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ARIZONA U.S.A.
EXP 09-30-2020

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LAND SUBSIDENCE & EARTH FISSURE EVALUATION
TASK 1 & TASK 2 EARTH FISSURE EXPLORATION PROGRAM.

SUNVALLEY RANCH, TRACT L, APN 218-16-023
SWC E. BILLINGS STREET & N. SOSSAMAN ROAD
MESA, MARICOPA COUNTY, ARIZONA

GCI Project No. 2017-144

January 29, 2018
Revised: April 7, 2018

NOTICE

The geologic and soils observations, findings, conclusions and recommendations presented in this report are based on (1) data from published and unpublished sources available at the time of this study; (2) photo-geological interpretation, (3) geological reconnaissance, and (4) subsurface exploration of the Sunvalley Ranch Tract L (APN 218-16-023) parcel located on the southwest corner of East Billings Street and North Sossaman Road, Mesa, Maricopa County, Arizona. The services provided by Geological Consultants Inc. (GCI) to Cornerstone Property Services were performed according to generally accepted principals and standard practices for land subsidence and earth fissure investigations used by reputable members of the geological profession in the same or similar locality at the time of this study.

It must be recognized that subsurface geologic and soil conditions may vary from place to place and from those interpreted at locations where evaluations are made by the investigator. No warranty or representation, either expressed or implied, is or should be construed regarding geological or soil conditions at locations other than those observed by the investigator.

The accurate prediction of where earth fissures will form, or when they will form, is not possible due to the dynamics of the natural system in which they could form. Ground failure, as a result of earth fissure formation processes, can be caused by natural events (such as induced stresses and weather) or by human activity (such as groundwater pumping and land development). Several interrelated factors, over which we have no control, come into play that can induce land subsidence and cause earth fissures to form. Therefore, we make no guarantees regarding the safety of individuals or properties in these environments. However, the use of sound professional geological and engineering judgement, principles, and practices, applied by experienced geologists and engineers to the evaluation of land subsidence and potential or actual earth fissure formation can identify potential risks and generally, potential risk areas or ‘earth fissure risk mitigation zones’. Once this information is available, reasonable designs can be developed to reduce the risk of injury and damage to properties.

We offer the recommendations presented herein for the purpose of improving the safety within properties affected by land subsidence and earth fissures, but we cannot guarantee the effectiveness of the recommendations provided herein for the prevention of personal injury or damage to structures.

This report was prepared in accordance with the scope of work outlined in the Geological Consultants Inc. proposal for geological services dated December 15, 2017 and as authorized by Mr. Bryson Bennett, Manager, for Cornerstone Property Services, on December 12, 2017.

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1.0 INTRODUCTION

This report presents the results of the activities pertaining to a land subsidence and earth fissure exploration program at a proposed development parcel located on the southwest corner of East Billings Street and North Sossaman Road, Mesa, Maricopa County, Arizona (Figures 1 & 2). The Sunvalley Ranch, Tract L parcel has a documented and mapped earth fissure trending from the southeast corner toward the northwest corner of the parcel Arizona Geological Survey (AzGS, 2017) (Figure 3). This earth fissure was first documented in 1962 and in subsequent research publications in 1974 (Schumann) and in 1978 (Raymond et al). The site was subjected to an earth fissure investigation in 1983 (Scott Geotechnical Services) and in 1971 and 1987 (Pewe). The central segment the fissure is mapped as a “discontinuous earth fissure” and the northwest and southeast segments are mapped as “reported but unconfirmed” earth fissures by the AzGS. Because of the “discontinuous” and the “reported but unconfirmed” earth fissure designation and the act that surface expression of the earth fissure was obliterated by past wildcat grading and backfill with an earth fill mixed with rubble debris and trash, this land subsidence and earth fissure exploration program implemented by Geological Consultants Inc. (GCI) consists of two parts: a Task 1 Land Subsidence and Earth Fissure Investigation; and, a Task 2 Earth Fissure Exploration. This investigative program was designed to conform to the “Suggested Guidelines for Investigating Land Subsidence and Earth Fissure Hazards in Arizona” (AzGS, 2017)

The Task 1 portion of the program included detailed research of available land subsidence-related geologic and hydrogeological data for this parcel and the surrounding areas. On December 27, 2017, GCI conducted a site specific geological field reconnaissance to determine the current conditions of the parcel in order to identify new or suspect earth fissure features and determine the surface extent of the known earth fissure, within the proposed development site. The ultimate objective of the Task 1 investigation and Task 2 exploration program is to compile information concerning land subsidence and earth fissuring at the proposed development to:

1) Describe and document the current and future potential land subsidence conditions and the earth fissure identified at the site using available geological

and hydrogeological data, geological interpretation of available aerial photography, and space-borne InSAR imagery (Figure 4).

2) Conduct a field geological reconnaissance of the project site to attempt to locate the surface expression of the known earth fissure that was backfilled several years ago by parties unknown.

3) Confirm (or refute) the locations of previously mapped, new, or extensions of earth fissures and the existence of suspected earth fissures at locations identified in Task 1.

4) Conduct an earth fissure exploration program to define the limits of known earth fissure in order to determine reasonable estimates of the present lateral extent of earth fissure zones, their width and length.

5) Prepare a report documenting the land subsidence evaluation and the earth fissure exploration program with the results based on the findings made along with a summary of our recommendation to deal with the land subsidence issues and earth fissures. This would include the plans and details needed to implement and construct the recommended earth fissure mitigation measures.

6) Prepare a report documenting the land subsidence evaluation and the earth fissure exploration program with the results based on the findings made along with a summary of our recommendation to deal with the land subsidence issues and earth fissures. This would include the plans and details needed to implement and construct the recommended earth fissure mitigation measures.

1.1 Scope of Work - Task 1 Investigation

To accomplish the objectives of the Task 1 Investigation, GCI performed geological research and assessment of the known land subsidence phenomena affecting the proposed development. This work included the following:

- Acquisition and compilation of current available land subsidence and earth fissure data concerning the subject parcel from a variety of sources including the GCI library, the U.S. Geological Survey, U.S. Corps in Engineer, U.S. Bureau of Reclamation, U.S. National Geodetic Survey and the Arizona Department of Water Resources (ADWR).

- Examinations of the latest InSAR space imagery interferograms and land subsidence publications by the Arizona Department of Water Resources (ADWR) to assess whether or not recent land subsidence is documented within the study area.

- Conducted a ground-truth field geological reconnaissance of the site and adjacent areas to determine the current site conditions.

1.2 Scope of Work - Task 2 Earth Fissure Exploration

The objectives of the Task 2 Exploration, GCI was to perform a subsurface investigation to determine the extent of the existing earth fissure and to determine if any unmapped earth fissures were present on the site. This work included the following:

- Excavation of seven backhoe trenches to a depth of approximately 5 to 6 feet and to lengths between 58 and 109 feet (Figure 5).

- Detailed geologic examination of the excavations to locate the earth fissure(s) that were present. The mapped earth fissure was exposed in each of the exploration trenches.

- Where earth fissure evidence was observed, a log was prepared of the critical trench section and excavation and logging of any necessary additional trenches across the expected fissure alignment to determine the extent of the earth fissure.

- Using the information and data obtained during the Task 1 Investigation and Task 2 Exploration program, developed recommendations to mitigate the mapped earth fissure and prepared site specific mitigation plans and details.

2.0 CONCLUSIONS AND RECOMMENDATIONS

2.1 The study area borders an area of ongoing land subsidence and earth fissuring. Research data indicates that land subsidence and related earth fissuring have been active for more than 40 years. Recent InSAR data and well records suggest subsidence is ongoing in the project vicinity.

2.2 AzGS reported one mapped earth fissure on the project site, trending from the southeast to northwest property corners. The Task 2 subsurface exploration program confirmed this mapped earth fissure, and also a second earth fissure which appears to stem off from, and run parallel to the original fissure, then curve back toward the primary earth fissure (Sheet 1).

2.3 Based on review and analysis of available data, the potential for future earth fissure development on the subject property should currently be considered moderate for this property due to the slightly declining groundwater levels at the time of this investigation as well as the ongoing residual subsidence in the project vicinity.

2.4 The subsurface exploration program defined the extent of two earth fissures on the Sunvalley Ranch, Track L parcel. The locations of trenches T1 through T7, that were excavated to map the trend of the earth fissures across the site, are detailed on Attachments T1 through T7.

2.5 Although ADWR well records within a reasonable distance of the site are limited, those available suggest the water levels within a 5-mile radius of the parcel are declining, although at a very slow rate (Appendix A).

2.6 Survey benchmarks located within unstable land subsidence areas are unreliable and should not be used for survey control. We recommend vertical and horizontal survey benchmarks, founded in stable, undisturbed bedrock, be used to establish survey control points for grading and other construction purposes for the proposed development of the Sunvalley Ranch, Track L parcel.

In areas where there is a limited amount of available subsidence data, a current survey of the property using elevation control tied to benchmarks in bedrock could be appropriate.

An evaluation of level survey control data can be compared to earlier level survey data gathered in the site area to determine reasonably conservative subsidence rates that can be incorporated into the design of infrastructure facilities for the project area.

2.7 Mitigation of the potential adverse effects of subsidence, such as earth fissures, changes in land surface gradient, and reversal of normal surface runoff, should be addressed during the planning and design for the development. Our general recommendation for development is no habitable or occupied structures shall be constructed within the earth fissure mitigation zone. We recommend design of the proposed Sunvalley Ranch, Track L parcels consider the mitigation alternatives recommended in this report (Sheets 1 through 4) to mitigate potentially adverse impact of the earth fissures.

Because of the potential for active land subsidence and earth fissure growth in this area, proper land use, grading, and drainage of lands within and adjacent to the development, will be critical for mitigating the existing earth fissure conditions and future potential effect of land subsidence and earth fissures. Please refer to page (i), Notice, concerning the limitations regarding the earth fissure mitigation measures proposed herein.

If during the design or construction phases of the proposed development, the owner, project designer, or construction contractor requests a modification of a recommended mitigation alternative, a request for the modification shall be submitted to the engineering geologist/engineer of record for review. The request shall include the reasons and justification for the modification, supported by appropriate design modification drawings and analyses justifying the proposed design change. No modifications of the recommended earth fissure mitigation alternatives documented in this report will be permitted without the review and approval of the engineering geologist/engineer of record.

2.8 Earth fissure mitigation plans and details are depicted in Sheets 1, 2, 3, and 4. The mitigation alternatives should apply to an area that covers a minimum of 10-feet along each side of the earth fissure trace as depicted in Sheet 2, Detail 1. The earth fissure mitigation zone can be expanded as necessary to allow for easy equipment access to backfill and compact the fill soils or for special conditions such as earth fissure or earth fissure gullies located within roadway and utility easements. We recommend the soil back fill should be compacted to at least 95-percent of the maximum density and optimum moisture content determined from standard Proctor soil tests (ASTM 698) ofwritten the excavated soil stockpiled for structural backfill and other soil recommendations as may be specified by the geotechnical (soil) engineer of record. The previously placed rubble and trash included with the backfill that obliterated the surface exposure of the earth fissure shall not be used with the engineered backfill used for the earth fissure mitigation zone.

The depth of the earth fissure mitigation zone should be as follows:

- A minimum of 10-feet below the native ground surface if no cuts and/or fill are utilized at the earth fissure location.

- A minimum of 10-feet below the bottom of the cut surface, where excavations are made to lower grades at the earth fissure location or within the limits of the earth fissure mitigation zone.

- A minimum of 10-feet below the bottom of fill material, where fill is utilized to raise grades at the earth fissure location or within the limits of the earth fissure mitigation zone.

- If both cuts and fills are necessary, the depth should still be a minimum of 10-feet below the bottom of the cut or fill material, whichever is greater, within the limits of the earth fissure mitigation zone.

- The minimum depth of the mitigation zona excavated within earth fissure gully areas shall be 10-feet or to the depth of the fissure gully where its aperture (opening) is less than 2-feet, whichever depth is greater.

- These depths can be increased if necessary to allow for utilities to pass through the earth fissure mitigation area. See Sheet 4, Detail 6 for earth fissure mitigation at utility crossings.

2.9 Within the earth fissure mitigation zone, the exposed subgrade should be scarified and compacted, so that the geogrid and geotextile filter fabric can be placed on a relatively smooth, uniform surface within the over-excavation trench according to the recommended details provided in Sheet 2, Detail 1. The biaxial geogrid should be Tensar

BX1200 or equal and the geotextile fabric should be Mirafi® 159B nonwoven polypropylene geotextile fabric or equal. The technical specifications for the geogrid and geotextile fabric are presented in Appendix A.

To avoid damage to the fabric, a minimum of 6-inches of loose fill soils should cover the placed Geogrid and fabric before allowing equipment is used to place and compact the backfill within the earth fissure mitigation zone area.

Sheet 4, Detail 6 illustrates the mitigation measures for utility crossings. Utilities can cross the earth fissure mitigation zone provided the following criteria are followed:

1) The utility lines must be placed a minimum of 1-foot above the geotextile fabric. If upgrade or repairs to the lines are required, this should allow for a sufficient buffer zone for work to commence without damaging the earth fissure mitigation measures.

2) Water and sewer lines should bridge the earth fissure mitigation zone completely. No pipe joints for storm drain sewer line or water line utility connections should be placed within the mitigation zone unless design, construction, or site conditions limit the implementation of this recommendation. If single pipe connection must be made within the earth fissure mitigation zone, the pipe connection joints shall sealed completely per the manufacturers specifications. All sealed pipe connection joints shall be inspected by a qualified third-party inspector to insure proper installation backfill burial. Multiple pipe joint connections should be avoided within the earth fissure mitigation zone. Where multiple joint connections are require, such as at Tee's or headers, they should be place outside of the earth fissure mitigation zone. Where metal pipe and connections are used within the mitigation zone, additional corrosion protection shall be applied to the exterior of the joints and the pipes.

   We recommend the site soil and backfill soil used for the earth fissure mitigation zone be tested to assess the soil's corrosion potential to determine the extent of corrosion protection needed for the metal pipes and connection placed within the earth fissure mitigation zone

2.10 Streets and utilities may be placed to cross mitigated fissures or fissure gullies, however, they should be dealt with on a case-by-case basis based on the types of utilities that will cross the fissure, the diameter of utilities, and maximum depth below natural grades. Where streets cross earth fissures, a non-woven geotextile fabric (See Appendix B for product specifications) should be placed on the street subgrade and a biaxial geogrid (Tensar BX1200 or equivalent; See Appendix B for specifications) in the street subgrade (Sheet 3, Details 3 and 4).

2.11 In landscape areas, the elevated berm/green belt mitigation alternative, or similar, may be employed to direct surface runoff away from the mitigation zone. Drip irrigation systems for park and landscape areas are not recommended because of leakage problems commonly associated with this type of system. Likewise, flood irrigation should not be used. Landscape water features, such as lined ponds and swimming, pools, should not be constructed within 50-feet of earth fissure traces. Water retention basins, detention basins, or dry wells, or effluent disposal systems shall not be located within 100-feet of the earth fissure trace because of water infiltrating from such features or basins could cause subsurface piping and erosion of soils into the earth fissure as well as potential contamination of the groundwater aquifer and for compliance with Arizona Department of Environmental Quality regulations. See Sheet 4, Detail 5.

2.12 In areas where stream/drainage channels must be crossed, GCI recommends that a geomembrane be extended for a minimum of 20 feet on each side of the earth fissure trace (Sheet 4, Detail 5). Drainage channel segments located within earth fissure mitigation zones shall be reinforced. Drainage channels constructed to carry runoff water across earth fissure mitigation zones should be appropriately engineered and designed with reinforced, lined concreted / shotcrete channel sections that extend a minimum of 20-feet beyond the earth fissure mitigation zone limits

Where drainage channels are located outside the limits (20-feet minimum) of the earth fissure mitigation zone, these channel sections should be lined with a geomembrane covered with a minimum of 12-inches of uncompacted backfill prior to compaction. We recommend smooth-drum compactors or wheel-rolling with heavy earth-moving equipment be used for compaction. Once the geomembrane backfill cover is compacted, a filter fabric shall be installed on top of the compacted backfill to minimize soil erosion. To reduce the potential for erosion that could expose the membrane liner, we recommend the placement of an appropriately sized (D50) rip-rap throughout the affected section to accommodate the maximum anticipated flow velocity and flow level elevations plus one-foot of freeboard. A product data sheet for a suggested geomembrane liner (GSE HD) is provided in Appendix A.

2.13 GCI recommends earth fissure cutoff walls be constructed at the termini of each earth fissure mitigation zone and in each area where earth fissures or earth fissure mitigation zones cross parcel boundaries (Sheet 1 and Sheet 2, Detail 2). For ease of excavation and the constructability of the earth fissure protection cut off walls, cut off trenches wider than 1.5 feet (18 inches) are permissible. The cutoff wall shall be constructed across the entire width of the earth fissure mitigation zone. The orientation and the placement of the cut off wall may be adjusted for the site conditions with the approval of the engineering geologist/engineer of record. The cutoff wall should be a minimum of 1.5 feet (18 inches) wide and extend 15 feet below cut-finish grades or the cut/fill boundary where fill is placed to raise grades. The wall should be constructed using a 3-bag per cubic yard ABC slurry mix. To reduce the potential for cutoff wall cracking, we recommend 6x6-W1.4/1.4 (6x6-10/10) welded-wire mesh, preferably panels, or an approved alternative be used to reinforce the cutoff walls.

2.14 We recommend the preliminary construction plans and details, and any requested modifications to the recommended earth fissure mitigation alternatives, be reviewed by GCI to confirm compliance with the earth fissure mitigation recommendations provided herein (also refer to section 2.7). We also recommend a registered profession geotechnical engineer or geologist, with documented experience with earth fissure mitigation provide independent special inspection services during the excavation and construction of the earth fissure mitigation measures at this site.

3.0 GEOGRAPHIC SETTING

3.1 Location

The project site lies within the town of Mesa, in eastern Maricopa County, north of U.S. 60 (Figure 1). The property can be accessed by paved and maintained city roads.

3.2 Physical Features

Regionally, the project area is situated within the East Salt River Valley Basin. The basin is bounded on the north and east by the McDowell, Usery, Goldmine, and Superstition Mountains, on the west and southwest by the San Tan and Sacaton Mountains. Surface runoff from the site, as noted in the available topographic maps, is to the southwest, however due to human activity and development of the surrounding areas, this has changed. Future runoff would be determined by the grading and drainage plan, and handled with City of Mesa storm drains. The dominant topographic feature in the vicinity is a small hill known as Double Kolls, which is approximately 3 miles northeast of the parcel and rises to an elevation of about 1,655 feet.

Maximum relief within Sunvalley Ranch, Track L parcel is not accurately available due to human activity on the site, and the age of the available topographic maps, but is likely to be less than 5 feet.

3.3 Climate and Vegetation

The climate of the area is arid to semiarid. Average annual temperature ranges from about 72° to 74° Fahrenheit (F) with summer maximums reaching more than 100° F and winter minimums below freezing (32° F). The precipitation is confined to essentially two seasons during the year, one in the summer and the other in the winter. Average annual rainfall is about 6 to 8 inches. Natural desert vegetation is dominantly creosotebush, mesquite, paloverde, annual grasses, Saguaro, and Cholla (Adams, 1974).

4.0 GEOLOGICAL EVALUATION

4.1 Site Setting

The site is located within the Sonoran Desert region in the north-central portion of the Basin and Range Physiographic Province near its boundary with the Transition Zone. The Basin and Range Province is characterized by northwest, north, and northeast trending mountains that rise abruptly from broad, elongated, deep sediment-filled valleys produced by block faulting and folding. The basin fill within the valley commonly makes up the principle groundwater aquifer of the region.

Structurally, the region has been uplifted to its present position by episodes of mountain/basin bounding fault movements (Cooley, 1977). The tectonic episodes and deformation, evident in the orientation of foliation planes and joint dip set discontinuities exposed in the bedrock terrain, have provided the mechanics necessary for deep intermontane basins that were subsequently filled with sediment.

4.1.1 General Basin Stratigraphy

The study area is situated near the northern border of a broad alluvium-filled valley that is bounded on the west and southwest by the San Tan and Sacaton Mountains and on the north and east by the McDowell, Usery, Goldmine, and Superstition Mountains. The alluvial deposits are expected to be a few feet thick near the mountains due to the presence of a shallow buried bedrock pediment. Beyond the pediment edge (to the north), the basin fill thickens rapidly to several 1,000's of feet reaching to more than 10,000 feet southeast of Gilbert (ADWR, VII, 1994).

The basin filled strata can be grossly subdivided into three zones: an upper sand and gravel units that range in thickness from nil to more than 300 feet, a middle silt and clay unit that ranges in thickness from less than 100 feet to more than 1,800 feet, and a lower conglomerate unit that range in thickness from less than 100 feet to more than 9,000 feet (ADWR VII, 1994).

4.1.2 Site Stratigraphy

Within the project vicinity, the thickness of the basin fill alluvium, consists of upper layers of recent stream channel and sheet flow silt, sand and gravel deposits ranging from nil, where bedrock is exposed about 3 miles north of the site, to a depth about 300 feet. Within a few feet of the ground surface, the coarse-grained sediments are commonly weakly to strongly cemented with caliche. Underlying the upper coarse-grained units, older interlayered deposits of thick clay, silt, and sandy silt range ranged from about 300 feet to about more than 800 feet below the ground surface. South of the site, the basin fill, including compressible sediment, thickens rapidly to a depth of about more than 11,000 feet in the central portion of the basin near Chandler (Oppenheimer, 1980).

5.0 LAND SUBSIDENCE

5.1 Overview

Land subsidence is known to occur in alluvium filled valleys of Arizona where agricultural activities and urban developments have caused substantial over-drafting or removal of groundwater from thick basin aquifers. The magnitude of subsidence is directly related to the subsurface geology, the thickness, and compressibility of the alluvial sediments deposited in the valleys, and the net groundwater decline. According to Bouwer (1977), land subsidence rates range from about one-hundredth to one-half foot per 10-foot drop in groundwater level, depending on the thickness and compressibility of the basin fill sediments.

There are three categories of land subsidence: (1) active subsidence; (2) residual subsidence; and (3) total subsidence. Land subsidence induced by groundwater over-drafting (or over pumping) is referred to as "active subsidence" and it does not immediately stop once pumping is stopped. As groundwater levels stabilize, or begin to rise, the subsidence continues gradually diminishes for some time before it and stops. The land subsidence that continues after groundwater levels stabilize or rise is referred to as "residual subsidence" and generally continues for several years. The entire land subsidence process cannot be considered complete until basin achieves equilibrium and residual subsidence ceases, whereas the cumulative drop in the land surface, known as "total subsidence" can be determined (EPA, 2001). The Sunvalley Ranch, Track L parcel is located within an area of residual subsidence.

Subsidence and earth fissures in urban and agricultural areas can cause a variety of problems. Structures built across fissures may be damaged, street cracks, flow in gravity water and sewer lines can be reversed, and differential subsidence (although rare) can rupture buried utilities (Arizona Geological Survey, 1987). However, design measures can be implemented to mitigate the effects of land subsidence (such as grade modification and earth fissures). Some of these mitigation measures can include additional structural reinforcement, over-sized pipes, surface grading and drainage controls, bridging the subsidence feature, and avoidance.

5.2 Groundwater

The major human-induced factor contributing to subsidence is the large scale pumping and removal of groundwater. Nearly all of the populated southern Arizona basins from Phoenix to Tucson have experienced at least a 100+ foot drop in groundwater level, and an area surrounding the town of Stanfield, Arizona has dropped more than 500 feet. In the basin south of the Sunvalley Ranch, Track L parcel, the groundwater level had dropped about 350 feet by 1983 (Scott, 1983). A search of ADWR recent well records, with relatively current water level readings, provided data for three wells within five miles of the property (Appendix A), which will be discussed below.

5.2.1 Groundwater Use in the East Salt River Valley Sub-Basin and Site Vicinity

The Sunvalley Ranch Tract L parcel is within the East Salt River Valley Sub-Basin (ESRV), one of the seven groundwater sub-basins within the Phoenix Active Management Area (AMA) as defined by the Arizona Department of Water Resources (ADWR). Prior to 1923, the groundwater system in the East Salt River Valley was in equilibrium because the groundwater recharge and outflow were balanced. By 1950, 2.3 million acre-feet per year were needed to meet agricultural demands. As a result, groundwater flow directions were impacted due to the lowering of the water table. Currently, most of the groundwater flows toward three cones of depression, which have been created by the large scale pumping of groundwater. The cones of depression are located near Scottsdale, Mesa, and Queen Creek (ADWR, VII, 1994).

Groundwater pumping estimates prior to1984 are not readily available for the ESRV, but are available for the entire Salt River Valley (SRV). In 1915, 15,000 acre-feet of groundwater were pumped from wells in the SRV. By 1942, the annual volume of groundwater withdrawn had increased to approximately one million acre-feet. Approximately 2.3 million acre-feet per year were pumped from the aquifer when groundwater withdrawal peaked in the 1950's. By 1992, annual usage in the SRV had decreased to 1.1 million acre-feet. Approximately 304,900 acre-feet of groundwater were pumped from the ESRV in 1990 (ADWR, VII, 1994).

Water levels in the ESRV steadily declined from 1923 to 1976 to more than 400' below original levels near the San Tan Mountain. Water levels rose over most of the ESRV from 1976 to 1983 due to heavy runoff and abundant surface water supply. Changes in water levels during this time ranged from a decline of 175 feet in the cone of depression near Queen Creek to a rise of 93 feet north of Queen Creek (ADWR, VII, 1994).

5.3 Regional Subsidence

Prior to the utilization of groundwater resources within the Phoenix area, the water table was higher and hydrogeologic conditions were in equilibrium. Water levels within the aquifer were lowered when pumping was initiated and the basin fill sediments were dewatered. In the arid southwest, the water in the aquifer may be removed by pumping faster than it can be naturally replenished causing a net water table decline. As a result, the weight of the soil column is gradually increased as the buoyant effects and aquifer pressures induced by the water acting on the soil column are decreased. This condition causes increased vertical loading stresses to consolidate portions of the thick compressible sediments that result in the lowering (subsidence) of the land surface over a large area as well as tensional stresses that contributed to earth fissure formation along the margins of the basin.

Land subsidence was first documented in Arizona in 1934 following the releveling of first-order survey lines by the Coast and Geodetic Survey (now the National Geodetic Survey (NGS)). Subsequent leveling by the NGS, the U.S. Geological Survey, the Bureau of Reclamation, and the ADOT has documented substantial land surface subsidence in south central Arizona including the Salt River Valley, the Queen Creek Apache Junction area, and the Eloy Casa Grande Stanfield area as overdrafting of the aquifer continues.

5.3.1 Study Area Subsidence

No formal studies to document the amount of land subsidence have been completed within or adjacent to the subject parcel. However, regional level surveys conducted previously by the National Geodetic Survey between 1932 and 1992, have been used by researchers to evaluate historical land subsidence in the East Salt River Valley. Schumann (1974) estimated that subsidence through 1967 was 3.9 feet near Queen Creek. Subsidence in the central portions of the East Salt River Valley, closer to the subject parcel, is estimated to have reached as much as seven or more feet as of 1974. National Geodetic Survey level line data indicates that land subsidence and related earth fissuring have been active for more than 30 years. Due to the fact that groundwater withdrawal has occurred near the site and that earth fissures have formed within and in the vicinity of the site, it is likely that subsidence has been ongoing at the site for over 30-years (Strange, 1983).

Based on the groundwater level information (ADWR, 2017), it would appear the project area is in a period of residual subsidence. However, well information for the surrounding area was very limited. One well, A-01-07 18Acc, located approximately 0.8 miles northwest of the project site, showed a water level increase of approximately 230 feet between 1983 and 2016. Two wells, A-01-07 23ACA and A-01-07 26AAC showed decreasing water levels. Well A-01-07, located approximately 3.6 miles east of the parcel, recorded a groundwater decrease of approximately 45 feet between 1998 and 2014. Well A-01-07 26AAC, located approximately 4.0 miles southeast of the parcel, recorded a groundwater decrease of approximately 35 feet between 1994 and 2015. If the groundwater table rises, subsidence rates will decrease to nil in the area as the system slowly reaches equilibrium. However, if additional groundwater pumping causes water levels in the basin to drop below historic lows, active land subsidence could be reinitiated. The two wells with declining water levels are located within an area of ongoing land subsidence, as discussed below.

5.3.1.1 Interferometric Synthetic Aperture Radar (InSAR) Analysis

Interferometric synthetic Aperture Radar (InSAR) is a remote sensing technique that uses radar satellite images. A radar satellite shoots constant beams of radar waves toward earth and records them after they bounce back off the Earth's surface. The intensity of the wave bounced back to the satellite indicates how much of the wave has been absorbed and how much has reflected back to the satellite. The phase of the wave, indicates the time necessary for the radar wave to hit the ground and return to the satellite. The intensity information is used to characterize the material the wave bounced off of. The phase information is used to determine any changes in elevation that have occurred over time. A phase reading taken at the same point over time should be identical. If there is a difference in readings, something has occurred to make it different. By using both the intensity and phase data, ground movement (land subsidence) can be located and measured (USGS, 2002).

InSAR data is very good at depicting vertical land movement (potentially subsidence) at locations where the land has remained undisturbed for the period of time during which the data was collected. This technology does not provide useful data in areas where the land surface changes on a somewhat regular basis (agricultural lands, rivers, etc.). In these areas, the data decorrelates and it is unreadable.

InSAR data for a 6.9 year period (5/15/2010 - 3/15/2017) was used by ADWR to prepare a graphic showing the total land subsidence in the east valley, south and east of the Sunvalley Ranch Tract L parcel. The total subsidence in the graphic ranges from zero to 15 cm or 5.9 inches (Figure 4).

5.4 Earth Fissures

Fissures occur in unconsolidated sediments, typically near the margins of alluvial valleys or near the bedrock pediment edge where ground water levels have dropped from about 200 feet to 500 feet below the ground surface (Schumann, 1986).

Fissures are initiated deep underground when tensile stresses exceed the strength of the soils. Tensile stresses induced by the subsidence continue to increase until the ground breaks to form earth fissures. The fissure apertures range from hairline-crack openings to openings less than two inches wide. Examples of typical earth fissure characteristics are provided in Figure 6.

Field evidence indicates fissures propagate upward and are exposed after overlying sediments are eroded by surface water runoff from rainfall or irrigation (Pewe, 1982). The surface expressions of the fissures are exaggerated because the initial hairline crack is attacked by water to create wide (10 to 20 feet) and deep (more than 15 feet) erosional gullies that often have vegetation growing in them. The fissures are commonly perpendicular to natural drainage channels. The length of the fissure at the ground surface varies, usually less than one mile but one fissure near Picacho is more than 9 miles long. These features are easily recognizable on aerial photographs and in the field except where the land surface is modified by agricultural activities or urban development. The fissures often have vegetation growing in them because the ground is commonly moister along the earth fissure. Other physical features associated with fissures include differential settlements of large sediment blocks that form graben-like cross sections with surface relief from nil to two or more feet, and drainage patterns associated with fissure gullies that do not conform to the areas local drainage pattern.

A regional gravity survey has been conducted covering the study area (Oppenheimer, 1980). The map depicts the estimated the depth to bedrock under the study area is about 400 feet below ground surface and to the southwest, the buried bedrock surface increases to more than 800 feet below ground surface.

5.4.1 Earth Fissures in the Project Vicinity

Several earth fissures have been mapped in the east Mesa and Apache Junction area, including the earth fissure that traverses the Sunvalley Ranch Tract L property (Figures 3 and 5).

5.4.1.1 Earth Fissures at the Sunvalley Ranch Tract L Property

One earth fissure has been mapped within the Sunvalley Ranch, Tract L parcel the AzGS (2017(Figure 3) and by GCI (Figure 5). The earth fissure enters the project site near the northeast corner of the parcel and it continues diagonally across the site toward the southeast corner of the parcel where it exits the site. Although human activity (dumping, grading and backfilling) has obscured the surface expression of the earth fissure, a 1983 report by Scott Geotechnical Services confirmed and mapped the earth fissure, and at some time in about the last two years, two erosion pipes have reopened the fissure to the ground surface; near the southeast corner of the property (GCI, 2017; recent Task 1 investigation and Task 2 exploration).

5.4.2 Future Potential Earth Fissure Development

Based on review and analysis of available data, the potential for the development of new earth fissure within the southern portion of the site should currently be considered moderate to low due to the measurable land subsidence from InSAR mapping by ADWR south and east of the project site. Pumping of groundwater, if required for this development or others in the project vicinity, could cause a local water table decline. Depending on the magnitude of the water table decline, active land subsidence could extend into the project area. If active land subsidence in the area is reactivated, the potential for future earth fissure development should be revised to high for the Sunvalley Ranch Tract L parcel.

A low potential for earth fissure development indicates that groundwater levels are static or rising and no subsurface structural controls that would contribute to earth fissure development were identified during this investigation. A moderate potential for earth fissure development indicates (1) groundwater levels are static or rising and subsurface structural controls that could contribute to earth fissure development were identified or

(2) groundwater levels are declining with no identified subsurface structural controls that could contribute to future earth fissure development. A high potential for earth fissure development indicates that groundwater levels are declining and subsurface structural controls that could contribute to earth fissure development were identified.

6.0 SUBSURFACE EXPLORATION

6.1 Trench Exploration

The previously open (pre 1983) earth fissure gully, following it initial burial, has been periodically reopened and backfill with soil mixed with a variety of trash and rubble. The latest reopening in the fissure gully within the last two years included two erosion pipes, designated F1 and F2 (Figure 5). Continued erosion of one of the fissure pipes (F2) as of the date of our investigation has resulted in the formation of a new fissure gully.

Several backhoe exploration trenches were excavated across the expected alignment of the buried, obliterated surface expression of the original earth fissure. Seven subsurface exploration trenches were made along the trend of the earth fissure within the parcel. A backhoe was used to excavate each trench for distances ranging from about 58 to 109. The trench locations and the reported earth fissure traces are shown in Figure 5. Table 1 is a summary of the trench details and findings. Attachments T1 through T7 document the trench and earth fissure details.

6.1.1 Exploration Trench Field Procedures

Trench logging required the careful cleaning of excess dirt and removing smeared soil marks from the trench walls and floors that was caused by the backhoe bucket. The cleaning was required to clearly expose the soil stratigraphy and discontinuities such as cracks or fissure features that might be present. Trench sections that displayed evidence of earth fissuring were carefully logged and described by experienced engineering geologists.

6.1.1.1 Trench T1

Trench T1 was excavated to a length of 58 feet and a depth of approximately 5.3 feet. The subsurface earth fissure trace F3 was located approximately 29 feet from the north end of the trench. Trench details and earth fissure information are documented in Attachment T1.

6.1.1.2 Trench T2

Trench T2 was excavated to a length of 62 feet and a depth of approximately 5.0 feet. The subsurface earth fissure trace F4 was located approximately 24 feet from the north end of the trench. Trench details and earth fissure information are documented in Attachment T2.

6.1.1.3 Trench T3

Trench T3 was excavated to a length of 89 feet and a depth of approximately 5.0 feet. The subsurface earth fissure trace F5 was located approximately 22.5 feet from the north end of the trench. Trench details and earth fissure information are documented in Attachment T3.

6.1.1.4 Trench T4

Trench T-4 was excavated to a length of 69 feet and a depth of approximately 5 feet. Two earth fissure features were exposed in this trench. Fissure trace F6 was located about 30 feet from the north end of the trench and the second earth fissure feature (F1-1) was located about 50 feet from the north end of the trench. Trench details and earth fissure information are documented in Attachment T4.

6.1.1.5 Trench T5

Trench T5 was excavated to a length of 100 feet and a depth of approximately 5.1 feet. Two earth fissure features were exposed in this trench. Fissure trace F7 was located about 48 feet from the north end of the trench and the second earth fissure feature (F1-2a) was located about 50 feet from the north end of the trench. Trench details and earth fissure information are documented in Attachment T5.

6.1.1.6 Trench T6

Trench T6 was excavated to a length of 109 feet and a depth of approximately 6.0 feet. One earth fissure trace F8 was located approximately 45 feet from the north end of the trench. Trench details and earth fissure information are documented in Attachment T6.

6.1.1.7 Trench T7

Trench T7 was excavated to a length of 93 feet and a depth of approximately 5.3 feet. One earth fissure trace F9 was located approximately 46.8 feet from the north end of the trench. Trench details and earth fissure information are documented in Attachment T7.

6.2 SOIL

The trenches were logged and the soil characterized. The following table, Table 1, summarizes the soil descriptions recorded during the excavation. Refer to Attachments T1 throughT7 for trench documentation and earth fissure photographs and details.

Table 1 - Soil Characterization Summary
Task 2 Earth Fissure Exploration Program
Sunvalley Ranch Tract L

Trench	Layer	Depth (ft bgs)	Description
T1	1	0 - 1.1	Fill with concrete debris. Silty Sand with fine gravel; brown, coarse-grained sand, some caliche fragments.
	2	1.1 - 4.7	Silty Sand with caliche coated gravel; brown, slightly cemented, very dense, massive, crudely stratified with some sand zones.
	3	4.7 - bottom	Same as Layer 2 - strong (Stage II-111) cementation. Open void below trench bottom.
T2	1	0 - 3.3	Fill with large concrete rubble fragments. Silty sand; loose with voids around concrete fragments.
	2	3.3 - 5.0	Silty Sand with Gravel; fine gravel, slight caliche cementation.
	3	5.0 to bottom	Same as Layer 2 - very strong (Stage IV to V) caliche cementation. Open void below trench bottom.
T3	1	0 - 0.9	Fill; Silty Sand; dense to loose, some trash debris to 0.5 feet bgs.
	2	0.9 - 4.5	Silty Sand with gravel; massive, coarse grained sand, fine gravel, channel deposits.
	3	4.5 - bottom	Same as Layer 2; strong (Stage II-111) caliche cementation. Open void below trench bottom.

Table 1 (continued)- Soil Characterization Summary
Task 2 Earth Fissure Exploration Program
Sunvalley Ranch Tract L

Trench	Layer	Depth (ft bgs	Description
T4	1	0 - 1.2	Fill, mixed with asphaltic concrete rubble filling fissure gully 8 ft. wide at top of trench
	2	1.2 - 3.7	Silty Sand; massive, coarse sand, loose (channel deposits).
	3	3.7 to bottom	Same as Layer 2, strong (Stage II-111) caliche cementation. Open void below trench bottom.
T5	1	0 - 0.84	Fill; Silty Sand; brown, fine to coarse grained, angular, poorly sorted.
	2	0.84 - 3.67	Silty Sand with Gravel; reddish brown, coarse, poorly sorted, few caliche nodules, fine caliche coated gravel.
	3	3.67 - bottom	Same as Layer 2; caliche cementation increasing at depth (Stage II to Stage III). Open void below trench bottom.
T6	1	0 - 1.5	Fill; Silty Sand with Gravel; light brown, some debris present.
	2	1.5 - 3.75	Silty Sand with Gravel; reddish brown, fine to coarse sand, hard, dense, poorly sorted, angular to subangular gravel.
	3	3.75 to bottom	Same as Layer 2; increasing caliche cementation at depth (Stage II to III). Open void below trench bottom.
T7	1	0 - 0.9	Fill; Silty Sand; tan brown, some debris.
	2	0.9 - 2.17	Silty Sand with gravel; reddish brown, loose, moderately consolidated, fine to coarse grained sand; fine gravel.
	3	2.17 to bottom	Silty Sand with gravel; reddish brown, some interbedding with coarser grained sandy units, caliche cementation near bottom (Stage II to Stage III. Open void below trench bottom.

7.0 BIBLIOGRAPHY

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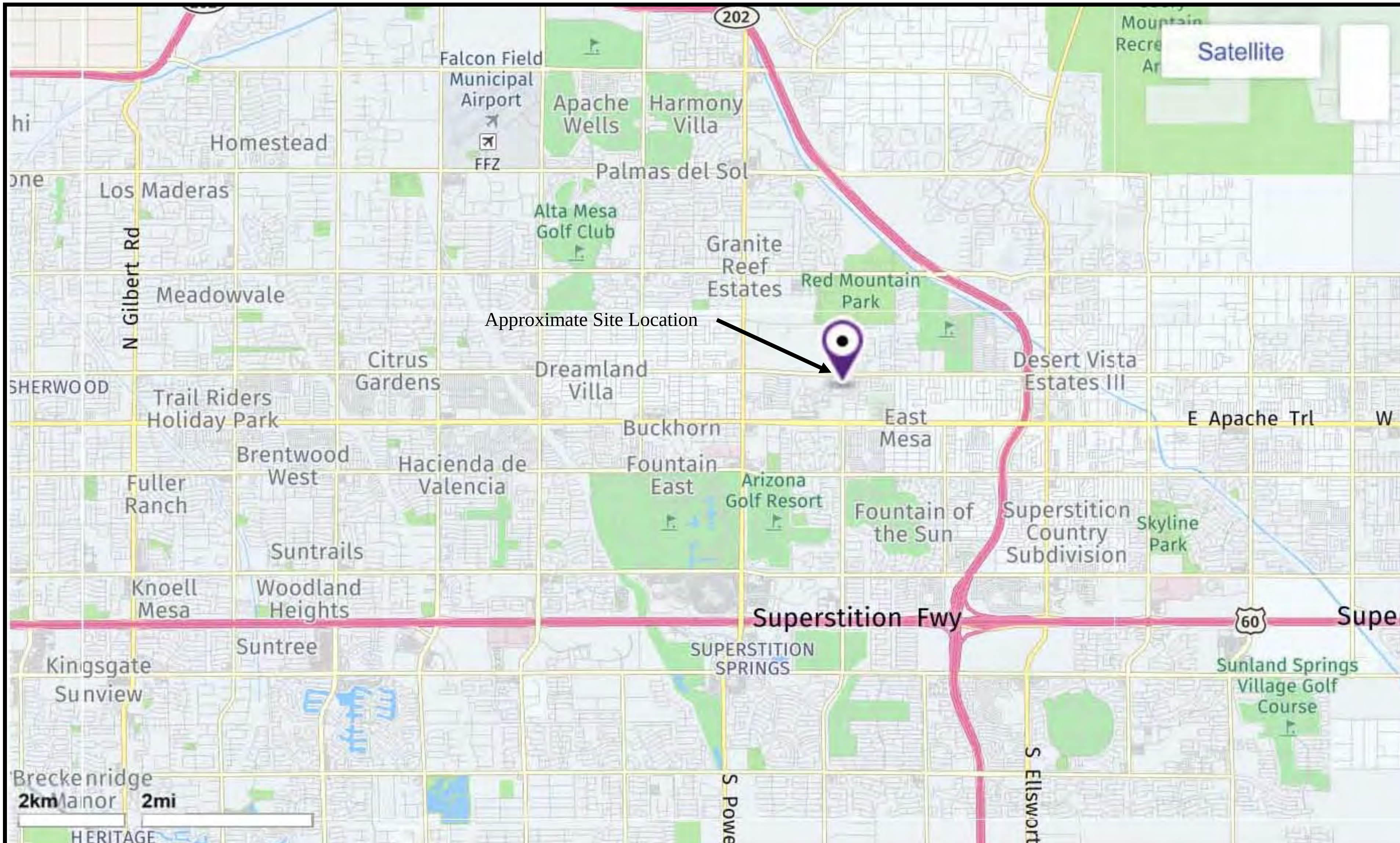
Figures



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Note: Basemap from Yahoo Maps, 2018

Land Subsidence & Earth Fissure Evaluation
Task 1 & Task 2 Earth Fissure Exploration Program
Sunvalley Ranch Tract L, APN 218-16-023
Site Vicinity Map
Figure 1

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EXPLANATION:

Parcel Boundary

Note: Basemap from Yahoo Maps, 2018

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Land Subsidence & Earth Fissure Evaluation
Task 1 & Task 2 Earth Fissure Exploration Program
Sunvalley Ranch Tract L, APN 218-16-023
Project Location Map
Figure 2

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Note: Basemap from Google Maps 2018, with AxGS Earth Fissure KMZ file (2017).

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Land Subsidence & Earth Fissure Evaluation
Task 1 & Task 2 Earth Fissure Exploration Program
Sunvalley Ranch Tract L, APN 218-16-023
Earth Fissure Location Map
Figure 3

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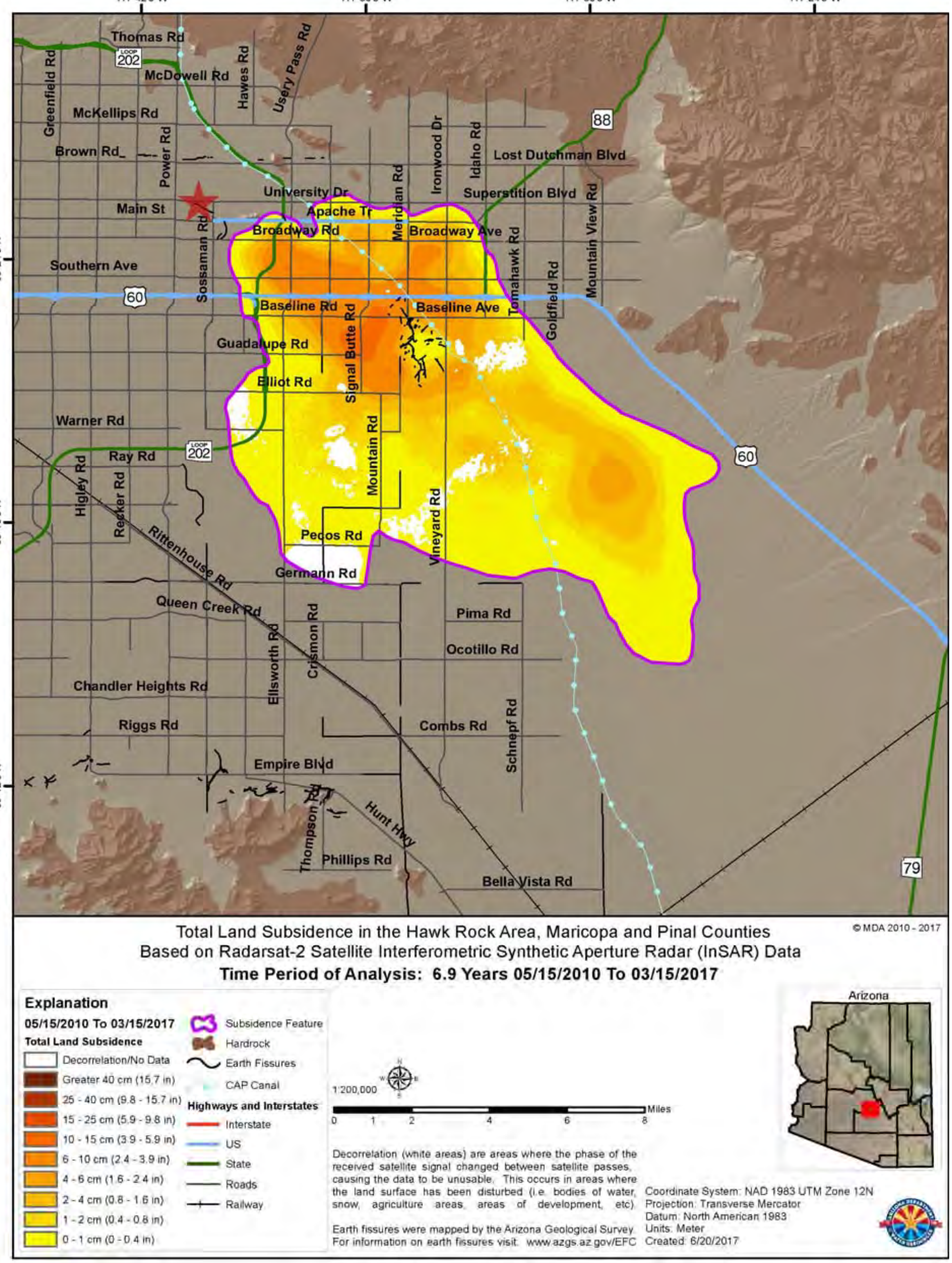

Explanation:

Approximate Property Location

N

Modified from ADWR, 2017.

Land Subsidence & Earth Fissure Evaluation
Task 1 & Task 2 Earth Fissure Exploration Program
Sunvalley Ranch Tract L, APN 218-16-023
East Valley Land Subsidence 2010 - 2017
Figure 4

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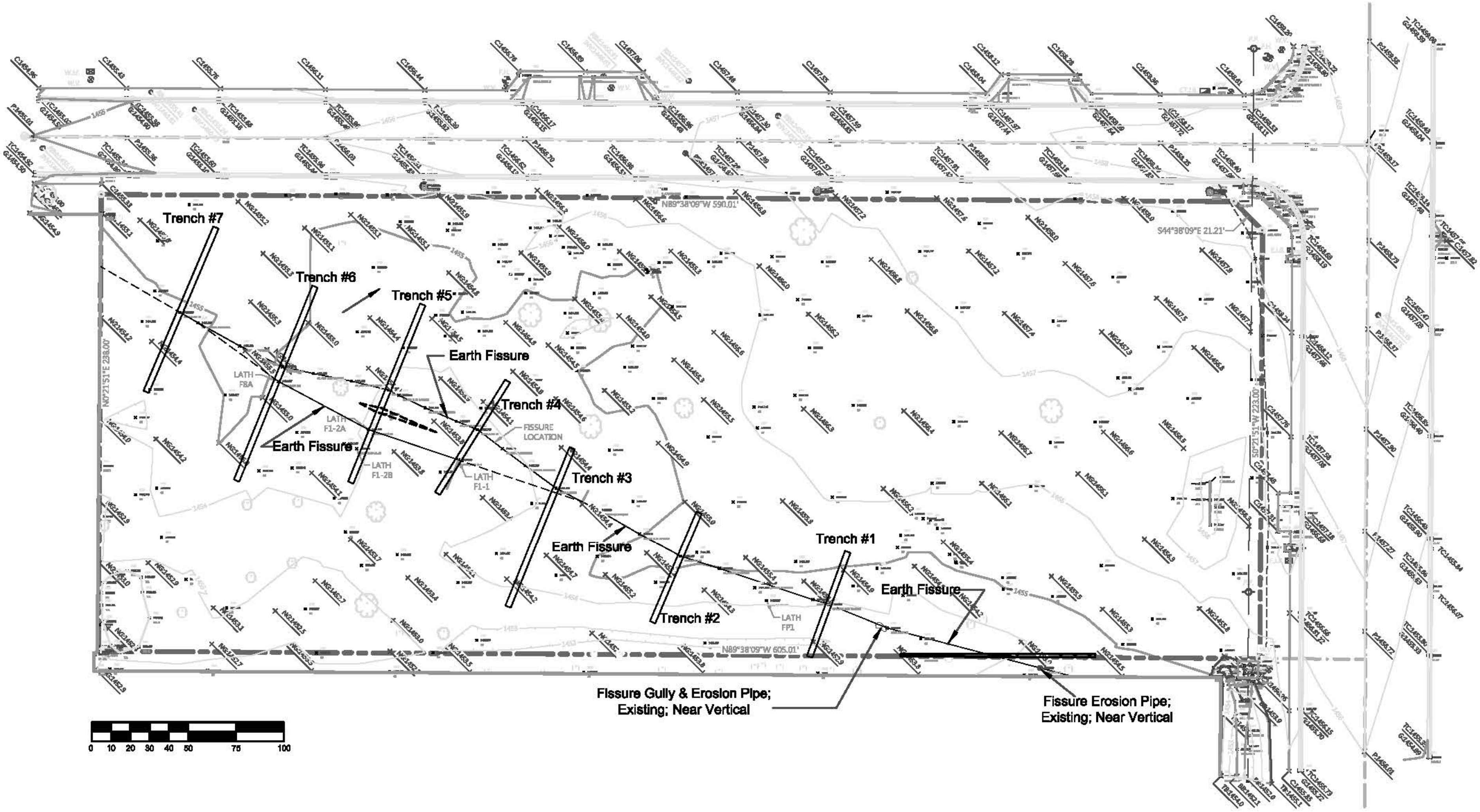

EXPLANATION:

Trench Location

N

Land Subsidence & Earth Fissure Evaluation
Task 1 & Task 2 Earth Fissure Exploration Program
Sunvalley Ranch Tract L, APN 218-16-023
Surveyed Earth Fissure & Trench Location Map
Figure 5

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ATTACHMENTS

Trench Details and Photographs

Photo 1: View of trench from southwest toward northeast.

Two earth fissures cracks were located in this trench. Fissure F3 is located approximately 29 ft. from the north end of the trenchSee Photos 2, 3, and 4 for details.

Photo 2: Earth Fissure F3 crack exposed across the bottom of the trench. The crack was found in caliche cemented soil about 0.4 feet wide and is filled with a brown silty sand with small fill debris. Fill bridges open fissure crack about 6.5 ft. bgs. Fissure bearing is N86°W.

Photo 3: Earth Fissure F3 exposed in east wall and bottom of trench wall. Width of fissure gully rubble backfill zone about 10 ft. wide along parallel to trench wall.. Several lateral to sublateral, partially fill erosion pipes exposed in trench wall. Fissure azimuth is N65°W.

Photo 4: Soil profile adjacent to fissure crack in east trench wall:

0 - 1.1 ft. bgs - Old fissure gully fill. Concrete rubble in silty sand with gravel fill mixed with caliche fragment.

1.1—4.7 ft. bgs - brown silty sand w/ gravel; , massive to crudely stratified., dense, calcareous.

4.7 ft. to bottom - caliche cemented silty sand w/ gravel

Trench Designation - T1

Trench Length: 58’ Average Trench Depth : 5.3 feet (approv.)
Trench Width: 3.0’
Bearing of Trench: S25˚W

Refer to Figure 5 for exploration trench location.

Land Subsidence & Earth Fissure Evaluation
Task 1 & Task 2 Earth Fissure Exploration Program
Sunvalley Ranch Tract L, APN 218-16-023
Trench T1 Details & Photos
Attachment T1

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Photo 1: View of trench T2 from the south-southwest looking Toward the north -northeast.

The primary earth fissure F4 was exposed in this trench. A secondary tension crack, associated with F4 was also exposed about 2 ft. Fissure F4 is located approximately 24 ft. from the north end of the trench, See Photos 2, 3, and 4 for details.

Photo 2: The primary earth fissure F4 is exposed across the bottom of the trench. The Earth fissure crack, about 0.15 ft. to 0.25 ft. wide, was found in caliche cemented soil below the fill and is filled with brown, fine silty sand with gravel. The fissure gully and fissure fill bridges open fissure crack about 5.5 ft. bgs. The earth fissure bearing is N68°W.

Photo 3: Subsidiary earth fissure-related tension crack (south) about 2 feet south of F4. This crack, with an aperture of about 0.09 ft. to 0.15 ft., was exposed across the bottom of the trench with . This crack opened up into a void a couple of inches below the bottom of the trench. Fissure bearing is N67°W.

Photo 4: Soil profile adjacent to the F4 fissure cracks in east wall of Trench 2:

0 - 3.3 ft. bgs - Old fissure gully fill. Large concrete rubble fragments (about 0.4 ft to 0.7 ft. in diameter) included with a matrix of loose silty sand. Fill contains numerous voids.

3.3 - 5.0 ft. bgs - light to dark loose, fine gravelly sand and dense and slightly calcareous silty sand, stratified.

5.0+ ft. to bottom - caliche cemented silty sand w/ gravel.

Trench Designation - T2

Trench Length: 62’ Average Trench Depth : 5’ (variable)
Trench Width: 3.0’
Bearing of Trench: S23˚W

Refer to Figure 5 for exploration trench location.

Land Subsidence & Earth Fissure Evaluation
Task 1 & Task 2 Earth Fissure Exploration Program
Sunvalley Ranch Tract L, APN 218-16-023
Trench T2 Details & Photos
Attachment T2

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Photo 1: View of trench T3 from the southwest looking toward the northeast.

The earth fissures F5 was exposed in this trench. F5 is located approximately 22.5 ft from the north end of the trench. See Photos 2, 3, and 4 for details.

Photo 2: View of west trench wall exposing earth fissure F5 across the bottom of the trench and in the trench wall. The aperture of the earth fissure crack in the west wall is about 0.80 ft. to wide. In the trench, the fissure is filled with fine silty sand with some coarse sand with some trash. The earth fissure gully fill, and the fissure crack fill, bridge an open fissure crack below the bottom of the trench.

Photo 4: Soil profile adjacent to the F5 fissure cracks in east wall of Trench 3:

0 - 0.9 ft. bgs - Old fissure gully fill zone. Dense to loose silty sand mixed with some trash. .

0.9 - 4.5 ft. bgs - Medium to dark brown loose to slightly dense, stratified silty sand with coarse sand and fine gravel that appear to be channel deposits.

4.5 to 5.0 ft. (trench bottom) - as above but caliche cemented.

Photo 3: Earth fissure F5 exposed in the bottom of the trench. This photo clearly shows this wide fissure aperture filled with silty, fine to coarse sand crack, that bridges the earth fissure. See Photo 4 that depicts the wide (about 1.4 ft.) filled fissure crack (darker, near vertical soil column) extending upward to the base of the fissure gully fill zone in the east wall of the Trench 3.

Trench Designation - T3

Trench Length: 89’ Average Trench Depth : 5’ (variable)
Trench Width: 3.0’
Bearing of Trench: S22˚W

Refer to Figure 5 for exploration trench location.

Land Subsidence & Earth Fissure Evaluation
Task 1 & Task 2 Earth Fissure Exploration Program
Sunvalley Ranch Tract L, APN 218-16-023
Trench T3 Details & Photos
Attachment T3

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Photo 1: View of trench T4 from the south-west looking toward the northeast.

The earth fissures F6 and F1-1 were exposed in this trench. F4 is located approximately 30 ft from the north end of the trench and F1-1 is approximately 50 feet from the north end of the trench, See Photos 2, 3, and 4 for details.

Photo 2: Earth fissure F6 is exposed across the bottom of the trench. The earth fissure crack, about 0.45ft. to 0.9 ft. wide, was found in caliche cemented soil below the overburden soil. The gully fill is with light brown, silty coarse sand mixed with trash and asphaltic concrete rubble. The fissure fill bridges open fissure crack to more than 5 ft. bgs.

Photo 3: The second earth fissure crack cut the trench bottom about 20 ft. south earth fissure F6. This crack, with an aperture of about 0.02 ft. to about 0.06 ft., appeared to be partially open on the west side of the trench. Most of the fissure bridged with a thin cover silty coarse sand. The bearing of fissure F1-1 in the trench is N62°W.

Photo 4: Soil profile adjacent to the F6 fissure cracks in east wall of Trench 4:

0 - 1.2 ft. bgs - Old fissure gully fill. Asphaltic concrete rubble and trash in a matrix of coarse sand. Width of fissure gully fill at trench top is about 8 ft.

1.2 - 3.7 ft. bgs - light to brown to tan loose to slightly dense, stratified silty sand and coarse sand that appear to be channel deposits.

3.7 to 5.0 ft. (trench bottom) - as above but caliche cemented.

Trench Designation - T4

Trench Length: 69' Average Trench Depth : 5' (variable)
Trench Width: 3.0'
Bearing of Trench: S32°W

Refer to Figure 5 for exploration trench location.

Land Subsidence & Earth Fissure Evaluation
Task 1 & Task 2 Earth Fissure Exploration Program
Sunvalley Ranch Tract L, APN 218-16-023
Trench T4 Details & Photos
Attachment T4

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Photo 1: View of trench from southwest toward northeast.

Two earth fissures cracks were located in this trench. One (F7) approximately 48’ from the north end of the trench; and, one (F1-2a approximately 70.5’ from the north end of the trench. See Photos 2, 3, and 4 for details.

Photo 2: Earth Fissure F7 crack exposed across the bottom of the trench. The crack was found in caliche cemented soil, is between 3” and 6” wide and is filled with a silty sand, slightly redder than the surrounding soil. Fissure azimuth is N63°W.

Photo 3: Earth Fissure F1-2a exposed in caliche cemented soils across trench bottom. Crack is approximately 1/2” to 1” wide and filled with silty sand. Fissure azimuth is N65°W.

Photo 4: Typical soil profile in trench wall:

0 - 10” bgs - silty sand fill soil, tan, loose, unconsolidated.

10” - 3’8” bgs - reddish brown medium to coarse sand with gravel. Some caliche nodules.

3’8” to bottom - caliche cemented silty sand and gravel.

Trench Designation - T5

Trench Length: 100’ Average Trench Depth : 4’9” (variable)
Trench Width: 3.0’
Bearing of Trench: S22˚W

Refer to Figure 5 for exploration trench location.

Land Subsidence & Earth Fissure Evaluation
Task 1 & Task 2 Earth Fissure Exploration Program
Sunvalley Ranch Tract L, APN 218-16-023
Trench T5 Details & Photos
Attachment T5

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Photo 1: View of trench from northeast to southwest.

One earth fissure crack (F8) was located in the bottom of the trench, approximately 45’ from the north end of the trench. See Photos 3 and 4 for details.

Photo 2: Earth Fissure F8 crack exposed across the bottom of the trench. The crack was found in caliche cemented soil, is approximately 3.5” wide with open voids below. The crack forms the southern boundary of an “earth fissure zone” which is approximately 6’ to 6.5’ wide and is characterized by a large slump north of the crack (Photo 3). The fissure crack trends N85°W.

Photo 3: The “slump” appears at the northern boundary of the earth fissure zone. It was filled with concrete and asphalt debris. The trench depth extended below the debris, into natural soil, where the cracking and slumping were apparent.

Note: The soil profile in Trench T6, was similar to Trench T5, varying only in the thickness of the units.

Trench Designation - T6

Trench Length: 109’ Average Trench Depth : 5’1” (variable)
Trench Width: 3.0’
Bearing of Trench: S22˚W

Refer to Figure 5 for exploration trench location.

Land Subsidence & Earth Fissure Evaluation
Task 1 & Task 2 Earth Fissure Exploration Program
Sunvalley Ranch Tract L, APN 218-16-023
Trench T6 Details & Photos
Attachment T6

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Photo 1: View of trench from northeast to southwest.

One earth fissure crack (F9) was located in the bottom of the trench, approximately 45’ from the north end of the trench. See Photos 3 and 4 for details.

Photo 2: Earth Fissure F9 crack exposed across the bottom of the trench. The crack was found in caliche cemented soil, is approximately 1” to 1.5” wide with erosion creating an approximately 3” wide void. The fissure crack trends N43°W.

Photo 3: Another view of the eroded fissure crack as it extends into the northwest trench wall.

Note: The soil profile in Trench T7, was similar to Trench T5, varying in the thickness of the units, looser and less consolidated with less caliche.

Trench Designation - T7

Trench Length: 93’ Average Trench Depth : 5’3” (variable)
Trench Width: 3.0’
Bearing of Trench: S23˚W

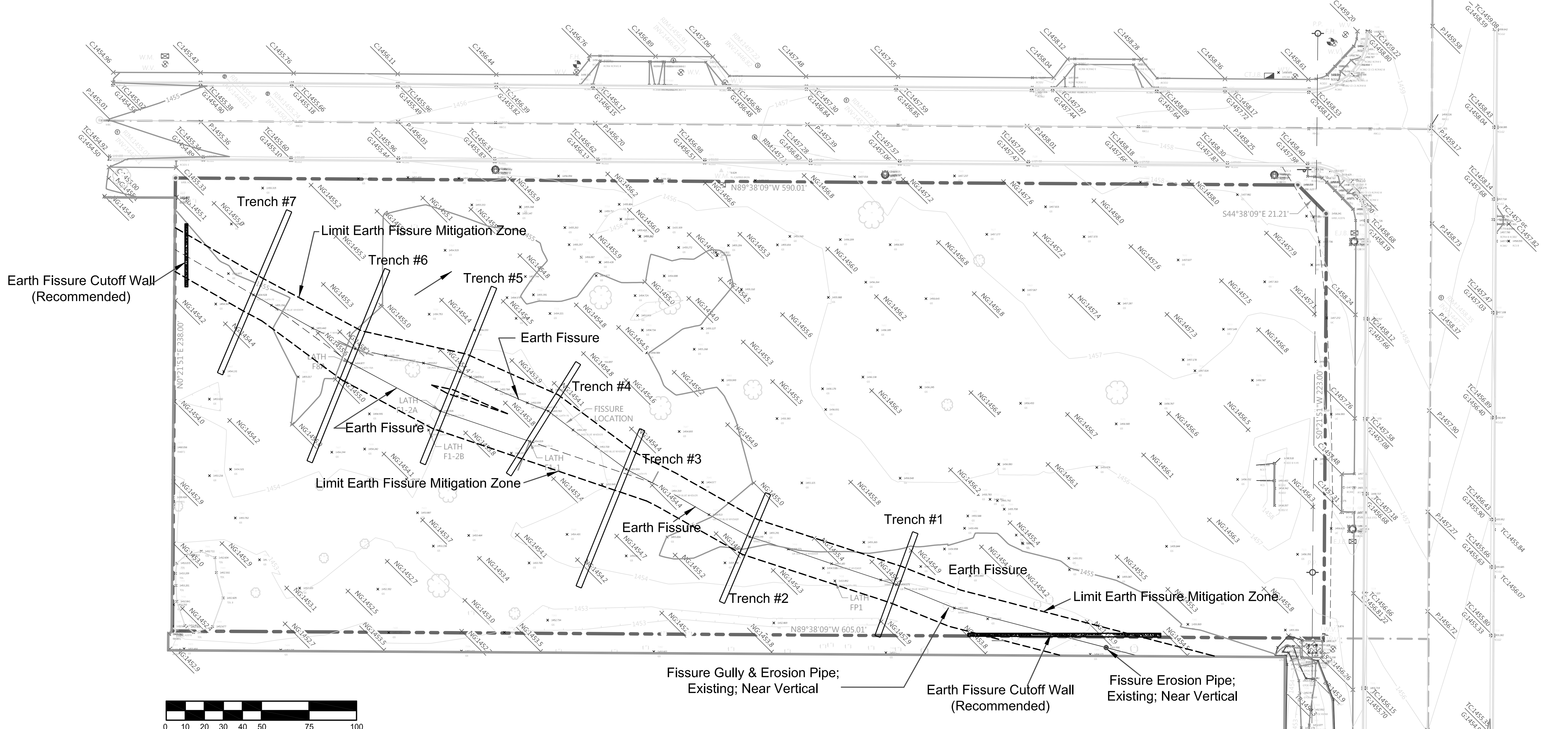
Refer to Figure 5 for exploration trench location.

Land Subsidence & Earth Fissure Evaluation
Task 1 & Task 2 Earth Fissure Exploration Program
Sunvalley Ranch Tract L, APN 218-16-023
Trench T7 Details & Photos
Attachment T7

Geological Consultants Inc.
2333 W. Northern Ave., Suite 1A
Phoenix, AZ 85021
phone: 602-864-1888
fax: 602-864-1899

Earth Fissure Mitigation Sheets

PRELIMINARY - NOT FOR CONSTRUCTION



1 EARTH FISSURE MITIGATION ZONE LOCATION MAP

Trench #2 — Earth Fissure Exploration Trench w/ Designation

Earth Fissure, Confirmed by Subsurface Exploration

Earth Fissure, Interpreted from Subsurface Exploration

Earth Fissure Mitigation Zone Limits

PRELIMINARY - NOT FOR CONSTRUCTION

Note: Topographic basemap, prepared by Westwood Multi-Disciplined Surveying & Engineering, January 16, 2018, modified by Geological Consultants Inc. to depict locations of earth fissure(s) and the earth fissure mitigation zone limits.

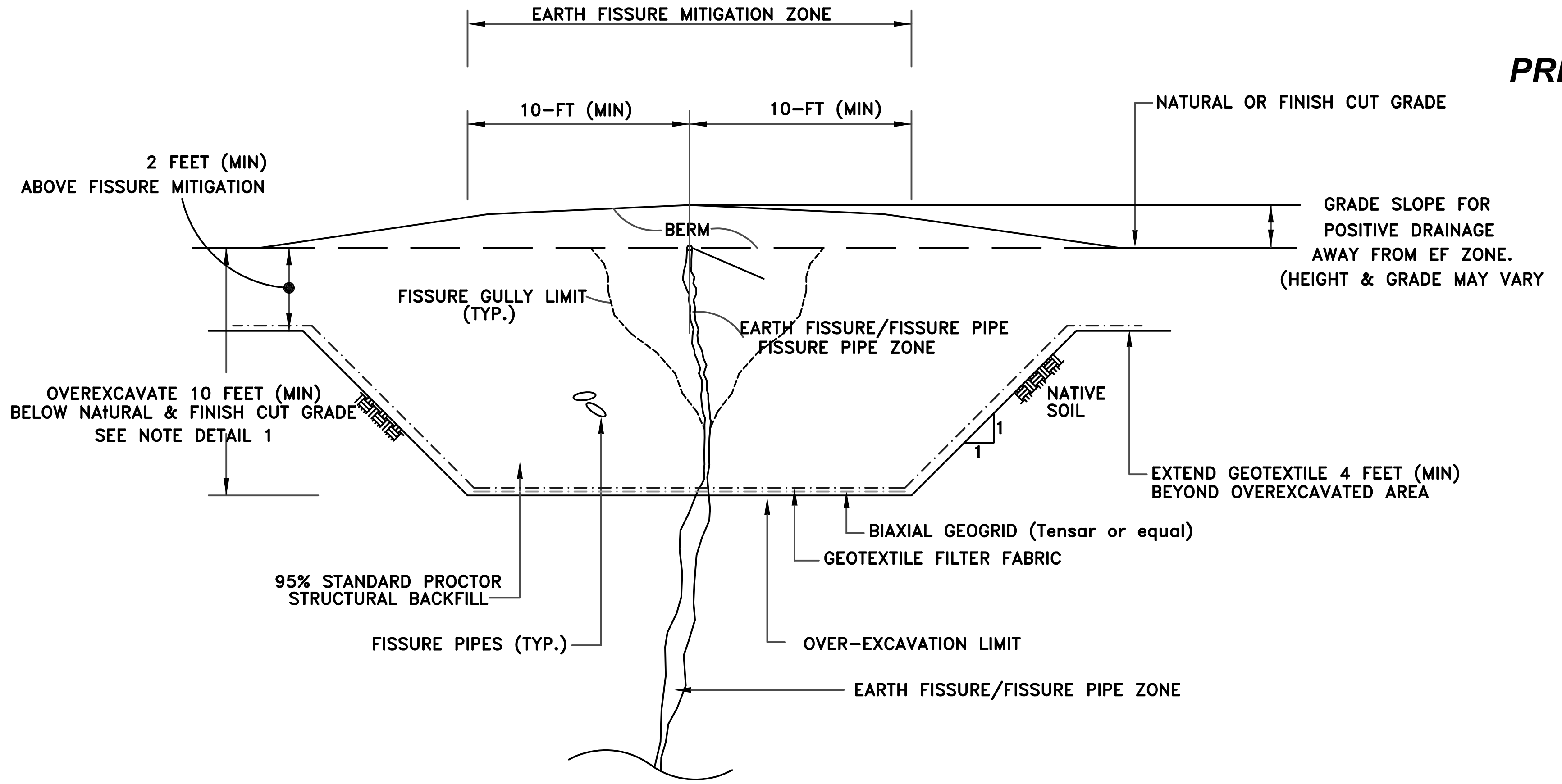
REGISTERED GEOLOGIST
CERTIFICATE NO.
10338
KENNETH M.
EUGE
DATE SIGNED
ARIZONA U.S.A.
EXP 09-30-2020

DRAWN BY: K. Euge, R.G., 01/18/2018
REVISION:

Task 2 Earth Fissure Investigation
Sossaman Road & Billings Street Parcel
Sheet 1
Earth Fissure Mitigation:
Mitigation Zone Layout

GEOLOGICAL CONSULTANTS INC.
2333 W. Northern Avenue, Suite 1A
Phoenix, AZ 85021
602-864-1888
602-864-1899 (Fax)

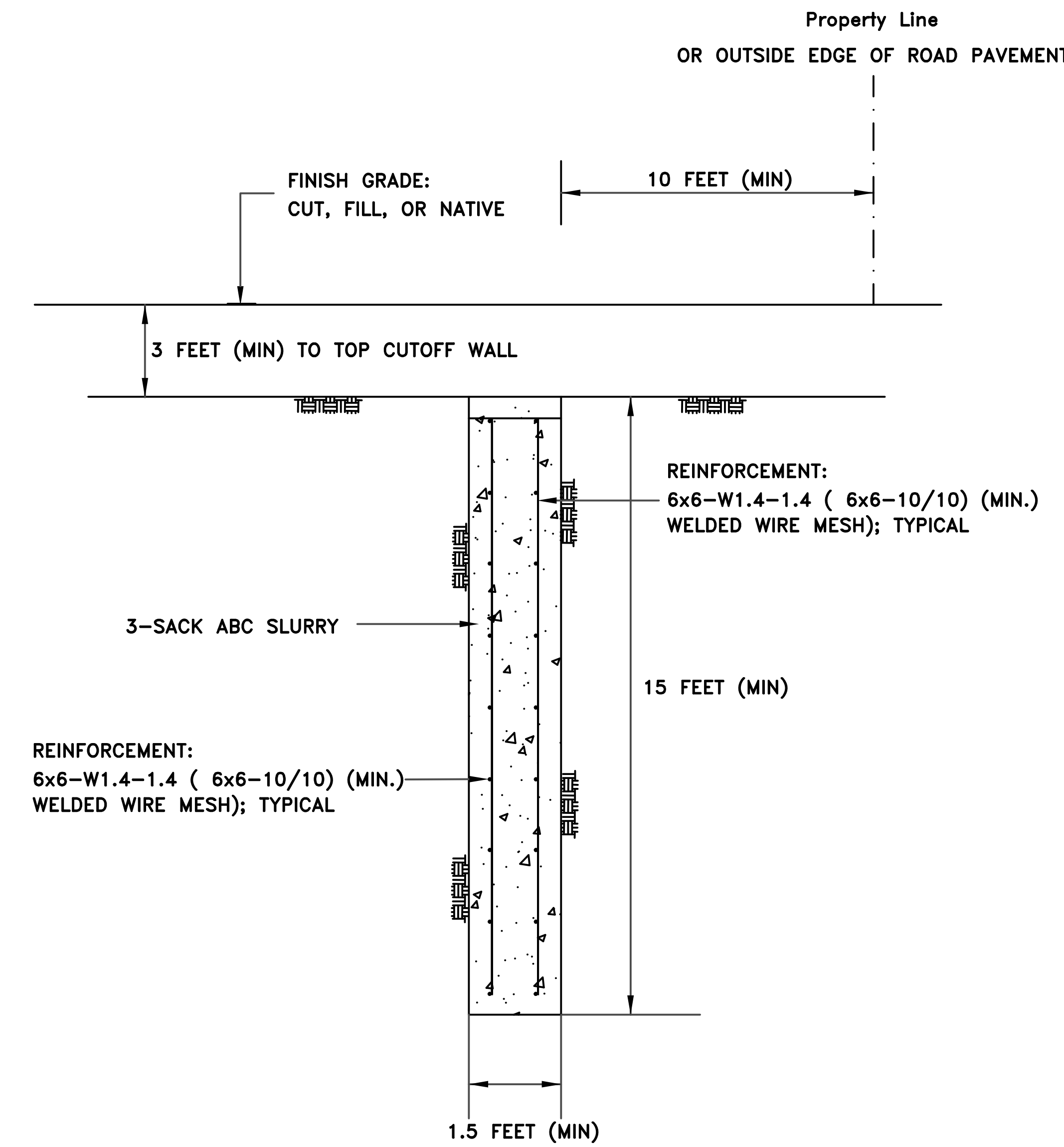
PRELIMINARY - NOT FOR CONSTRUCTION



1 MITIGATION TRENCH W/ ELEVATED BERM:
OPEN SPACE / GREENBELT ZONE (Not To Scale)

Note: The earth fissure mitigation zone shall be excavated below the native grade and/or the cut finish grade to a minimum depth of 10 feet (and in fill areas the earth fissure mitigation zone shall be excavated to a minimum depths of 10 feet below the bottom of the placed grade fill or embankment fill) if caliche cemented soils are not encountered within the earth fissure mitigation zone limits.

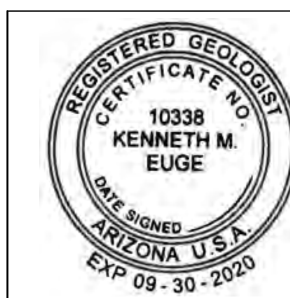
If caliche cemented soils are encountered within the mitigation zone between 5 and 10 feet below the native grade, the cut finish grade,and/or the place grade fill or embankment fill, the bottom of the earth fissure mitigation zone shall be excavated a minimum of one foot into the caliche cemented soil. The excavated earth fissure mitigation zone trench shall be inspected by a registered geotechnical engineer or a registered geologist to verify the earth fissure mitigation zone trench has been excavated to the require depth before the geogrid and filter fabric are installed and mitigation trench backfill is placed.



2 EARTH FISSURE CUTOFF WALL (TYPICAL)
(Not To Scale)

PRELIMINARY - NOT FOR CONSTRUCTION

NOTE: SEE SITE PLAN FOR LIMITS OF EARTH FISSURE MITIGATION ZONE TRENCHS & CUTOFF WALLS.



DRAWN BY: K. Euge, R.G., 01/18/2018
REVISION:

Task 2 Earth Fissure Investigation
Sossaman Road & Billings Street Parcel
Sheet 2
Earth Fissure Mitigation Details:
Mitigation Trench & Cutoff Wall

GEOLOGICAL CONSULTANTS INC.
2333 W. Northern Avenue, Suite 1A
Phoenix, AZ 85021
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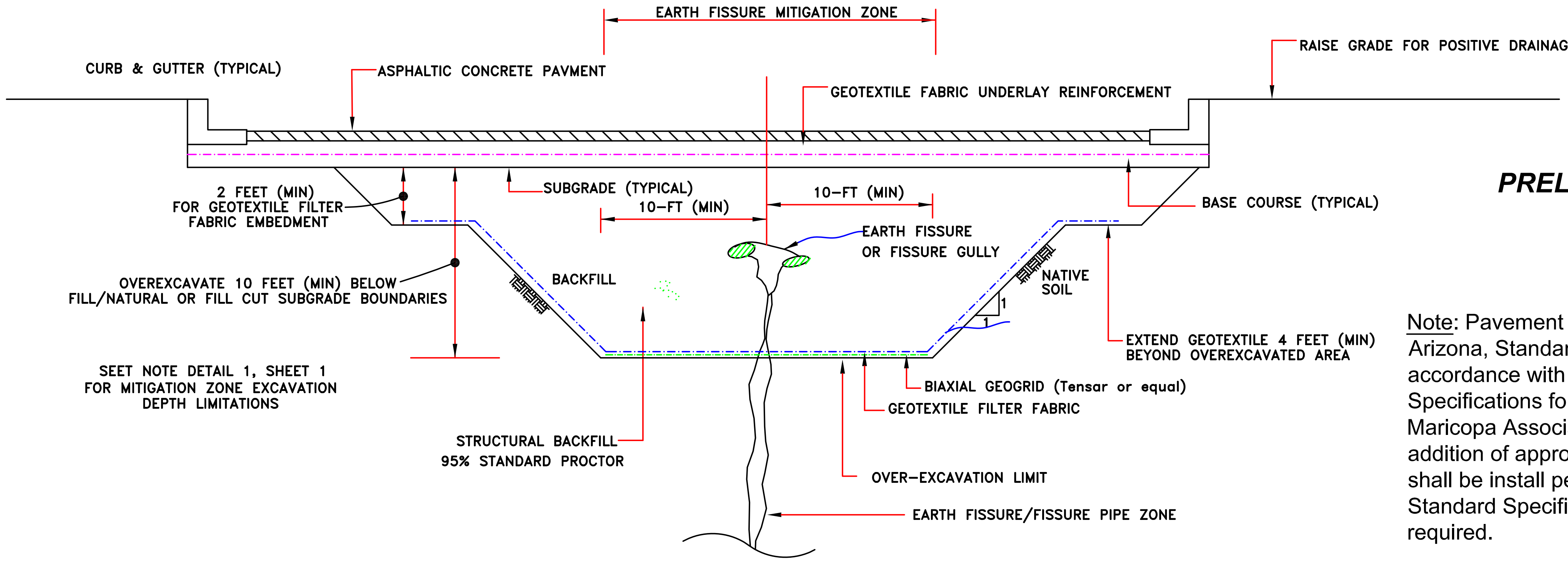
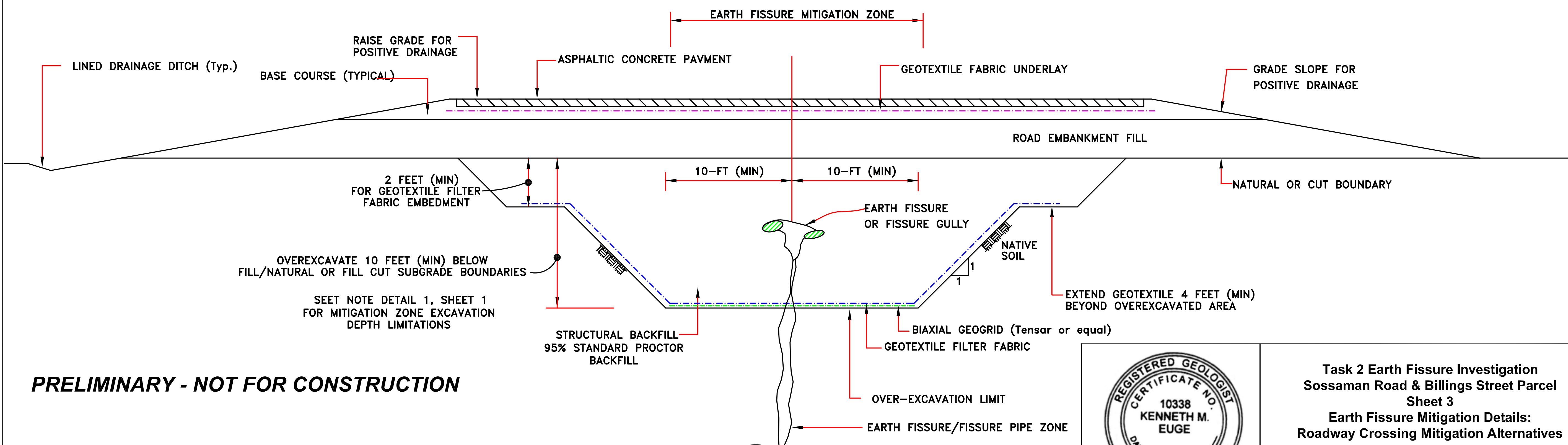
602-864-1899 (Fax)



3 EARTH FISSURE ROAD ALIGNMENT CROSSING ALTERNATIVE:
TYPICAL ROADWAY SECTION (CURB & GUTTER) Not to Scale

PRELIMINARY - NOT FOR CONSTRUCTION

Note: Pavement design shall comply with the current City of Mesa, Arizona, Standard Specifications for Public Works Construction in accordance with the 2015 edition of the Uniform Standard Specifications for Public Works Construction as sponsored by the Maricopa Association of Governments (MAG) as amended. The addition of appropriate geotextile fabric underlay reinforcement shall be install per the manufacturers recommendations and other Standard Specifications and Detail requirements, as may be required.



PRELIMINARY - NOT FOR CONSTRUCTION

4 EARTH FISSURE ROAD ALIGNMENT CROSSING ALTERNATIVE:
TYPICAL ROADWAY SECTION (SHOULDER) Not to Scale

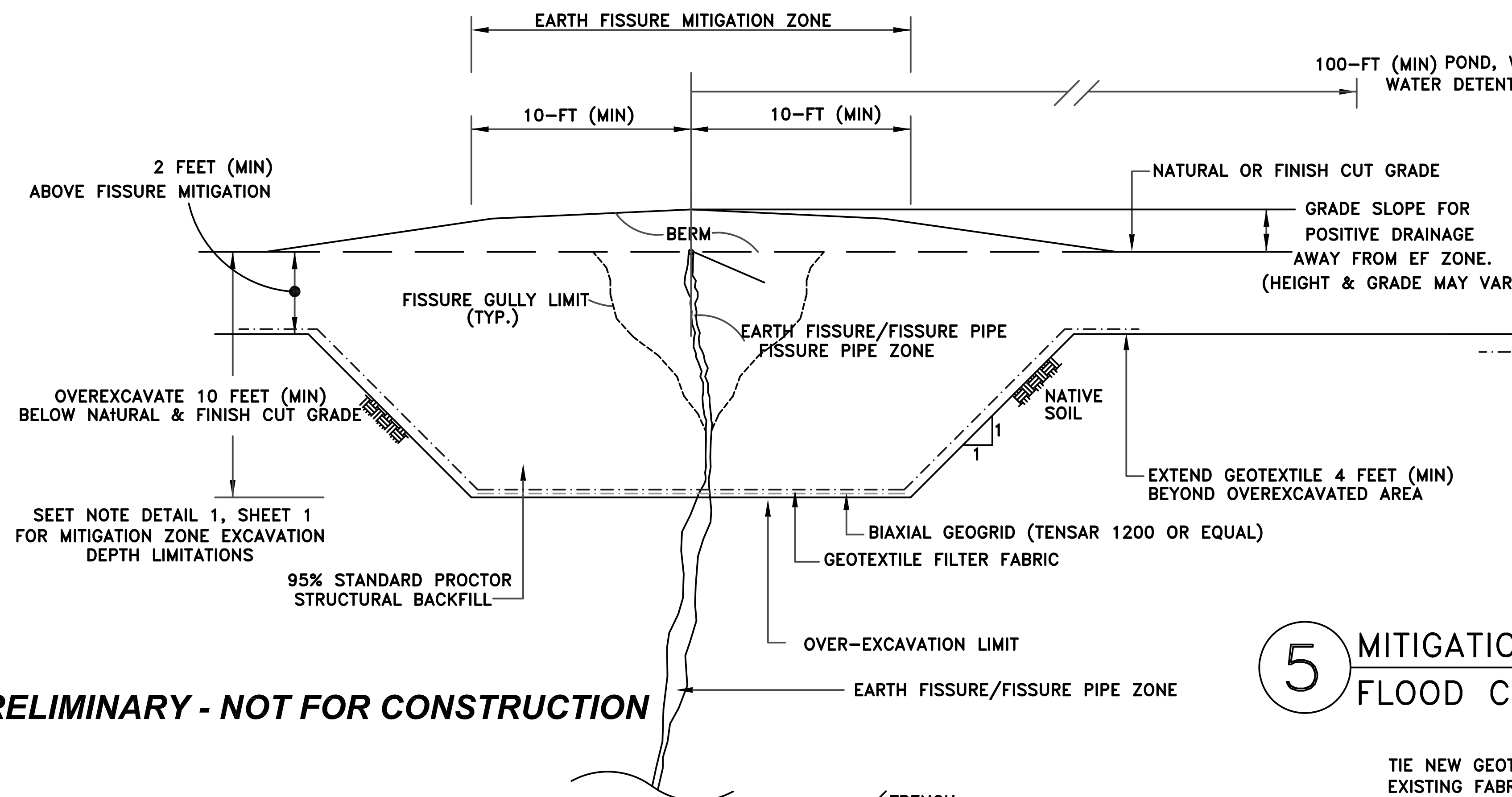
REGISTERED GEOLOGIST CERTIFICATE NO. 10338 KENNETH M. EUGE DATE SIGNED ARIZONA U.S.A. EXP 09-30-2020

DRAWN BY: K. Euge, R.G.; 01/18/2018
REVISION:

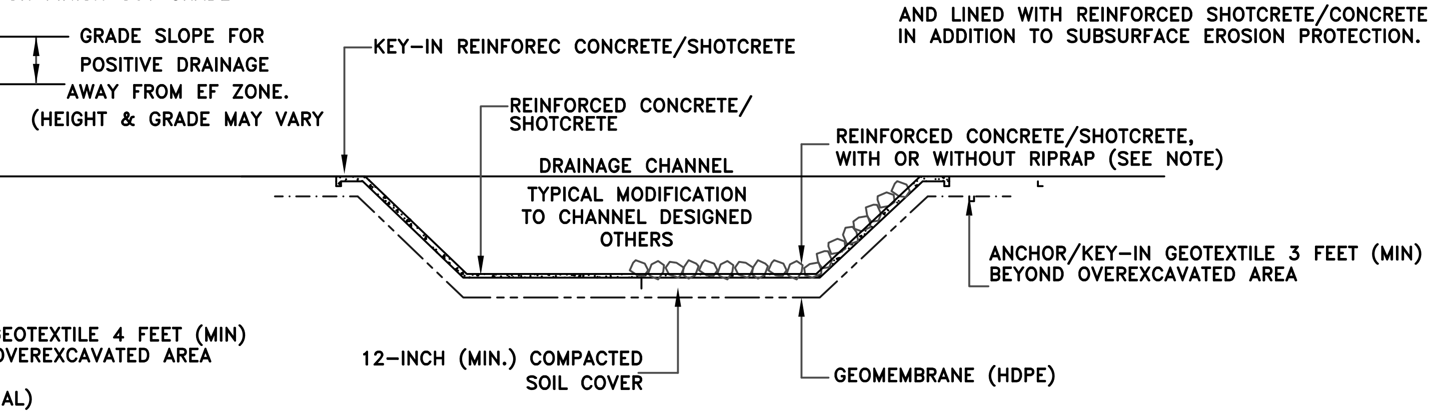
Task 2 Earth Fissure Investigation
Sossaman Road & Billings Street Parcel
Sheet 3
Earth Fissure Mitigation Details:
Roadway Crossing Mitigation Alternatives

GEOLOGICAL CONSULTANTS INC.
2333 W. Northern Avenue, Suite 1A
Phoenix, AZ 85021
602-864-1888
602-864-1899 (Fax)

PRELIMINARY - NOT FOR CONSTRUCTION

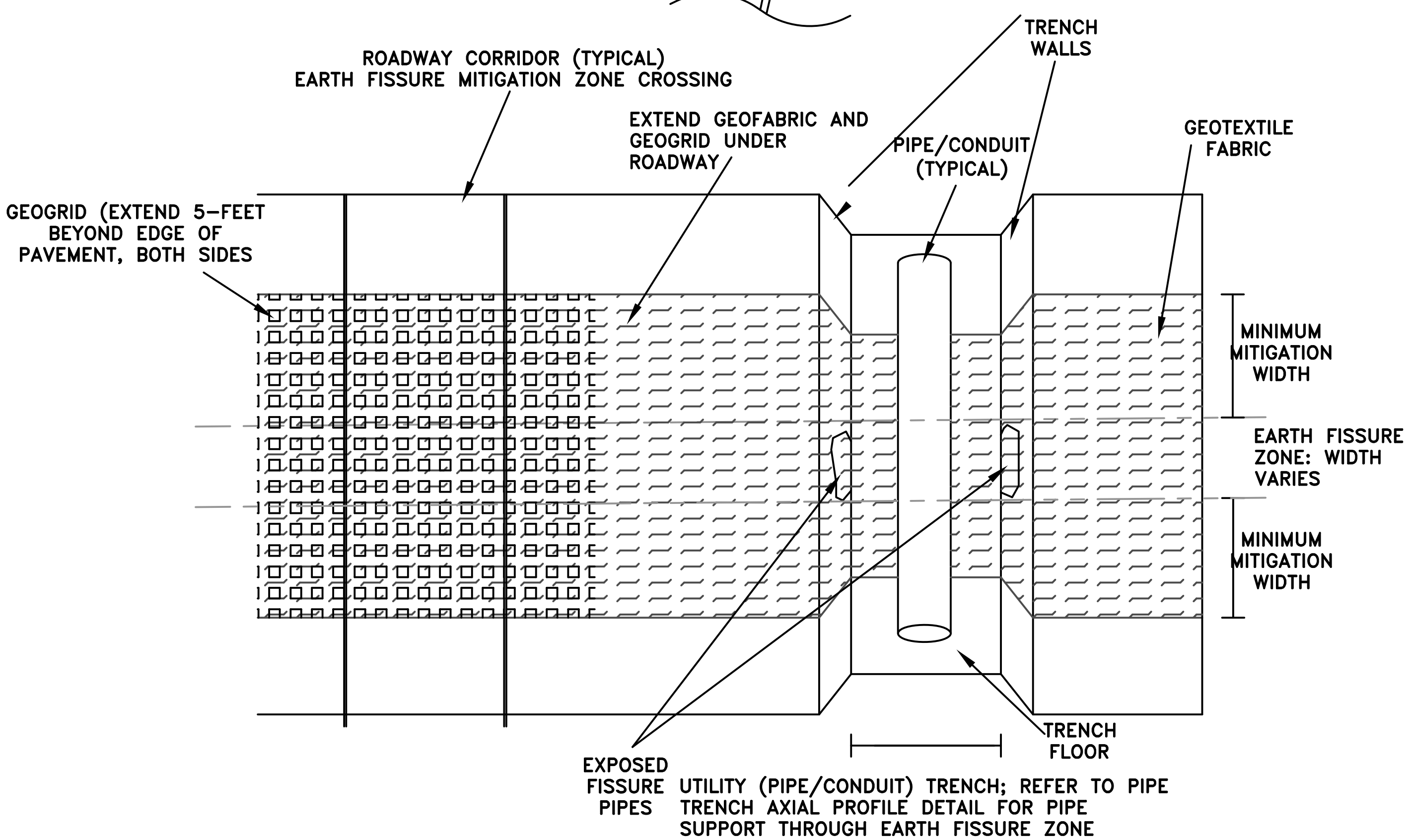


NOTE: DRAINAGE CHANNELS WITHIN OR CROSSING EARTH FISSURE MITIGATION ZONES SHALL BE DESIGNED ACCORDING TO PINAL COUNTY STANDARDS AND LINED WITH REINFORCED SHOTCRETE/CONCRETE IN ADDITION TO SUBSURFACE EROSION PROTECTION.

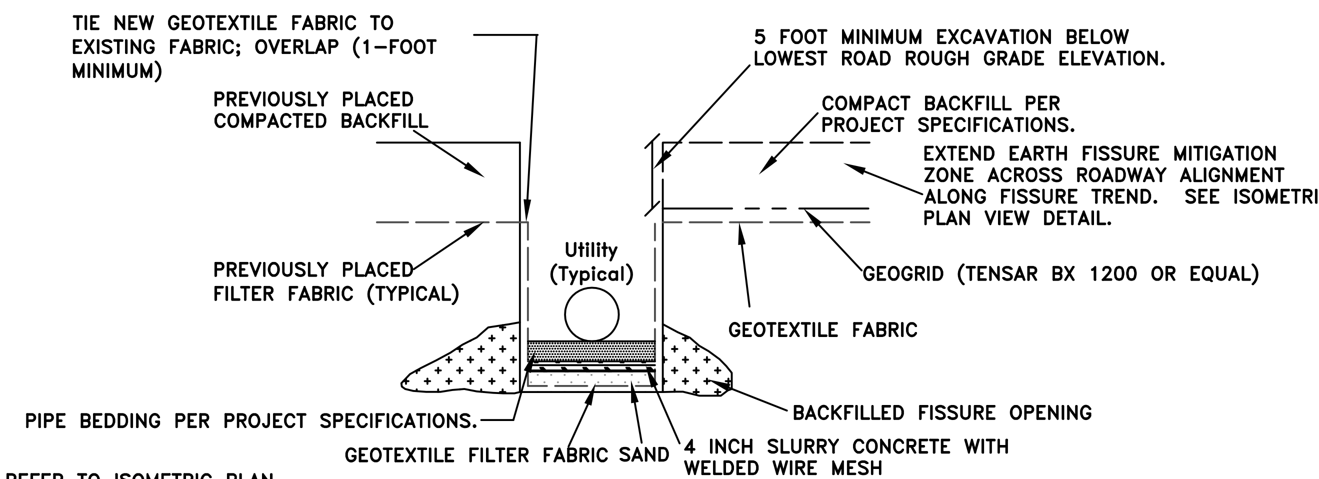


PRELIMINARY - NOT FOR CONSTRUCTION

5 MITIGATION ALTERNATIVE: WATER RUNOFF COORIDOR
FLOOD CONTROL CHANNEL, MODIFED STREAM CHANNEL N.T.S.



6a UTILITY TRENCH ISOMETRIC PLAN VIEW (TYPICAL)
Not To Scale



NOTE: REFER TO ISOMETRIC PLAN VIEW FOR ADDITIONAL DETAILS.

6b UTILITY TRENCH AXIAL PROFILE (TYPICAL)

6 MITIGATION ALTERNATIVE: TYPICAL UTILITY CROSSING
Not to Scale

REGISTERED GEOLOGIST CERTIFICATE NO. 10338 KENNETH M. EUGE DATE SIGNED ARIZONA U.S.A. EXP 09-30-2020

DRAWN BY: K. Euge, R.G.; 01/19/2018
REVISION:

Task 2 Earth Fissure Investigation
Sossaman Road & Billings Street Parcel
Sheet 4
Earth Fissure Mitigation Details:
Roadway Corridor, Drainage Corridor & Utility Crossing

GEOLOGICAL CONSULTANTS INC.
2333 W. Northern Avenue, Suite 1A
Phoenix, AZ 85021
602-864-1888
602-864-1899 (Fax)

Preconstruction Design Review:

Requests for Modification of Recommended Earth Fissure Mitigation

GEOLOGICAL CONSULTANTS INC

KENNETH M. EUGE, R.G.

March 28, 2018

Cornerstone Property Services
4360 E Brown Road, Suite 108
Mesa, AZ 85205

Attn: Mr. Bryson Bennett

Subject: Earth Fissure Mitigation Alternatives:
Preliminary Grading & Drainage Plan Review Comments
Aspire at Sun Valley
SWC East. Billings Street & North Sossaman Road
Mesa, Arizona
Geological Consultants Project No. 2017-144

Dear Mr. Bennett:

This letter is provided as followup to our conversation last week regarding the implementation of our recommended earth fissure mitigation measures included in your Preliminary Grading and Drainage Plans for the subject development. In our Task 2 report, we included several alternative recommendations for earth fissure mitigation that could be used for your site planning and development.

The earth fissure mitigation alternatives incorporated into the Aspire at Sun Valley site development plan can be considered, in our opinion, the preferred alternatives for earth fissure mitigation at this site. The implementation of the selected earth fissure mitigation alternatives at this site will remove the uncontrolled soil debris and rubble fill along the existing earth fissure and replace it with a controlled compacted earth fill with erosion protection and reinforcement within the earth fissure mitigation zone. Also, the placement of the internal access roadway on top of the earth fissure mitigation provides an additional level of mitigation against potential water infiltration into the earth fissure mitigation zone with the roadway subgrade reinforcement, grade, and runoff control along the mitigation zone alignment.

At your request, we reviewed your proposed design for the placement of the large underground tank retention design place within the roadway alignment relative to earth fissure mitigation. Based our review and your preliminary plan to implement additional earth fissure mitigation measures specific to the underground tank placement within the earth fissure mitigation zone, the proposed design is acceptable. We recommend that you and the contractor provide the construction final installation plans, shop drawings and details and any subsequent revisions of the retention system.

Please refer to section 2.14 of GCI's earth fissure exploration report regarding the review and approval of any revisions or changes to plans and details and special inspections related to earth fissure mitigation as the project moves forward.

Based on our review of the Preliminary Grading and Drainage Plans prepared by Westwood Professional Services Inc. for Aspire at Sun Valley, the implementation of our recommended earth fissure mitigation measures, in our opinion, satisfies the intended purpose to improve safety within a property affected by land subsidence-induced earth fissures.

Thank you for the opportunity to review your project plans.

Sincerely,

REGISTERED GEOLOGIST
CERTIFICATE NO.
10338
KENNETH M.
EUGE
DATE SIGNED 03/28/18
ARIZONA U.S.A.
EXP 09-30-2020

Kenneth M. Euge, R.G.
Principal Geologist

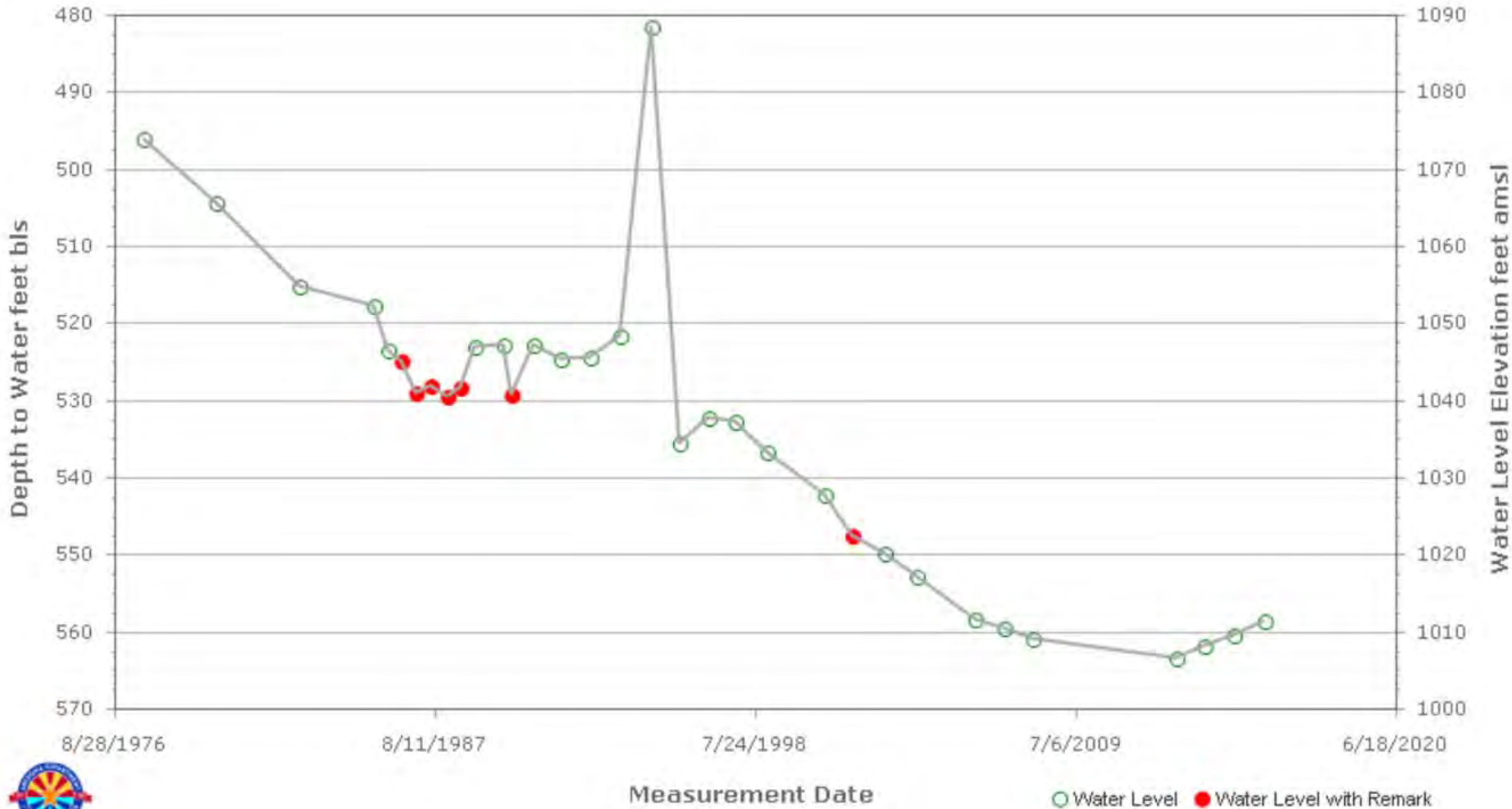
Appendix A

ADWR GWSI HYDROGRAPHS

Well Info Map Reset Graph Auto Site Hydrograph Email Help

Arizona GroundWater Monitoring Site Hydrograph

Local ID	Site ID	Registry ID	Latitude NAD27	Longitude NAD27	Alt. (ft amsl)	Water Use	Well Depth (ft)	Case Dia.(in)	Drill Date	Latest WL Date	DTW (ft)	WL Elv. (ft)
A-01-07 26AAC2	333345111360001	616590	33° 24' 15.0"	111° 36' .1"	1570	PUBLIC SUPPLY	1000	20	11/1/1976	12/8/2015	558.4	1011.6



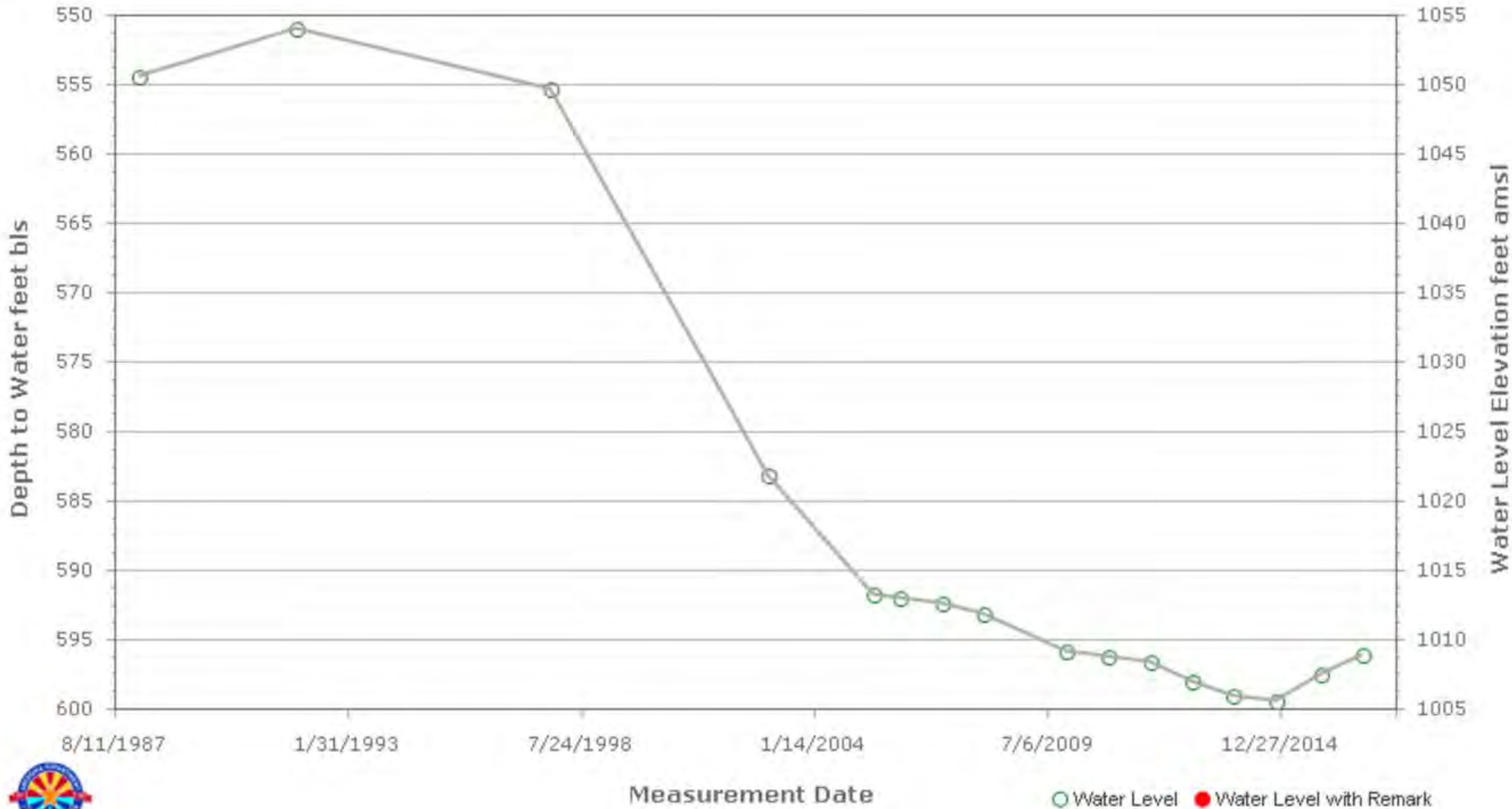
GWSI is ADWR's technical database of well locations, construction data, and water levels.

Created on 1/20/2018

View this well on the map | Reset Graph | Auto Site Hydrograph | Email | Help

Arizona GroundWater Monitoring Site Hydrograph

Local ID	Site ID	Registry ID	Latitude NAD27	Longitude NAD27	Alt. (ft amsl)	Water Use	Well Depth (ft)	Case Dia.(in)	Drill Date	Latest WL Date	DTW (ft)	WL Elv. (ft)
A-01-07 23ACA	332507111361001	613969	33° 25' 6.8"	111° 36' 10.6"	1605	UNUSED	700	8.62	7/15/1970	11/29/2016	596	1009



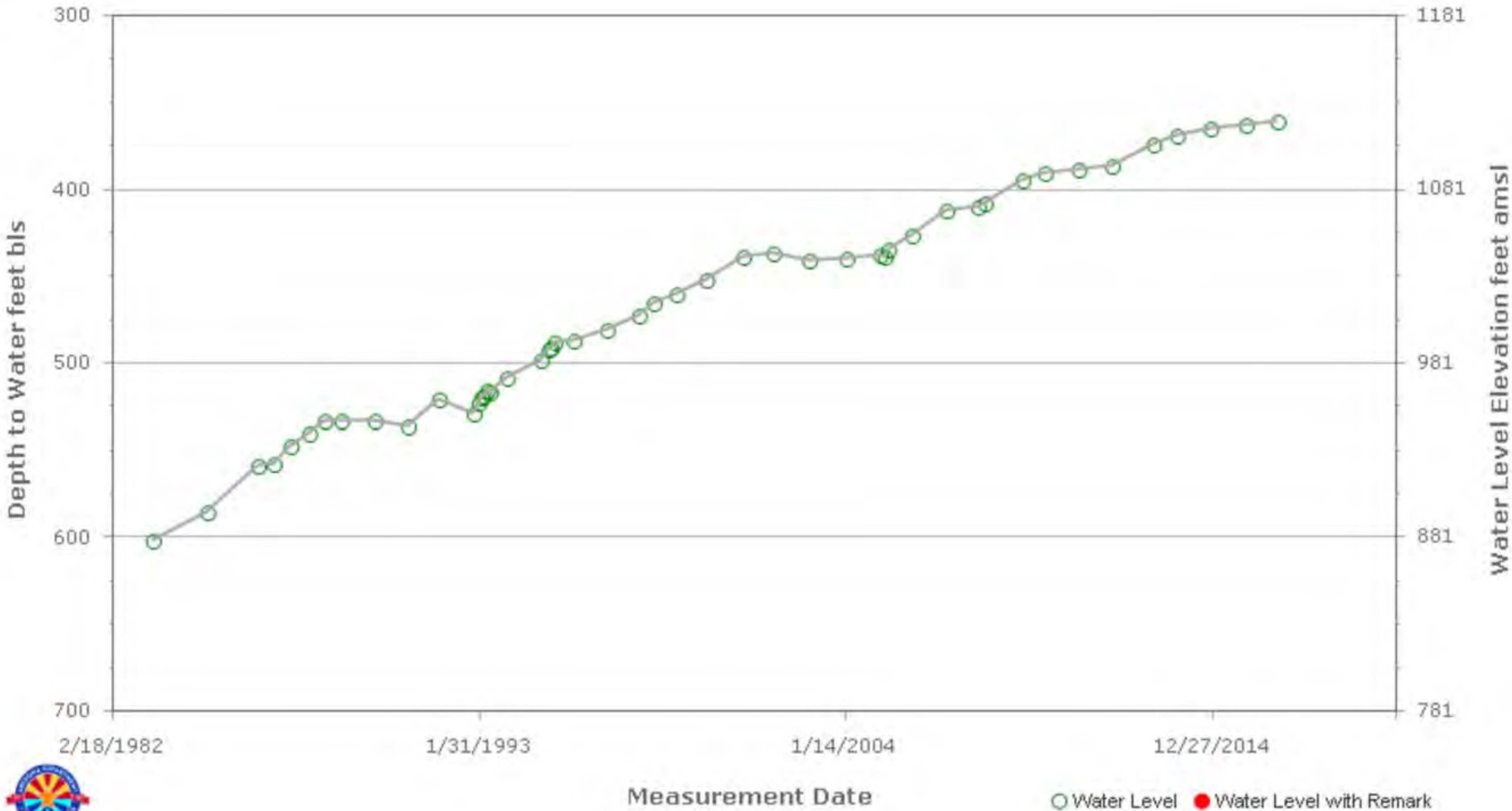
GWSI is ADWR's technical database of well locations, construction data, and water levels.

Created on 1/20/2018

Well Info Map Reset Graph Auto Site Hydrograph Email Help

Arizona GroundWater Monitoring Site Hydrograph

Local ID	Site ID	Registry ID	Latitude NAD27	Longitude NAD27	Alt. (ft amsl)	Water Use	Well Depth (ft)	Case Dia.(in)	Drill Date	Latest WL Date	DTW (ft)	WL Elv. (ft)
A-01-07 18ACC	332547111402701	500714	33° 25' 48.8"	111° 40' 28.7"	1481	UNUSED	1041	16	6/18/1981	11/21/2016	360.4	1120.6



GWSI is ADWR's technical database of well locations, construction data, and water levels.

Created on 1/20/2018

Appendix B

Nonwoven Filter Fabric and Biaxial Geogrid Technical Specifications

GSE HDPE Geomembrane Liner Product Data Sheet

Tensar®

Tensar International Corporation
2500 Northwinds Pkwy, Suite 500
Alpharetta, Georgia 30009
Phone: 800-TENSAR-1
www.tensarcorp.com

Product Specification - Biaxial Geogrid BX1200

Tensar International Corporation reserves the right to change its product specifications at any time. It is the responsibility of the specifier and purchaser to ensure that product specifications used for design and procurement purposes are current and consistent with the products used in each instance.

Product Type:	**Integrally Formed Biaxial Geogrid**
Polymer:	**Polypropylene**
Load Transfer Mechanism:	**Positive Mechanical Interlock**
Primary Applications:	**Spectra System (Base Reinforcement, Subgrade Improvement)**

Product Properties

Index Properties	**Units**	**MD Values[1]**	**XMD Values[1]**
▪ Aperture Dimensions[2]	mm (in)	25 (1.0)	33 (1.3)
▪ Minimum Rib Thickness[2]	mm (in)	1.27 (0.05)	1.27 (0.05)
▪ Tensile Strength @ 2% Strain[3]	kN/m (lb/ft)	6.0 (410)	9.0 (620)
▪ Tensile Strength @ 5% Strain[3]	kN/m (lb/ft)	11.8 (810)	19.6 (1,340)
▪ Ultimate Tensile Strength[3]	kN/m (lb/ft)	19.2 (1,310)	28.8 (1,970)
Structural Integrity			
▪ Junction Efficiency[4]	%	93	
▪ Flexural Stiffness[5]	mg-cm	750,000	
▪ Aperture Stability[6]	m-N/deg	0.65	
Durability			
▪ Resistance to Installation Damage[7]	%SC / %SW / %GP	95 / 93 / 90	
▪ Resistance to Long Term Degradation[8]	%	100	
▪ Resistance to UV Degradation[9]	%	100	

Dimensions and Delivery

The biaxial geogrid shall be delivered to the jobsite in roll form with each roll individually identified and nominally measuring 3.0 meters (9.8 feet) or 4.0 meters (13.1 feet) in width and 50.0 meters (164 feet) in length. A typical truckload quantity is 160 to 210 rolls.

Notes

1. Unless indicated otherwise, values shown are minimum average roll values determined in accordance with ASTM D4759-02. Brief descriptions of test procedures are given in the following notes.
2. Nominal dimensions.
3. Determined in accordance with ASTM D6637-10 Method A.
4. Load transfer capability determined in accordance with ASTM D7737-11.
5. Resistance to bending force determined in accordance with ASTM D7748-12, using specimens of width two ribs wide, with transverse ribs cut flush with exterior edges of longitudinal ribs, and of length sufficiently long to enable measurement of the overhang dimension.
6. Resistance to in-plane rotational movement measured by applying a 20 kg-cm (2 m-N) moment to the central junction of a 9 inch x 9 inch specimen restrained at its perimeter in accordance with GRI GG9.
7. Resistance to loss of load capacity or structural integrity when subjected to mechanical installation stress in clayey sand (SC), well graded sand (SW), and crushed stone classified as poorly graded gravel (GP). The geogrid shall be sampled in accordance with ASTM D5818 and load capacity shall be determined in accordance with ASTM D6637.
8. Resistance to loss of load capacity or structural integrity when subjected to chemically aggressive environments in accordance with EPA 9090 immersion testing.
9. Resistance to loss of load capacity or structural integrity when subjected to 500 hours of ultraviolet light and aggressive weathering in accordance with ASTM D4355-05.

This product specification supersedes all prior specifications for the product described above and is not applicable to any products shipped prior to February 1, 2013.

GSE HD Smooth Geomembrane

GSE HD is a smooth high density polyethylene(HDPE) Geomembrane manufactured with the highest quality resin specifically formulated for flexible geomembranes. this product is used in applications that require excellent chemical resistance and endurance properties.

[*]

AT THE CORE:
An HDPE geomembrane used in applications that require excellent chemical resistance and endurance properties.

Product Specifications

These product specifications meet or exceed GRI GM13.

Tested Property	Test Method	Frequency	Minimum Average Value			
Thickness, (min. average) mil (mm) Lowest Individual Reading (-10%)	ASTM D 5199	Every roll	30 (0.75) 27 (0.68)	40 (1.0) 36 (0.9)	60 (1.5) 54 (1.35)	80 (2.0) 72 (1.8)
Density, g/cm^3	ASTM D 792	90,000 Kg	≥ 0.94	≥ 0.94	≥ 0.94	≥ 0.94
Tensile Properties (each direction) Strength at Break, lb/in-width (N/mm) Strength at Yield, lb/in-width (N/mm) Elongation at Break, (%) Elongation at Yield, (%)	ASTM D 6693, Type IV Dumbbell, 2 imp G.L. 2.0 in (50 mm) G.L. 1.3 in (33 mm)	9,000 Kg	 114 (20) 63 (11) 700 12	 152 (27) 84 (15) 700 12	 228 (40) 126 (22) 700 12	 304 (53) 168 (29) 700 12
Tear Resistance, lb (N)	ASTM D 1004	20,000 Kg	21 (93)	28 (125)	42 (187)	56 (249)
Puncture Resistance, lb (N)	ASTM D 4833	20,000 Kg	54 (240)	72 (320)	108 (480)	144 (640)
Carbon Black Content, % (Range)	ASTM D 1603*/ 4218	9,000 Kg	2.0 - 3.0	2.0 - 3.0	2.0 - 3.0	2.0 - 3.0
Carbon Black Dispersion	ASTM D 5596	20,000 Kg	Note[1]	Note[1]	Note[1]	Note[1]
Notched Constant Tensile Load, hr	ASTM D 5397, appendix	90,000 Kg	> 400	> 400	> 400	> 400
Oxidative Induction Time (OIT) min	ASTM D 3895(200 °C, O2, 1atm)	90,000 Kg	> 100	> 100	> 100	> 100
Typical Roll Dimension						
Roll Length[2], (m)			280	210	140	105
Roll Width[2], (m)			7	5.8	5.8	4
Roll Area[2], (m^2)			1960	1218	812	420

NOTES:

- [1]Dispersion only applies to near spherical agglomerates. 9 of 10 views shall be Category 1 or 2. No more than 1 view from Category 3.
- [2]Roll lengths and widths have a tolerance of ±1%.
- GSE HD is available in rolls weighing approximately 1200 kg.
- All GSE geomembranes have dimensional stability of ±2% when tested according to ASTM D 1204 and LTB of <-77°C when tested according to ASTM D 746.
- *Modified.

GSE is a leading manufacturer and marketer of geosynthetic lining products and services. We've built a reputation of reliability through our dedication to providing consistency of product, price and protection to our global customers.

Our commitment to innovation, our focus on quality and our industry expertise allow us the flexibility to collaborate with our clients to develop a custom, purpose-fit solution.

GSE ENVIRONMENTAL™

[DURABILITY RUNS DEEP] For more information on this product and other. please visit us at GSEworld.com. call 20.2.38288888 or contact your local sales office.

TENCATE

Mirafi®

SEPARATION DRAINAGE

Mirafi® N-Series Nonwoven Polypropylene Geotextiles

for Soil Separation and Drainage

Mirafi® N-Series Nonwoven Geotextiles

TenCate develops and produces materials that function to increase performance, reduce costs and deliver measurable results by working with our customers to provide advanced solutions.

The Difference Mirafi® N-Series Nonwoven Geotextiles Make:

- Construction. Mirafi® N-Series polypropylene nonwoven geotextiles easily conform to the ground or trench surface for trouble free installation.
- Strength. Mirafi® N-Series geotextiles withstand installation stresses with high puncture and tear resistance.
- Drainage. High permittivity properties provide high water flow rates while providing excellent soil retention.
- Environmental. Mirafi® N-Series geotextiles are chemically stable in a wide range of aggressive environments.
- Cost Effective. Mirafi® N-Series geotextiles provide economical solutions to many civil engineering applications including a cost effective alternative to graded aggregate filters.

APPLICATIONS

Mirafi® N-Series nonwoven geotextiles are used in a wide variety of applications including soil separation and drainage applications. Lightweight nonwovens are predominantly used for subsurface drainage applications along highways, within embankments, under airfields, and athletic fields. For these drainage structures to be effective, they must have a properly designed protective filter.

Mirafi® N-Series nonwoven geotextiles eliminates the challenge of determining the aggregate gradation required to match soil conditions, finding a convenient and economical source of a specific aggregate, transporting and placing graded aggregate, and assuring that the constructed in-place drainage system provides effective filter performance.

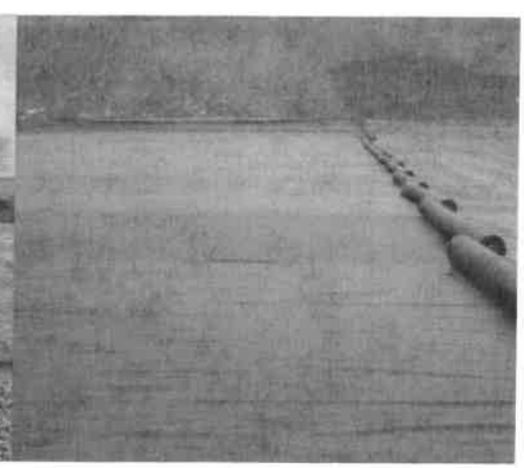
Heavyweight nonwovens are used in critical subsurface drainage systems, soil separation, permanent erosion control, and geomembrane liner protection within landfills. These geotextiles provide the required strength and abrasion resistance to withstand installation and application stresses to create an effective, long term drainage solution.

INSTALLATION GUIDELINES*

French and Trench Drains Geosynthetic Placement

Cut geosynthetic to proper width prior to placement. Width should be enough to conform to the trench perimeter with at least a 15cm (6in) top overlap. Place the geosynthetic roll over the trench, and unroll enough geosynthetic that the geosynthetic can be placed down into the trench. Anchor the edges of the geosynthetic with heavy objects to prevent the geosynthetic from falling into the trench. Where overlaps are necessary between rolls, allow for 1m (3ft) overlap from the upstream to the downstream roll.

* These guidelines serve as a general basis for installation. Detailed instructions are available from your TenCate™ representative.



Protective & Outdoor Fabrics
Aerospace Composites
Armour Composites
Geosynthetics
Industrial Fabrics
Synthetic Grass

TENCATE
materials that make a difference

TENCATE Mirafi®

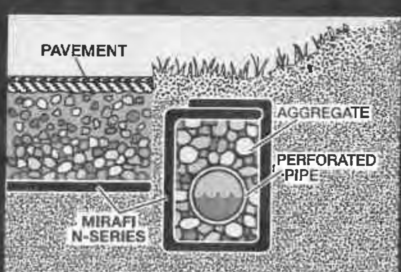
Mirafi® N-Series Nonwoven Polypropylene Geotextiles
for Soil Separation and Drainage

Property / Test Method	Units	140NL	140NC	140N	160N	170N	[illegible]	1100N	1120N	1160N
MECHANICAL PROPERTIES						Minimum Average Roll Value				
Grab Tensile Strength ASTM D4632										
Strength	lbs (N)	90 (401)	100 (445)	120 (534)	160 (712)	180 (801)	205 (912)	250 (1113)	300 (1335)	380 (1691)
Elongation	%	50	50	50	50	50	50	50	50	50
Trapezoid Tear Strength	lbs	40	45	50	60	75	80	100	115	140
ASTM D4533	(N)	(178)	(200)	(223)	(267)	(334)	(356)	(445)	(512)	(623)
CBR Puncture Strength	lbs	250	250	310	410	450	500	700	800	1025
ASTM D6241	(N)	(1113)	(1113)	(1380)	(1825)	(2003)	(2224)	(3115)	(3560)	(4561)
HYDRAULIC PROPERTIES										
						Maximum Opening Size				
Apparent Opening Size (AOS) ASTM D4751	US Sieve mm	50 (0.30)	70 (0.212)	70 (0.212)	70 (0.212)	70 (0.212)	80 (0.18)	100 (0.15)	100 (0.15)	100 (0.15)
						Minimum Roll Value				
Permittivity ASTM D4491	sec^{-1}	2.0	2.0	1.7	1.5	1.4	1.4	0.8	0.8	0.7
Flow Rate ASTM D4491	$gal/min/ft^2$ ($l/min/m^2$)	145 (5907)	140 (5704)	135 (5500)	110 (4481)	105 (4278)	95 (3870)	75 (3056)	65 (2648)	50 (2037)
						Minimum Test Value				
UV Resistance after 500 hrs. ASTM D4355	% strength	70	70	70	70	70	70	70	70	70

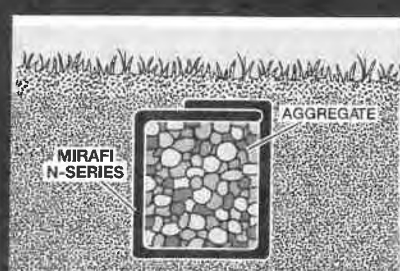
Packaging	Units	140NL	140NC	140N	160N	170N	[illegible]	1100N	1120N	1160N
Roll Width	ft (m)	12.5 (3.8) 15.0 (4.6)	12.5 (3.8) 15.0 (4.6)	12.5 (3.8) 15.0 (4.6)	15.0 (4.6)	15.0 (4.6)	15.0 (4.6)	15.0 (4.6)	15.0 (4.6)	15.0 (4.6)
Roll Length	ft (m)	360 (110)	360 (110)	360 (110)	300 (91)	300 (91)	300 (91)	300 (91)	300 (91)	150 (46)
Area	yd^2 (m^2)	500 (418) 600 (502)	500 (418) 600 (502)	500 (418) 600 (502)	500 (418)	500 (418)	500 (418)	500 (418)	500 (418)	250 (209)

Note: Values and methods could change without notice

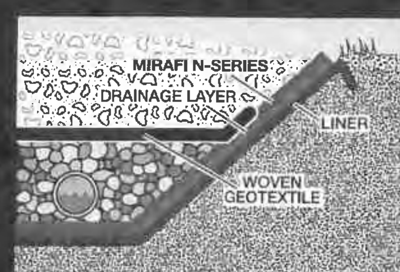
Mirafi® N-Series Nonwoven Geotextiles



Cut-off/Interceptor Drain Along a Roadway Or Another Critical Structure



French Drain Without Pipe



Liner Protection Within a Landfill

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TENCATE materials that make a difference

Figures

ATTACHMENTS

Trench Details and Photographs

Earth Fissure Mitigation Sheets

Preconstruction Design Review:

Requests for Modification of Recommended Earth Fissure Mitigation

Appendix A

ADWR GWSI HYDROGRAPHS

Appendix B

Nonwoven Filter Fabric and Biaxial Geogrid Technical Specifications

GSE HDPE Geomembrane Liner Product Data Sheet