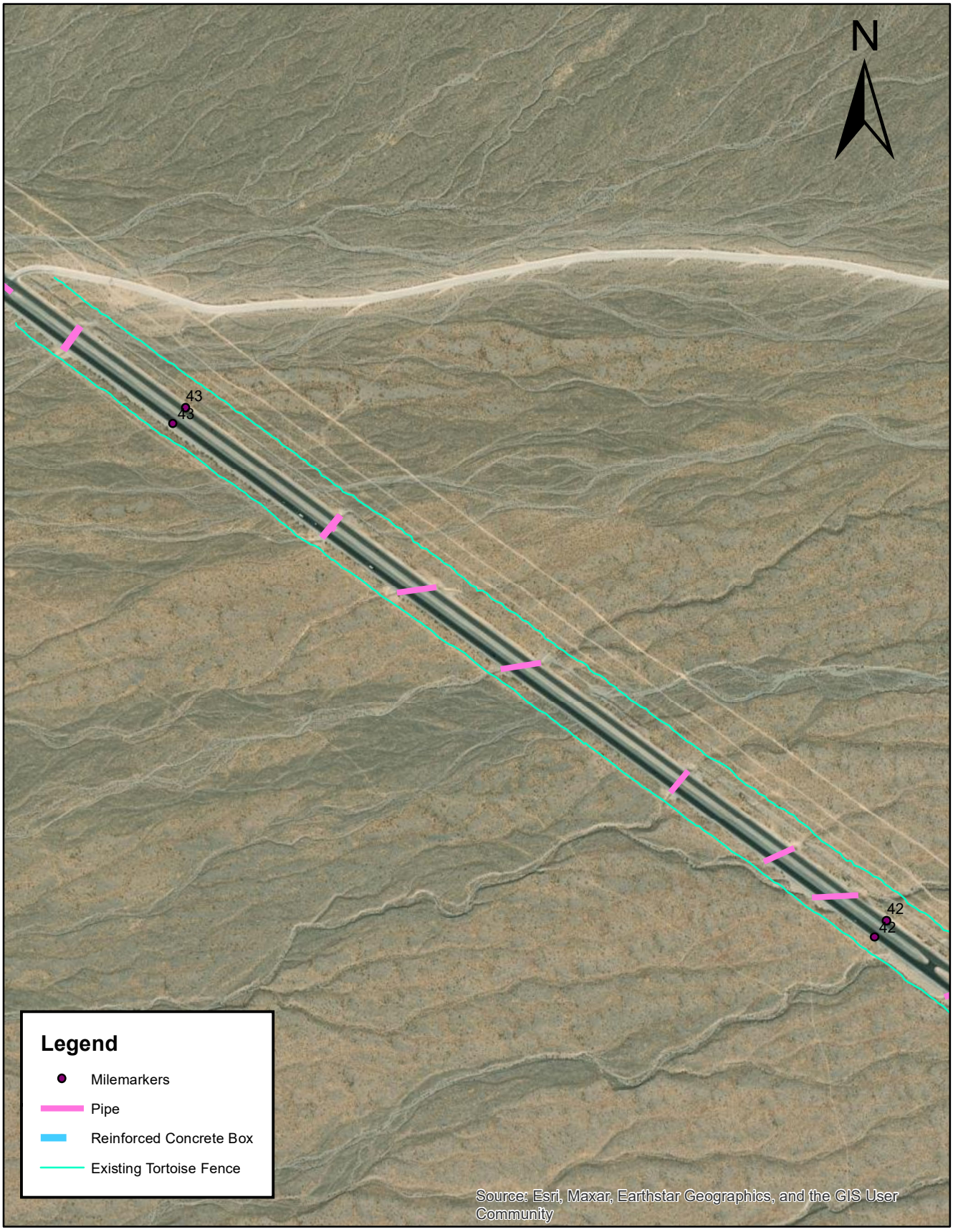
Culvert Map
SR 160
MP 40-42



Created by V. Furutani 6/20/23

0 0.1 0.2 0.4 0.6 0.8 Miles

Culvert Map
SR 160
MP 42-43.28



Created by K. Holcomb 9/27/23

0 0.05 0.1 0.2 0.3 0.4
Miles