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GEOPHYSICAL INVESTIGATION REPORT

ADOT Project No. 095 LA 158 F0706 01D

South of Parker Dam

October 2, 2025

Prepared by

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ARIZONA DEPARTMENT OF TRANSPORTATION

BRIDGE GROUP

GEOTECHNICAL SERVICES

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This report presents the results of our geophysical testing services to support the proposed construction for the State Route (SR) 95, South of Parker Dam, project. The project is located on SR 95 between mileposts 158 and 162 between Parker and Lake Havasu City in La Paz County within the Arizona Department of Transportation (ADOT) Southwest District.

A geotechnical field investigation included conducting two refraction seismic survey lines for the purpose of evaluating the surficial and near subsurface soil and rock conditions at the site.

The results of the field investigation as well as the evaluation of the excavatability of the subsurface soil and rock materials for the proposed construction are presented in this report.

Should there be any questions regarding the contents of this report or its appropriate incorporation into designs, please do not hesitate to contact us.

Sincerely,

Tad C. Niemyjski, P.E.
Geotechnical Design Team Lead

Reviewed by:

Patrice Brun, P.E.
Geotechnical Service Section

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1.0 INTRODUCTION

This report presents the results of our geotechnical investigation and geophysical testing services to support the proposed construction. The purpose of this project is to construct rockfall containment systems to improve the protection of the traveling public from rockfall material that may enter the travel lanes of State Route 95 (SR 95) and to improve the roadside drainage systems. The project is located along SR 95 between mileposts (MP) 158 to 162 in La Paz County within the Arizona Department of Transportation (ADOT) Southwest District.

1.1 Project Description

It is our understanding from the project's Stage III Plans that the planned improvements include roadside drainage improvements and constructing rockfall protection systems along existing roadway cuts adjacent to SR 95 between Parker and Lake Havasu City. These proposed improvements for this project generally include:

- Installing rockfall drape along NB 95 between MP 158.8 and 158.9
- Roadside drainage improvements between MP 160.7 and 160.8
- Roadside drainage improvements adjacent to the NB lane near MP 161
- Constructing a flat bottom deepened rockfall ditch with concrete half barrier adjacent to the NB lane between MP 161.3 and 161.5

1.2 Rockfall Hazard Rating System

ADOT's Geotechnical Services Section has developed a database of rockfall hazard locations along the state's highway system when there was still funding for a geohazard subprogram. The most recent data for cut slopes within the bounds of this project identified four slope areas that were ranked in either 1995 or 1998 with ranks ranging from 1 (low priority) to 5 (very high priority). No slopes in this project area were rated using the Rock Hazard Rating System.

Table 1: SR 95 Cut Slope Inventory within this project area

Direction	Beginning Milepost	Ending Milepost	Year	Rating	Anticipated Work	Project Priority Rank
NB/SB	158.7	158.9	1998	1	Scale and drape cut slope	1
NB	160.05	160.15	1995	5	Slope drainage imp.	4
NB	160.7	160.8	1995	5	Slope drainage imp.	3
NB	161.3	161.5	1995	3	Rockfall ditch, barrier	2

The safety improvement options at each of these locations were evaluated and ranked with available funding in mind.

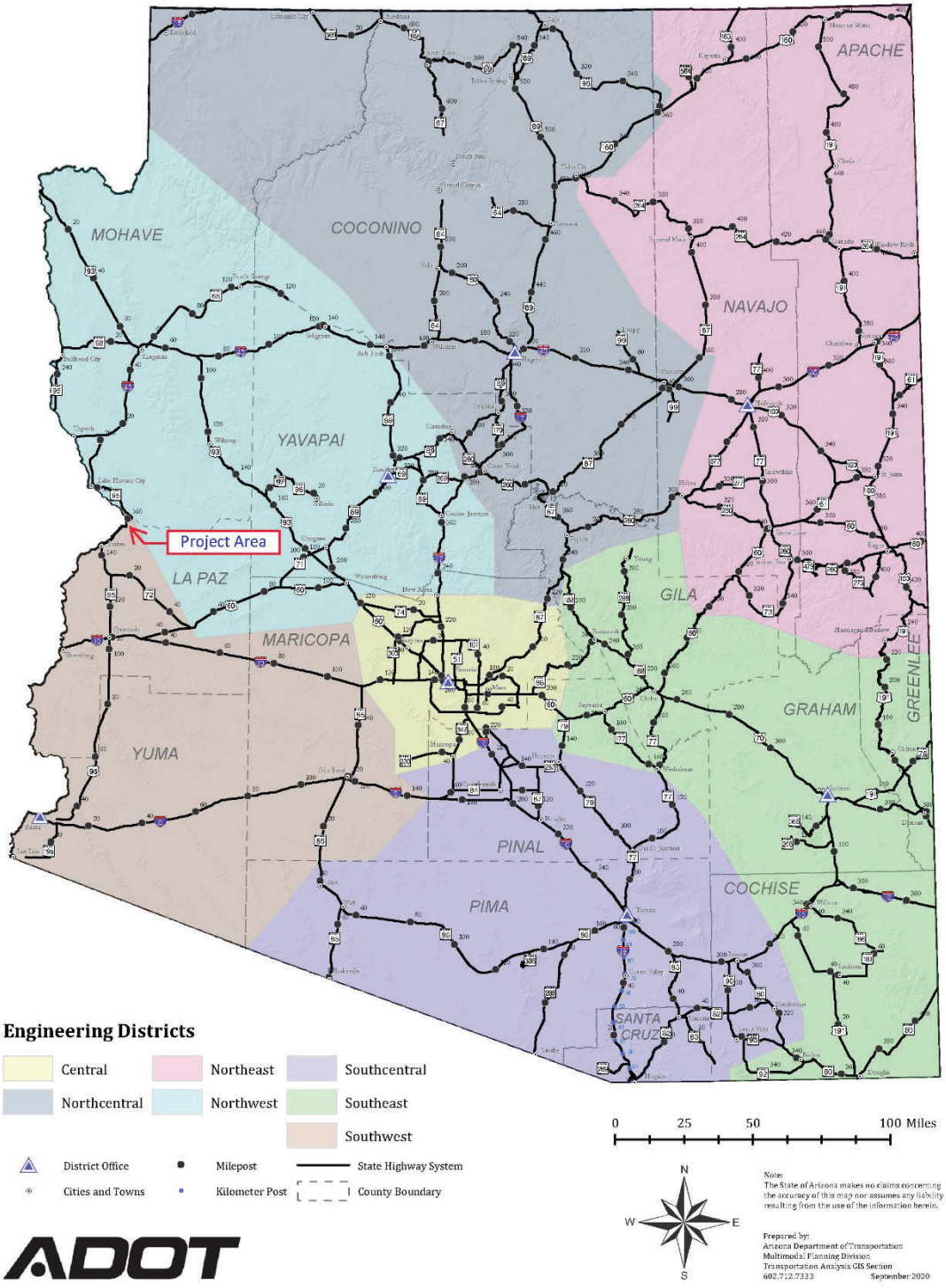

Figure 1: State of Arizona and Project Location

1.3 Geologic Background Setting

This portion of western La Paz County is characterized by "unconsolidated to strongly consolidated alluvial and eolian deposits," including coarse, poorly sorted alluvial fan and terrace deposits on middle and upper piedmonts, sand, silt and clay on alluvial plains and playas, and wind-blown sand deposits. Rock outcrops and roadway cuts expose the bedrock underlying the alluvial soils. This bedrock is composed of granite, gneiss, mafic dikes and hypabyssal intrusions. Johnson, et al. (2021)

2.0 FIELD INVESTIGATION

Two refraction seismic survey lines were conducted on or adjacent to cut slopes on the east side of SR 95. The location of these two refraction seismic lines are shown in Appendix A.

2.1 Site Description

During our investigation it was noted that the cut slope sites were characterized as granitic bedrock with areas of alluvial sand and gravel overlying in the cut slopes north of MP 160. Vegetation consisted of sparse native grasses, bushes and a few cacti were present in the vegetated areas above the surface above the roadway cuts.

The cut slope at the location of SL-1 where the slope drape is proposed is a fractured and jointed granite and gneiss bedrock. Because the slope was not accessible, the seismic refraction line was conducted along the base of the cut slope.

Figure 2: View of the cut slope along NB travel lanes at the location of SL-1

The location of the cut slope where SL-2, near the north end of the project, was selected because this cut slope exposed the granite and gneiss bedrock and the alluvial soil overlying the faulted granitic bedrock.

Figure 3: View of the cut slope along NB travel lanes at the location of SL-2

Aerial view of refraction seismic line locations are included in the Appendix A.

3.0 SUBSURFACE INVESTIGATION

Two refraction seismic lines were conducted along with the proposed pathway alignment and potential utility excavations. Aerial images showing the refraction seismic line locations are presented in Appendix A of this report and the results of the processed seismic data are included in Appendix B.

3.1 Refraction Seismic Survey

Two refraction seismic survey lines were completed in April of 2024 by Tad Niemyjski, P.E. and Michael Simpson, P.E. at selected locations along the project corridor. This location was selected because deeper excavations were anticipated to be needed through this area to control the finished pathway grade. The refraction seismic survey was performed to aid in characterizing the subsurface geotechnical profile, provide general strength parameters for the subsurface materials, and assist contractors in their evaluation of the potential difficulties of

installing slope drape and excavating the subsurface materials for the construction of any new roadside drainage systems.

Figure 4 shows the location of seismic survey line SL-1 at the base of the slope where anchored rockfall drape is planned to be installed. The refraction seismic surveys were conducted using a 24-channel, signal enhancement seismograph (Geometrics SmartSeis ST Model SE-24) and a sledgehammer served as the energy source for the survey. The survey line was 120 feet long with geophones placed at 5-foot intervals. Data was retrieved using hammer impacts about 15-foot away from the ends of the seismic line array and a location near the middle of the array. Data from multiple impacts at each impact location are added together to increase signal resolution to obtain the seismic record. The results of the refraction seismic survey provide additional subsurface data to a depth on the order of approximately 30 to 45 feet below the existing grade.

Figure 4: Seismic Line SL-1 located along the base of the proposed draped slope

The data sets collected in the field are then processed in the office using Geometrics software to provide two dimensional models of the subsurface conditions. The refraction seismic surveys were performed in general conformance with the guidelines presented in ASTM D5777-95 Standard Guide for Using the Seismic Refraction Method for Subsurface Investigation for refraction using compression waves.

3.2 Soil and Bedrock Conditions

Evaluation of the subsurface conditions was limited to observation of the surficial materials exposed at the ground surface, exposed in roadway cut slopes and correlations with the refraction seismic data. The existing roadway cut slopes adjacent to SR 95 expose the soil and bedrock conditions. The surficial soils along the location of the seismic refraction lines are weakly cemented silty sands and gravels with some cobble sized clasts. These soils overly the hard granitic bedrock.

3.3 Groundwater Conditions

The level of groundwater was not determined during the geophysical field investigations. Inconsistent areas of intermittent perched groundwater or a narrow layer of saturated subsurface soils may be encountered along the surface of the sandstone bedrock particularly after extended periods of wet weather conditions.

4.0 RECOMMENDATIONS

4.1 General Discussion

Based on field observations and results of the geophysical testing performed at the site, the geotechnical conditions at the sites are generally favorable for installation of rock anchors for draped mesh and shallow excavations. Cutting back slopes that contain the granitic bedrock would require blasting. The following sections provide geotechnical design information and recommendations for use in excavations related to the proposed drainage and rockfall containment improvements.

4.2 Refraction Seismic Survey Results

Two refraction seismic surveys were located near the proposed location of the rockfall mitigation portions of this project. Stratigraphic interpretation at the survey location was developed from the refraction seismic survey data and observations made of the site geology during the field investigation. This data provides the basis to define the qualitative excavatability of soils and/or bedrock that may be encountered during the construction of the structures at this site.

The results of the refraction seismic survey data and field investigation data are summarized in the table below. Subsurface P-wave velocity model interpretations of the refraction seismic data is presented in Appendix B of this report.

Table 2: Geophysical Survey Results

Survey Lines	Estimated Surface Elevation Range (MSL in ft.)	Layer	Depth Below Surface* (ft.)	Average P-wave Velocity (ft./sec.)
SL-1	365 to 405	1	0 to 25	5,150
		2	3 to 40	7,650
SL-2	4945 to 550	1	0 to 45	5,280
		2	35 to 45	6,950

* Depths to layer changes vary along the length of the length of the seismic line and variations can be gradual within horizontal and vertical extents

4.3 Rippability

The correlation between refraction seismic velocities and rock rippability is a fundamental relationship in geotechnical engineering and construction planning. This relationship allows engineers and contractors to assess excavation difficulty and select appropriate equipment based on seismic wave propagation characteristics. Seismic refraction velocities measure how quickly P-waves (primary or compressional waves) travel through subsurface materials. These velocities correlate strongly with rock strength, density, and degree of fracturing; the same properties that determine how easily rock can be mechanically excavated or "ripped."

Table 3: General Classification of Rock Rippability

P-wave Velocity Range	Rippability
Less than 2,000 feet/second (fps.)	Easy
2,000 to 4,000 fps.	Moderately difficult
4,000 to 5,500 fps.	Difficult, possible blasting
5,500 to 7,000 fps.	Very difficult, probable blasting
Greater than 7,000 fps.	Blasting generally required

These rippability values may be conservative and may depend on the prevailing structure of underlying rock materials. The fracture spacing and orientation can greatly affect the effectiveness of heavy equipment.

More detailed ranges of rippability for rock materials with different equipment configurations are published in the Caterpillar Performance Handbook (Caterpillar, 2018). The rippability classification scheme shall be used with discretion where a contractor's experience and equipment can and will influence the effectiveness of excavation efforts.

4.4 Excavation

The data from the seismic refraction lines completed for this site indicates that the existing surface and shallow subsurface conditions appear to consist of partially cemented soils, weathered and intact granitic bedrock. Variable to difficult excavation conditions may be encountered with weathered to moderately hard granitic bedrock anticipated within the limits of excavations necessary for grade control and installation of the rockfall containment drape system.

The information provided in this report is for design purposes. The contractor shall review all available information and provide their own assessment to determine the equipment and technical requirements that will be used to construct this project according to the plans and specifications for this project.

4.5 Earthwork Factors

Earthwork factors are dependent on the existing soil conditions, contractor methods of handling the materials, wind losses and compaction achieved during construction. Potential bidders should consider these factors in preparing the estimates and are encouraged to review all available data and make their own conclusions regarding excavation conditions. For the purpose of design volume estimation, Earthwork Factors are recommended in the table below.

Table 4: Earthwork Factors

Earthwork Factors		
Station	Ground Compaction	Excavation Factor
Entire project	0.10 feet	10% swell

4.6 Water Requirements

Approximately 80 gallons of water per cubic yard may be estimated for compaction of base and subgrade materials. This estimate is based on the tested optimum compaction moisture content and includes a conservative overrun for losses due to seepage, evaporation, inadequate mixing, spillage, etc. Precipitation before and/or during construction may also reduce the required amount of water significantly.

5.0 REFERENCES

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APPENDIX A

Site Plans

Figure A-1: P-wave Velocity Model for refraction seismic line SL-1

Figure A-2: P-wave Velocity Model for seismic refraction line SL-2

APPENDIX B

Refraction Seismic Survey Results

Figure B-2: P-wave Velocity Model for seismic refraction line SL-1

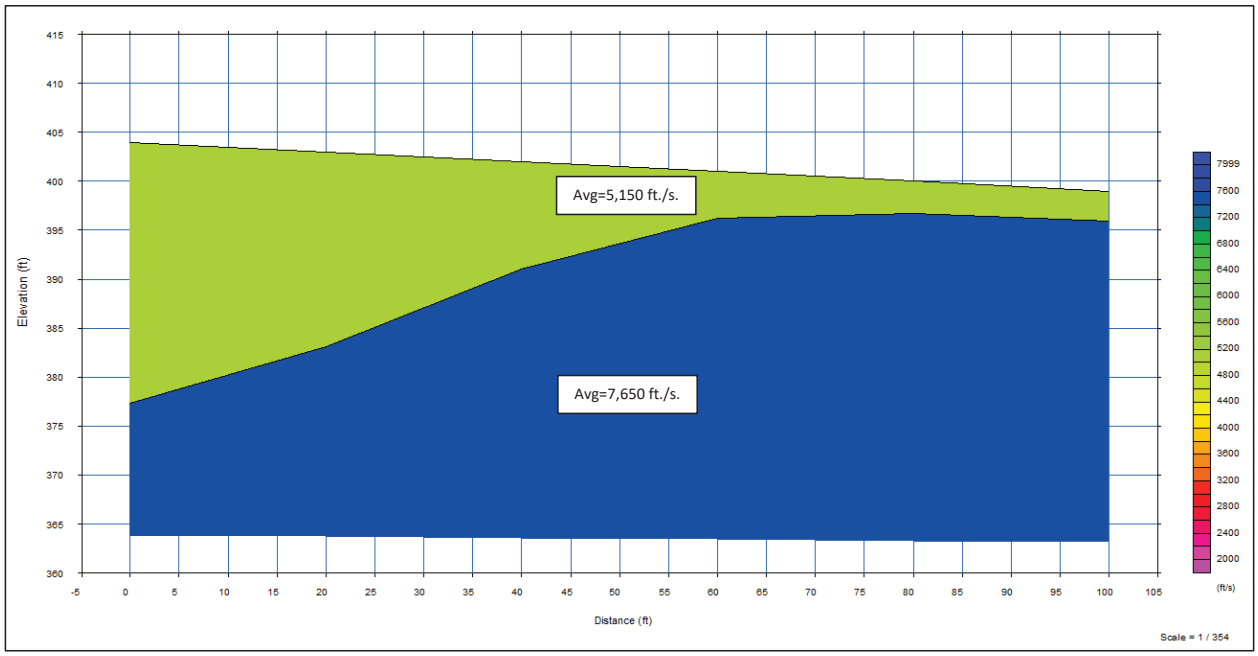

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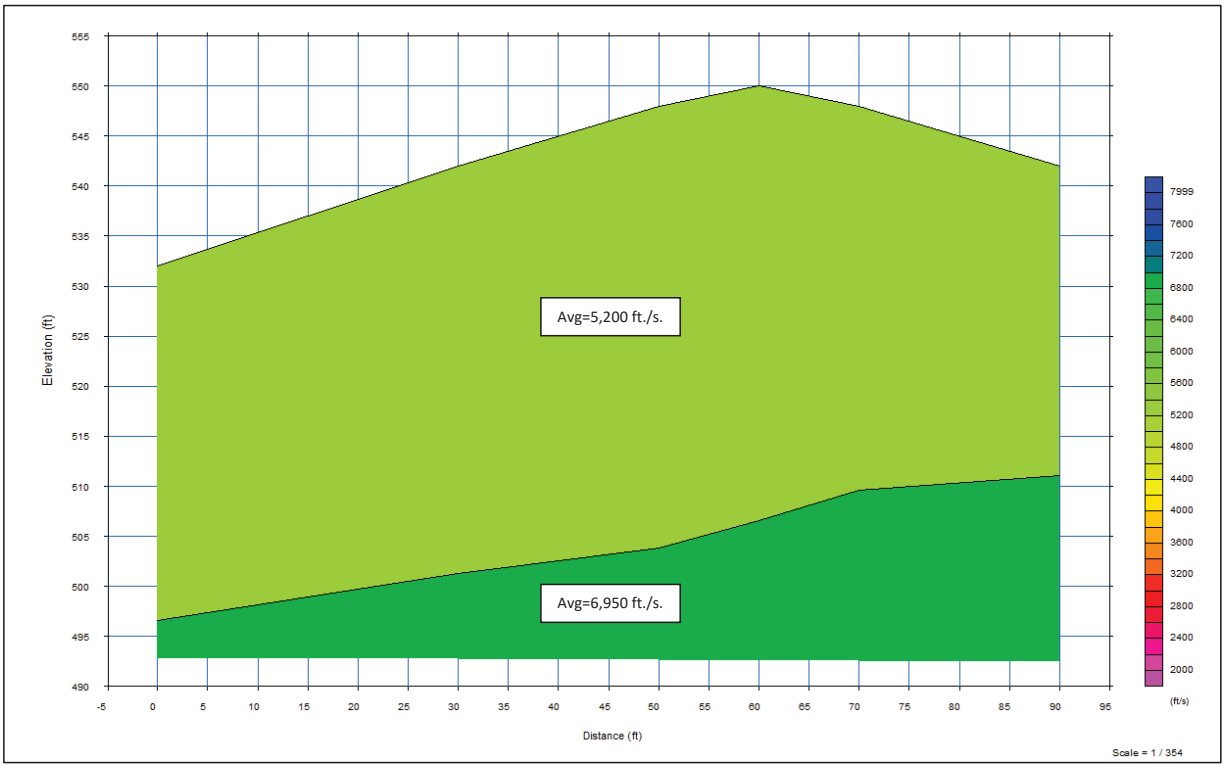
Figure B-3: P-wave Velocity Model for seismic refraction line SL-2



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