February 10, 2016
Project No. 604970001

Ms. Angeline To
Pinal County Public Works
31 North Pinal Street, Building F
Florence, Arizona 85132

Subject: Geotechnical Services
Mountain View Estates Access Road
Eloy, Pinal County, Arizona

Dear Ms. To:

In accordance with our proposal dated November 2, 2015 and your authorization on November 10, 2015, we have performed geotechnical services associated with the design and construction of a new paved access road from Sunland Gin Road westerly, intersecting John Jacob Astor Avenue, south of Quartz Drive, in Eloy, Pinal County, Arizona. It is general knowledge that there are potential earth fissures traversing the proposed project site, as well as other factors limiting development along the proposed alignment; therefore, a variety of methods were used to assess the alignment with regards to geologic hazards including a site reconnaissance, seismic refraction surveys, a ground penetrating radar profile, and test trenching. The purpose of our evaluation was to assess subsurface conditions at the project site to provide geotechnical recommendations for a new pavement section for the new roadway and evaluate earth fissures within the project area.

SCOPE OF SERVICES

The scope of our services for this project generally included:

- Reviewing readily available aerial photographs and published geologic literature, including maps and reports pertaining to the project site and vicinity.
- Conducting a walking geologic survey to evaluate possible earth fissure lineaments within and adjacent to the proposed corridor.
- Conducting a walking geologic survey to evaluate the possible exploration locations.

- Notifying Arizona811 of proposed exploration locations.
- Performing proof-of-method seismic refraction line surveys at the site to evaluate the presence of earth fissures located beneath the surface. The purpose of this survey was to check if known features and associated voids or anomalies are detectable using the seismic refraction method.
- Conducting ground penetrating radar (GPR) profiles across the length of the subject alignment in order to aid in feature detection and facilitate correlation with the collected seismic data.
- Excavating test trenches (TT) to validate the findings of the SL and GPR surveys, and to evaluate the extent and nature of earth fissures beneath the surface.
- Performing laboratory tests on selected samples for developing index and strength properties. The results of the laboratory testing are presented in Appendix A.
- Compiling the collected data and performing engineering analyses.
- Preparing this report presenting our findings, conclusions, and recommendations regarding the design and construction of the planned access road.

SITE DESCRIPTION

The project alignment is situated within Township 7 South, Range 6 East in Section 24 in Eloy, Pinal County, Arizona. The project alignment is generally bounded by Arica Road to the north, John Jacob Astor Avenue to the west, Sunland Gin Road to the east, and undeveloped desert land to the south. The approximate location of the site is depicted on Figure 1. At the time of our evaluation, Arica Road consisted of a two-lane, east-west trending, paved roadway to the north of the site, John Jacob Astor Avenue consisted of a two-lane, north-south trending, paved roadway to the west of the site, and Sunland Gin Road consisted of a two-lane, north-south trending, paved roadway to the east of the site. Scattered residential and commercial development surrounded the project site. Within the project limits, the site was relatively flat and consisted of undeveloped desert land with desert vegetation and natural drainage patterns.

According to the Casa Grande Mountains, Arizona-Pinal Co., 7.5-Minute Series United States Geological Survey (USGS) Topographic Quadrangle Map (2013), the site elevations range from approximately 1,475 feet relative to mean sea level (MSL) at the western end of the proposed

roadway alignment to approximately 1,485 feet relative to MSL at the eastern end. Based on the information from the quadrangle map, the adjacent region slopes gently northwest to southeast.

Aerial photographs taken between 1961 and 2015, from Google Earth™ and Nationwide Environmental Title Research, LLC (NETR Online™), were reviewed for this project. The aerial photographs depicted the site as undeveloped desert land. The 1963 aerial photograph depicted Sunland Gin Road as a paved roadway and the 1996 photograph depicted Arica Road as a paved roadway and John Jacob Astor Avenue as a dirt road; the 1996 aerial photograph also depicted commercial development on the east side of the intersection at Arica Road and Sunland Gin Road. The 2003 aerial photograph depicted more commercial development at the intersection at Arica Road and Sunland Gin Road and scattered residential development to the west of John Jacob Astor Road. Aerial photographs from 2004 on depicted continued scattered residential development to the west of John Jacob Astor Road; the 2014 photograph depicted the site as being similar to its current condition.

PROPOSED CONSTRUCTION

We understand that in general, the project consists of the design and construction of an approximately ½-mile long, 50-foot wide, paved access road for the Mountain View Estates development from Sunland Gin Road westerly, to John Jacob Astor Avenue, south of Quartz Drive. The access road will consist of a new asphalt concrete (AC) pavement section whose final grades will generally match existing grades. No structures and/or underground utilities are planned.

FIELD EXPLORATION

Geologic Reconnaissance

On November 19, 2015, Ninyo & Moore conducted a walking geologic reconnaissance in order to assess the current site conditions. During this reconnaissance, numerous surface expressions were observed that are consistent with earth fissures. Multiple locations where surface expressions were made were consistent with the delineation of earth fissures as

recorded on Arizona Geological Society (AZGS) maps, including unconfirmed earth fissure locations (defined as those which could not be confirmed by surface investigations by AZGS geologists, but which have been previously reported by Professional Geologists in published documents or maps.

Seismic Refraction

On November 22 and 23, 2015, Ninyo & Moore conducted seismic refraction surveys (SL) along the proposed access road alignment. The SL surveys were conducted using a 24 channel, Geometrics Geode seismograph 24-with twenty-four 10-Hertz geophones placed apart at 15-foot intervals. The seismic lines extended for 345 feet for lines SL-1 through SL-7 and 285 feet for line SL-8. The SL surveys were approximately situated perpendicular to suspected earth fissures. The surveys started approximately 25 feet from the eastern edge of pavement along John Jacob Astor Avenue, and traversed westward along the proposed alignment. The approximate seismic refraction line locations are depicted on Figure 3.

The seismic refraction method uses first-arrival times of refracted seismic waves to evaluate the thicknesses and seismic velocities of subsurface layers. Seismic waves generated at the surface are refracted at boundaries separating materials of contrasting velocities. These refracted seismic waves are then detected by a series of surface geophones and recorded with a seismograph. The travel times of the seismic waves are used in conjunction with the shot-to-geophone distances to obtain thickness and velocity information on the subsurface materials.

In general, seismic wave velocities can be correlated to material density and/or rock hardness. The relationship between rippability and seismic velocity is empirical and assumes a homogenous mass. Areas of differing composition, texture, or structure may affect both the measured data and the actual rippability of the mass.

A seismic source was introduced to the subsurface by impacting a 20-pound sledge hammer on a steel plate placed at the surface. The time for the compression wave (p-wave) to reach the geophones along each of the refraction lines was recorded. Five “shots” were performed

on each line, one at each end, and three spaced equally within the length of the seismic lines. At each "shot" location, our geophysicist interpreted the data in real time to evaluate whether any unexpected time delays, or other abrupt lateral changes, were recorded in the geophones that could indicate anomalies associated with the presence of earth fissures in the field. Preliminary data and signal processing was also completed in our office for each line in order to better analyze the raw field data.

Ground-Penetrating Radar

On November 22 and 23, 2015, Ninyo & Moore used Geophysical Survey Systems, Inc. (GSSI) GPR equipment as a geophysical method to image the subsurface along the alignment. The nondestructive method uses electromagnetic radiation in the microwave band (UHF/VHF frequencies) of the radio spectrum, and detects the reflected signals from subsurface structures. Ground-penetrating radar was used to evaluate anomalous subsurface features along the length of the proposed alignment, assessing changes in material properties and voids and cracks interpreted from the radar data and analysis. The information collected was correlated with the seismic information in order to confirm locations of possible earth fissures in the vicinity.

Exploratory Trenches

Between December 7 and 10, 2015, Ninyo & Moore contracted with a backhoe excavator to dig exploratory TT in an attempt to corroborate refractive survey anomalies along the seismic study alignment. A total of 12 trenches were excavated along the proposed alignment. The approximate TT locations are depicted on Figure 3. The TT were approximately 2.5 feet wide by 20 feet long, and were excavated to a depth of approximately 8 feet bgs. Several bulk soil samples were collected. The samples were transported to our laboratory in Phoenix for further evaluation and testing.

At the time of our evaluation, clearing operations and construction layout were being performed for the roadway alignment and our work area was limited; as such, Ninyo &

Moore employees were limited in evaluating the excavations to maintain compliance with Occupational Safety and Health Administration (OSHA) guidelines.

GEOLOGIC SETTING

The project site is located in the Sonoran Desert Section of the Basin and Range Physiographic Province, which is typified by broad alluvial valleys separated by steep, discontinuous, subparallel mountain ranges. The mountain ranges generally trend north-south and northwest-southeast. The basin floors consist of alluvium with thickness extending to several thousands of feet.

The basins and surrounding mountains were formed approximately 10 to 18 million years ago during the mid-to late-Tertiary age. Extensional tectonics resulted in the formation of horsts (mountains) and grabens (basins) with vertical displacement along high-angle normal faults. Intermittent volcanic activity also occurred during this time. The surrounding basins filled with alluvium from the erosion of the surrounding mountains, as well as from deposition from rivers. Coarser-grained alluvial material was deposited at the margins of the basins near the mountains.

The surficial geology of the site is described as unconsolidated gravel, sand, and silt in stream channels and bolson plain; and colluvium (Bergquist et al., 1978). The soil units are mapped as loam, an agricultural soil classification that refers to a soil comprised of a mixture of clay, silt, and sand.

Subsurface Conditions

Our knowledge of the subsurface conditions at the project site is based on our field exploration, laboratory testing, and our understanding of the general geology of the area.

Native alluvium was encountered at the ground surface in our excavations. From a visual classification of material excavated in the TT by our geologist, the alluvial material generally consisted of sandy silts (ML) and silty sands (SM) with varying amounts of fine to coarse, sub-rounded gravel with no to some roots or organic material, and few scattered

caliche nodules. Laboratory results for bulk samples tested are presented below within this report.

Groundwater

Groundwater was not encountered at the time of our exploration. Based on well data published by the Arizona Department of Water Resources (ADWR), regional groundwater has historically been recorded as deep as 171 feet bgs in the site vicinity. Groundwater levels can fluctuate due to seasonal variations, irrigation, groundwater withdrawal or injection, flows within nearby washes or drainages and other factors.

GEOLOGIC HAZARDS

The following sections describe potential geologic hazards at the site, including land subsidence and earth fissures, and faulting.

Land Subsidence and Earth Fissures

Groundwater depletion, due to groundwater pumping, has caused land subsidence and earth fissures in numerous alluvial basins in southern Arizona. It has been estimated that subsidence has affected more than 3,000 square miles and has caused damage to a variety of engineered structures and agricultural land (Schumann and Genualdi, 1986). Ninyo & Moore reviewed land subsidence maps and available Synthetic Aperture Radar Interferometry (InSAR) imagery from the ADWR website. InSAR is an application used to measure the rate of ground subsidence by measuring subtle changes in the ground surface elevation versus time. To monitor elevation changes, elevation data points are collected at separate passes during satellite orbits and the change in elevation is depicted on an interferogram image.

According to the information from ADWR, the project alignment lies within the Picacho-Eloy land subsidence feature. The InSAR data that compared satellite passes on January 14, 2004, and September 29, 2010, indicated that about 1 to 2 centimeters of subsidence had occurred at some locations within the project limits within the approximate 6.7-year

timespan. The InSAR data on the more recent available imagery was obtained by comparing satellite passes on May 15, 2010, and April 19, 2015, indicated that about 2 to 4 centimeters of subsidence had occurred at some locations during the approximate 5-year timespan. Therefore, within the last approximately 12 years, up to about 6 centimeters (or 2.4 inches) of subsidence has been measured in the project area. Historic subsidence may have also occurred prior to ADWR's 2004 measurements. The InSAR data from ADWR for the site are depicted on Figures 2A and 2B.

In Arizona, earth fissures are generally associated with land subsidence and pose an on-going geologic hazard. Earth fissures generally form near margins of geomorphic basins where a significant amount of groundwater depletion has occurred. Earth fissures have also formed due to tensional stress caused by differential subsidence of the unconsolidated alluvial materials over buried bedrock ridges and irregular bedrock surfaces (Schumann and Genualdi, 1986).

Based on our field reconnaissance and review of the referenced material, earth fissures are present and underlying the project alignment (Arizona Geologic Survey [AZGS], 2008). Per the AZGS map legend, solid black lines represent the location of earth fissures manifested as open cracks or gullies, solid red lines represent the location of discontinuous earth fissures manifested as elongated to circular depressions or as abbreviated or irregular (frequently representing an incipient surface expression of an earth fissure), and green lines represent the approximate locations of unconfirmed earth fissures, defined as fissures which could not be checked by surface evaluations by AZGS, but have previously been reported by Professional Geologists in published documents or maps. As depicted on Figure 4, there are four earth fissures that bisect and/or are intersected by the proposed access road alignment; based on our walking geologic reconnaissance of the project site, open cracks or gullies and unconfirmed earth fissures exist along the alignment between John Jacob Astor Avenue and Sunland Gin Road. Mitigation techniques are discussed at the end of this report and should be considered for the design and construction of the roadway.

Faulting

The site lies within the Sonoran Zone, which is a relatively stable tectonic region located in southwestern Arizona, southeastern California, southern Nevada, and northern Mexico (Euge et al., 1992). This zone is characterized by sparse seismicity and few Quaternary faults. Based on our field observations, review of pertinent geologic data and analysis of aerial photographs, faults are not located on or adjacent to the property. The closest fault to the site is the Whitlock Wash Fault Zone, located approximately 63 miles east of the project site. The Whitlock Wash Fault Zone is a series of north- to northwest-trending faults offset Pliocene basin-fill deposits on the east side of the northern San Pedro Valley, in southeastern Arizona. Quaternary fault activity is suspected based on the prominent escarpment formed on basin-fill deposits. However, a detailed map of the southern part of this fault zone shows no offset of lower to middle Quaternary deposits, so Quaternary activity is uncertain (Shenk, 1990). Recent movement along this fault is undocumented. The slip-rate category of this fault is unknown, though likely less than 0.02 millimeters per year (Pearthree, 1998).

FINDINGS

Based on our field work at this site, it is our opinion that several exposed and underlying earth fissures cross the proposed access road alignment. Reductions in the energy of the received seismic signals and/or significant delays in time of the arrivals across the features were observed at the ground surface at multiple SL locations and were via “ground truthing” in TT No. 2, 4, 5, 7, and 8 through 12. These locations are depicted on Figure 3.

As stated previously, the data for SL locations evaluated were observed to have unexpected time delays and any other indications of lateral changes between some geophone location. GPR data interpretations were compared and correlated with the findings from the SL locations.

Multiple TT were also excavated and evaluated the presence of distress features typically associated with earth fissures crossing the proposed project alignment. Each trench was evaluated for typical signs of earth fissuring, such as aligned animal burrows, aligned lineaments

of ground depressions, soft sections of ground and significant soil cracks along the trench sidewalls and bottom of the excavation. Photographic documentation is presented in Appendix B.

The native soil in the trench sidewalls of TT1 thru 12 consisted of sandy silts and silty sand with gravel. Trace to several roots were present and generally extended from the surface to a depth of approximately 6 feet bgs. Soils were brown to light brown, dry and moderately to weakly cemented with scattered caliche nodules present. In TT-7, TT-8, TT-10 and TT-12 a sandy gravel layer was observed at approximately 5.5 feet bgs. This layer was light brown to gray, dry, loose and contained fine to coarse, sub-rounded gravel. The extents of the gravel layer were not reached due to safety concerns and limitations of the excavation equipment. Each trench was extended to approximately 8 feet bgs.

There were no visible cracks, wet or soft areas, or other ground disturbances observed in TT-1, TT-3 and TT-6.

In the trench sidewalls of TT-2, one nearly vertical crack and one north-east/south-west trending crack was observed at 0.5 feet bgs, and extended to the bottom of the trench, approximately 6 feet bgs. These features were undulating, with no in-filling or coating along the edges and showed no evidence of water movement along openings.

In the trench sidewalls of TT-4, one nearly vertical crack was observed on the south facing wall at approximately 4 feet bgs. Cracks were approximately 1.5 inches wide and extended to the bottom of the trench, approximately 6 feet bgs. This feature was undulating, with no in-filling or coating along the edges and showed no to little evidence of water movement along openings.

In the trench sidewalls of TT-5, two nearly vertical cracks were observed on the north and northwest facing walls at approximately 2.5 feet bgs. Cracks were less than 0.5 inches wide and extended to the bottom of the trench, approximately 4 feet bgs. These features were undulating, with no in-filling or coating along the edges and showed no to little evidence of water movement along openings.

In the trench sidewalls of TT-9, four, nearly vertical, cracks were observed on the south facing wall at approximately 0.5 feet bgs. These cracks were less than 0.5 inches wide and extended to the bottom of the trench, approximately 4.2 feet bgs. These features were undulating to relatively planner, with no in-filling or coating along the edges, some roots present and showed some evidence of water movement along openings.

In the trench sidewalls of TT-11, one east trending to nearly vertical crack was observed on the south facing wall at approximately 3 feet bgs, 2.5 inches wide and extended to the bottom of the trench, approximately 4 feet bgs. This feature was undulating, with no in-filling or coating along the edges and little to no evidence of water movement along openings.

LABORATORY TESTING

We collected bulk samples of the alluvial deposits from select trenches. Three samples were collected near seismic line locations SL-7, Sl-10, and SL-12. The soil samples collected were transported to the Ninyo & Moore laboratory in Phoenix, Arizona for geotechnical laboratory analysis. The analysis included moisture content, gradation, Atterberg limits, and corrosivity characteristics (including pH, minimum electrical resistivity, and soluble sulfate and chloride contents). Descriptions of the visual classifications of soils identified in the field are presented above. A description of each laboratory test method and the test results are presented in Appendix A.

Based on the results of our laboratory testing, soil tested from native alluvial samples generally consisted of clayey sands (SC) with trace gravel, poorly graded sands with silt (SP-SM), and well-graded sands with silt (SW-SM).

CONCLUSIONS

Based on the results of our subsurface evaluation, laboratory testing, and data analysis, it is our opinion that the proposed construction is feasible from a geotechnical standpoint, provided that the recommendations of this report are incorporated into design and construction of the proposed project, as appropriate. Geotechnical considerations include the following:

- The surface on-site materials are considered generally excavatable with heavy-duty earthmoving equipment in good operating condition. Varying gravel deposits, roots, and scattered caliche nodules were encountered in our test trenches, which may be more difficult to excavate and may slow the rate of excavation during construction.

- Imported soils and soils generated from on-site excavation activities that exhibit very low to low swell potential and low plasticity indices can generally be used as engineered fill.

- Groundwater was not observed in our test trenches. The groundwater table in the area is anticipated to be located, based on historic nearby well data, at a depth of approximately 171 feet bgs.

- Documented earth fissures are present within the project limits. In addition, up to about 6 centimeters (or 2.4 inches) of subsidence has occurred in the project area over the past 12 years. Continued groundwater withdrawal in the area may result in further subsidence and the formation of new fissures or the extension of existing fissures. Future land subsidence in the project area is possible and should be considered in the design of grade-sensitive elements, if any are planned. Earth fissure mitigation recommendations are presented herein, and should be implemented where earth fissures cross the alignment.

- Corrosivity test results indicate that subgrade materials are corrosive to ferrous metals and the sulfate content of the soils presents a negligible sulfate exposure to concrete.

- Based on our field work, it is our opinion that the surficial expressions associated with the SL surveys and the visual observations within the trenches along the proposed access road alignment are indicative of underlying earth fissures. These earth fissures should be mitigated as part of this project. It is possible that new (previously undiscovered) earth fissures will be encountered during construction. The lateral extent of the earth fissures observed was not evaluated as part of our scope for this project; therefore, the length of the fissures (perpendicular to the roadway) is unknown.

RECOMMENDATIONS

Based on our understanding of the project, the following sections present our geotechnical recommendations for the proposed design and construction. If the proposed construction is changed from that discussed in this report, Ninyo & Moore should be contacted for additional recommendations.

General Earthwork

The following sections provide our earthwork recommendations for this project. In general, we understand that Pinal County generally follows the earthwork specifications contained in

Maricopa Association of Governments (MAG), *Uniform Standard Specifications and Details for Public Works Construction*, as amended by the City of Eloy, are expected to apply, except as noted.

Excavations

Our evaluation of the excavation characteristics of the site soils is based on the results of our site observations, trench excavations, and our experience with similar materials. Based on our evaluation, excavation of the near-surface site soils can generally be accomplished using heavy-duty excavation equipment in good working condition. However, varying amounts of gravel, roots, and scattered caliche nodules were encountered in some of our excavations. This material might be more difficult to excavate and might slow the excavation rate depending on the actual particle size encountered during construction. Based on aerial photography review, several natural drainages crossed the project alignment. This may result in changes in soil conditions along the alignment that may not have been observed during our field work.

The contractor should provide safely sloped excavations or an adequately constructed braced shoring system, in compliance with OSHA guidelines, for employees working in an excavation that may expose them to the danger of moving ground. If construction or earth material is stored or equipment is operated near an excavation, flatter slope geometry or stronger shoring should be used during construction.

Grading, Fill Placement, and Compaction

Vegetation and debris from the clearing operation, as well as demolition debris (if any), should be removed from the site and disposed of at a legal dumpsite. Obstructions that extend below finish grade, if present, should be removed and the resulting holes filled with compacted soil.

The geotechnical consultant should carefully evaluate any areas of soft, loose, or wet soils prior to placement of fill or other construction. Drying or over-excavation of some materials may be appropriate.

On-site and imported soils that exhibit relatively low plasticity indices are generally suitable for re-use as engineered fill. Relatively low plasticity indices are defined as a Plasticity Index (PI) value of 15 or less, as defined by the American Society for Testing and Materials (ASTM) Test Method D 4318. The Atterberg limits tests performed on selected samples from our borings resulted in PI values of 0 (non-plastic) to 19. As such, some of the on-site soils are not considered suitable for re-use as engineered fill for this project. Not every soil condition could be observed in the field during our field exploration; as such, there may be areas of unacceptable soils encountered during construction. Additional field sampling and laboratory testing should be performed by the Contractor during construction to evaluate the suitability of the site soils.

In addition to the above recommendations, suitable fill below new pavement should not have an R-value less than 30, or include organic material, construction debris, or other non-soil fill materials. Rock particles and clay lumps should not be larger than 4 inches in dimension. Unsuitable fill material should be disposed of off-site or in non-structural areas.

Below new pavement and flatwork, we recommend that the existing materials be improved to a depth of 24 inches, or more. The improvement below these areas should extend laterally to a distance that is equivalent to the depth of improvement.

Engineered fill should be placed in horizontal lifts no more than approximately 8 inches in loose thickness and compacted by appropriate mechanical methods to a relative compaction of 95 percent or more as evaluated by ASTM D 698 and at moisture content generally near optimum. An earthwork (shrinkage) factor of 10 to 20 percent for the on-site soils is estimated.

Following the remedial grading as described above, and prior to the placement of new fill or pavement, the resulting exposed surface should be carefully evaluated by Ninyo & Moore for the presence of soft, loose, or wet soils. Proof-rolling of the exposed surface should be observed by Ninyo & Moore. Based on this evaluation, additional remediation may be

needed. This could include scarification of the exposed surface. This additional remediation, if needed, should be addressed by Ninyo & Moore during the earthwork operations.

Earth Fissure Mitigation Considerations

As mentioned earlier, earth fissures have been observed along the proposed project alignment. The approximate locations of the documented earth fissures are depicted on Figure 4. Table 2 below presents earth fissure locations anticipated as a result of our evaluation and analyses as measured with a cloth measuring tape from approximately 25 feet of the eastern edge of pavement (EOP) along John Jacob Astor (JJA) Road:

Test Trench (TT) Location	Anticipated Earth Fissure Location (Feet, East of 25-foot JJA Road EOP Offset)
TT-2	325 - 345
TT-4	1001 - 1021
TT-5	1142 - 1162
TT-9	2127 - 2147
TT-11	2320 - 2340

Our distance measurements were taken with a cloth measuring tape, with JJ Astor road as a starting point. There are limitations to the accuracy of this method. These are not as exact as surveyed points. As we moved from west to east, we assume that there is an approximately 2 feet to 10 feet reduction in reported distances, respectively.

It is recommended that for fissure locations encountered during construction, interceptor trenches be used on both sides of the roadway along the fissure/crack alignment, as well as a fissure mitigation trench beneath the roadway. An illustration of the fissure mitigation technique is depicted on Figure 5. An illustration of the interceptor trenches being excavated to depths of about 10 feet bgs are depicted on Figure 6. An illustration of the fissure mitigation trench being excavated to a depth of about 5 feet bgs is shown on Figure 7.

Following the excavation, the interceptor trenches should be lined with a 40-mil high-density polyethylene (HDPE) membrane and backfilled with low-strength cement slurry. The top of the interceptor trench and HDPE membrane should be placed 12 inches, or more below grade (Figure 6). The fissure mitigation trench should be lined with a separation geotextile fabric and backfilled with aggregate base (AB) material. The separation geotextile fabric should be placed over the trench, enclosing the AB material (see Figure 7). The select material for the fissure mitigation trench should consist of a washed, narrowly graded mixture of stone or gravel. We recommend that ASTM D 448 (coarse-aggregate grading Size 57), with 100 percent passing a 1-1/2- inch sieve and 0 to 5 percent passing a No. 8 sieve be used for the specification of this material. Also, it is suggested that this material consist mainly of rounded to sub-rounded particles.

Due to the unpredictable nature of earth fissures, the apparent proximity of fissures near the proposed access road, and the susceptibility of potential new fissures to form along the alignment, it is recommended that geogrid underlain by a separation geotextile fabric be used along the new roadway within the study limits. The fabric should be placed between the improved subsurface and the AB layer to reduce the potential for infiltration of fill material into the earth fissure voids and to mitigate crack propagation to the surface, and provide strength to the pavement section should underlying cracking occur.

Maintenance of grades and drainage slopes will be important to the long term performance of the roadway. If subsidence activity or fissuring is noticed within the roadway, early detection may allow for actions that slow or stop progressive damage. After construction, we recommend that monitoring points be established and surveyed on a regular basis to estimate ground subsidence and subsequent earth fissure development. In addition, county maintenance personnel should be trained to visually monitor the existing earth fissures in the area and watch for the development of new fissures.

Imported Fill Material

Imported fill, if utilized, should consist of granular material meeting the specifications outlined in the MAG guidelines. In addition, material needed within 2 feet of the roadway subgrade should have an R-value of 30 or more. Import material in contact with ferrous materials should preferably have low corrosion potential (minimum resistivity more than 2,000 ohm-cm, chloride content less than 25 parts per million [ppm]). In lieu of this, corrosion protection techniques (e.g., cathodic protection, pipe wrapping, etc.), can be implemented. A corrosion specialist should be consulted for recommendations. Imported material in contact with concrete should have a soluble sulfate content of less than 0.1 percent. The geotechnical consultant should evaluate such materials and details of their placement prior to importation.

Pavement Design Summary

Based on our evaluation, for areas to receive new pavement, we recommend that AC be used. The pavement section given below is assumed to bear on imported or improved on-site soils as described above with an R-value of 30, or more. The pavement design was performed in general accordance with American Association of State Highway and Transportation (AASHTO) Pavement Design Methods using the parameters summarized below.

Traffic Volumes and Truck Factor Growth Rates

Traffic data associated with this project was obtained from an Intersection Analysis report dated February 14, 2014, prepared by Southwest Traffic Engineering, LLC, for the intersection of Sunland Gin Road and Arica Road. Additionally, we incorporated traffic information based on previous work with Pinal County; specifically, we used the following information for estimated traffic volumes to develop design Equivalent Single Axle Loads (ESALs) for the pavement design:

- The Average Daily Traffic (ADT) counts in the project vicinity are less than approximately 2,000 vehicles per day (two-way).

- The design life for this pavement is 20 years (2015-2035).
- The anticipated traffic growth rate is about 1.14 percent per year.
- Passenger cars will account for 99 percent and trucks will account for 1 percent of the traffic volume (50 percent directional distribution).

Based on these assumptions, and using the AASHTO procedure for pavement design, the two-way flexible pavement ESALs is estimated to be less than 750,000.

Resilient Modulus

A design R-value of 30 was used in our analysis. Based on an R-value of 30 and a seasonal variation factor of 1.1, a resilient modulus of approximately 16,881 pounds per square inch (psi) was calculated.

Serviceability

An initial serviceability of 4.1 and a terminal serviceability of 2.6 were used for the design of flexible pavements. The resulting serviceability index loss is 1.5.

Standard Deviation and Level of Reliability

A standard deviation of 0.45 was used for the design of the roadway pavement. A level of reliability of 85 percent was used for the design. A standard normal deviation (Z_R) value of -1.037 was used for 85 percent reliability.

Recommended Pavement Sections

Based on the inputs noted above, the 20-year design ESALs were calculated to be less than 750,000 resulting in a structural number of 2.34 inches for the roadway under study. Table 1 below presents our recommended pavement section:

Pavement Sections	PASS-QB Oil (in)	CRS-TR (in)	AC (in)	AB (in)	Pavement Section Thickness (in)
Mountain View Access Road: John Jacob Astor Avenue to Sunland Gin Road	-	-	4.0	5.0	9.0

Pavement Sections	PASS-QB Oil (in)	CRS-TR (in)	AC (in)	AB (in)	Pavement Section Thickness (in)
Mountain View Access Road: John Jacob Astor Avenue to Sunland Gin Road*	½	3/8	-	5.0	5.0(plus chip seals)*
****Pavement design life is significantly reduced for double chip seal applications; similarly, increased routine maintenance can be expected.** **NOTE: Chip seal applications do not contribute to the overall pavement structural number; additionally, chip seal applications may/may not protect the subgrade from moisture infiltration, a critical hazard for this project as it pertains to earth fissures.**					

We recommend that AC used for this project be constructed in accordance with MAG guidelines. The roadway is designated as "local" by Pinal County. The recommended pavement thickness assumes that the above pavement section is founded on improved soil as outlined previously.

CONCRETE FLATWORK

To reduce the potential manifestation of distress to exterior concrete flatwork (such as curbs and sidewalks) due to possible movement of the underlying soil, we recommend that such flatwork (if utilized for this project) be installed with crack-control joints at appropriate spacing as designed by the structural engineer. Additionally, we recommend that concrete flatwork be supported on 24 or more inches of adequately moisture-conditioned and compacted fill as described above. Positive drainage should be established and maintained adjacent to flatwork.

CORROSION

The corrosion potential was evaluated using the results of our laboratory testing on a representative bulk soil sample obtained from TT-9 collected between 0 and 4.2 feet bgs.

Laboratory testing consisted of pH, minimum electrical resistivity, and chloride and soluble sulfate contents. The pH and minimum electrical resistivity tests were performed in general accordance with Arizona Test 236c, while sulfate and chloride tests were performed in

accordance with Arizona Tests 733 and 736, respectively. The results of the corrosivity tests are presented in Appendix B.

The pH value of the selected soil sample was 7.9, which is considered to be alkaline. The minimum electrical resistivity value of the sample tested was about 1,930 ohm-cm, which represents a corrosive environment to ferrous materials. The chloride content of the sample tested was 172 ppm, which is also corrosive to ferrous materials. The soluble sulfate content of the sample tested was 0.007 percent by weight, which represents a negligible sulfate exposure to concrete.

The results of the chloride content and minimum electrical resistivity tests on the sample tested indicated that the materials are generally corrosive to ferrous materials. Based on our experience with other nearby projects, we recommend that special consideration be given to the use of heavy-gauge, corrosion-protected, underground steel pipe. As an alternative, plastic pipe could be considered. A corrosion specialist should be consulted for further recommendations.

CONCRETE

A laboratory chemical test performed on a selected sample of on-site soils indicated a sulfate content of 0.007 percent by weight. Notwithstanding the sulfate test results and due to the limited number of chemical tests performed, as well as our experience with similar soil conditions and regional practice, we recommend that “Type II” cement be used for the construction of concrete structures at this site. Due to potential uncertainties as to the use of reclaimed irrigation water, or topsoil that may contain higher sulfate contents, pozzolan or admixtures designed to increase sulfate resistance may be considered.

The concrete should have a water-cementitious materials ratio of no more than 0.50 by weight for normal weight aggregate concrete. The structural engineer should ultimately select the concrete design strength based on the project-specific loading conditions. However, higher strength concrete may be selected for increased durability and resistance to shrinkage cracking.

SITE DRAINAGE

Surface drainage should be provided to divert water off of paved surfaces. Surface water should also not be permitted to pond on or below pavement areas. Positive drainage is defined as a slope of 2 percent, or more, for a distance of 5 feet, or more, away from the pavements. To deter accumulation of water below the new pavement sections, the bottom of the over-excavated zone below the new pavement should be sloped toward the edges of the roadway.

PRE-CONSTRUCTION CONFERENCE

We recommend that a pre-construction conference be held. Representatives of the owner, the civil engineer, Ninyo & Moore, and the contractor should be in attendance to discuss the project plans and schedule. Our office should be notified if the project description included herein is incorrect or if the project characteristics are significantly changed.

CONSTRUCTION OBSERVATION AND TESTING

During construction operations, we recommend that Ninyo & Moore perform observation and testing services for the project. These services should be performed to evaluate exposed subgrade conditions, including the extent and depth of over-excavation (if needed), to evaluate the suitability of proposed borrow materials for use as fill, and to observe placement and test compaction of fill soils. If another geotechnical consultant is selected to perform observation and testing services for the project, we request that the selected consultant provide a letter to the owner, with a copy to Ninyo & Moore, indicating that they fully understand our recommendations and they are in full agreement with the recommendations contained in this report. Qualified subcontractors utilizing appropriate techniques and construction materials should perform construction of the proposed improvements.

LIMITATIONS

The field evaluation, laboratory testing, and geotechnical analyses presented in this geotechnical report have been conducted in general accordance with current practice and the standard of care exercised by geotechnical consultants performing similar tasks in the project area. No warranty,

expressed or implied, is made regarding the conclusions, recommendations, and opinions presented in this report. There is no evaluation detailed enough to reveal every subsurface condition. Variations may exist and conditions not observed or described in this report may be encountered during construction. Uncertainties relative to subsurface conditions can be reduced through additional subsurface exploration. Additional subsurface evaluation will be performed upon request. Please also note that our evaluation was limited to assessment of the geotechnical aspects of the project, and did not include evaluation of structural issues, environmental concerns, or the presence of hazardous materials. This document is intended to be used only in its entirety. No portion of the document, by itself, is designed to completely represent any aspect of the project described herein. Ninyo & Moore should be contacted if the reader requires additional information or has questions regarding the content, interpretations presented, or completeness of this document.

This report is intended for design purposes only. It does not provide sufficient data to prepare an accurate bid by contractors. It is suggested that the bidders and their geotechnical consultant perform an independent evaluation of the subsurface conditions in the project areas. The independent evaluations may include, but not be limited to, review of other geotechnical reports prepared for the adjacent areas, site reconnaissance, and additional exploration and laboratory testing. Our conclusions, recommendations, and opinions are based on an analysis of the observed site conditions. If geotechnical conditions different from those described in this report are encountered, our office should be notified and additional recommendations, if warranted, will be provided upon request. It should be understood that the conditions of a site could change with time as a result of natural processes or the activities of man at the subject site or nearby sites. In addition, changes to the applicable laws, regulations, codes, and standards of practice may occur due to government action or the broadening of knowledge. The findings of this report may, therefore, be invalidated over time, in part or in whole, by changes over which Ninyo & Moore has no control.

This report is intended exclusively for use by the client. Any use or reuse of the findings, conclusions, and/or recommendations of this report by parties other than the client is undertaken at said parties' sole risk.

We appreciate the opportunity to be of service to you during this phase of the project.

Sincerely,
NINYO & MOORE

Sabrina N. Perez, EIT
Project Manager

Steven D. Nowaczyk, PE
Managing Principal Engineer

Registered Professional Engineer (Civil)
CERTIFICATE NO. 34866
STEVEN D. NOWACZYK
Date Signed 2-10-16
ARIZONA U.S.A.
Expires 06-30-2018

SNP/BJC/ECT/DT/SDN/tlp

Attachments: Figure 1 – Site Location
Figures 2A and 2B – InSAR Maps
Figure 3 – Field Evaluation Locations
Figure 4 – Approximate Earth Fissure Locations
Figure 5 – Typical Plan View of Fissure Mitigation Technique
Figure 6 – Typical Interceptor Trench Guidelines
Figure 7 – Typical Earth Fissure Mitigation Guidelines
Appendix A – Laboratory Testing
Appendix B – Photographic Documentation

Distribution: (1) Addressee (Electronic Copy)

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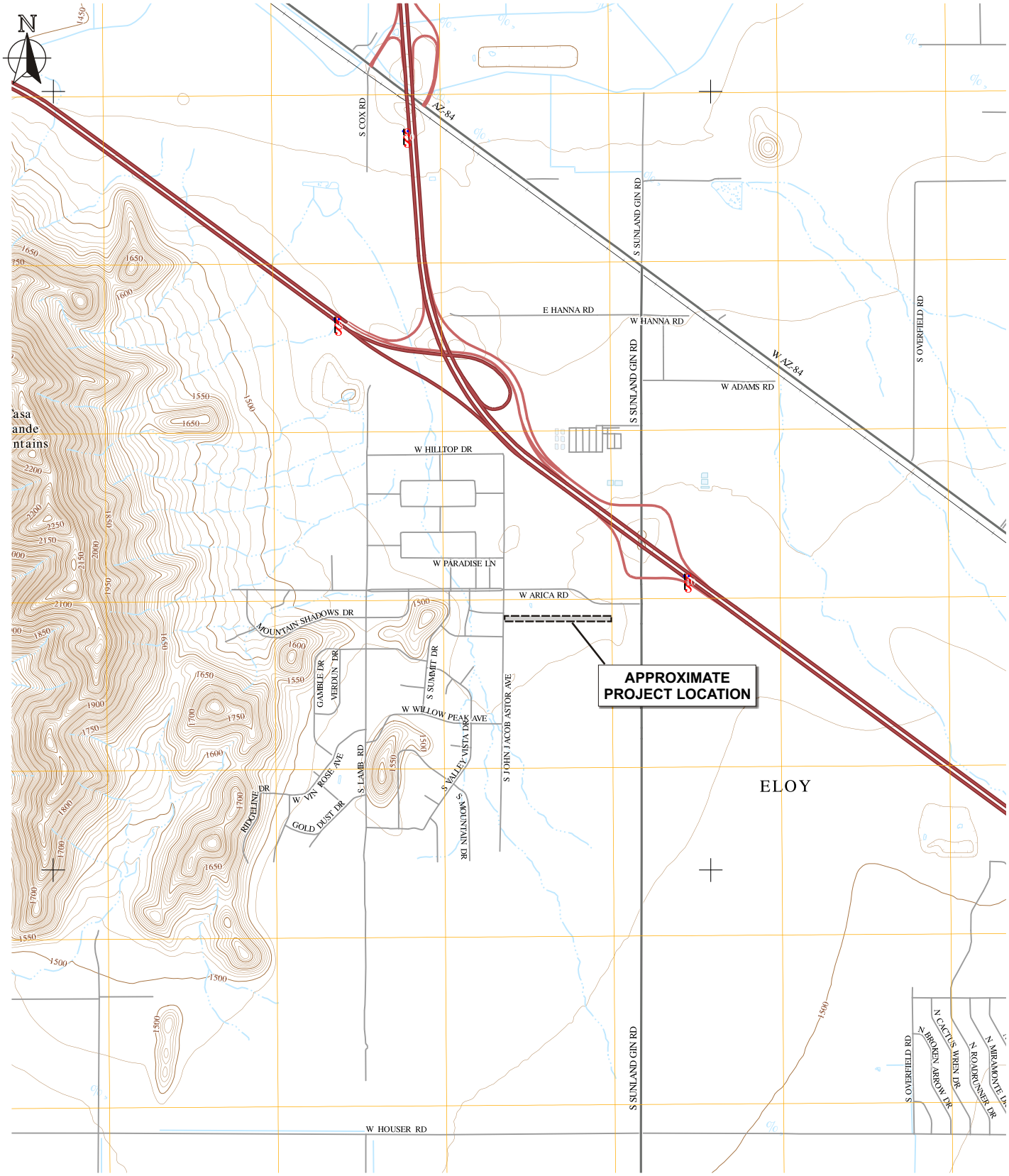
Aerial Photograph Review

Source	Date
Google Earth™	1996, 2003-2007, 2009-2014
NETR Online™	1961, 1963, 1996, 2005, 2007, 2010, 2013



Source: US Geological Survey 7.5-minute topographic map, Casa Grande, Arizona, 2014.

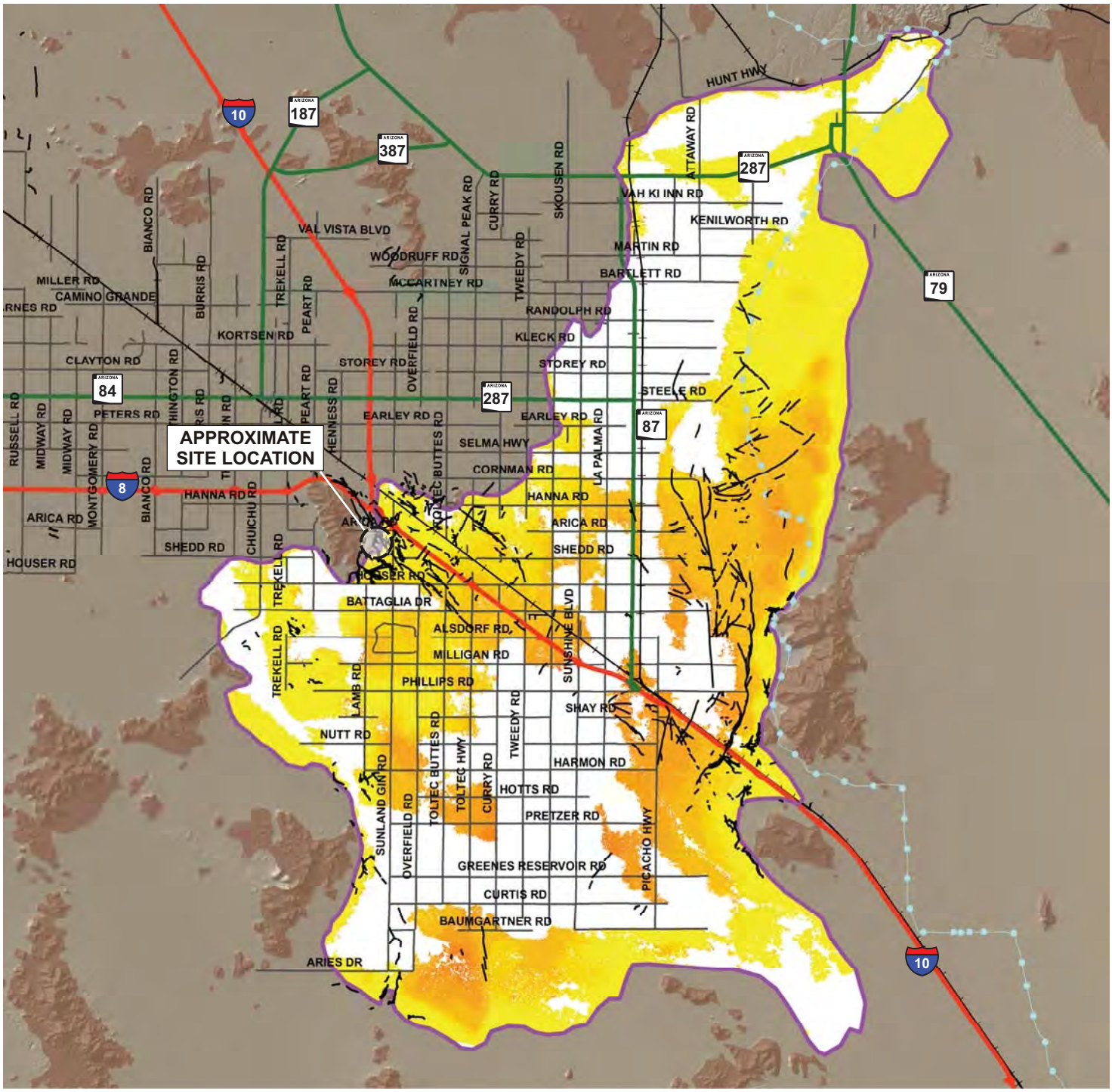
0 3000

Approximate Scale:
1 inch = 3000 feet

Note: Dimensions, directions and locations are approximate.

Ninyo & Moore	SITE LOCATION	FIGURE
PROJECT NO: 604970001 / DATE: 2/16	MOUNTAIN VIEW ESTATES ACCESS ROAD ELOY, PINAL COUNTY, ARIZONA	1

file no: 4970vmap0116



© ESA 2004 - 2010

Total Land Subsidence in the Eloy Sub-Basin, Pinal County
Based on Envisat Satellite Interferometric Synthetic Aperture Radar (InSAR) Data
Time Period of Analysis: 6.7 Years 01/14/2004 To 09/29/2010

Explanation

01/14/2004 To 09/29/2010
Total Land Subsidence
- Decorrelation/No Data
- Greater 40 cm (15.7 in)
- 25 - 40 cm (9.8 - 15.7 in)
- 15 - 25 cm (5.9 - 9.8 in)
- 10 - 15 cm (3.9 - 5.9 in)
- 6 - 10 cm (2.4 - 3.9 in)
- 4 - 6 cm (1.6 - 2.4 in)
- 2 - 4 cm (0.8 - 1.6 in)
- 1 - 2 cm (0.4 - 0.8 in)
- 0 - 1 cm (0 - 0.4 in)

- Subsidence Feature
- Hardrock
- Earth Fissures
- CAP Canal

Highways and Interstates
- Interstate
- US
- State
- Roads
- Railway

1:347,876

N

0 2 4 8 12 16 Miles

Note: All dimensions, directions and locations are approximate.

Ninyo & Moore

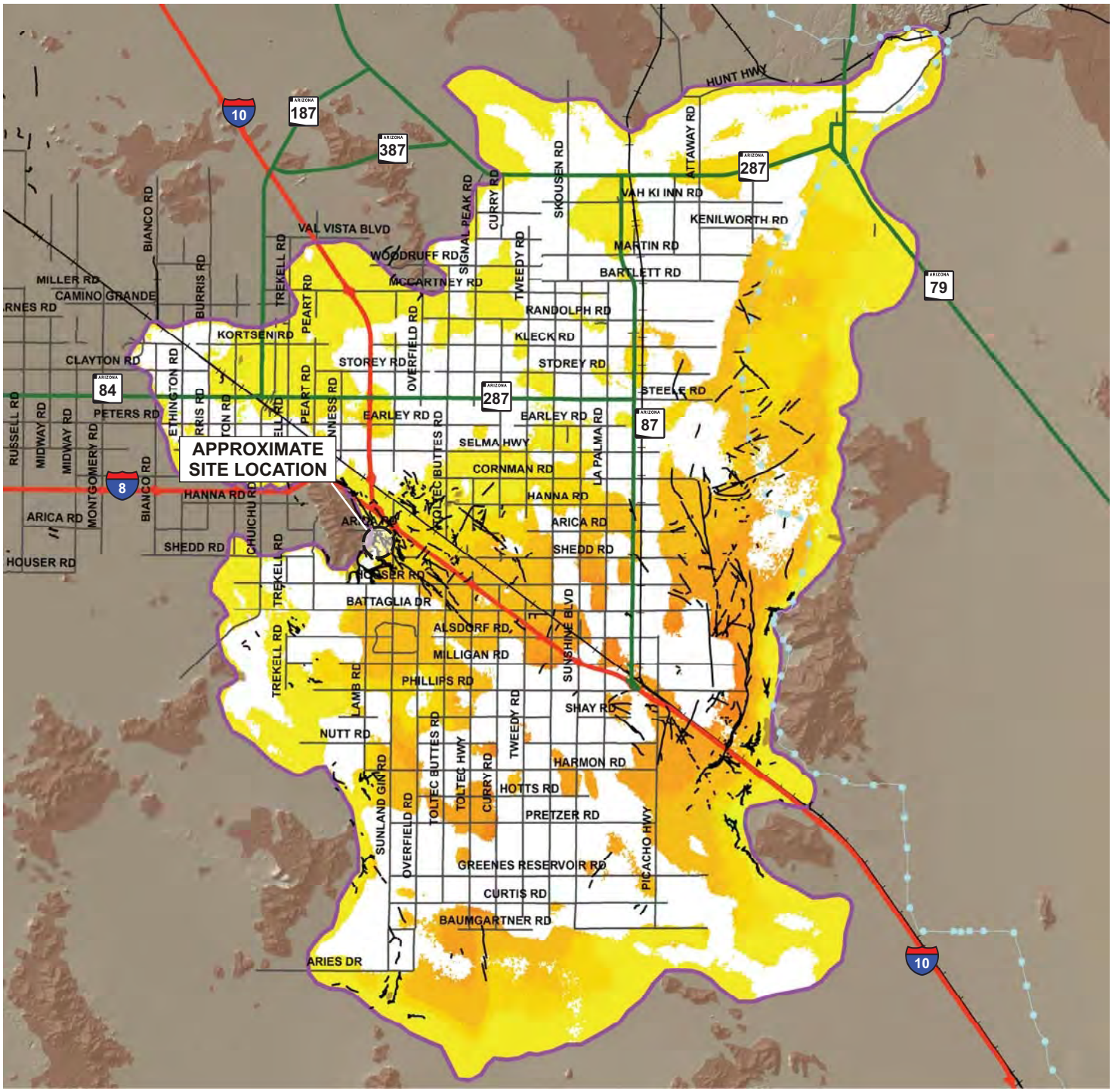
InSAR MAP 01/14/2004 TO 09/29/2010

FIGURE

2A

PROJECT NO:	DATE:	MOUNTAIN VIEW ESTATES ACCESS ROAD ELOY, PINAL COUNTY, ARIZONA
604970001	2/16	

file no: 4970sar0116a



© MDA 2010 - 2015

Total Land Subsidence in the Eloy Sub-Basin, Pinal County
Based on Radarsat-2 Satellite Interferometric Synthetic Aperture Radar (InSAR) Data
Time Period of Analysis: 5.0 Years 05/15/2010 To 04/19/2015

Explanation

05/15/2010 To 04/19/2015

Total Land Subsidence

- Decorrelation/No Data
- Greater 40 cm (15.7 in)
- 25 - 40 cm (9.8 - 15.7 in)
- 15 - 25 cm (5.9 - 9.8 in)
- 10 - 15 cm (3.9 - 5.9 in)
- 6 - 10 cm (2.4 - 3.9 in)
- 4 - 6 cm (1.6 - 2.4 in)
- 2 - 4 cm (0.8 - 1.6 in)
- 1 - 2 cm (0.4 - 0.8 in)
- 0 - 1 cm (0 - 0.4 in)

- Subsidence Feature
- Hardrock
- Earth Fissures
- CAP Canal

Highways and Interstates

- Interstate
- US
- State
- Railway
- Roads

1:347,876

N

0 2 4 8 12 16 Miles

Note: All dimensions, directions and locations are approximate.

Ninyo & Moore

InSAR MAP 05/15/2010 TO 04/19/2015

FIGURE

2B

PROJECT NO:	DATE:	MOUNTAIN VIEW ESTATES ACCESS ROAD ELOY, PINAL COUNTY, ARIZONA
604970001	2/16	

file no: 4970sar0116b

Source: NAVTEQ, 12/20/14.

N

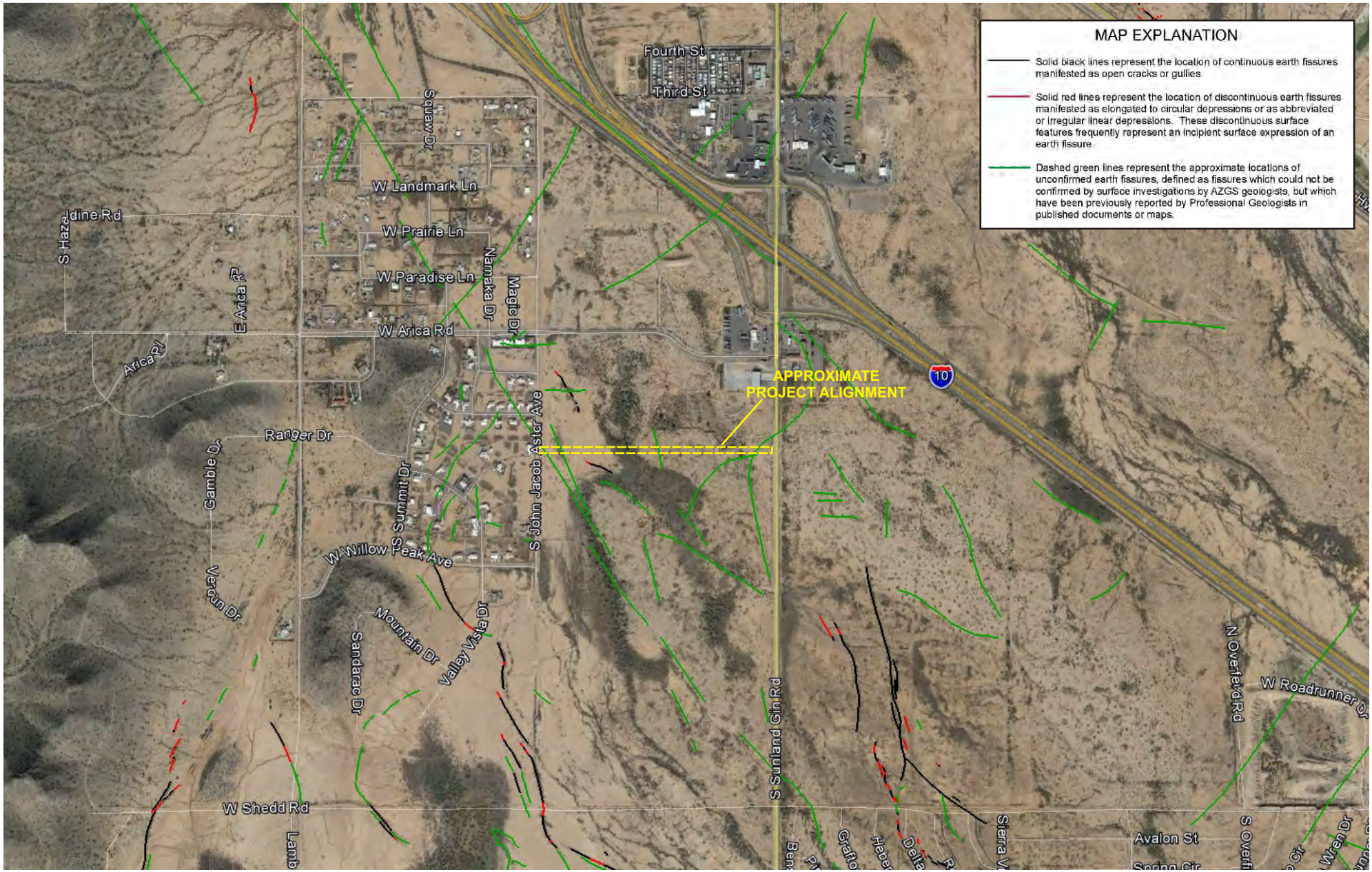
0 380

Approximate Scale:
1 inch = 380 feet

Note: Dimensions, directions, and locations are approximate.

file no: 4970exp0116

Ninyo & Moore	FIELD EVALUATION LOCATIONS	FIGURE
PROJECT NO: 604970001 / DATE: 2/16	MOUNTAIN VIEW ESTATES ACCESS ROAD ELOY, PINAL COUNTY, ARIZONA	3



Source: NAVTEQ, 12/20/14.

N

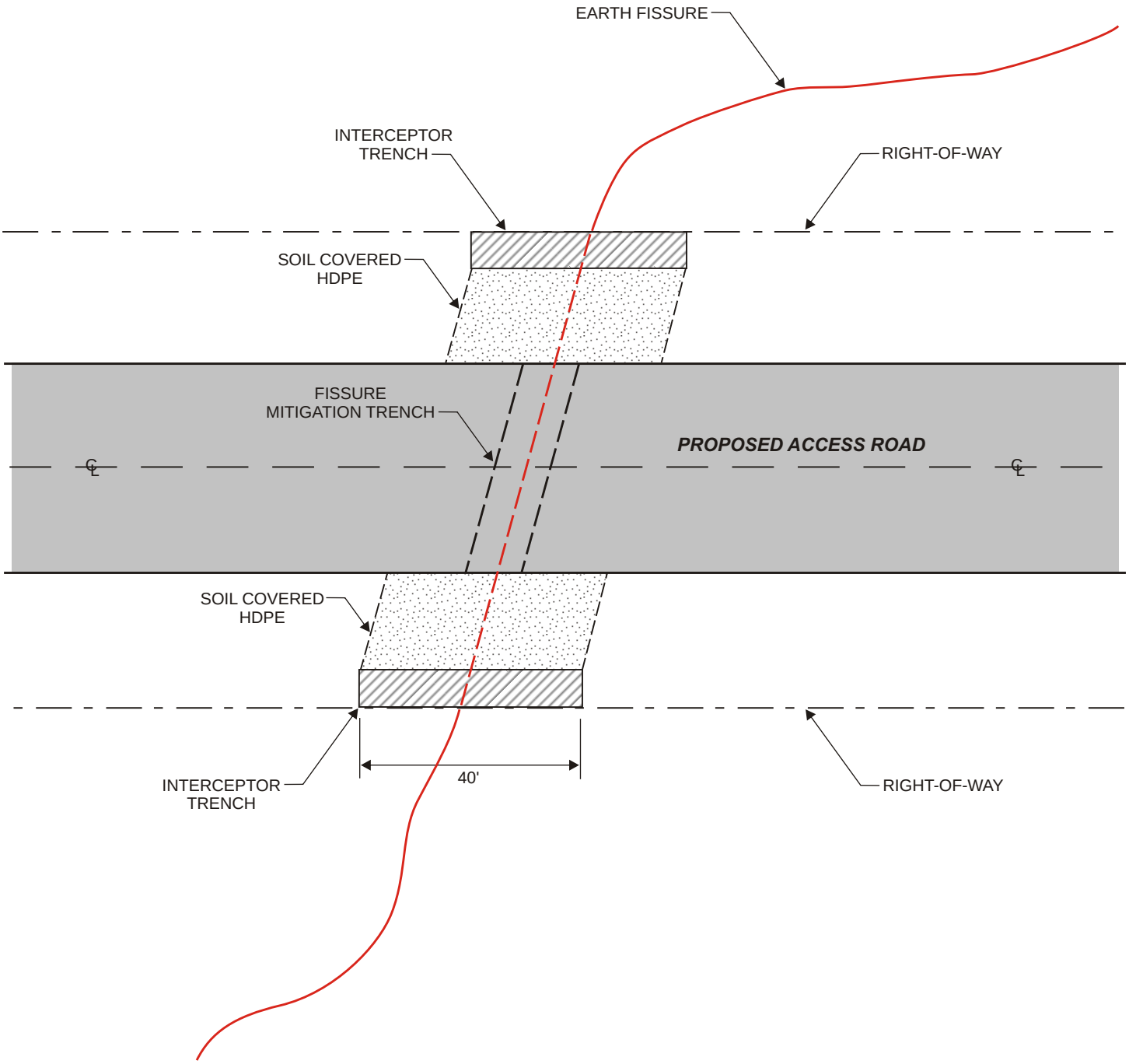
0 1,500

Approximate Scale:
1 inch = 1,500 feet

Note: Dimensions, directions, and locations are approximate.

file no: 4970loc0116

Ninyo & Moore	APPROXIMATE EARTH FISSURE LOCATIONS	FIGURE
PROJECT NO: 604970001 / DATE: 2/16	MOUNTAIN VIEW ESTATES ACCESS ROAD ELOY, PINAL COUNTY, ARIZONA	4

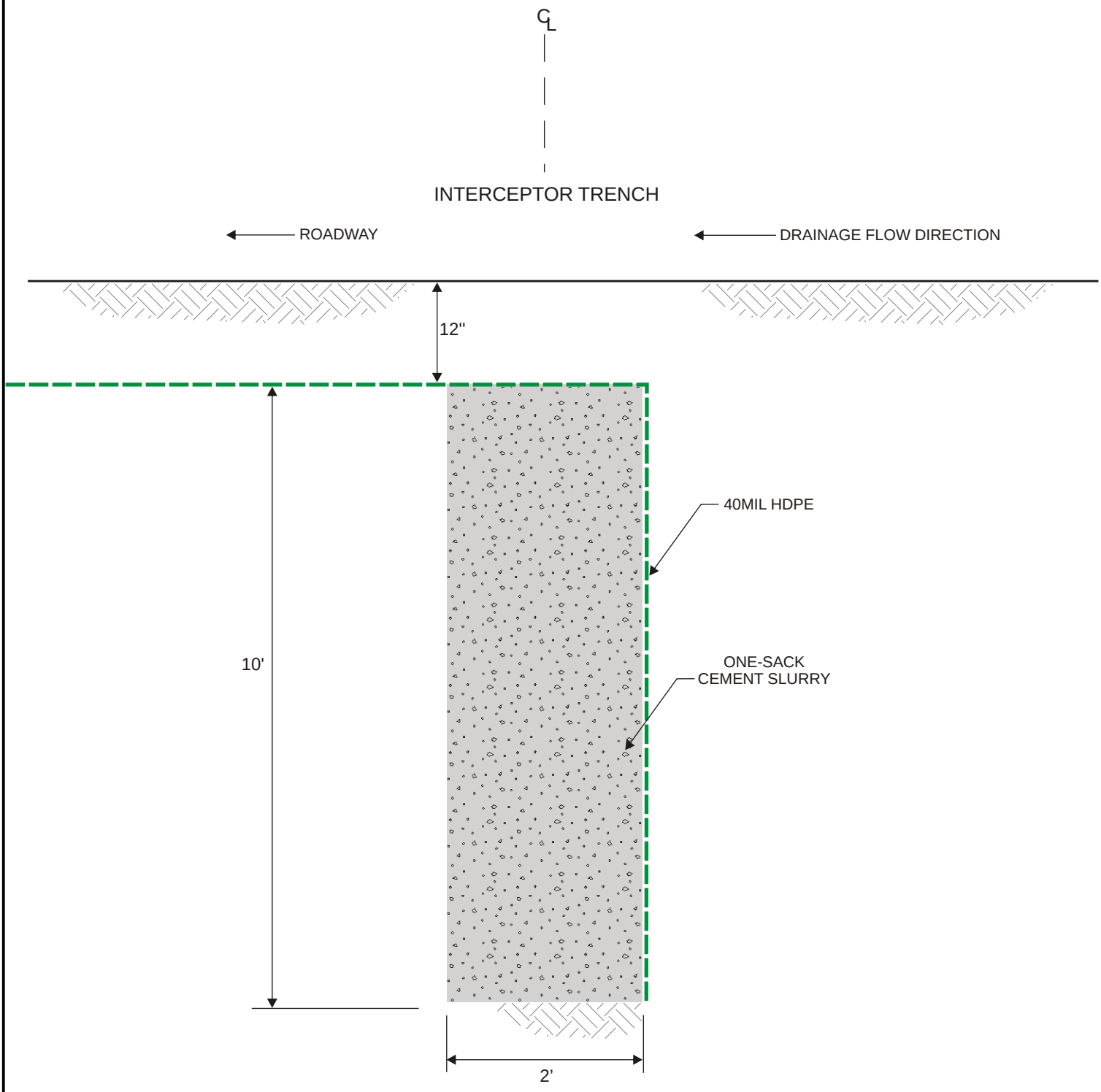


NOT TO SCALE

Note: Dimensions, directions and locations are approximate.

Ninyo & Moore	TYPICAL PLAN VIEW OF FISSURE MITIGATION TECHNIQUE	FIGURE
PROJECT NO: 604970001 / DATE: 2/16	MOUNTAIN VIEW ESTATES ACCESS ROAD ELOY, PINAL COUNTY, ARIZONA	5

4970sch0116c

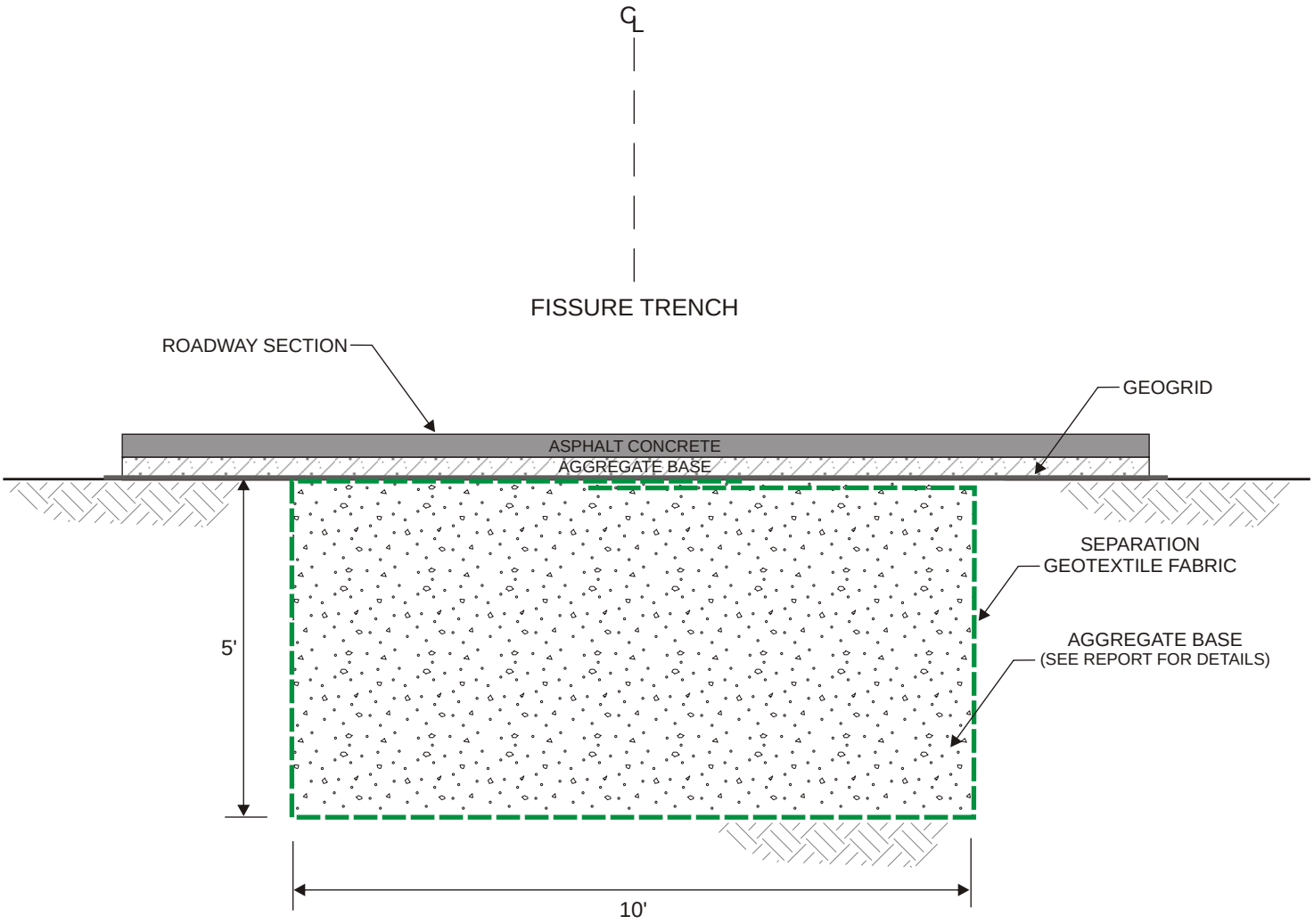


NOT TO SCALE

Note: Dimensions, directions and locations are approximate.

Ninyo & Moore	TYPICAL INTERCEPTOR TRENCH GUIDELINES	FIGURE
PROJECT NO: 604970001 / DATE: 2/16	MOUNTAIN VIEW ESTATES ACCESS ROAD ELOY, PINAL COUNTY, ARIZONA	6

4970sch0116b



NOT TO SCALE

Note: Dimensions, directions and locations are approximate.

Ninyo & Moore	TYPICAL EARTH FISSURE MITIGATION GUIDELINES	FIGURE
PROJECT NO: 604970001 / DATE: 2/16	MOUNTAIN VIEW ESTATES ACCESS ROAD ELOY, PINAL COUNTY, ARIZONA	7

4970sch0116c

APPENDIX A

LABORATORY TESTING

APPENDIX A

LABORATORY TESTING

Classification

Soils were visually and texturally classified in accordance with the Unified Soil Classification System (USCS) in general accordance with ASTM D 2488. Soil classifications are described within the report.

Gradation Analysis

Gradation analysis tests were performed on selected representative soil samples in general accordance with ASTM D 422. The grain-size distribution curves are shown on Figures A-1 and A-5. The test results were utilized in evaluating the soil classifications in accordance with the USCS.

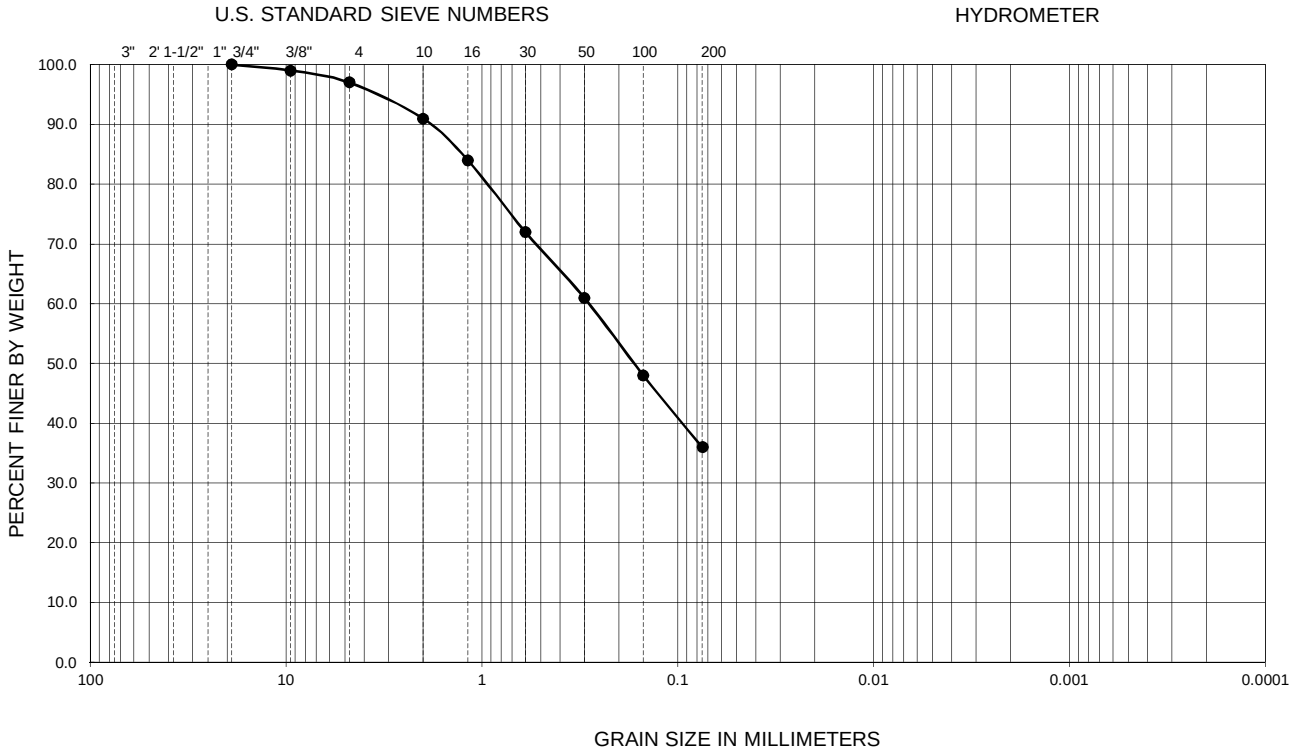
Atterberg Limits

Tests were performed on selected representative fine-grained soil samples to evaluate the liquid limit, plastic limit, and plasticity index in general accordance with ASTM D 4318. These test results were utilized to evaluate the soil classification in accordance with the USCS. The test results and classifications are shown on Figure A-6.

Soil Corrosivity Test

A soil pH and resistivity test was performed on a representative bulk sample in general accordance with Arizona Test Method 236c. The soluble sulfate and chloride content of the selected sample was evaluated in general accordance with Arizona Test Method 733 and Arizona Test Method 736, respectively. The test results are presented on Figure A-7.

GRAVEL		SAND			FINES	
Coarse	Fine	Coarse	Medium	Fine	SILT	CLAY

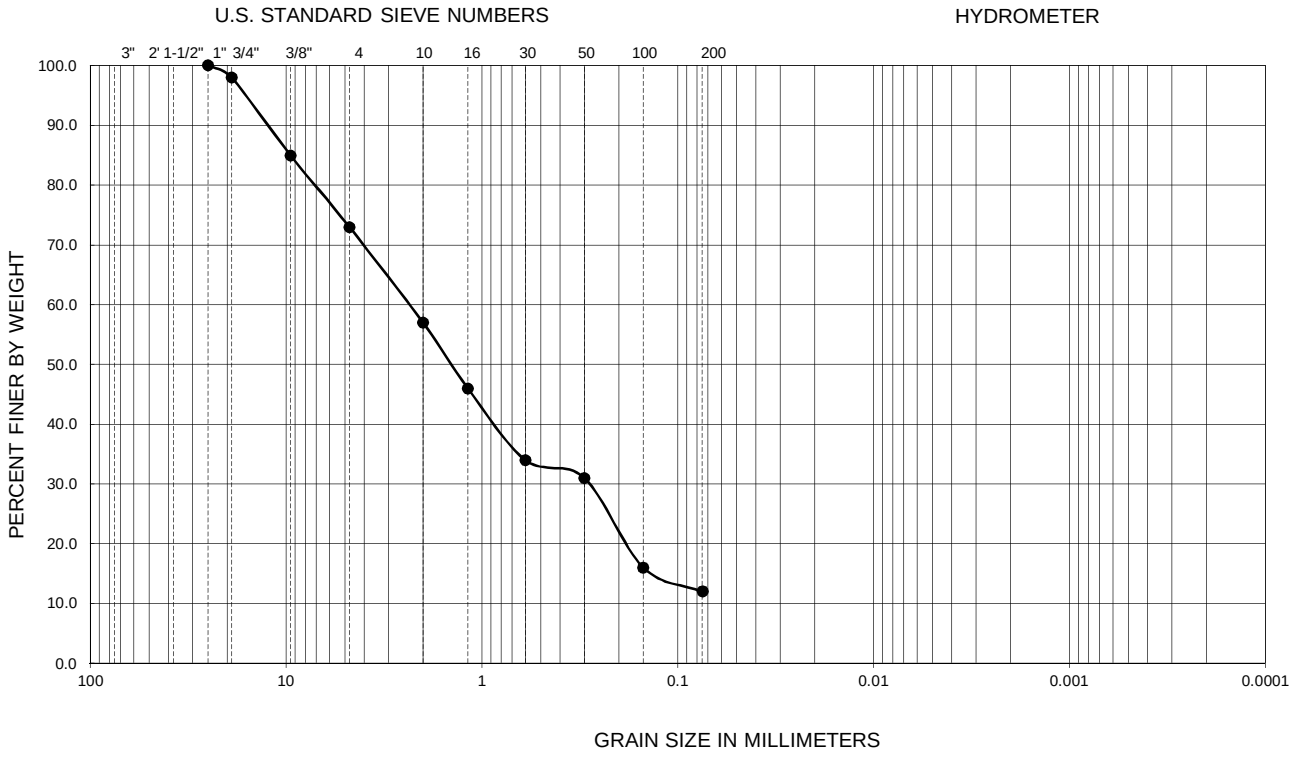


Symbol	Sample Location	Depth (ft)	Liquid Limit	Plastic Limit	Plasticity Index	D_{10}	D_{30}	D_{60}	C_u	C_c	Passing No. 200 (%)	USCS
●	TT-7	0.0-5.5	27	14	13	--	--	--	--	--	36	SC

PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 422

Ninyo & Moore	GRADATION TEST RESULTS	FIGURE
PROJECT NO. / DATE	MOUNTAIN VIEW ESTATES ACCESS ROAD ELOY, PINAL COUNTY, ARIZONA	A-1
604970001 / 2/16		

GRAVEL		SAND			FINES	
Coarse	Fine	Coarse	Medium	Fine	SILT	CLAY



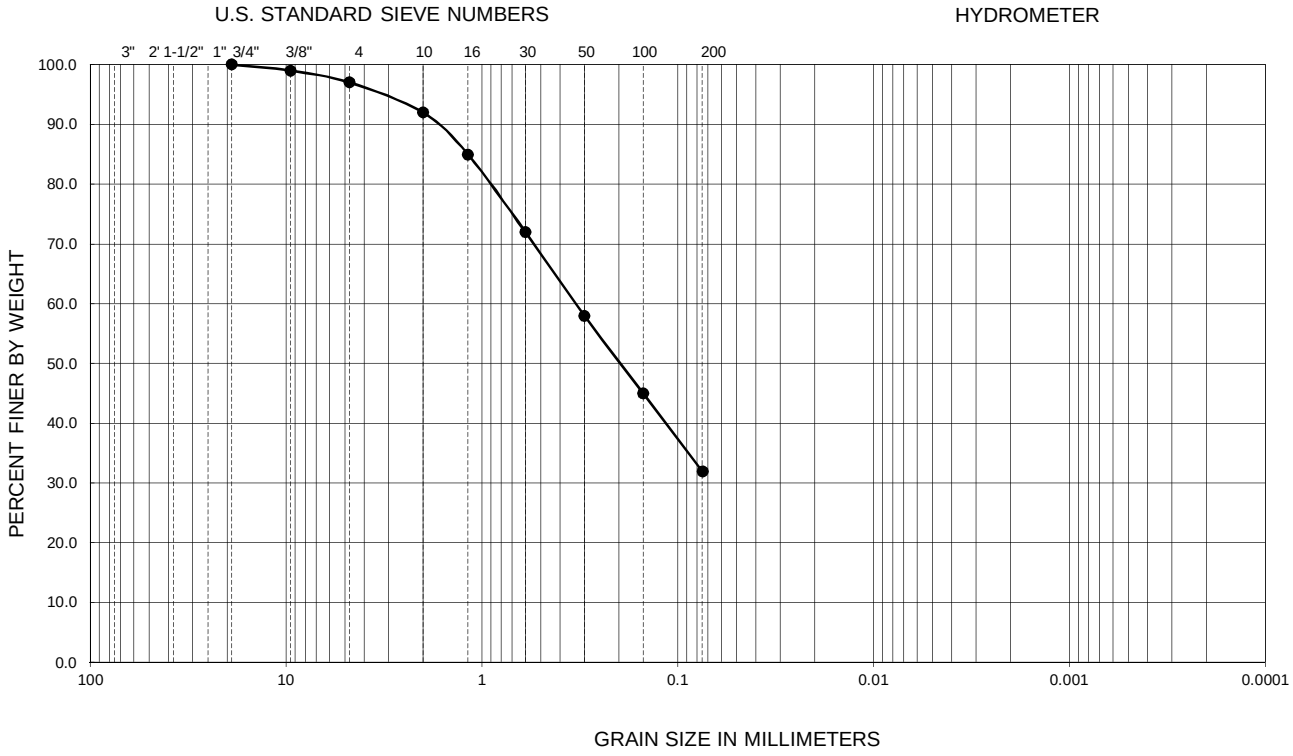
Symbol	Sample Location	Depth (ft)	Liquid Limit	Plastic Limit	Plasticity Index	D_{10}	D_{30}	D_{60}	C_u	C_c	Passing No. 200 (%)	USCS
●	TT-7	6.0-10.0	--	--	NP	0.06	0.29	2.50	41.7	0.6	12	SP-SM

PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 422

NP - INDICATES NON-PLASTIC

Ninyo & Moore	GRADATION TEST RESULTS	FIGURE
PROJECT NO. / DATE	MOUNTAIN VIEW ESTATES ACCESS ROAD ELOY, PINAL COUNTY, ARIZONA	A-2
604970001 / 2/16		

GRAVEL		SAND			FINES	
Coarse	Fine	Coarse	Medium	Fine	SILT	CLAY

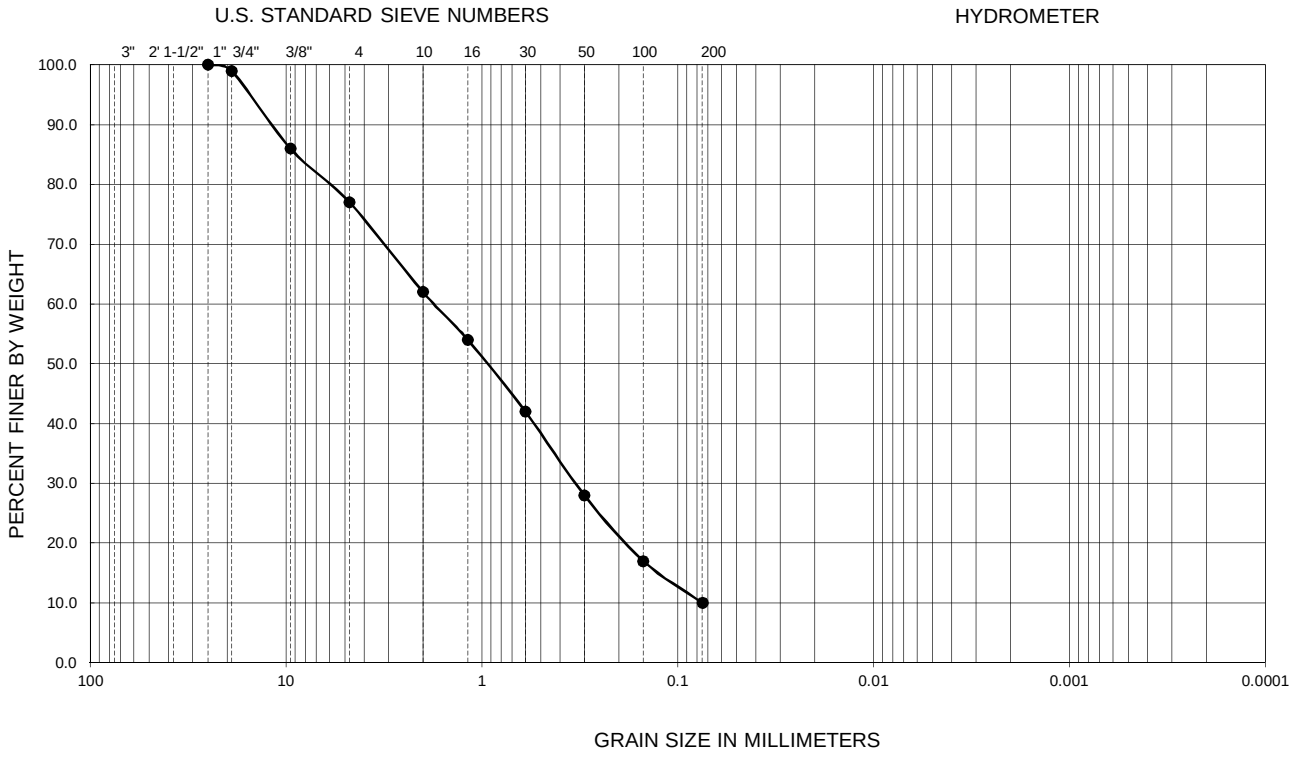


Symbol	Sample Location	Depth (ft)	Liquid Limit	Plastic Limit	Plasticity Index	D_{10}	D_{30}	D_{60}	C_u	C_c	Passing No. 200 (%)	USCS
●	TT-10	0.0-5.5	37	19	18	--	--	--	--	--	32	SC

PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 422

Ninyo & Moore	GRADATION TEST RESULTS	FIGURE
PROJECT NO. / DATE	MOUNTAIN VIEW ESTATES ACCESS ROAD ELOY, PINAL COUNTY, ARIZONA	A-3
604970001 / 2/16		

GRAVEL		SAND			FINES	
Coarse	Fine	Coarse	Medium	Fine	SILT	CLAY



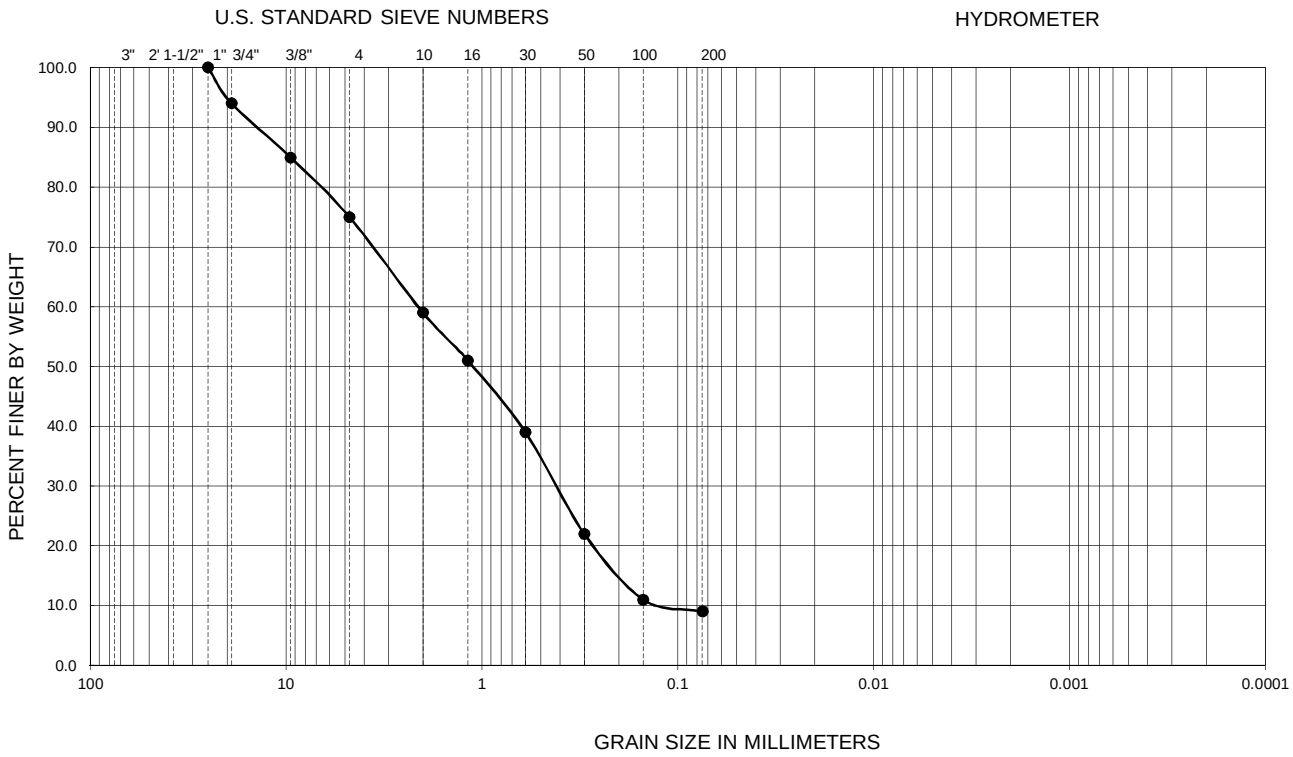
Symbol	Sample Location	Depth (ft)	Liquid Limit	Plastic Limit	Plasticity Index	D_{10}	D_{30}	D_{60}	C_u	C_c	Passing No. 200 (%)	USCS
●	TT-10	6.0-8.0	--	--	NP	0.08	0.34	1.80	24.0	0.9	10	SP-SM

PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 422

NP - INDICATES NON-PLASTIC

Ninyo & Moore	GRADATION TEST RESULTS	FIGURE
PROJECT NO. / DATE	MOUNTAIN VIEW ESTATES ACCESS ROAD ELOY, PINAL COUNTY, ARIZONA	A-4
604970001 / 2/16		

GRAVEL		SAND			FINES	
Coarse	Fine	Coarse	Medium	Fine	SILT	CLAY



Symbol	Sample Location	Depth (ft)	Liquid Limit	Plastic Limit	Plasticity Index	D_{10}	D_{30}	D_{60}	C_u	C_c	Passing No. 200 (%)	USCS
●	TT-12	5.0-10.0	--	--	NP	0.08	0.45	2.20	27.5	1.2	9	SW-SM

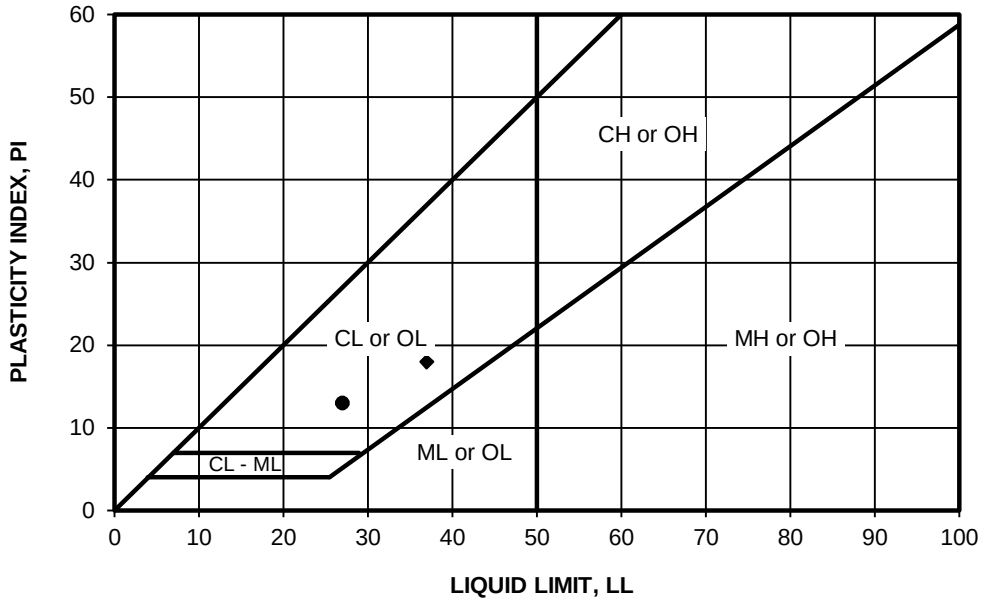
PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 422

NP - INDICATES NON -PLASTIC

Ninyo & Moore	GRADATION TEST RESULTS	FIGURE
PROJECT NO. / DATE	MOUNTAIN VIEW ESTATES ACCESS ROAD ELOY, PINAL COUNTY, ARIZONA	A-5
604970001 / 2/16		

SYMBOL	LOCATION	DEPTH (FT)	LIQUID LIMIT, LL	PLASTIC LIMIT, PL	PLASTICITY INDEX, PI	USCS CLASSIFICATION (Fraction Finer Than No. 40 Sieve)	USCS (Entire Sample)
●	TT-7	0.0-5.5	27	14	13	CL	SC
■	TT-7	6.0-10.0	--	--	NP	ML	SP-SM
◆	TT-10	0.0-5.5	37	19	18	CL	SC
○	TT-10	6.0-8.0	--	--	NP	ML	SP-SM
□	TT-12	5.0-10.0	--	--	NP	ML	SW-SM

NP - INDICATES NON-PLASTIC



PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 4318

Ninyo & Moore	ATTERBERG LIMITS TEST RESULTS	FIGURE
PROJECT NO. / DATE	MOUNTAIN VIEW ESTATES ACCESS ROAD ELOY, PINAL COUNTY, ARIZONA	A-6
604970001 / 2/16		

SAMPLE LOCATION	SAMPLE DEPTH (FT)	pH [1]	RESISTIVITY [1] (Ohm-cm)	SULFATE CONTENT [2]		CHLORIDE CONTENT [3] (ppm)
				(ppm)	(%)	
TT-9	0.0-4.2	7.9	1,930	67	0.007	172

[1] PERFORMED IN GENERAL ACCORDANCE WITH ARIZONA TEST METHOD 236c
[2] PERFORMED IN GENERAL ACCORDANCE WITH ARIZONA TEST METHOD 733
[3] PERFORMED IN GENERAL ACCORDANCE WITH ARIZONA TEST METHOD 736

Ninyo & Moore		CORROSIVITY TEST RESULTS	FIGURE
PROJECT NO.	DATE	MOUNTAIN VIEW ESTATES ACCESS ROAD ELOY, PINAL COUNTY, ARIZONA	A-7
604970001	2/16		

APPENDIX B

PHOTOGRAPHIC DOCUMENTATION

Photo No. 1 **Location: Trench T-1** **Date: 12/7-12/10/15**

Facing west, from eastern end within trench T-1.

Photo No. 2 **Location: Trench T-1** **Date: 12/7-12/10/15**

Northern sidewall of trench T-1.

Photo No. 3 **Location: Trench T-2** **Date: 12/7-12/10/15**

Facing east, from western end of trench T-2.

Photo No. 4 **Location: Trench T-2** **Date: 12/7-12/10/15**

Exposed crack (indicator of possible earth fissure presence) in sidewall of trench T-2.

Photo No. 5 **Location: Trench T-3** **Date: 12/7-12/10/15**

Facing east, from western end of trench T-3.

Photo No. 6 **Location: Trench T-3** **Date: 12/7-12/10/15**

Depth of trench T-3

Photo No. 7 **Location: Trench T-4** **Date: 12/7-12/10/15**

Excavation of trench T-4.

Photo No. 8 **Location: Trench T-4** **Date: 12/8-12/9/15**

View of trench T-4

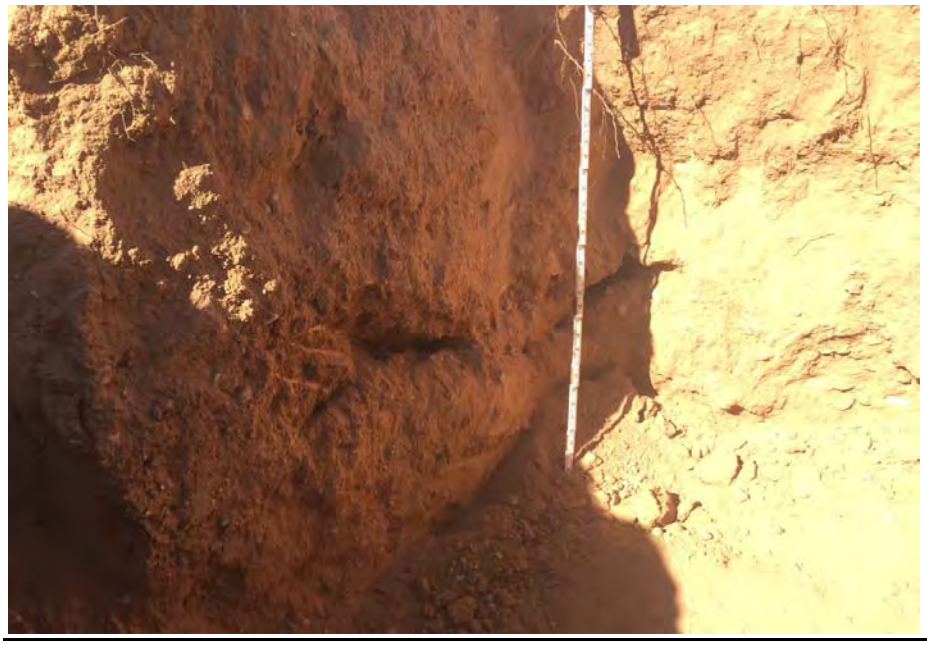


Photo No. 9 **Location: Trench T-5** **Date: 12/7-12/10/15**

Location of earth fissure crack exposed in sidewall, as measured from the bottom of trench T-5.

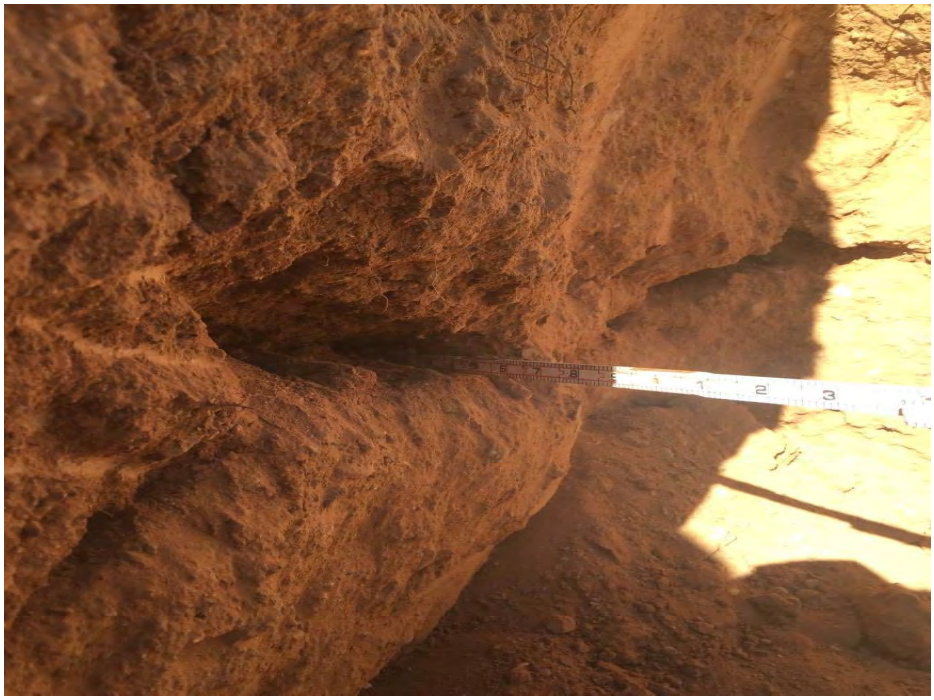


Photo No. 10 **Location: Trench T-5** **Date: 12/7-12/10/15**

Depth of earth fissure crack exposed in sidewall of trench T-5.

Photo No. 11 **Location: Trench T-5** **Date: 12/7-12/10/15**

Height at which earth fissure crack was exposed in sidewall, as measured from the bottom of trench T-5.

Photo No. 12 **Location: Trench T-6** **Date: 12/7-12/10/15**

Facing east, from western end of trench T-6.

Photo No. 13 **Location: Trench T-6** **Date: 12/7-12/10/15**

Depth of trench T-6.

Photo No. 14 **Location: Trench T-7** **Date: 12/7-12/10/15**

View of trench T-7.

Photo No. 15 **Location: Trench T-7** **Date: 12/7-12/10/15**

Depth of trench T-7 at approximate midpoint of trench T-7. View of gravel layer.

Photo No. 16 **Location: Trench T-7** **Date: 12/7-12/10/15**

Depth of trench T-7 at gravel layer.

Photo No. 17 **Location: Trench T-8** **Date: 12/7-12/10/15**

View of trench T-8.

Photo No. 18 **Location: Trench T-8** **Date: 12/7-12/10/15**

Exposed cracks in sidewall of trench T-8.

Photo No. 19 **Location: Trench T-9** **Date: 12/7-12/10/15**

View of trench T-9.

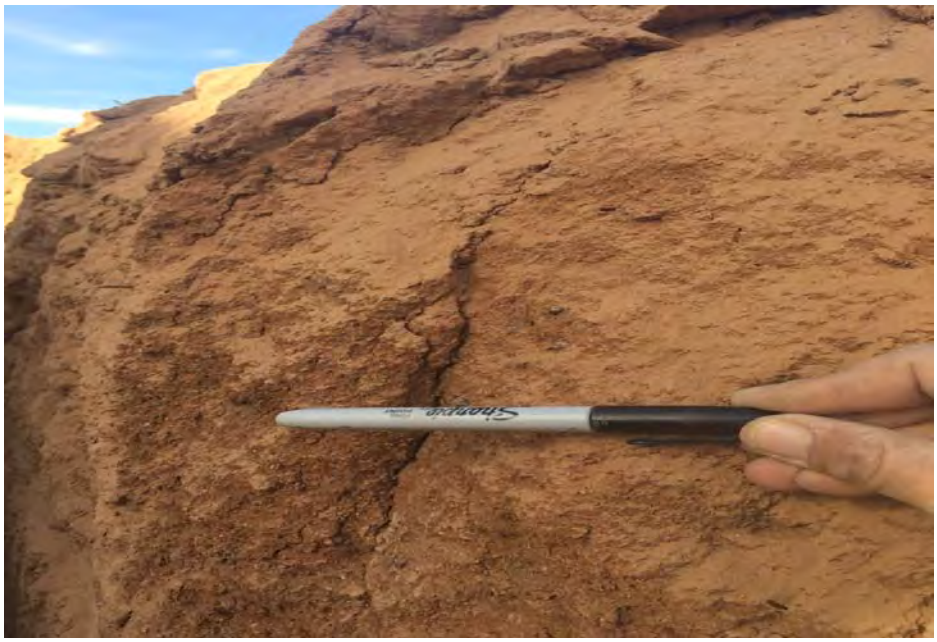


Photo No. 20 **Location: Trench T-9** **Date: 12/7-12/10/15**

Exposed crack in sidewall of trench T-9.

Photo No. 21 **Location: Trench T-10** **Date: 12/7-12/10/15**

View of trench T-10.

Photo No. 22 **Location: Trench T-10** **Date: 12/7-12/10/15**

Bottom of trench T-10.

Photo No. 23 **Location: Trench T-11** **Date: 12/7-12/10/15**

View of trench T-11.

Photo No. 24 **Location: Trench T-11** **Date: 12/7-12/10/15**

Exposed cracks in sidewall of trench T-11.

Photo No. 25 **Location: Trench T-12** **Date: 12/7-12/10/15**

View of trench T-12.

Photo No. 26 **Location: Trench T-12** **Date: 12/7-12/10/15**

Facing east, from western end of trench T-12. View of gravel layer.