R E P O R T

GEOLOGIC HAZARDS EVALUATION
AJ ROCK LLC PROPERTY
6695 SOUTH WASATCH BOULEVARD
COTTONWOOD HEIGHTS, UTAH

Prepared for

Gordon Geotechnical Engineering, Inc.
4426 South Century Drive, Suite 100
Salt Lake City, Utah 84123

May 11, 2020

Prepared by

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May 11, 2020

Patrick R. Emery – Principal Engineer
Gordon Geotechnical Engineering, Inc.
4426 South Century Drive, Suite 100
Salt Lake City, Utah 84123

Letter of Transmittal: REPORT
Geologic Hazards Evaluation
AJ Rock LLC Property
6695 South Wasatch Boulevard
Cottonwood Heights, Utah

Dear Mr. Emery:

Western Geologic & Environmental has completed a Geologic Hazards Evaluation for the AJ Rock LLC Property at 6695 South Wasatch Boulevard in Cottonwood Heights, Utah and submits the attached report for your review.

If you have any questions regarding this report, please contact us at (801) 359-7222.

Sincerely,
Western Geologic & Environmental LLC

Bill. D. Black, P.G.
Subcontract Geologist

Reviewed By:

Kevin J. Thomas, P.G.
Principal Geologist

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WG&E Project No. 5342

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1.0 INTRODUCTION

This report presents the results of a geology and geologic hazards review and evaluation conducted by Western Geologic & Environmental LLC (Western Geologic) for the AJ Rock LLC property at roughly 6695 South Wasatch Boulevard in Cottonwood Heights City, Utah (Figure 1 – Project Location). The site is in eastern Salt Lake Valley at the western base of the Wasatch Range north of Big Cottonwood Canyon, in the SE¼ Section 23, Township 2 South, Range 1 East (Salt Lake Base Line and Meridian). Elevation of the site is about 4,820 to 5,010 feet above sea level. The site has been an active gravel mining operation since the mid-1950s and considerable material (up to 100 feet or more in the eastern part) has been removed. Much of the site is mantled by fill of varying thicknesses from gravel mining operations. Based on an April 24, 2020 McNeil Engineering conceptual grading plan, the site is currently proposed for mixed-used development by five commercial buildings, a hotel, a large apartment building, a condominium tower, a senior living center, various ancillary parking areas and re-alignment of Wasatch Boulevard.

2.0 PURPOSE AND SCOPE

The purpose and scope of this investigation is to identify and interpret surficial geologic conditions at the site to identify potential risk from geologic hazards to the Project. This investigation is intended to: (1) provide preliminary geologic information and assessment of geologic conditions at the site; (2) identify potential geologic hazards that may be present and qualitatively assess their risk to the intended site use; and (3) provide recommendations for additional site- and hazard-specific studies or mitigation measures, as may be needed based on our findings. Such recommendations could require further multi-disciplinary evaluations, and/or may need design criteria that are beyond our professional scope. Our investigation was conducted concurrently with a geotechnical engineering study performed at the Project by Gordon Geotechnical.

Maps included in Appendix A of the Cottonwood Heights City's Sensitive Lands Evaluation & Development Standards (SLEDS; Cottonwood Heights City Municipal Code Title 19, Chapter 19.72) show the property is located in Surface Fault Rupture Study Area (Map 1), a "High" Slope Stability Hazard Area (Map 2), a "Very Low" Liquefaction Hazard Area (Map 3), a "Low" Debris Flow Hazard Area (Map 4), and a "Moderate" Rock Fall Hazard Area (Map 5). Appendix A, Map 10, provides a surficial geologic map based on U.S. Geological Survey Map I-2106 (Personius and Scott, 1992), which is incorporated into Personius and Scott (2009).

2.1 Methodology

The following services were performed in accordance with the above-stated purpose and scope:

- A site reconnaissance conducted by an experienced certified engineering geologist to assess the site setting and look for adverse geologic conditions;

- Review of readily-available geologic maps, reports, and air photos;
- Logging of eight exploratory trenches at the site in 2009 and one trench in 2020 to identify the presence and location of any active faults, assess zones of fault-related deformation, and recommend appropriate fault set-back distances and safe "buildable" areas should faults be discovered;
- Preparation of three cross section profiles based on site-specific subsurface data and inferred conditions; and
- Evaluation of available data and preparation of this report, which presents the results of our study.

The engineering geology section of this report has been prepared in accordance with Bowman and Lund (2016), current generally accepted professional engineering geologic principles and practice in Utah, and the Cottonwood Heights City SLEDS. However, we do not include discussion of radon hazard potential, as recommended in Bowman and Lund (2016), because radon gas poses an environmental health hazard and indoor levels are heavily influenced by several post-construction, non-geologic factors. The hazard from radon should be evaluated by long-term testing following construction.

2.2 Limitations and Exceptions

This investigation was performed at the request of the Client using the methods and procedures consistent with good commercial and customary practice designed to conform to acceptable industry standards. The analysis and recommendations submitted in this report are based upon the data obtained from site-specific observations and compilation of known geologic information. This information and the conclusions of this report should not be interpolated to adjacent properties without additional site-specific information. In the event that any changes are later made in the location of the proposed site, the conclusions and recommendations contained in this report shall not be considered valid unless the changes are reviewed and conclusions of this report modified or approved in writing by the engineering geologist.

This report has been prepared by the staff of Western Geologic for the Client under the professional supervision of the principal and/or senior staff whose seal(s) and signatures appear hereon. Neither Western Geologic, nor any staff member assigned to this investigation has any interest or contemplated interest, financial or otherwise, in the subject or surrounding properties, or in any entity which owns, leases, or occupies the subject or surrounding properties or which may be responsible for environmental issues identified during the course of this investigation, and has no personal bias with respect to the parties involved.

The information contained in this report has received appropriate technical review and approval. The conclusions represent professional judgment and are founded upon the findings of the investigations identified in the report and the interpretation of such data based on our experience and expertise according to the existing standard of care. No other warranty or limitation exists, either expressed or implied.

The investigation was prepared in accordance with the approved scope of work outlined in our proposal for the use and benefit of the Client; its successors, and assignees. It is based, in part, upon documents, writings, and information owned, possessed, or secured by the Client. Neither this report, nor any information contained herein shall be used or relied upon for any purpose by any other person or entity without the express written permission of the Client. This report is not for the use or benefit of, nor may it be relied upon by any other person or entity, for any purpose without the advance written consent of Western Geologic.

In expressing the opinions stated in this report, Western Geologic has exercised the degree of skill and care ordinarily exercised by a reasonable prudent environmental professional in the same community and in the same time frame given the same or similar facts and circumstances. Documentation and data provided by the Client, designated representatives of the Client or other interested third parties, or from the public domain, and referred to in the preparation of this assessment, have been used and referenced with the understanding that Western Geologic assumes no responsibility or liability for their accuracy. The independent conclusions represent our professional judgment based on information and data available to us during the course of this assignment. Factual information regarding operations, conditions, and test data provided by the Client or their representative has been assumed to be correct and complete. The conclusions presented are based on the data provided, observations, and conditions that existed at the time of the field exploration.

3.0 GEOLOGY

3.1 Surficial Geology

Utah Geological Survey Map 243DM (Surficial geologic map of the Salt Lake City segment and parts of adjacent segments of the Wasatch fault zone, Davis, Salt Lake, and Utah Counties, Utah; Personius and Scott, 2009) maps the site in an area underlain by Bells Canyon glacial outwash; and clay, silt, sand, and gravel related to the transgressive stage of Lake Bonneville. Two main, west-dipping traces of the active Salt Lake City section of the WFZ are mapped by Personius and Scott (2009) diverging from a single trace southeast of the site into two northwest-trending en-echelon traces that cross the Project. A third main west-dipping trace is mapped by Personius and Scott (2009) near the northeastern site corner.

More-recent, 1:24,000-scale mapping by McKean (2018) and McKean and Solomon (2018) is provided on Figure 2. McKean (2018) shows the Project straddles a broad zone of fault deformation bounded by two west-dipping main traces of the WFZ on the east and west, with a third partly concealed west-dipping trace crossing the site (Figure 2). All these fault traces diverge from a single trace further south similar to Personius and Scott (2009). McKean (2018) maps the site in an area underlain by Holocene to upper Pleistocene stream deposits, upper Pleistocene deltaic deposits related to the Bonneville shoreline and transgressive phase of Lake Bonneville, and lacustrine gravel and sand of similar provenance (units Qaly, Qdlb and Qlgb; Figure 2). McKean (2018) describes these units as follows:

Qaly **–** Young stream deposits, undivided (Holocene to upper Pleistocene). Poorly to moderately sorted pebble and cobble gravel, locally bouldery, with a matrix of sand and silt; mapped in channels and active floodplains of Big Cottonwood, Parleys, Emigration, and Mill Creeks and small creeks; locally includes small alluvial-fan and colluvial deposits; includes level-2 stream deposits (Qal2) incised by active streams with level-1 stream deposits (Qal1); Qal1 and Qal2 deposits cannot be mapped separately, due to lack of bars and swales and because patches of deposits are too small to show separately at map scale; postdates regression of Lake Bonneville from the Provo shoreline and lower shorelines; thickness variable, probably less than 30 feet (10 m).

Deposits related to the Bonneville shoreline and transgressive phase of Lake Bonneville: Mapped between the Bonneville and Provo shorelines. The Bonneville shoreline is at elevations from about 5160 to 5230 feet (1570–1595 m) in the Sugar House quadrangle (table 1).

Qldb **–** Deltaic deposits, undivided (upper Pleistocene). Moderately to well-sorted gravel and sand, locally including thin beds of silt and sandy silt; clasts subrounded to rounded; thin to thick planar and cross-bedded foreset beds; locally includes topset alluvial beds; locally weakly cemented with calcium carbonate; undivided (Qldb) where exposed in bluffs between streams or below terraces, subdivided into a gravelly unit (Qldbg) where delta contains clast-supported, pebble and cobble gravel in a matrix of sand and silt; present near the mouth of Big Cottonwood Canyon; previously mapped near the mouth of Big Cottonwood Canyon as outwash of Bells Canyon age by Personius and Scott (1992; gbco), but mapped here as deltaic based on the delta fan-shape and moderately to well-sorted, well-rounded gravel and sand in planar and foreset beds exposed in sand and gravel pits; exposed thickness less than 130 feet (40 m).

Qlgb **–** Lacustrine gravel and sand (upper Pleistocene). Moderately to well-sorted, clast-supported, pebble to cobble gravel, with boulders near bedrock sources, with a matrix of sand and pebbly sand; locally interbedded with thin beds and lenses containing silt and clay; clasts commonly subrounded to rounded, but some deposits consist of poorly sorted, angular gravel derived from nearby bedrock outcrops; deposited between the Bonneville and Provo shorelines in planar and cross-bedded beds; typically overlies bedrock near the foot of the Wasatch Range; commonly covered by unmapped colluvium from adjacent steep slopes on erosional benches at the Bonneville shoreline; this colluvium is thin and does not cover the benches; exposed thickness less than 75 feet (25 m).

Citations, tables and/or figures referenced above, and descriptions of nearby surficial geologic units shown on Figure 2 are not provided herein but are in McKean (2018).

3.2 Seismotectonic Setting

The property is located in Salt Lake Valley at the western base of the Wasatch Range about 1.1 miles northwest of the mouth of Big Cottonwood Canyon. Salt Lake Valley is a deep, sediment-filled structural basin of Cenozoic age that is bounded by two uplifted range blocks, the Oquirrh Mountains and the Wasatch Range (to the west and east, respectively). The valley lies at the eastern edge of the Basin and Range physiographic province (Stokes, 1977, 1986). The Basin and Range province is characterized by a series of generally north-trending elongate mountain ranges, separated by predominately alluvial and lacustrine sediment-filled valleys and typically bounded on one or both sides by major normal faults (Stewart, 1978). The boundary between the Basin and Range and Middle Rocky Mountains provinces is the prominent, west-facing escarpment along the Wasatch fault zone at the western base of the Wasatch Range. Late Cenozoic normal faulting, a characteristic of the Basin and Range, began between about 17 and 10 Ma (million years ago) in the Nevada (Stewart, 1980) and Utah (Anderson, 1989) portions of the province. The faulting is a result of a roughly east-west directed, regional extensional stress regime that has continued to the present (Zoback and Zoback, 1989; Zoback, 1989).

The Wasatch fault zone (WFZ) is one of the longest and most active normal-slip faults in the world and extends for 213 miles along the western base of the Wasatch Range from southeastern Idaho to north-central Utah (Machette and others, 1992). The fault zone generally trends north-south and, at the surface, can form a zone of deformation up to several hundred feet wide containing many subparallel west-dipping main faults and east-dipping antithetic faults. Previous studies divided the fault zone into 10 sections, each of which rupture independently and are capable of generating large-magnitude surface-faulting earthquakes (Machette and others, 1992). The central five sections of the fault (Brigham City, Weber, Salt Lake, Provo, and Nephi) have each produced two or more surface-faulting earthquakes in the past 6,000 years (Black and others, 2003).
The site is located along the active Salt Lake City section of the WFZ, which trends across the heavily populated east side of Salt Lake Valley. The Salt Lake City section is further divided into three subsections (from north to south): Warm Springs, East Bench, and Cottonwood. The site is located at the northern end of the Cottonwood (southernmost) subsection.

Personius and Scott (2009) and McKean (2018; Figure 2) map three main traces of the WFZ that bound and/or cross the site and trend generally northward. The faults form a broad zone of en-echelon, down-to-the-west faulting from 700 to 1,200 feet wide on which the site is situated. The Working Group on Utah Earthquake Probabilities (2016; Table 4.1-1) indicates mean timing (+ 2σ) for the last four surface-faulting earthquakes on the Salt Lake City section is: (1) 1,300 + 200 years, (2) 2,200 + 200 years, (3) 4,100 + 300 years, and (4) 5,300 + 200 years. The Working Group on Utah Earthquake Probabilities (2016; Table 4.1-2) indicates a closed mean recurrence interval for the Salt Lake City section, based on timing for the last four surface-faulting earthquakes, of 1,300 + 100 years.

The site is also in the central portion of the Intermountain Seismic Belt (ISB), a generally north-south trending zone of historical seismicity along the eastern margin of the Basin and Range province extending from northern Arizona to northwestern Montana (Sbar and others, 1972; Smith and Sbar, 1974). At least 16 earthquakes of magnitude 6.0 or greater have occurred within the ISB since 1850; the largest of these earthquakes was a M 7.5 event in 1959 near Hebgen Lake, Montana. None of these earthquakes occurred along the Wasatch fault or other known late Quaternary faults (Arabasz and others, 1992; Smith and Arabasz, 1991). The closest event was the 1934 Hansel Valley (M 6.6) event north of the Great Salt Lake. The March 18, 2020 M 5.7 earthquake north of Magna, Utah reportedly showed a style, location, and slip depth consistent with an earthquake on the Wasatch fault system (https://earthquake.usgs.gov/earthquakes/eventpage/uu60363602/executive). Despite being moderate in size (less than magnitude 6.0), this earthquake was felt from southern Idaho to south-central Utah and caused serious damage to multiple buildings (https://www.ksl.com/article/46731630/).

3.3 Lake Bonneville History

Lakes occupied nearly 100 basins in the western United States during late-Quaternary time, the largest of which was Lake Bonneville in northwestern Utah. The Bonneville basin consists of several topographically closed basins created by regional extension in the Basin and Range (Gwynn, 1980; Miller, 1990), and has been an area of internal drainage for much of the past 15 million years. Lake Bonneville consisted of numerous topographically closed basins, including the Salt Lake and Cache Valleys (Oviatt and others, 1992). Sediments from Lake Bonneville comprise much of the unconsolidated deposits in the site vicinity.

Timing of events related to the transgression and regression of Lake Bonneville are indicated in Oviatt (2015). Approximately 30,000 years ago, Lake Bonneville began a slow transgression (rise) to its highest level of 5,160 to 5,200 feet above mean sea level. The lake rise eventually slowed as water levels approached an external basin threshold in northern Cache Valley at Red Rock Pass near Zenda, Idaho. Lake Bonneville reached the Red Rock Pass threshold and occupied its highest shoreline, termed the Bonneville beach, around 18,000 years ago. Headward erosion of the Snake River-Bonneville basin drainage divide, possibly combined with landsliding in the threshold area, then caused a catastrophic incision that caused the lake level to lower by about 425 feet in less than a year (Jarrett and Malde, 1987; O'Conner, 1993). Following the Bonneville flood, the lake stabilized and formed a lower shoreline referred to as the Provo shoreline up to about 16,000 years ago. Climatic factors then caused the lake to regress rapidly from the Provo shoreline, and by about 13,000 years ago the lake had eventually dropped below historic levels of Great Salt Lake. Oviatt and others (1992) deem this low stage the end of the Bonneville lake cycle. Great Salt Lake then experienced a brief transgression between 12,800 and 11,600 years ago to the Gilbert level at about 4,250 feet before receding to and remaining within about 20 feet of its historic average level (Lund, 1990; Oviatt, 2015). The site is located slightly above the Provo shoreline, but below the highest Bonneville shoreline.

Glaciers in Little Cottonwood and Bells Canyons advanced into eastern Salt Lake Valley from the Wasatch Range between 26,000 and 18,000 years ago (Personius and Scott, 1992, 2009). Lake Bonneville was in its transgressive stage during this time, but stood at an intermediate level prior to reaching its highest Bonneville shoreline. Till deposited by the glaciers formed prominent moraines extending into the valley, and meltwater from glaciers in Bells Canyon and Little and Big Cottonwood Canyons deposited gravelly outwash fans along the range front (Personius and Scott, 1992). The site is partly mapped in outwash deposits from Big Cottonwood Canyon (unit gbco, Figure 2). As Lake Bonneville continued rising, the glaciers retreated up their respective valleys, the outwash deposits were eventually inundated by the lake, and deposition continued in deltas extending into the lake. When Lake Bonneville receded, the deltas and outwash deposits were downcut and eroded by Big and Little Cottonwood Creeks.

4.0 SITE CHARACTERIZATION

4.1 Empirical Observations

On March 25-26, 2020, Mr. Bill D. Black of Western Geologic conducted a brief reconnaissance of the property to observe geomorphic and surficial conditions. The reconnaissance was conducted in conjunction with additional subsurface investigation in the northern part of the site. Weather on March 25 was cloudy with snow and temperatures in the 30's (°F). The site is in eastern Salt Lake Valley at the western base of the Wasatch Range north of Big Cottonwood Canyon and has been an active gravel mining operation since the mid-1950s. Considerable material has been removed in the fault zone by gravel mining, with subvertical cut slopes a hundred feet high or more in this area. Much of the site is mantled by fill of varying thicknesses from gravel mining operations. The gravel pit was not in operation at the time of our reconnaissance, but was active when most of the trenching was conducted at the site in 2009. No springs or seeps were observed at the Project and no evidence for characteristic debris-flow features, landslides, recent or ongoing slope instability, rock fall source areas, or other geologic hazards was observed to the extent that surface areas at the Project could be accessed and viewed.

4.2 Air Photo Observations

Figure 3A shows a 1938 pre-gravel mining air photo of the site from historical photography flown for the Salt Lake Aqueduct Project (frames sla1-20 and sla1-21, original scale 1:20,000; Bowman and Beisner, 2008). The air photo center was approximately registered to the UTM NAD83 grid system by Bowman and Beisner (2008). However, we further adjusted the photo scale, rotation, and placement to correspond to range front bedrock exposures evident on the 1938 photos and 2006 U.S. Geological Survey digital orthophotography available from Utah AGRC. The 1938 photos were then enlarged and overlaid with the site boundary for stereo viewing. Several northwest-trending escarpments were observed on Figure 3A crossing the site, which correspond to locations of significant faults encountered in the trenches (discussed below and shown in red, with bar and ball on downthrown side). Except for some broad correlations, surficial faulting evidence is obscured by gravel mining disturbance on 1977 and later air photos and a 2013 geoprocessed LIDAR image available from the Utah AGRC (Figures 3B through 3E). No evidence for other geologic hazards was observed on the air photos at the site or in the area.

4.3 Subsurface Investigation

Eight trenches were excavated and logged at the Project in 2009 and one trench was excavated and logged in 2020 to evaluate subsurface geologic conditions and assess the potential hazard from surface faulting. The 2009 investigation was conducted prior to formalization of the current Cottonwood Heights City SLEDS, based on an estimated timeline provided by Tim Thompson of GeoStrata. No work plan was prepared for the 2009 investigation, and no Project scoping or field reviews were conducted. A work plan dated March 2, 2020 was prepared for the 2020 investigation that was approved by Tim Thompson of GeoStrata on March 17, 2020. A field review for trench T-9 was conducted with Mr. Thompson on March 27, 2020.

Trench excavation and logging in 2009 was performed on weekends to facilitate backfilling and restoration and allow for unrestricted construction vehicle access prior to active operations each following Monday. Subsurface exploration was limited to accessible areas not mantled by large gravel piles, such as along roads, and further restricted by the easement for the aqueduct crossing the site. No exploration was conducted in steep areas of the eastern part of the Project (east of the steep escarpments from gravel mining) and no long continuous trench exposures were feasible. The trenches were excavated to a safe depth sufficient to expose lacustrine sediments from Lake Bonneville capable of displaying active faulting and providing good chronostratigraphic markers. Deep fill materials were encountered in places that complicated excavation and logging, such as from active and inactive utility lines, old pit excavations, backfilled settling ponds, and past grading activities. Although native sediments were exposed, excavation in some areas could not extend deep enough to expose correlative stratigraphy across exposed faults. The trenches also exposed bedded fills that appeared similar to native sediments, which we do not consider unusual given the site use as a gravel pit operation; in general, we interpreted fills where sediments contained anomalous materials or had an abnormal appearance from soil organics inclusion, conservatively erring on the side of a fill interpretation.

Figure 4 is a site plan at a scale of 1:1,200 (1 inch equals 100 feet) showing the site boundary, current development plan, locations for the trenches conducted for our study, locations of three Gordon Geotechnical borings conducted in March 2020, and exposed faults in the trenches (shown by small red lines, with bar and ball on the downthrown side). Trench locations were measured in the field using a handheld GPS and by trend and distance methods, and subsequently surveyed to provide positional accuracy. The 2009 trenches were surveyed by Benchmark Engineering and the 2020 trench (T-9) was surveyed by McNeil Engineering. Surveyed elevations for significant faults are tagged in blue on Figure 4 to show the highest point of the fault in the trench exposure. Fault elevation is shown because the site has been and will be subject to significant surface modification, which may change the fault location depending on dip direction, angle, and amount of surface material removed. The trenches generally provide good overlapping coverage given a presumed overall fault trend of about N15°W.

The trenches at the Project were excavated in three general alignments: (1) a southern alignment formed by T-1, T-2, T-7, and T-8; (2) a middle alignment consisting of T-3, T-4, T-5, and T-6; and (3) a northern alignment consisting of T-9 (Figure 4). T-1 extended an overall S87°W for a total distance of 125 feet (stations -5.0 feet to 120.0 feet, east to west, Figures 4 and 5). T-2 extended an overall S64°W for a total distance of 280 feet (stations -5.0 feet to 275.0 feet, east to west, Figures 4 and 6). T-3 extended an overall S85°E for a total distance 192.5 feet (stations -1.5 feet to 191.0 feet, west to east, Figures 4 and 7). T-4 extended an overall S73°E for a total distance of 211.4 feet (stations -4.0 to 207.4 feet, west to east, Figures 4 and 8). T-5 extended sinuously an overall S82°E for a total distance of 339 feet (stations -5.0 feet to 334.0 feet, west to east, Figures 4 and 9). T-6 extended an overall S77°W for a total distance of 171 feet (stations -5.0 feet to 166.0 feet, east to west, Figures 4 and 10). T-7 extended an overall N79°E for a total distance of 146.3 feet (stations -3.4 feet to 143.0 feet, west to east, Figures 4 and 11). T-8 extended an overall S77°W for a total distance of 373.1 feet (stations -3.1 feet to 370 feet, east to west, Figures 4 and 12). T-9 extended an overall N87°W for a total distance of 218 feet (stations -5.0 feet to 218.0 feet, east to west, Figures 4 and 13).

Figures 5 through 13 are detailed logs of the trenches at a scale of 1:60 (1 inch equals 5 feet). Due to space restraints and the scale of the logs, all of the trenches cover multiple sheets. Except for some schematic clasts and within the defined log scale, the logs generally accurately depict notable bedding and texture observed in the trenches. With the exception of trench T-2, which was excavated west from the east end and then east from west end to mate up, original stations and logging direction are preserved on the logs. Trench locations are shown on Figure 4 with stations denoted on the logged wall. The trenches were digitally photographed to document the exposures at either 5- or 10-foot intervals. These photos are not provided herein, but are available on request. Trench logging generally followed methodology in McCalpin (1996), with the exception that soil horizons were not logged due to surficial disturbance.

The trenches at the site mainly exposed a well-bedded sequence of lacustrine-deltaic fine sand and silt that coarsened eastward to sandy, cobbly, and bouldery crossbedded gravels. Alluvium may have been present at the surface overlying the lacustrine-deltaic sediments, but was stripped off during early gravel pit activities and was not observed in the trenches. The depositional sequence exposed in the trenches at the site consisted of (from oldest to youngest): (1) a lower, strongly east-dipping, crossbedded sandy gravel below an intra-unit angular unconformity and an overlying west-dipping cobbly to bouldery gravel (exposed as unit 1a in T-5 and T-7, and unit 2 in T-6; Figures 9 through 11); (2) a thin unit of deformed sand to silt, likely from a low-energy landslide that occurred subaqueously in Lake Bonneville shortly after its transgression across the site (exposed as unit 1a in T-3, and 1b in T-1, T-2, T-4, and T-5; Figures 5-9); and (3) a sequence of interbedded and crossbedded sand and gravel deposits with lesser silt (exposed as unit 1c in T-1, T-5, and T-7; units 1c and 1d in T-2 and T-4; unit 1b in T-3; and unit 1g in T-8; Figures 5 through 9, 11, and 12). Interbedded and interfingering sand and gravel was exposed in trench T-9 that we infer corresponds to the latter. The sediments likely represent glacial outwash from Big Cottonwood Canyon accumulating in the delta emanating from the canyon mouth, followed by Lake Bonneville inundation and subsequent deltaic deposition in the lake. Trench T-8 also exposed lacustrine clay and gravelly clay likely deposited in a lagoon behind a longshore barrier bar (units 1e an 1f, Figure 12) , and T-6 exposed a pre-Lake Bonneville or near-shore landslide deposit comprised of lean to fat blue-gray clay with mineralized wood debris and bone fragments in the footwall of fault F9 (unit 1, Figure 10).

All of the trenches at the site, except for T-5, exposed one or more faults that displace the Lake Bonneville stratigraphic sequence. No evidence for faulting was observed in T-5. Major faults showing more than 4 feet of displacement were observed in trenches T-3, T-6, T-7, and T-8, corresponding to three main, west-dipping, en-echelon traces (from west to east): (1) a trace formed by F1 and F2 on the west side of the project, which appears to converge northward; (2) fault F7 in the central part of the project; and (3) faults F8 and F9 in the eastern part of the project, which also converge northward (Figure 4). The faults correspond to visible west-facing escarpments on Figure 3A that form a series of steps from west to east across the site. Minor faults with between 0.3 and 4.0 feet of displacement were observed in T-2, T-4, and T-7, corresponding to faults F2 through F6. These faults converge northward with F1 and F7 (Figure 3A). Two antithetic faults were also exposed in the trenches: (1) AF1 on the west side of the project in the westernmost escarpment on Figure 4, and (2) AF2 on the east side, which forms a graben bounded by a fourth major west-dipping fault to the east on Figure 3A. Small displacement faults with less than 0.3 feet of displacement were observed in T-1, T-2, and T-4. The small displacement faults in T-2 and T-4 are in the F3/F4 zone, whereas the faults in T-1 appear to be unrelated and do not correspond to any surficial features on Figure 3A. Trench T-9 exposed a fault with 0.5 feet of down-to-the-west offset that displaces and is overlain by lacustrine sand and gravel (which is suggestive an intra-lacustrine event), a younger fault with 0.7 feet of down-to-the-west offset that displaces the lacustrine sequence to the fill base, and a narrow zone of crack fill in the lacustrine sequence that displayed no net displacement. A lineament is on the 1938 air photo that suggests this fault (F10, Figure 4) trends to the southeast and then bends eastward to converge with F9. No trenching could be conducted to confirm the fault location southeast of trench T-9 due to the aqueduct easement.

4.4 Cross Sections

Figures 14 through 16 shows three cross sections (A-A’, B-B’, and C-C’) across the site as located on Figure 4. Figure 14 is at a scale of 1 inch equals 25 feet, Figure 15 is at a scale of 1 inch equals 50 feet, and Figure 16 is at a scale of 1 inch equals 40 feet with no vertical exaggeration. The topographic profiles are based on geoprocessed 2013 LIDAR data. The LIDAR data provides a snapshot of topographic conditions at the time it was acquired; past, present and future topographic conditions may vary. Cross Section A-A’ is based on the stratigraphic sequence in trenches T-5, T-6, and T-9. Cross Section B-B’ is based on the stratigraphic sequence in trenches T-5 and T-6 and subsurface data from Gordon Geotechnical boring B-3. Cross section C-C’ is based on the stratigraphic sequence in trenches T-6, T-7, and T-8, as well as subsurface data from Gordon Geotechnical boring B-2. Units and contacts should be considered approximate and inferred, and variations should be expected at depth and laterally. We caution that some portions of the cross sections have limited or no subsurface data.

No groundwater was encountered in Gordon Geotechnical boring B-3 or any of the trenches at the site, except for in the base of the old tank excavation in trench T-2 (Figure 6C, stations 155 feet to about 190 feet). Groundwater in trench T-2 was at a depth of about 13 feet below the ground surface (bgs), and was encountered at a depth of 22.5 feet bgs in boring B-1 and at a depth of 29 feet bgs in boring B-2 (Figure 4). Based on this, groundwater deepens between trench T-2 and boring B-2 from 13 to 29 feet deep, and deepens to more than 100 feet between borings B-2 and B-3. These data suggest a southwestward flow direction. Inferred groundwater levels are shown on the cross sections.

5.0 GEOLOGIC HAZARDS

Assessment of potential geologic hazards and the resulting risks imposed is critical in determining the suitability of the site for development. Table 1 below shows a summary of the geologic hazards reviewed at the site, as well as a relative (qualitative) assessment of risk to the Project for each hazard. A "high" hazard rating (H) indicates a hazard is present at the site (whether currently or in the geologic past) that is likely to pose significant risk and/or may require further study or mitigation techniques. A "moderate" hazard rating (M) indicates a hazard that poses an equivocal risk. Moderate-risk hazards may also require further studies or mitigation. A "low" hazard rating (L) indicates the hazard is not present, poses little or no risk, and/or is not likely to significantly impact the Project. Low-risk hazards typically require no additional studies or mitigation. We note that these hazard ratings represent a conservative assessment for the entire site and risk may vary in some areas. Careful selection of development areas can minimize risk by avoiding known hazard areas.

Table 1. *Geologic hazards summary.*

Hazard	H	M	L
Earthquake Ground Shaking	X		
Surface Fault Rupture	X		
Liquefaction and Lateral-spread Ground Failure		X	
Tectonic Deformation	X		
Seismic Seiche and Storm Surge			X
Stream Flooding			X
Shallow Groundwater		X	
Landslides and Slope Failures		X	
Debris Flows and Floods			X
Rock Fall			X
Problem Soil and Rock			X

5.1 Earthquake Ground Shaking

Ground shaking refers to the ground surface acceleration caused by seismic waves generated during an earthquake. Strong ground motion is likely to present a significant risk during moderate to large earthquakes located within a 60 mile radius of the Project area (Boore and others, 1993). Seismic sources include mapped active faults, as well as a random or "floating" earthquake source on faults not evident at the surface. The Utah Geological Survey Quaternary Fault Database (Black and others, 2003; January 2017 update) shows numerous class A faults within 60 miles of the Project that may pose potential seismic sources.

The extent of property damage and loss of life due to ground shaking depends on factors such as: (1) proximity of the earthquake and strength of seismic waves at the surface (horizontal motions are the most damaging); (2) amplitude, duration, and frequency of ground motions; (3) nature of foundation materials; and (4) building design. Based on 2018 IBC provisions, a site class of D (stiff soil), and a risk category of II, calculated seismic values for the site (centered on 40.6300° N, -111. 7979° W) are summarized below:

Table 2. *Seismic hazards summary.*

Type	Value
S_S	*1.341 g*
S_1	*0.498 g*
S_{MS} (F_a x S_S)	*1.341 g*
S_{M1} (F_v x S_1)	*See ASCE 7-16 Section 11.4.8*
S_{DS} (2/3 x S_{MS})	*0.894 g*
S_{D1} (2/3 x S_{M1})	*See ASCE 7-16 Section 11.4.8*
Site Coefficient, F_a	*= 1.000*
Site Coefficient, F_v	*See ASCE 7-16 Section 11.4.8*
Peak Ground Acceleration, PGA	*= 0.609 g*

Given the above information, earthquake ground shaking poses a high risk to the site. Earthquake ground shaking is a regional hazard common to all Wasatch Front areas. The hazard is mitigated by design and construction in accordance with the current adopted building code. We note that IBC 2018 provisions require calculation of the spectral acceleration value (S_{M1}), seismic design value (S_{D1}), and site coefficient (F_v) differently from IBC 2015. In municipalities where IBC 2018 has been adopted, the Project engineer or architect should determine these seismic values in accordance with ASCE 7-16 Section 11.4.8 guidelines.

5.2 Surface Fault Rupture

Movement along faults at depth generates earthquakes. During earthquakes larger than Richter magnitude 6.5, ruptures along normal faults in the intermountain region generally propagate to the surface (Smith and Arabasz, 1991) as one side of the fault is uplifted and the other side down dropped. The resulting fault scarp has a near-vertical slope. The surface rupture may be expressed as a large singular rupture or several smaller ruptures in a broad zone. Ground displacement from surface fault rupture can cause significant damage or even collapse to structures located on an active fault.

All of the trenches at the site, except for T-5, exposed one or more faults that displace the Lake Bonneville stratigraphic sequence. No evidence for faulting was observed in T-5. Faults displaying 0.3 feet or more of displacement in the trench exposures are correlated across the site on Figure 4 (bold red dashed lines) based on trend, displacement sense and air photo evidence (Section 4.2). The faults are labeled for reference purposes with "F" where west dipping and "AF" where east dipping, and appended with a number (1 through

10 for west-dipping faults, and 1 or 2 for east-dipping faults) to denote specific traces (Figure 4). Small displacement faults (less than 0.3 feet) are noted where they were encountered in a trench, but are not correlated. With the exception of trench T-1, all of the small displacement faults were observed in existing fault zones with larger displacements. Table 3A is a compilation of fault data from the trenches at the site, and shows the log station of each trenched fault, fault trends, and dip angles.

Given the above, the risk from surface faulting is high at the site. Based on our current understanding that surface fault rupture and deformation tend to follow past patterns, we recommend a non-buildable (setback) zone around the projected traces of the fault crossing the site as shown on Figure 4. Calculated setback distances based on the fault parameters and guidelines in Lund and others (2016) are also indicated on Table 3A. Recommended setback distances are shown on Table 3B. The fault setback for the downthrown side of active faults at the Project was calculated using:

$$\mathbf{S = U\,(2D + F/\tan\theta)}$$

where:

S = Setback distance from active faults;

U = Criticality factor (2.0 for IBC class IIb structures);

D = Expected maximum fault displacement per event (assumed to be the measured vertical displacement or, if not measured or confidently determined, a maximum displacement of 8.5 feet is used; all displacements are conservatively assumed to be from a single event unless there is evidence otherwise);

F = Maximum depth of footing or subgrade portion of the building (assumed to be 8 feet); and

θ = Dip of the fault.

The fault setback for the upthrown side of the faults was calculated using the same parameters and:

$$\mathbf{S = U\,(2D)}$$

Small displacement faults (< 0.3 feet of offset) are not listed on Table 3A, but two such faults were observed in trench T-1 underlying Pad E (Figures 4 and 5A). These faults show no evidence for Holocene reactivation that would suggest a future larger displacement is likely. We believe the faults pose a low life-safety risk, but recommend the structure be designed to withstand up to 0.3 feet of vertical offset to reduce the risk of costly repairs. Utility lines that cross faults should also be engineered to withstand expected displacements and/or have design features to ensure life safety.

Table 3A. *Fault parameters and calculated setbacks; fault numbers correspond to Figure 4.*

TRENCH 2, east to west.										
								Setback Distance (S), F=8		Safety
Fault	Elevation[1]	Station[2]	Width (ft)[3]	Trend	Dip (°Θ)	D (ft)	TanΘ	UFS	DFS	Factor[4]
F4	4813.08	10.9	0	N9°W	65	1.0	2.1	4.0	11.5	0.9
F3	4813.57	35.7	0.6	N15°W	68	2.3	2.5	9.2	16.3	0.8
F2	4821.44	219.5-226.1	6.3	N10°W - N15°W	69	2.3	2.6	9.2	21.6	0.8
AF1	4819.36	271.7	0	N10°W	78	1.2	4.7	4.8	8.2	0.4

TRENCH 3, west to east.										
								Setback Distance (S), F=8		Safety
Fault	Elevation[1]	Station[2]	Width (ft)[3]	Trend	Dip (°Θ)	D (ft.)	TanΘ	UFS	DFS	Factor[4]
F1	4810.43	14.9	0	N15°W	59	8.5	1.7	34.0	43.6	1.2
AF1	4810.49	20.2	0	N12°W	47	4.8	1.1	19.2	34.1	1.9
F2	4818.12	48.8	0	N16°W	53	8.5	1.3	34.0	46.1	1.5

TRENCH 4, west to east.										
								Setback Distance (S), F=8		Safety
Fault	Elevation[1]	Station[2]	Width (ft)[3]	Trend	Dip (°Θ)	D (ft.)	TanΘ	UFS	DFS	Factor[4]
F3	4821.24	23	0	N15°W	51	3.9	1.2	15.6	28.6	1.6
F4	4820.32	92.5	0	N13°W	57	0.8	1.5	3.2	13.6	1.3

TRENCH 6, east to west.										
								Setback Distance (S), F=8		Safety
Fault	Elevation[1]	Station[2]	Width (ft)[3]	Trend	Dip (°Θ)	D (ft.)	TanΘ	UFS	DFS	Factor[4]
F9	4837.15	81.6	0	N33°W	75	8.5	3.7	34.0	38.3	0.5

TRENCH 7, west to east.										
								Setback Distance (S), F=8		Safety
Fault	Elevation[1]	Station[2]	Width (ft)[3]	Trend	Dip (°Θ)	D (ft.)	TanΘ	UFS	DFS	Factor[4]
F5	4816.65	30.8-32.0	0.5	N18°E - N27°E	77	1.2	4.3	4.8	9.0	0.5
F6	4816.47	37.6-39.1	1.2	N18°W - N10°W	66	0.6	2.2	2.4	10.7	0.9
F7	4814.01	56.6-62.3	4.6	N18°W	71	5.2	2.9	20.8	30.9	0.7

TRENCH 8, east to west.										
								Setback Distance (S), F=8		Safety
Fault	Elevation[1]	Station[2]	Width (ft)[3]	Trend	Dip (°Θ)	D (ft.)	TanΘ	UFS	DFS	Factor[4]
AF2	4835.04	11.4	0	N10°E	78	1.3	4.7	5.2	8.6	0.4
F9	4833.72	24.6-26.3	1.7	N48°W	57	8.5	1.5	34.0	46.1	1.3
F8	4838.44	139.3	0	N18°W	89	8.0	57.3	32.0	32.3	0.0

TRENCH 9, east to west.										
								Setback Distance (S), F=8		Safety
Fault	Elevation[1]	Station[2]	Width (ft)[3]	Trend	Dip (°Θ)	D (ft.)	TanΘ	UFS	DFS	Factor[4]
F10	4887.04	6.6	0	N35°W	75	0.7	3.7	2.8	7.1	0.5

[1] Surveyed elevation (in 2009 for trenches 1 through 8, in 2020 for trench 9) minus the distance from the ground surface to the highest fault point on the log.

[2] Distance in feet from 0 horizontal.

[3] Width of fault zone between correlative units, or highest fault points if no stratigraphic correlation.

[4] Setback adder per foot where footings are at depths exceeding 8 feet (see below).

Table 3B. *Recommended setbacks.*

Fault	Dip	Setback distance in feet (F=8) West	East	Safety Factor[4]	Notes
F1	SW	43.6	34.0	1.2	*Based on T-3 above.*
F2	SW	46.1	34.0	1.5	*Based on T-3 above.*
F3	SW	28.6	20.0	1.6	*Based on T-4 above.*
F4	SW	20.0	20.0	1.3	*Based on T-4 above.*
F5	NW	20.0	20.0	0.5	*Based on T-7 above.*
F6	SW	20.0	20.0	0.9	*Based on T-7 above.*
F7	SW	30.9	20.8	0.7	*Based on T-7 above.*
F8	SW-NW	32.3	32.0	0.0	*Based on T-8 above.*
F9	SW	46.1	34.0	1.3	*Based on T-8 above.*
F10	SW	20.0	20.0	0.5	*Based on T-9 above.*
AF1	NE	20.0	20.0	1.9	*Based on T-3 above.*

The setback distances on Tables 3A-B and Figure 4 are calculated assuming an 8-foot footing depth from existing grade. However, the Project may require cuts to create level building pads that would have deeper footing depths than we assume. We therefore show a safety factor on Tables 3A and 3B that should be added to the calculated setback distance (S, Table 3A) per 1-foot difference between the surveyed fault elevation (or existing grade) and proposed grade elevation where the difference exceeds 6 feet (assuming footings are 2 feet below grade, for a total depth of 8 feet). The distance between the fault and nearest portion of the structure should be more than the sum. The minimum setback is 20 feet. This safety factor only applies to the downthrown fault sides. For upthrown fault sides, cuts would shift a fault and the corresponding UFS setback horizontally in the direction of dip, i.e. westward for west-dipping faults and eastward for east-dipping faults. The distance may be calculated as follows:

$$\mathbf{\Delta S = H/\tan\theta}$$

where:

ΔS = horizontal distance (shift in feet);

H = cut height (difference in feet between existing and proposed grade elevations); and

θ = Dip of the fault.

We recommend not modifying the defined setback areas on Figure 4 to avoid complexity and because development plans may change. Instead, the Project civil engineer should review the above on a case-by-case basis to ensure that structures are at a safe distance in areas where significant cuts are planned. This may be shown as a table on the grading plan. It is our understanding that minor adjustments will be made with regard to the condominium and Pad E structures on Figure 4. The most-recent grading plan should be submitted at the time our report and the geotechnical engineering report are submitted to Cottonwood Heights City. Though plans may change (and may differ from the base provided on Figure 4), CAD fault and setback delineations on Figure 4 have been confirmed to accurately coincide with those of the Project civil engineer.

5.3 Liquefaction and Lateral-Spread Ground Failure

Liquefaction occurs when saturated, loose, cohesionless, soils lose their support capabilities during a seismic event because of the development of excessive pore pressure. Earthquake-induced liquefaction can present a significant risk to structures from bearing-capacity failures to structural footings and foundations, and can damage structures and roadway embankments by triggering lateral spread landslides. Earthquakes of Richter magnitude 5 are generally regarded as the lower threshold for liquefaction. Liquefaction potential at the site is a combination of expected seismic accelerations (earthquake ground shaking), groundwater conditions, and presence of susceptible soils.

Given subsurface soil conditions observed in the trenches and Gordon Geotechnical borings, sandy soils possibly susceptible to liquefaction are present underlying the site. The site is also in an area subject to strong ground shaking, and areas west of boring B-2 have groundwater at a depth less than 30 feet. McCalpin (2002) notes that an event between 17,000 to 20,000 years ago on the Salt Lake City section of the WFZ (which he terms event S?) may have been responsible for a landslide into the lake, and most of the trenches at the site conducted for our investigation exposed evidence for a similar subaqueous failure that occurred during the Bonneville transgression. This landslide may be related to liquefaction lateral spreading, although this is unconfirmed.

Based on the above, we rate the existing risk from liquefaction as moderate. We conservatively recommend that the hazard from liquefaction be considered and discussed in the Project geotechnical engineering evaluation. Future liquefaction from a large-magnitude earthquake on the Salt Lake City section of the WFZ, if it occurs, could similarly manifest as lateral spreading given the site slopes.

5.4 Tectonic Deformation

Tectonic deformation refers to subsidence from warping, lowering, and tilting of a valley floor that accompanies surface-faulting earthquakes on normal faults. Large-scale tectonic subsidence may accompany earthquakes along large normal faults (Lund, 1990). Tectonic subsidence is believed to mainly impact those areas immediately adjacent to the downthrown side of active normal faults. The Project straddles a broad zone of faulting with multiple west-dipping main traces and at least two east-dipping antithetic traces. Backtilting was also observed in several of the trenches conducted for our investigation and is inferred on the cross sections shown on Figures 14 through 16.

Given the above, the Project is in an area at a high risk from tectonic deformation. Tectonic deformation is not typically a life-safety issue but can tilt building pads and alter sewer and water flow gradients, which may require expensive subsequent repairs. The owner and all future owners should understand and be willing to accept the risk. We recommend that the hazard from tectonic deformation be disclosed in all future real estate transactions.

5.5 Seismic Seiche and Storm Surge

Earthquake-induced seiche presents a risk to structures within the wave-oscillation zone along the edges of large bodies of water, such as the Great Salt Lake. Given the elevation of the subject property and distance from large bodies of water, we rate the risk from seismic seiches as low.

5.6 Stream Flooding

Stream flooding may be caused by direct precipitation, melting snow, or a combination of both. In much of Utah, floods are most common in April through June during spring snowmelt. High flows may be sustained from a few days to several weeks, and the potential for flooding depends on a variety of factors such as surface hydrology, site grading and drainage, and runoff. No active drainages were observed crossing the Project and Federal Emergency Management Agency flood insurance rate mapping (Map Number 49035C0318G, effective 09/25/2009) classifies the Project in "Zone X - Area of Minimal Flood Hazard". Given the above, we rate the risk from stream flooding as low. Care should be taken that proper surface drainage is maintained.

5.7 Shallow Groundwater

As discussed Section 4.4 above, groundwater deepens between trench T-2 and Gordon Geotechnical boring B-2 from 13 to 29 feet deep (Figure 4), and deepens to more than 100 feet between borings B-2 and B-3. Given this, the western half of the site has a moderate risk from shallow groundwater. Foundation and site subsurface drainage concerns should be considered and discussed in the Project geotechnical engineering evaluation. Care should be taken that proper subsurface drainage is maintained.

5.8 Landslides and Slope Failures

Slope stability hazards such as landslides, slumps, and other mass movements can develop along moderate to steep slopes where a slope has been disturbed, the head of a slope loaded, or where increased groundwater pore pressures result in driving forces within the slope exceeding restraining forces. Slopes exhibiting prior failures, and also deposits from large landslides, are particularly vulnerable to instability and reactivation.

No landslides are mapped or evident at the Project on Figure 2, but trench T-6 exposed evidence for a relict landslide that incorporated surficial debris and likely occurred prior to or contemporaneous with the Bonneville transgression. James Kirkland of the Utah

Geological Survey believed the bone fragments incorporated in the landslide (Figure 10A, stations 11-12 feet) belonged to a Pleistocene ungulate based on a brief, informal, visual examination in May 2009. This presumed age would match the stratigraphic provenance.

Given the above and the steep slopes at the site associated with prior gravel mining operations, as profiled on Figures 14 through 16, we rate the risk from landslides and slope instability as moderate. We conservatively recommend that slope stability be evaluated by the Project geotechnical engineer based on site-specific soil conditions and the data provided in this report. Recommendations should be provided to reduce the landslide hazard risk if factors of safety are determined to be unsuitable. Water, steep man-made cuts, and non-engineered fill materials are often major contributors to slope instability. Care should therefore also be taken to maintain proper site drainage, that site grading does not destabilize slopes at the site without prior geotechnical analysis and grading plans, and that water from man-made sources is minimized in potentially unstable slope areas.

5.9 Debris Flows

Debris flow hazards are typically associated with unconsolidated alluvial fan deposits at the mouths of large range-front drainages, such as those along the Wasatch Front. Debris flows have historically significant damage in the Wasatch Front area. The site is not in a mapped active alluvial fan, and no evidence for debris-flow channels, levees, or other debris-flow features was observed at the site on air photos or during our reconnaissance. Given the above, we rate the risk as low.

5.10 Rock Fall

No significant bedrock outcrops are at the site or in adjacent higher slopes that could present a source area for rock fall clasts, and no boulders likely from rock falls were observed at the site. Based on the above, we rate the hazard from rock falls as low.

5.11 Problem Soil and Rock

Surficial soils that contain certain clays can swell or collapse when wet. Soil conditions and specific recommendations for site grading, subgrade preparation, and footing and foundation design should be provided in the Project geotechnical engineering evaluation.

6.0 CONCLUSIONS AND RECOMMENDATIONS

Earthquake ground shaking, surface fault rupture, and tectonic deformation are identified as posing a high relative risk to the proposed development. Liquefaction and lateral-spread ground failure, shallow groundwater, and landslides and slope failures are identified as posing a moderate risk. The following recommendations are provided with regard to the geologic characterizations in this report:

- ***Seismic Design*** **–** All habitable structures developed at the property should be constructed to current adopted seismic building codes to reduce the risk of damage, injury, or loss of life from earthquake ground shaking. The Project geotechnical engineer should confirm the ground-shaking hazard and provide appropriate seismic design parameters as needed. We note that earthquake ground shaking is a common hazard for all Wasatch Front areas and, although ground shaking and surface faulting are related earthquake hazards, they pose distinctly different risks.

- ***Geotechnical Evaluation*** **–** A design-level geotechnical engineering study should be conducted prior to construction to assess soil foundation conditions, assess the risk from shallow groundwater and liquefaction (and provide recommendations as needed), and evaluate slope stability. The stability evaluation should be based on geologic characterizations in this report and site-specific geotechnical data, and provide recommendations for reducing the risk of landsliding if the factors of safety are deemed unsuitable.

- ***Site Modifications and Drainage*** **–** No unplanned cuts should be made in the slopes at the site without prior geotechnical analyses, and proper surface and subsurface drainage should be maintained.

- ***Surface Fault Rupture Hazards*** **–** No structures intended for human occupancy should be located in the setback zones shaded in light red on Figure 4. It is generally accepted practice to allow streets, driveways, yards, and other non-occupied, non-attached structures to be constructed within these areas. No habitable structures should also be located in the unexplored area shaded in light green on Figure 4 without additional subsurface exploration to evaluate if active faults are present. The structure on Pad E, which overlies two small displacement faults observed in trench T-1 (Figures 4 and 5A), should be designed to withstand up to 0.3 feet of vertical offset. Utility lines that cross faults should also be engineered to withstand expected displacements and/or have design features to ensure life safety.

- ***Grading and Development Plan Review*** **–** Significant cuts could change fault locations and setback zone calculations. A safety factor and an upthrown fault side modifier are therefore provided in Section 5.2 to assist review of the grading and development plan by the Project civil engineer in areas where there such cuts may be planned. Care should be taken in these areas to ensure that proposed structures remain at a safe distance. Results of this review may be shown as a table on the grading plan. The most-recent grading plan should be included with our report and the geotechnical engineering report when the reports are submitted to Cottonwood Heights City. We have confirmed our fault and setback delineations on Figure 4 accurately coincide with CAD data of the Project civil engineer.

- ***Excavation Backfill Considerations*** **–** The trenches may be in areas where a structure could subsequently be placed. However, backfill may not have been replaced in the excavations in compacted layers. The fill could settle with time and upon saturation. Should structures be located in an excavated area, no footings or structure should be founded over the excavation unless the backfill has been removed and replaced with structural fill.

- ***Excavation Inspection*** **–** This report does not reflect subsurface variations that may occur laterally away from an exploration trench. Such variations may occur that could become evident during construction. Thus, it is important that we observe subsurface materials exposed in future excavations to take advantage of opportunities to recognize differing conditions that could affect the performance of a planned structure.

- ***Hazard Disclosures and Report Availability*** **–** All hazards identified as posing a high risk at the site should be disclosed to future buyers so that they may understand and be willing to accept any potential developmental challenges and/or risks posed by these hazards. This report should be made available to architects, building contractors, and in the event of a future property sale, real estate agents and potential buyers. The report should be referenced for information on technical data only as interpreted from observations and not as a warranty of conditions throughout the site. The report should be submitted in its entirety, or referenced appropriately, as part of any document submittal to a government agency responsible for planning decisions or geologic review. Incomplete submittals void the professional seals and signatures we provide herein. Although this report and the data herein are the property of the client, the report format is the intellectual property of Western Geologic and should not be copied, used, or modified without express permission of the authors.

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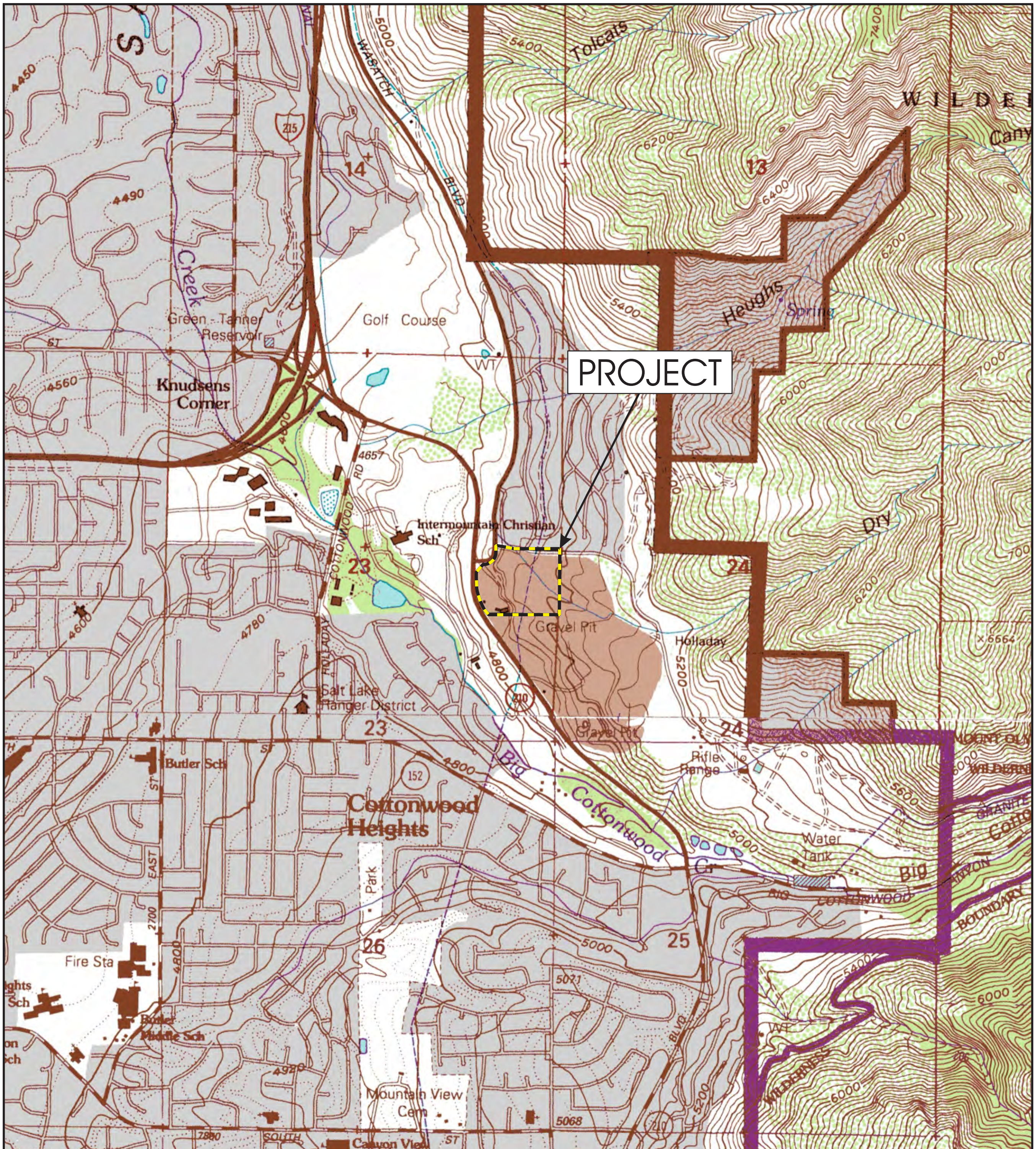
FIGURES



Source: U.S. Geological Survey 7.5 Minute Series Topographic Maps, Utah - Sugar House and Draper, 1998.

LOCATION MAP

GEOLOGIC HAZARDS EVALUATION

AJ Rock LLC Property
6695 South Wasatch Boulevard
Cottonwood Heights, Utah

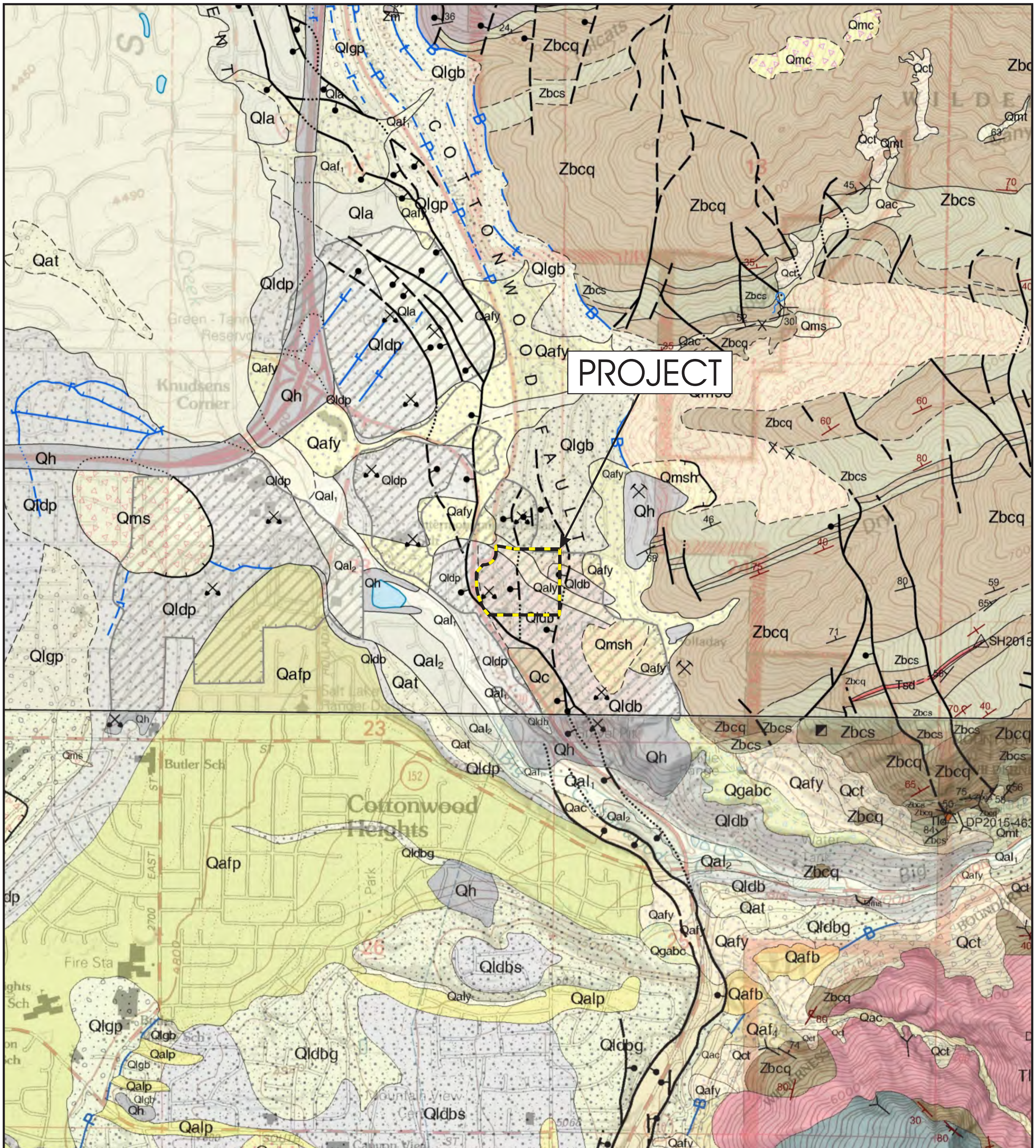
FIGURE 1

WESTERN GEOLOGIC

N W E S

0 1000 2000 feet

Scale 1:24,000
(1 inch = 2000 feet)



Source: McKean (2018; Sugarhouse Quadrangle) and McKean and Solomon (2018; Draper Quadrangle).
See text for description of surficial geologic units at Project.

N
W E
S

0 1000 2000 feet

Scale 1:24,000
(1 inch = 2000 feet)

WESTERN GEOLOGIC

GEOLOGIC MAP

GEOLOGIC HAZARDS EVALUATION

AJ Rock LLC Property
6695 South Wasatch Boulevard
Cottonwood Heights, Utah

FIGURE 2

WESTERN GEOLOGIC

Air Photo Source: 1938 U.S. Bureau of Reclamation Salt Lake Aqueduct historical photography, reproduced and georeferenced in Bowman and Beisner (2008), frame sla1-20, approximate original scale 1:20,000.

1938 AIR PHOTO

GEOLOGIC HAZARDS EVALUATION

AJ Rock LLC Property
6695 South Wasatch Boulevard
Cottonwood Heights, Utah

FIGURE 3A

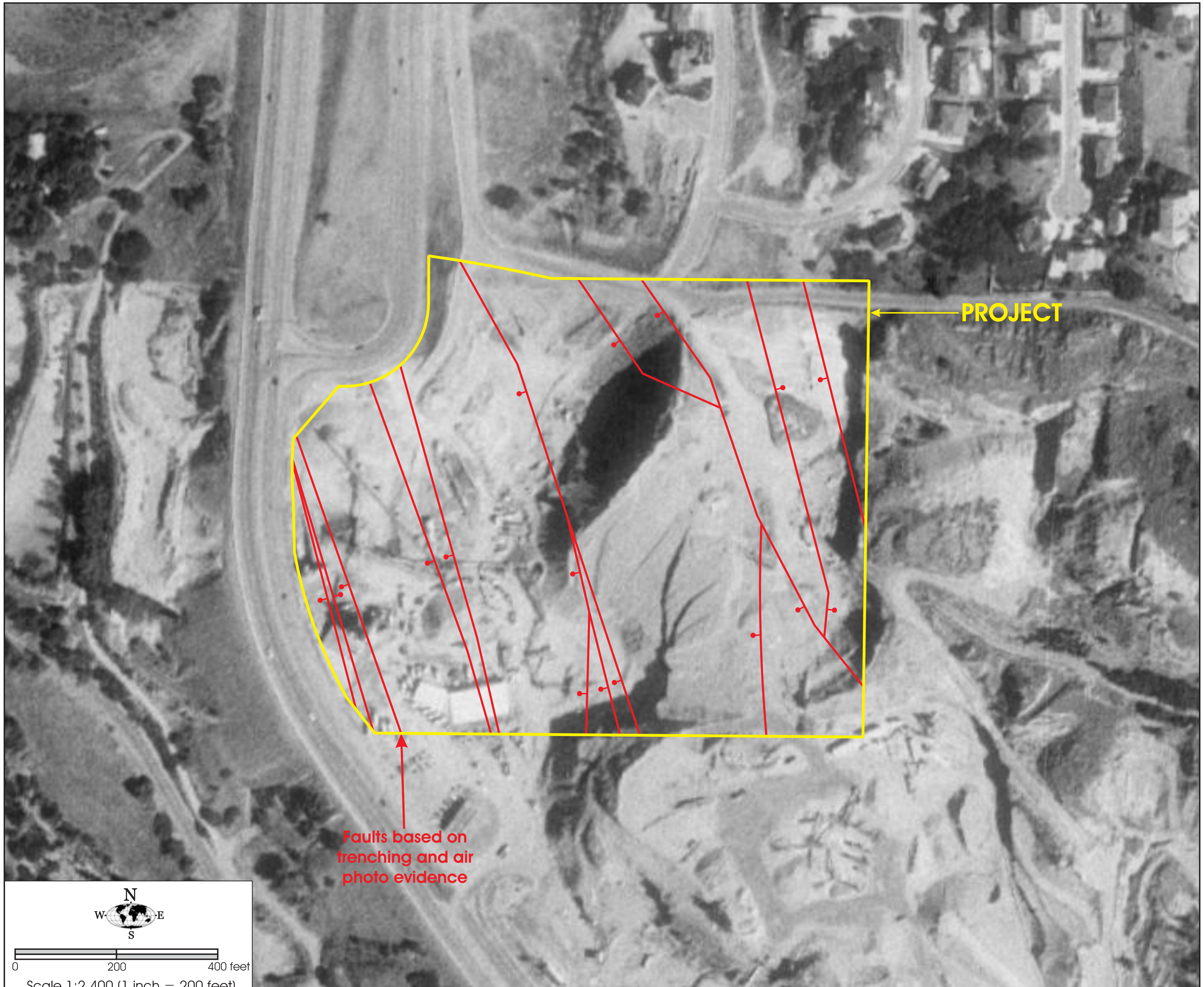
Air Photo Source: Utah AGRC, 1977 Digital Orthophoto Quadrangle, frame q1320-1977, 1 meter resolution.

1977 AIR PHOTO

GEOLOGIC HAZARDS EVALUATION

AJ Rock LLC Property
6695 South Wasatch Boulevard
Cottonwood Heights, Utah

FIGURE 3B



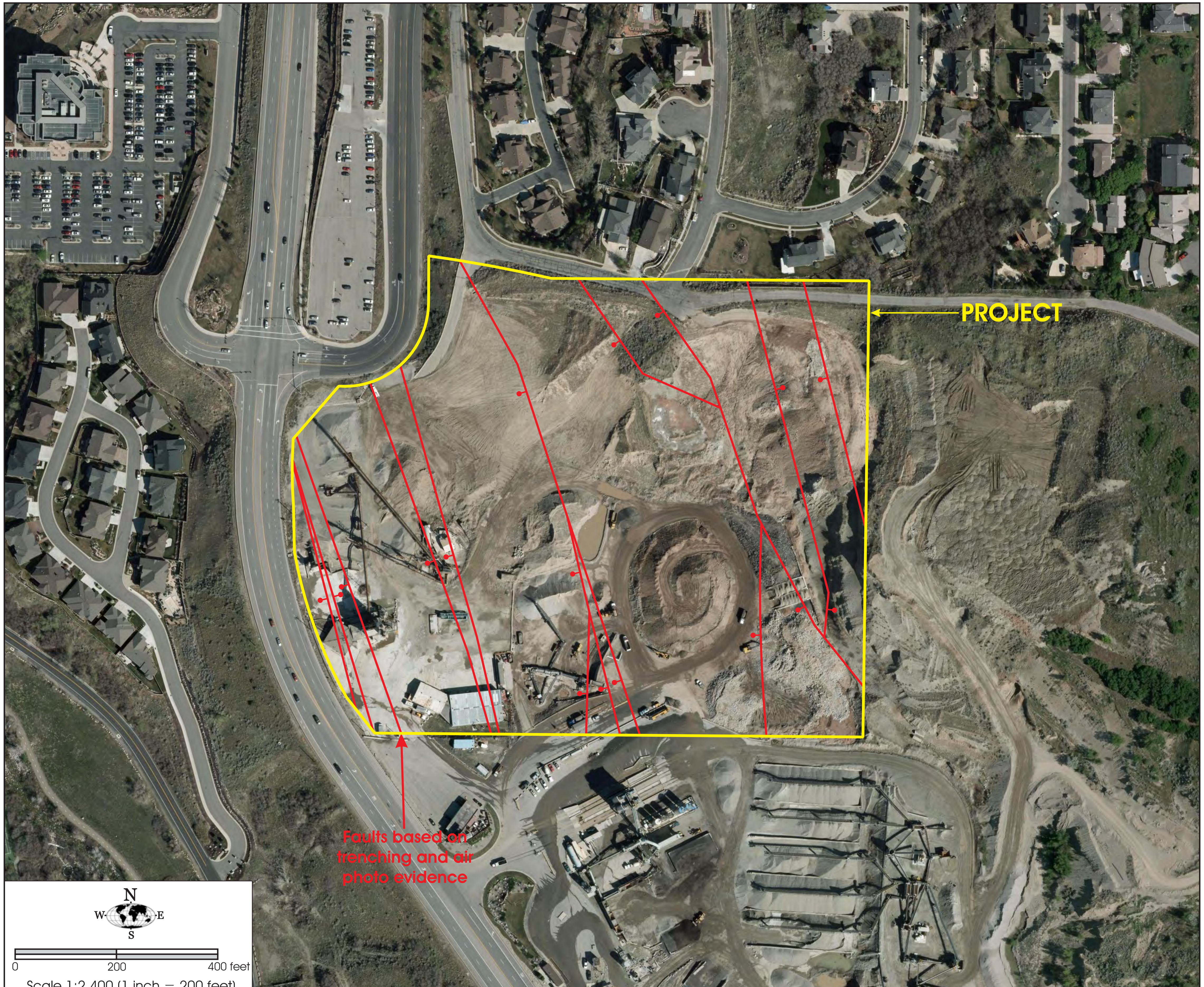
WESTERN GEOLOGIC

Air Photo Source: Utah AGRC, 1990s Digital Orthophoto Quadrangle, frame q1320-83, 1 meter resolution.

1993 AIR PHOTO

GEOLOGIC HAZARDS EVALUATION
AJ Rock LLC Property
6695 South Wasatch Boulevard
Cottonwood Heights, Utah

FIGURE 3C



WESTERN GEOLOGIC

Air Photo Source: Utah AGRC, 2012 High Resolution Orthophoto, frames 12TVK320960 and 12TVK320980, 12.5 centimeter resolution.

2012 AIR PHOTO

GEOLOGIC HAZARDS EVALUATION

AJ Rock LLC Property
6695 South Wasatch Boulevard
Cottonwood Heights, Utah

FIGURE 3D

WESTERN GEOLOGIC

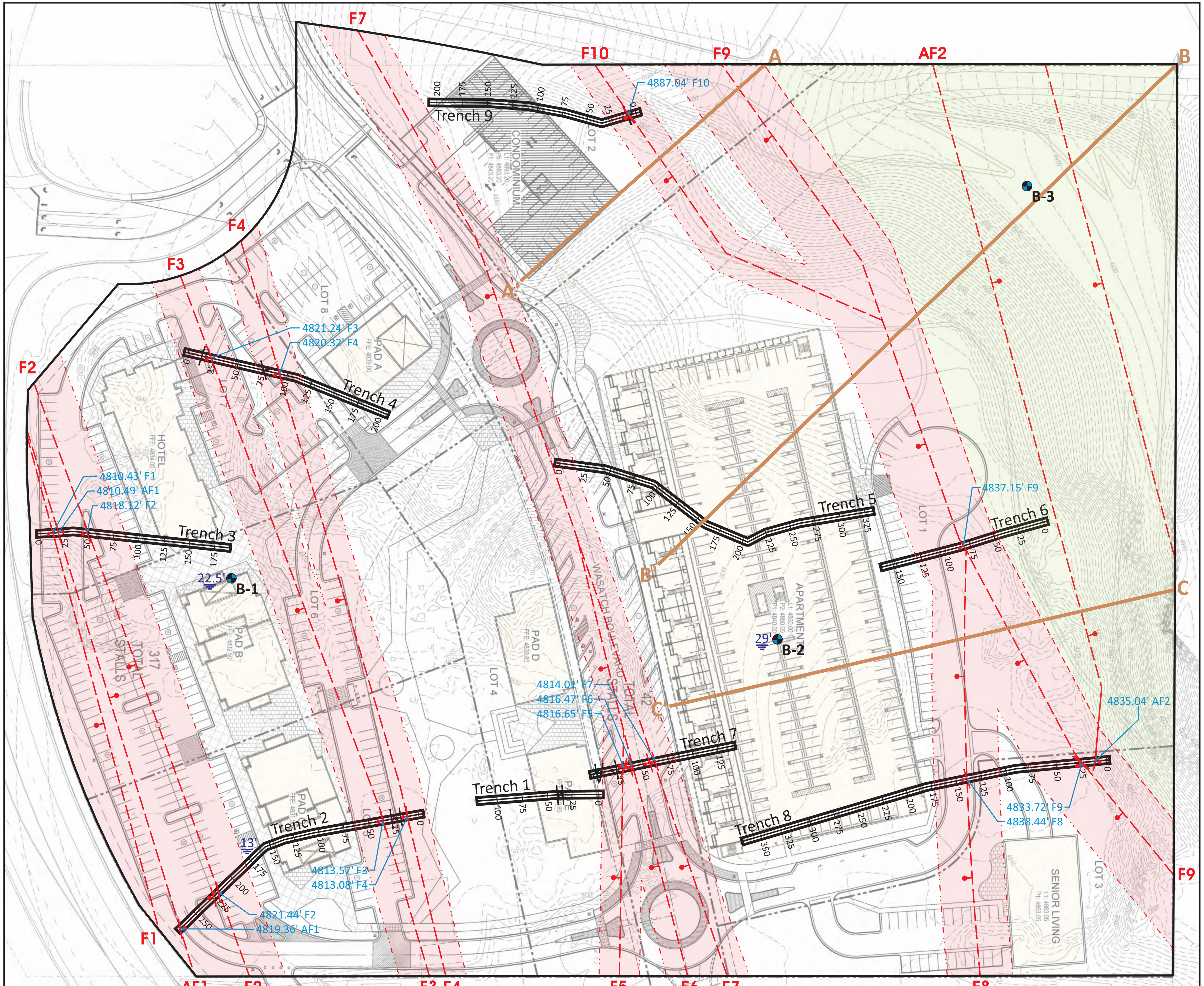
Air Photo Source: Utah AGRC, 2013 LIDAR Bare Earth DEM, frames BH12TVK3200096000 and BH12TVK3200098000, 50 centimeter resolution.

2013 LIDAR IMAGE

GEOLOGIC HAZARDS EVALUATION

AJ Rock LLC Property
6695 South Wasatch Boulevard
Cottonwood Heights, Utah

FIGURE 3E



EXPLANATION

Faults based on trenching and air photo evidence; bar and ball on downthrown side.

Trench for this study, stations denote distance in feet on logged wall; blue tags denote elevation of highest fault point in trench at time of surveying.

Setback zones (see text for explanation).

Unexplored area, no structures intended for human occupation should be placed in this area without additional exploration.

A' — A Cross section location (Figures 14 to 16)

B-2 Gordon Geotechnical boring

0 100 200 feet
Scale 1 inch equals 100 feet

N
W E
S

Base Map: McNeil Engineering concept grading plan SK-02 dated April 24, 2020.

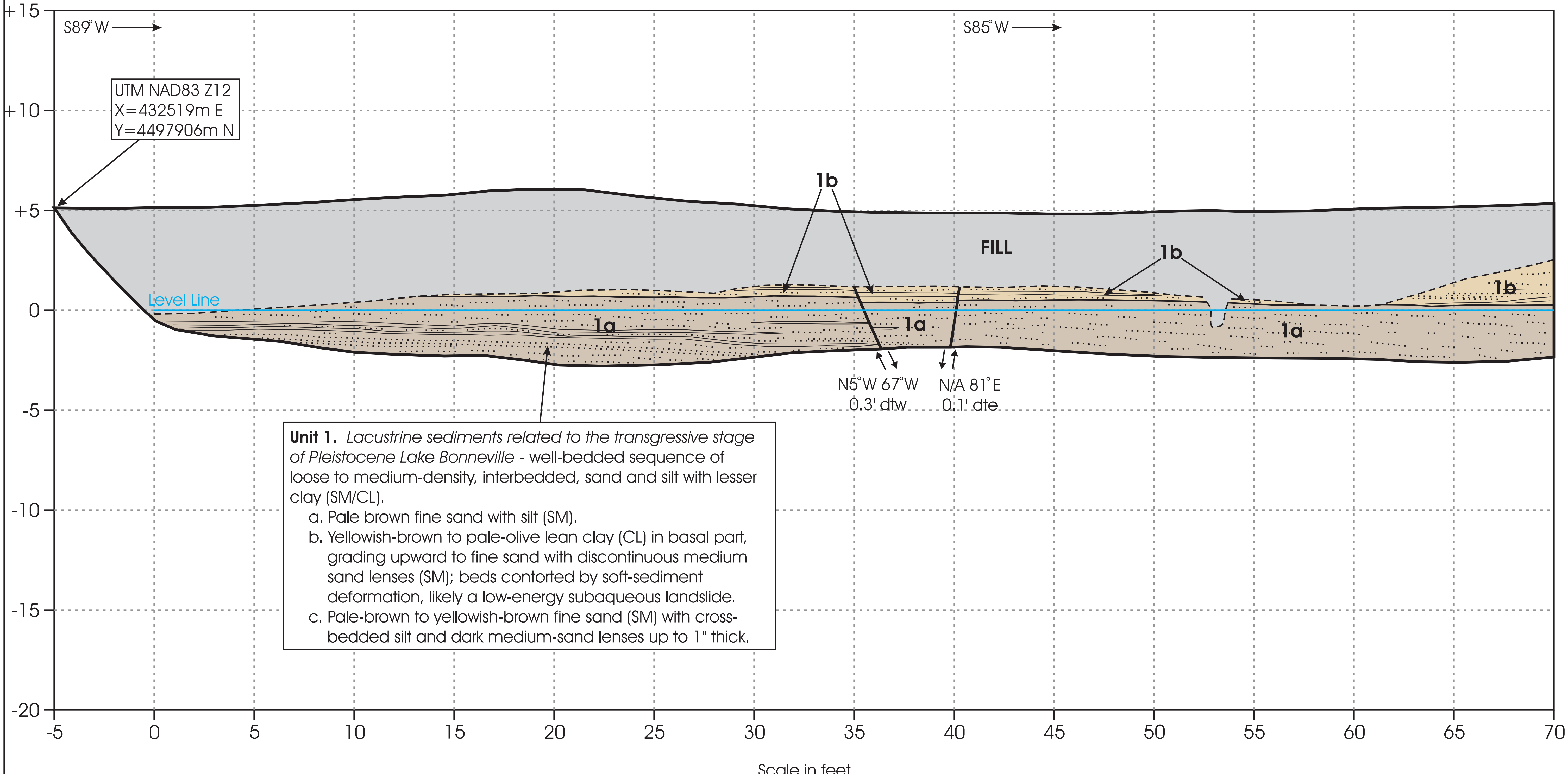
WESTERN GEOLOGIC

SITE PLAN

GEOLOGIC HAZARDS EVALUATION

AJ Rock LLC Property
6695 South Wasatch Boulevard
Cottonwood Heights, Utah

FIGURE 4



Unit 1. *Lacustrine sediments related to the transgressive stage of Pleistocene Lake Bonneville* - well-bedded sequence of loose to medium-density, interbedded, sand and silt with lesser clay (SM/CL).

a. Pale brown fine sand with silt (SM).

b. Yellowish-brown to pale-olive lean clay (CL) in basal part, grading upward to fine sand with discontinuous medium sand lenses (SM); beds contorted by soft-sediment deformation, likely a low-energy subaqueous landslide.

c. Pale-brown to yellowish-brown fine sand (SM) with cross-bedded silt and dark medium-sand lenses up to 1" thick.

WESTERN GEOLOGIC

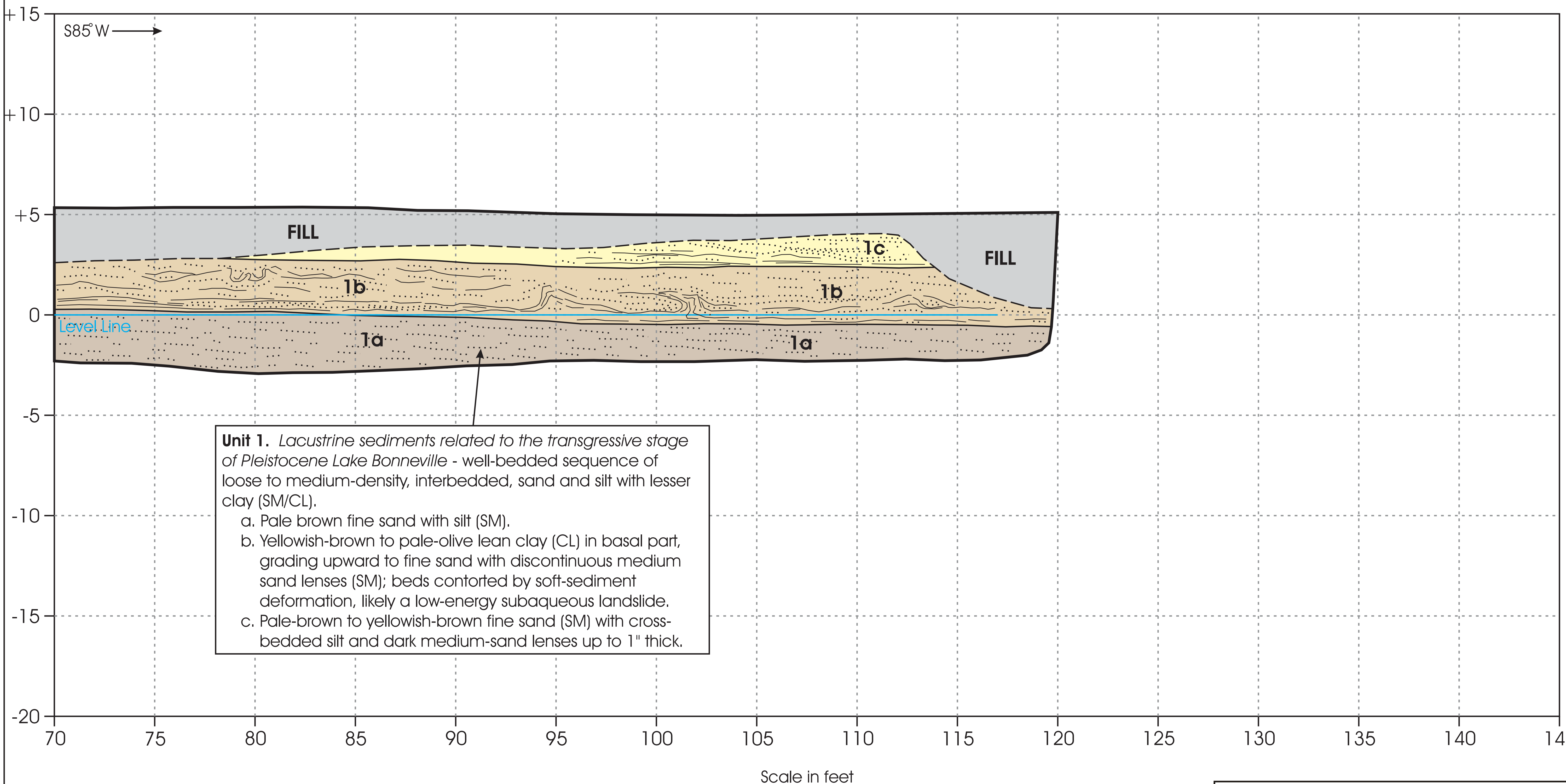
SCALE: 1 inch = 5 feet
(no vertical exaggeration)
South Trench Wall Logged

Trench logged by Bill Black, P.G. on April 25, 2009

TRENCH 1 LOG, SHEET 1

GEOLOGIC HAZARDS EVALUATION
AJ Rock LLC Property
6695 South Wasatch Boulevard
Cottonwood Heights, Utah

FIGURE 5A



WESTERN GEOLOGIC

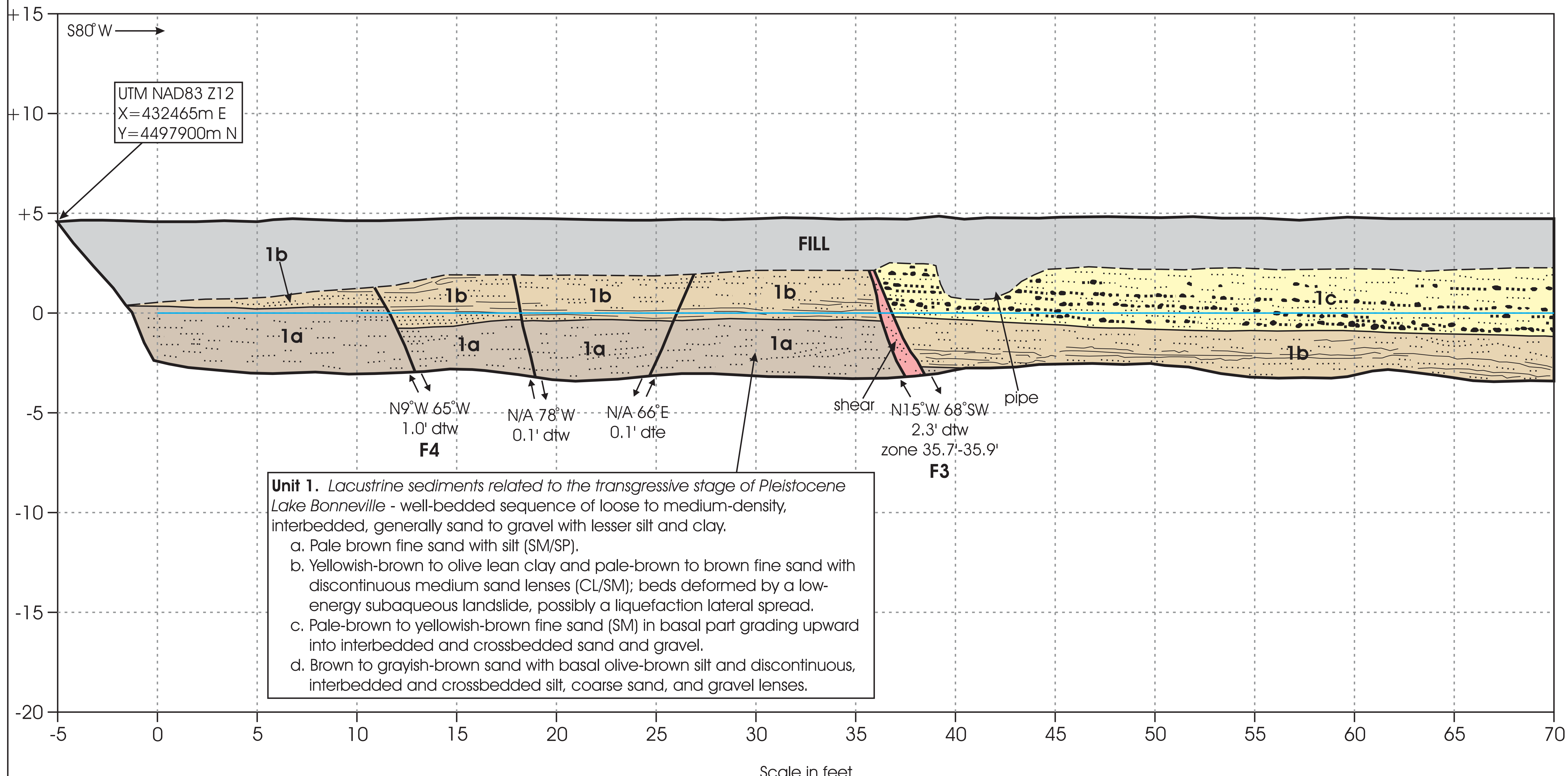
SCALE: 1 inch = 5 feet
(no vertical exaggeration)
South Trench Wall Logged

Trench logged by Bill Black, P.G. on
April 25, 2009

TRENCH 1 LOG, SHEET 2

GEOLOGIC HAZARDS EVALUATION
AJ Rock LLC Property
6695 South Wasatch Boulevard
Cottonwood Heights, Utah

FIGURE 5B



WESTERN GEOLOGIC

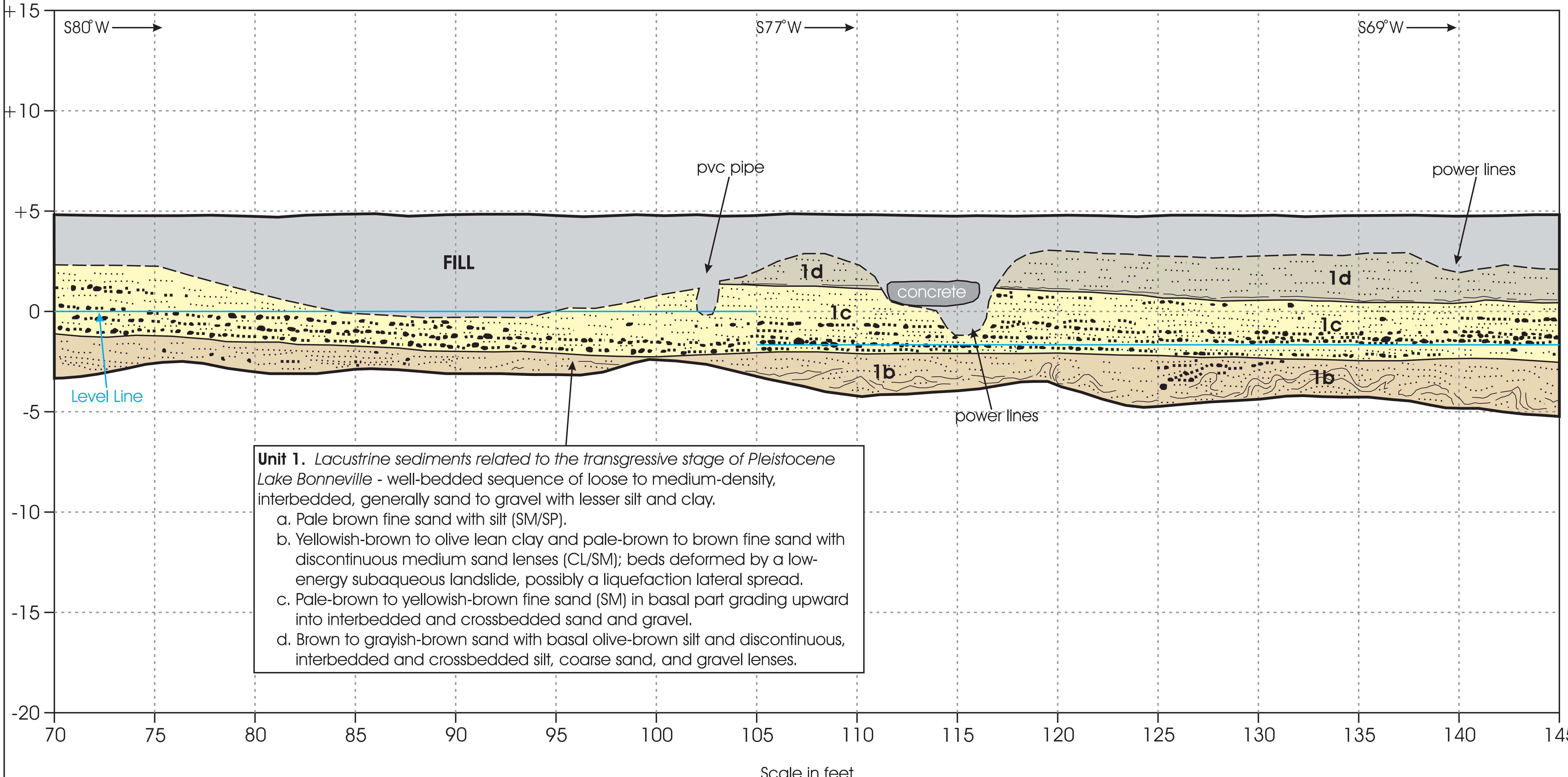
SCALE: 1 inch = 5 feet
(no vertical exaggeration)
South Trench Wall Logged

Trench logged by Bill Black, P.G. on
April 25-26 and May 9, 2009

TRENCH 2 LOG, SHEET 1

GEOLOGIC HAZARDS EVALUATION
AJ Rock LLC Property
6695 South Wasatch Boulevard
Cottonwood Heights, Utah

FIGURE 6A



Unit 1. *Lacustrine sediments related to the transgressive stage of Pleistocene Lake Bonneville* - well-bedded sequence of loose to medium-density, interbedded, generally sand to gravel with lesser silt and clay.

a. Pale brown fine sand with silt (SM/SP).
b. Yellowish-brown to olive lean clay and pale-brown to brown fine sand with discontinuous medium sand lenses (CL/SM); beds deformed by a low-energy subaqueous landslide, possibly a liquefaction lateral spread.
c. Pale-brown to yellowish-brown fine sand (SM) in basal part grading upward into interbedded and crossbedded sand and gravel.
d. Brown to grayish-brown sand with basal olive-brown silt and discontinuous, interbedded and crossbedded silt, coarse sand, and gravel lenses.

WESTERN GEOLOGIC

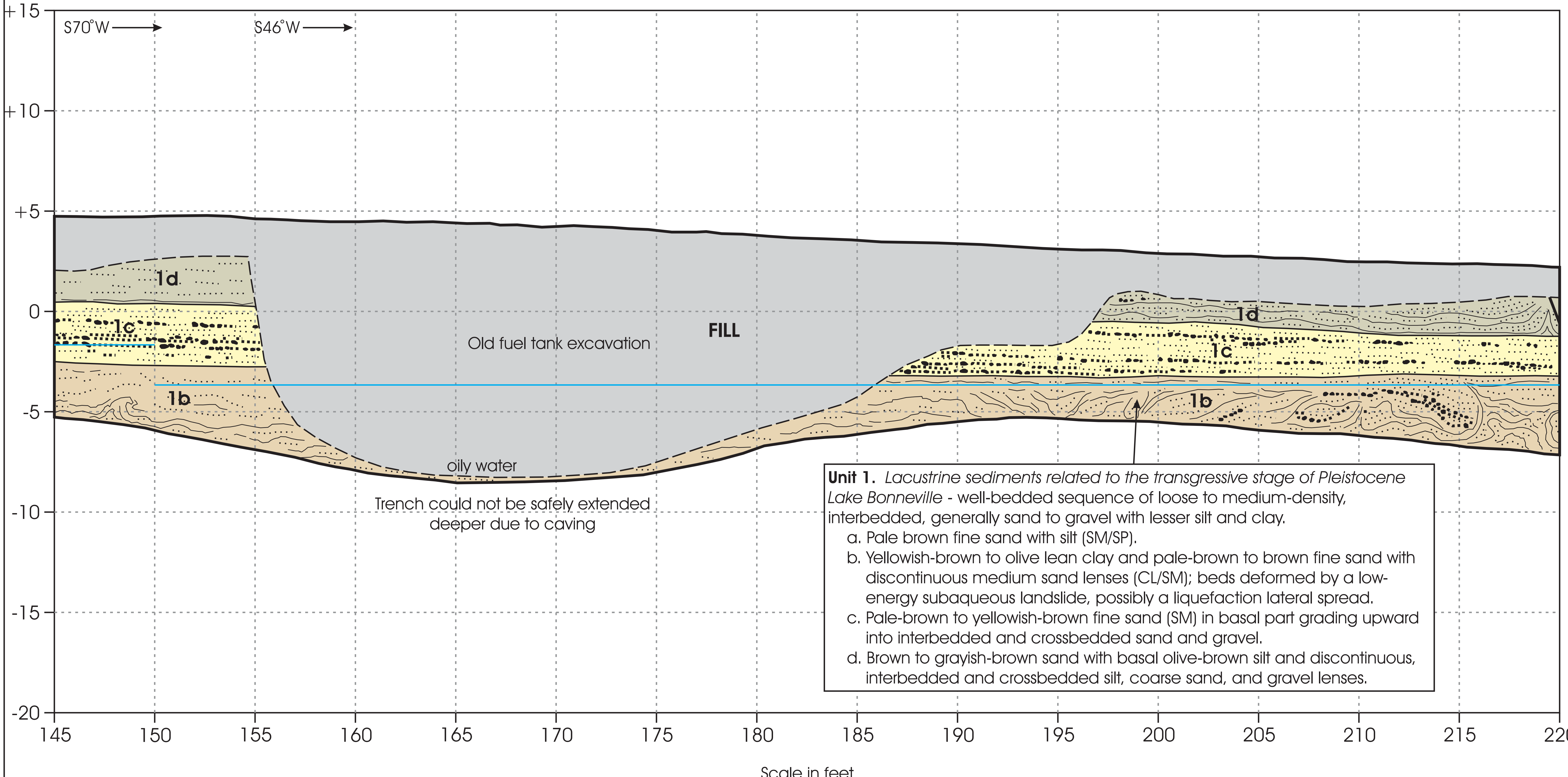
SCALE: 1 inch = 5 feet
(no vertical exaggeration)
South Trench Wall Logged

Trench logged by Bill Black, P.G. on
April 25-26 and May 9, 2009

TRENCH 2 LOG, SHEET 2

GEOLOGIC HAZARDS EVALUATION
AJ Rock LLC Property
6695 South Wasatch Boulevard
Cottonwood Heights, Utah

FIGURE 6B



SCALE: 1 inch = 5 feet
(no vertical exaggeration)
South Trench Wall Logged

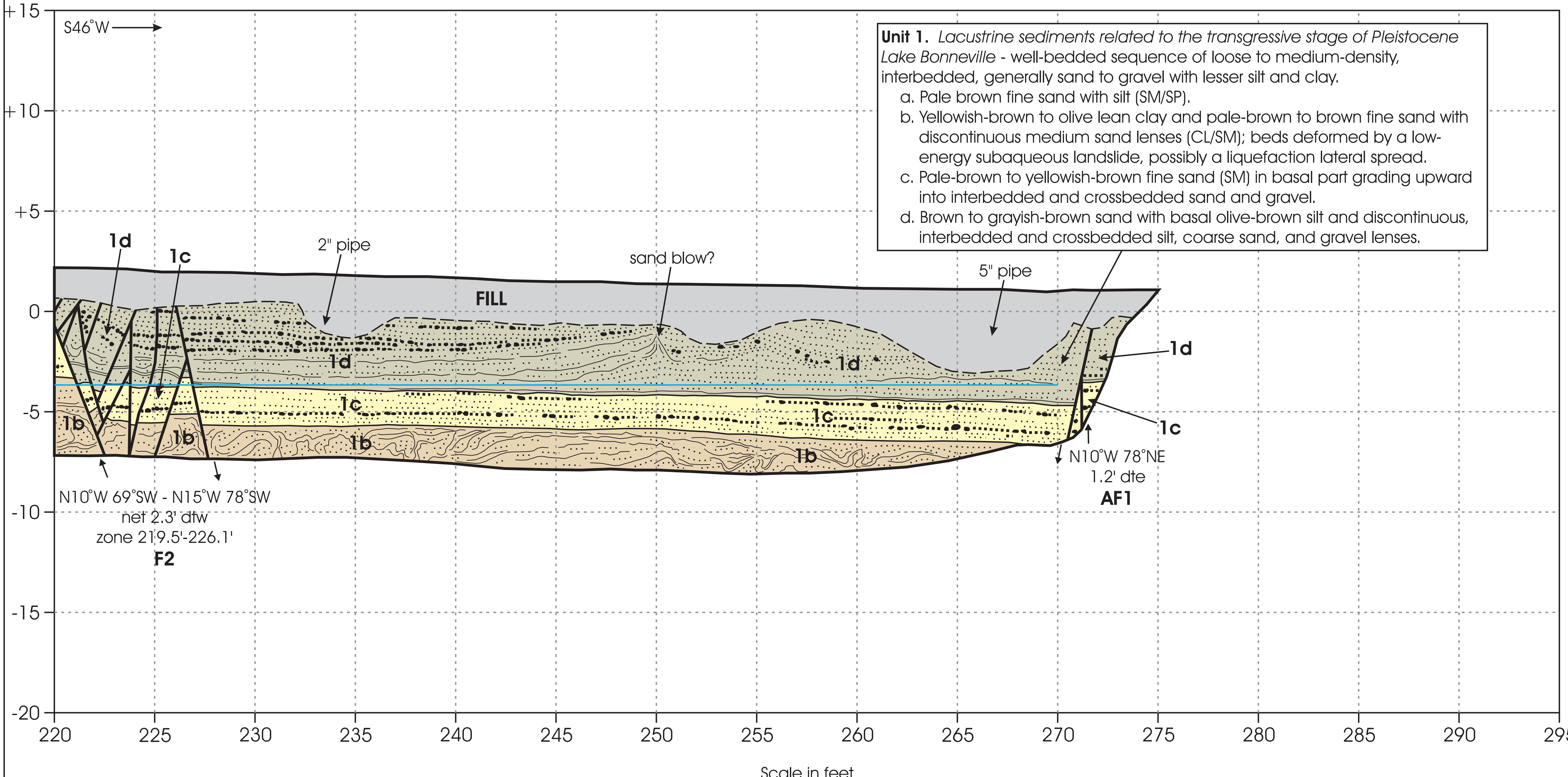
Trench logged by Bill Black, P.G. on
April 25-26 and May 9, 2009

WESTERN GEOLOGIC

TRENCH 2 LOG, SHEET 3

GEOLOGIC HAZARDS EVALUATION
AJ Rock LLC Property
6695 South Wasatch Boulevard
Cottonwood Heights, Utah

FIGURE 6C



SCALE: 1 inch = 5 feet
(no vertical exaggeration)
South Trench Wall Logged

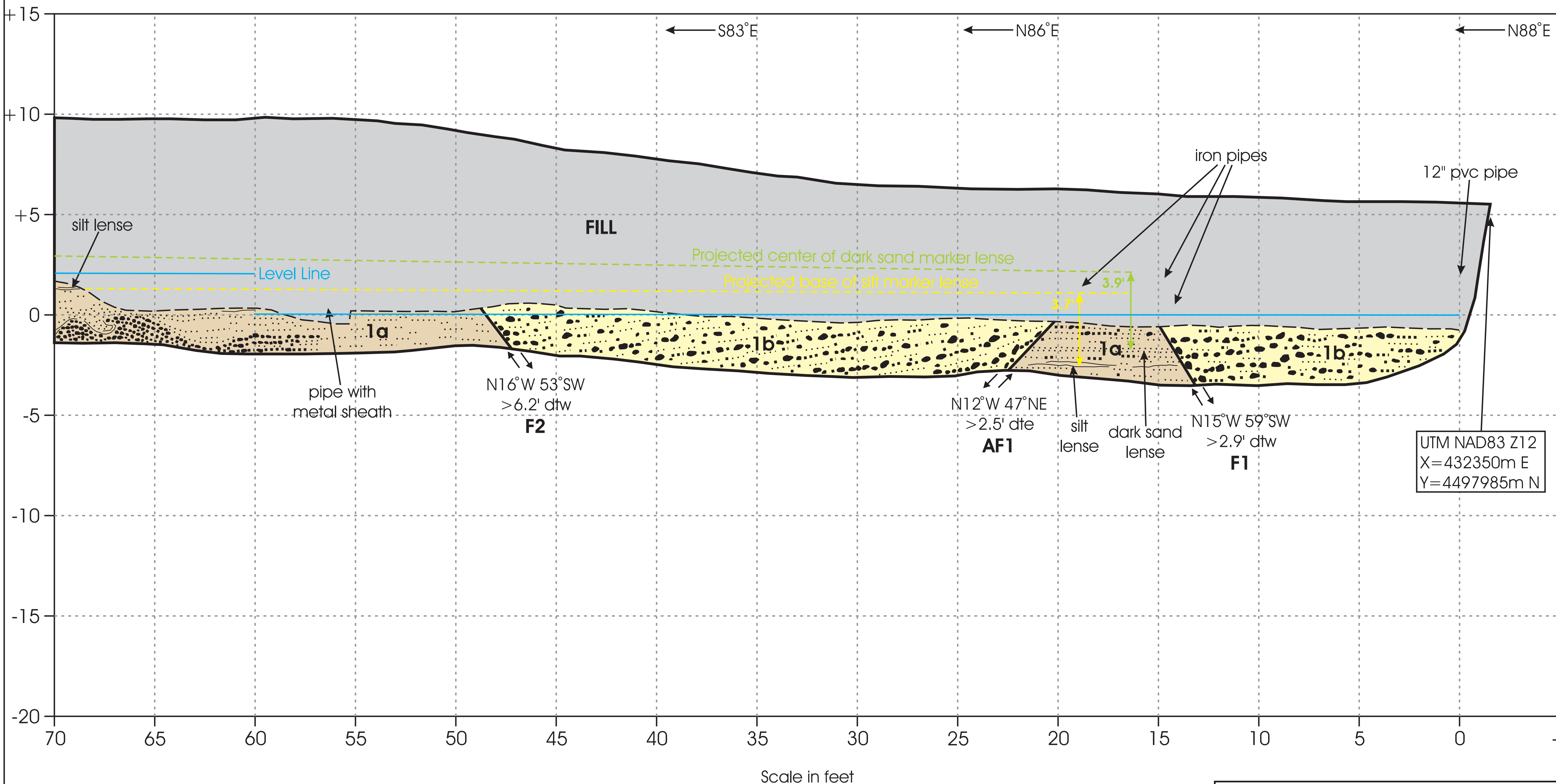
Trench logged by Bill Black, P.G. on
April 25-26 and May 9, 2009

TRENCH 2 LOG, SHEET 4

GEOLOGIC HAZARDS EVALUATION
AJ Rock LLC Property
6695 South Wasatch Boulevard
Cottonwood Heights, Utah

FIGURE 6D

WESTERN GEOLOGIC



SCALE: 1 inch = 5 feet
(no vertical exaggeration)
South Trench Wall Logged

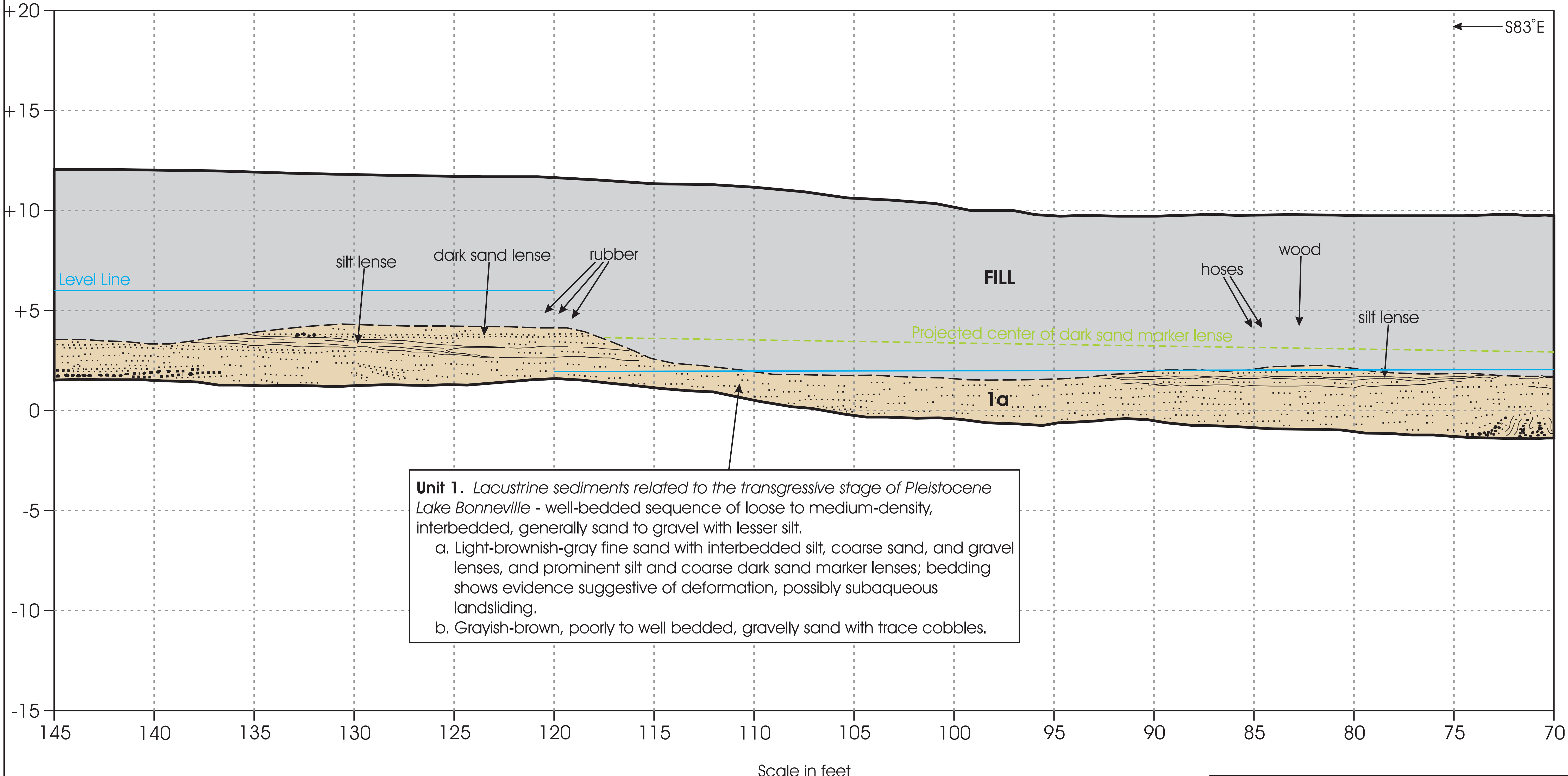
Trench logged by Bill Black, P.G. on
May 2, 2009

WESTERN GEOLOGIC

TRENCH 3 LOG, SHEET 1

GEOLOGIC HAZARDS EVALUATION
AJ Rock LLC Property
6695 South Wasatch Boulevard
Cottonwood Heights, Utah

FIGURE 7A



WESTERN GEOLOGIC

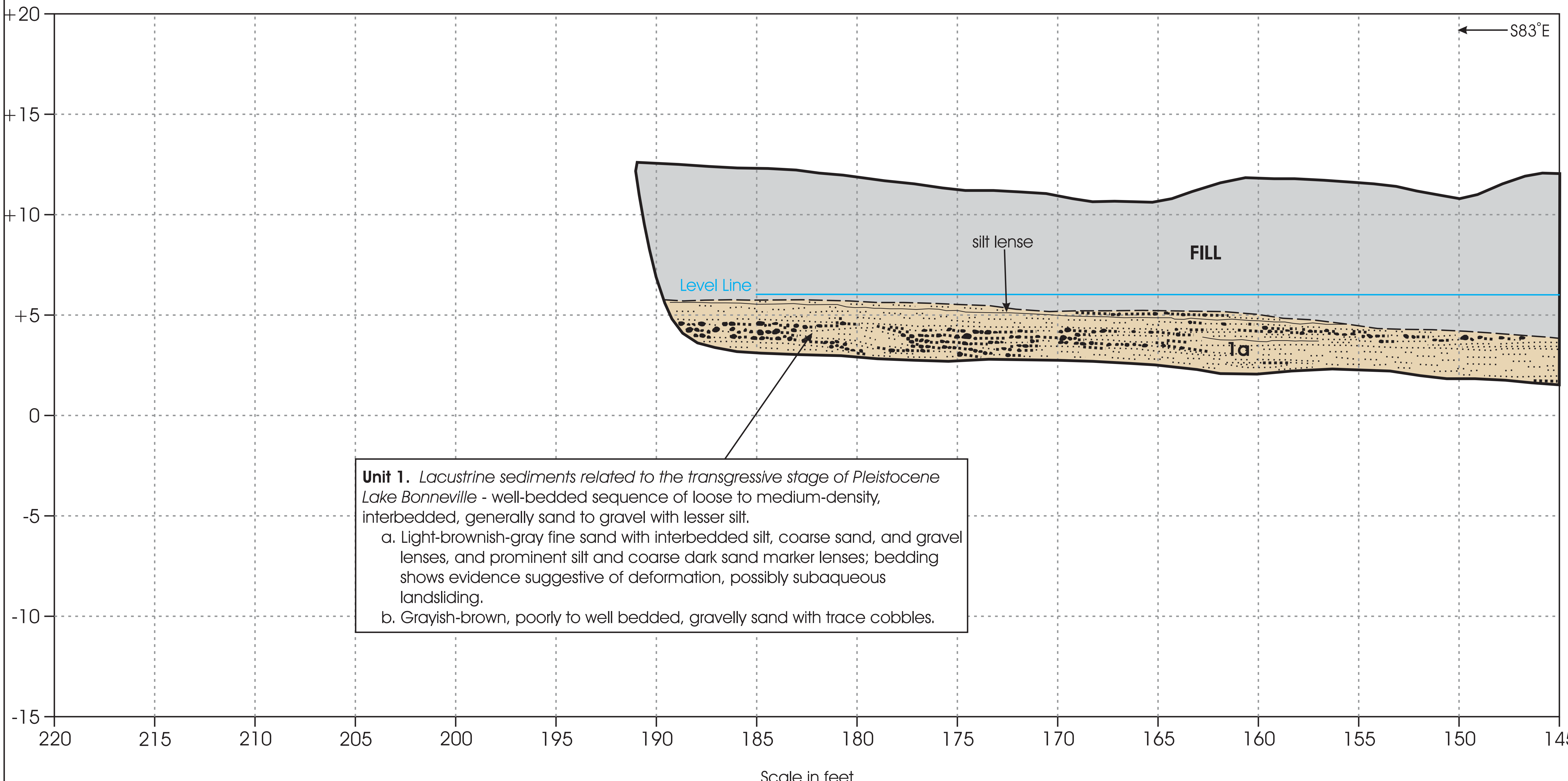
SCALE: 1 inch = 5 feet
(no vertical exaggeration)
South Trench Wall Logged

Trench logged by Bill Black, P.G. on
May 2, 2009

TRENCH 3 LOG, SHEET 2

GEOLOGIC HAZARDS EVALUATION
AJ Rock LLC Property
6695 South Wasatch Boulevard
Cottonwood Heights, Utah

FIGURE 7B



Unit 1. *Lacustrine sediments related to the transgressive stage of Pleistocene Lake Bonneville* - well-bedded sequence of loose to medium-density, interbedded, generally sand to gravel with lesser silt.

a. Light-brownish-gray fine sand with interbedded silt, coarse sand, and gravel lenses, and prominent silt and coarse dark sand marker lenses; bedding shows evidence suggestive of deformation, possibly subaqueous landsliding.

b. Grayish-brown, poorly to well bedded, gravelly sand with trace cobbles.

SCALE: 1 inch = 5 feet
(no vertical exaggeration)
South Trench Wall Logged

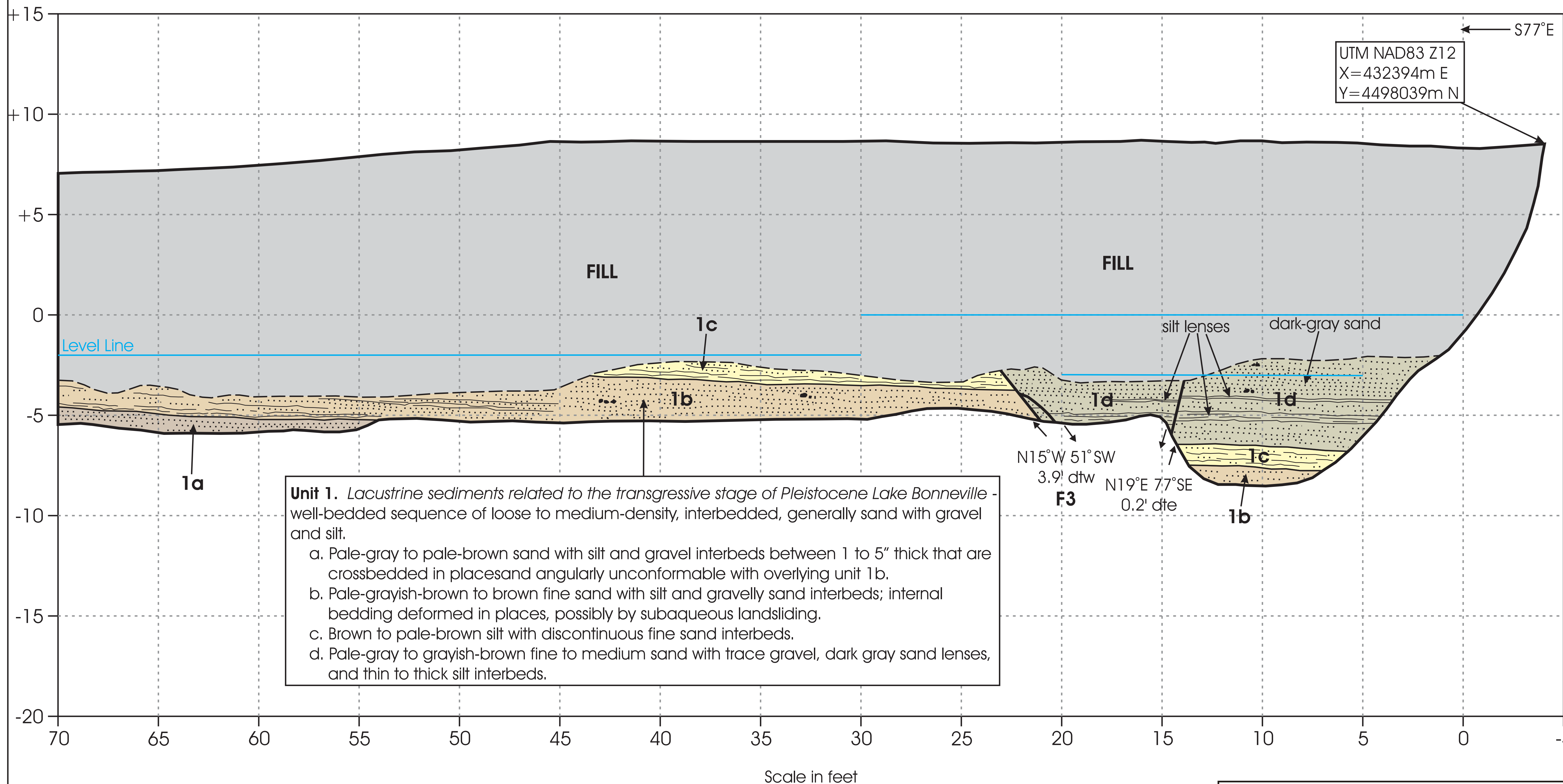
Trench logged by Bill Black, P.G. on
May 2, 2009

WESTERN GEOLOGIC

TRENCH 3 LOG, SHEET 3

GEOLOGIC HAZARDS EVALUATION
AJ Rock LLC Property
6695 South Wasatch Boulevard
Cottonwood Heights, Utah

FIGURE 7C



SCALE: 1 inch = 5 feet
(no vertical exaggeration)
South Trench Wall Logged

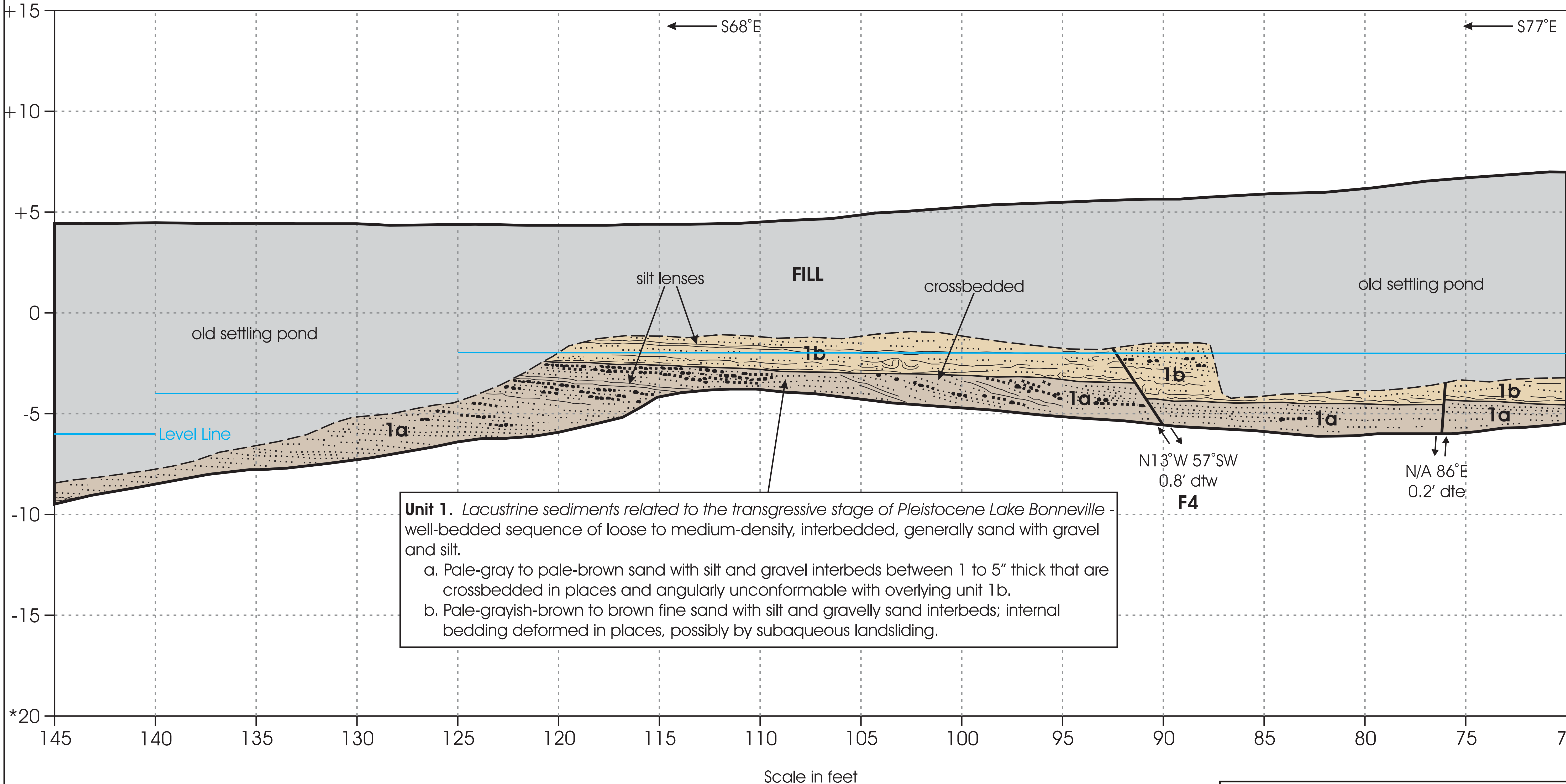
Trench logged by Bill Black, P.G. on
May 3 and 16, 2009

TRENCH 4 LOG, SHEET 1

GEOLOGIC HAZARDS EVALUATION
AJ Rock LLC Property
6695 South Wasatch Boulevard
Cottonwood Heights, Utah

FIGURE 8A

WESTERN GEOLOGIC



SCALE: 1 inch = 5 feet
(no vertical exaggeration)
South Trench Wall Logged

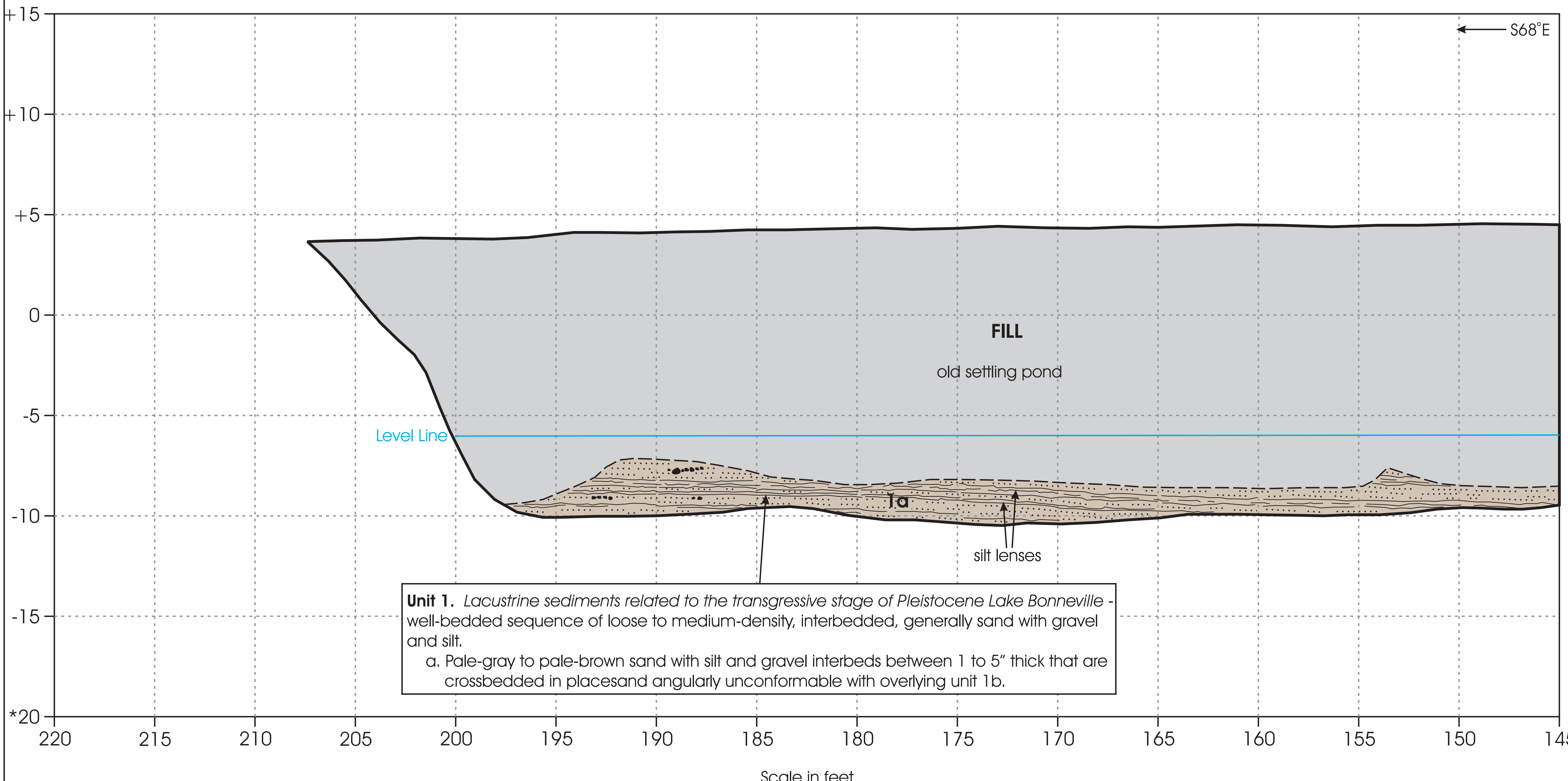
Trench logged by Bill Black, P.G. on
May 3 and 16, 2009

WESTERN GEOLOGIC

TRENCH 4 LOG, SHEET 2

GEOLOGIC HAZARDS EVALUATION
AJ Rock LLC Property
6695 South Wasatch Boulevard
Cottonwood Heights, Utah

FIGURE 8B



WESTERN GEOLOGIC

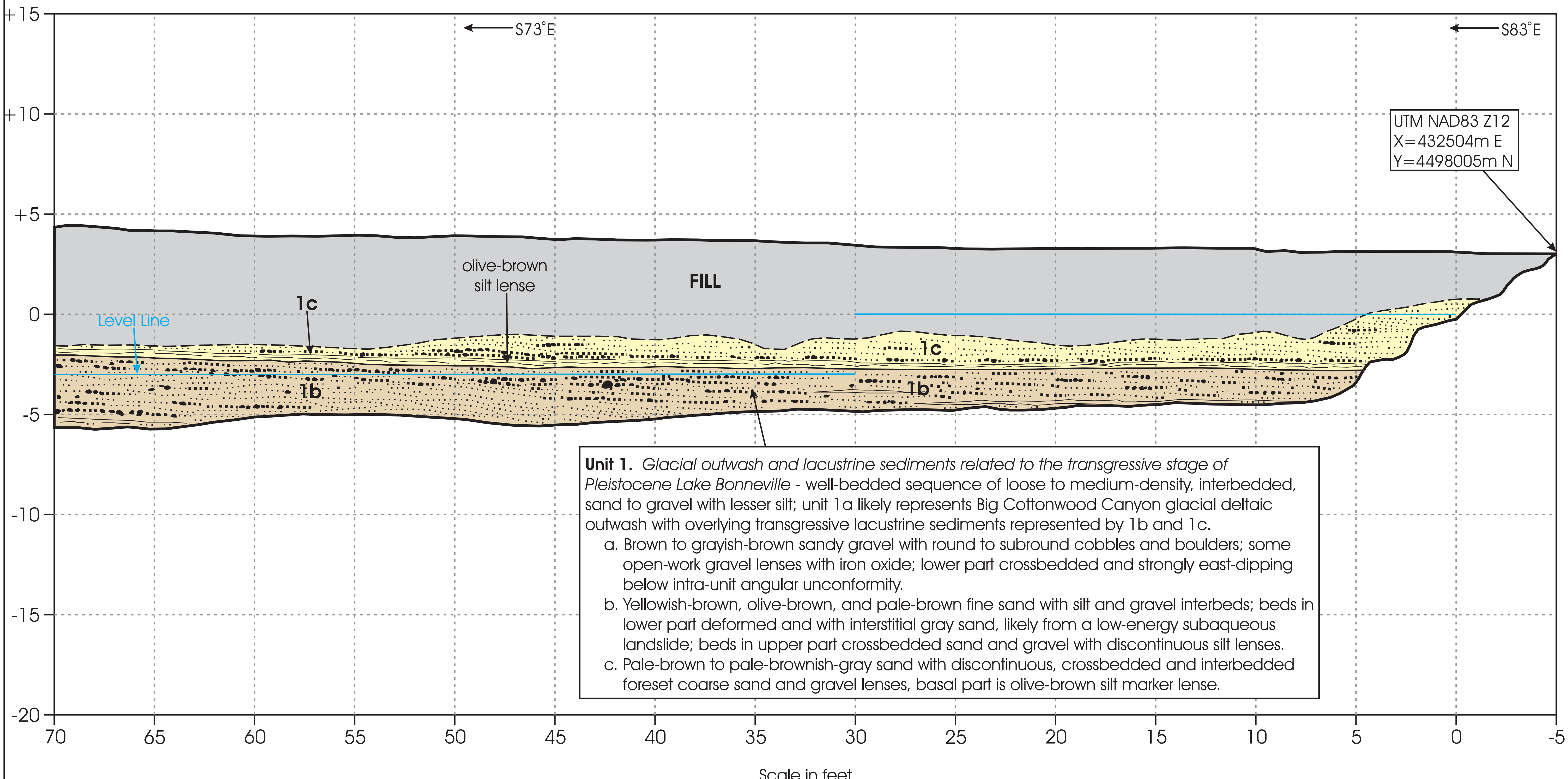
SCALE: 1 inch = 5 feet
(no vertical exaggeration)
South Trench Wall Logged

Trench logged by Bill Black, P.G. on
May 3 and 16, 2009
Log reviewed by Craig V Nelson, P.G., R.G., C.E.G

TRENCH 4 LOG, SHEET 3

GEOLOGIC HAZARDS EVALUATION
AJ Rock LLC Property
6695 South Wasatch Boulevard
Cottonwood Heights, Utah

FIGURE 8C



Unit 1. *Glacial outwash and lacustrine sediments related to the transgressive stage of Pleistocene Lake Bonneville* - well-bedded sequence of loose to medium-density, interbedded, sand to gravel with lesser silt; unit 1a likely represents Big Cottonwood Canyon glacial deltaic outwash with overlying transgressive lacustrine sediments represented by 1b and 1c.

a. Brown to grayish-brown sandy gravel with round to subround cobbles and boulders; some open-work gravel lenses with iron oxide; lower part crossbedded and strongly east-dipping below intra-unit angular unconformity.

b. Yellowish-brown, olive-brown, and pale-brown fine sand with silt and gravel interbeds; beds in lower part deformed and with interstitial gray sand, likely from a low-energy subaqueous landslide; beds in upper part crossbedded sand and gravel with discontinuous silt lenses.

c. Pale-brown to pale-brownish-gray sand with discontinuous, crossbedded and interbedded foreset coarse sand and gravel lenses, basal part is olive-brown silt marker lense.

SCALE: 1 inch = 5 feet
(no vertical exaggeration)
South Trench Wall Logged

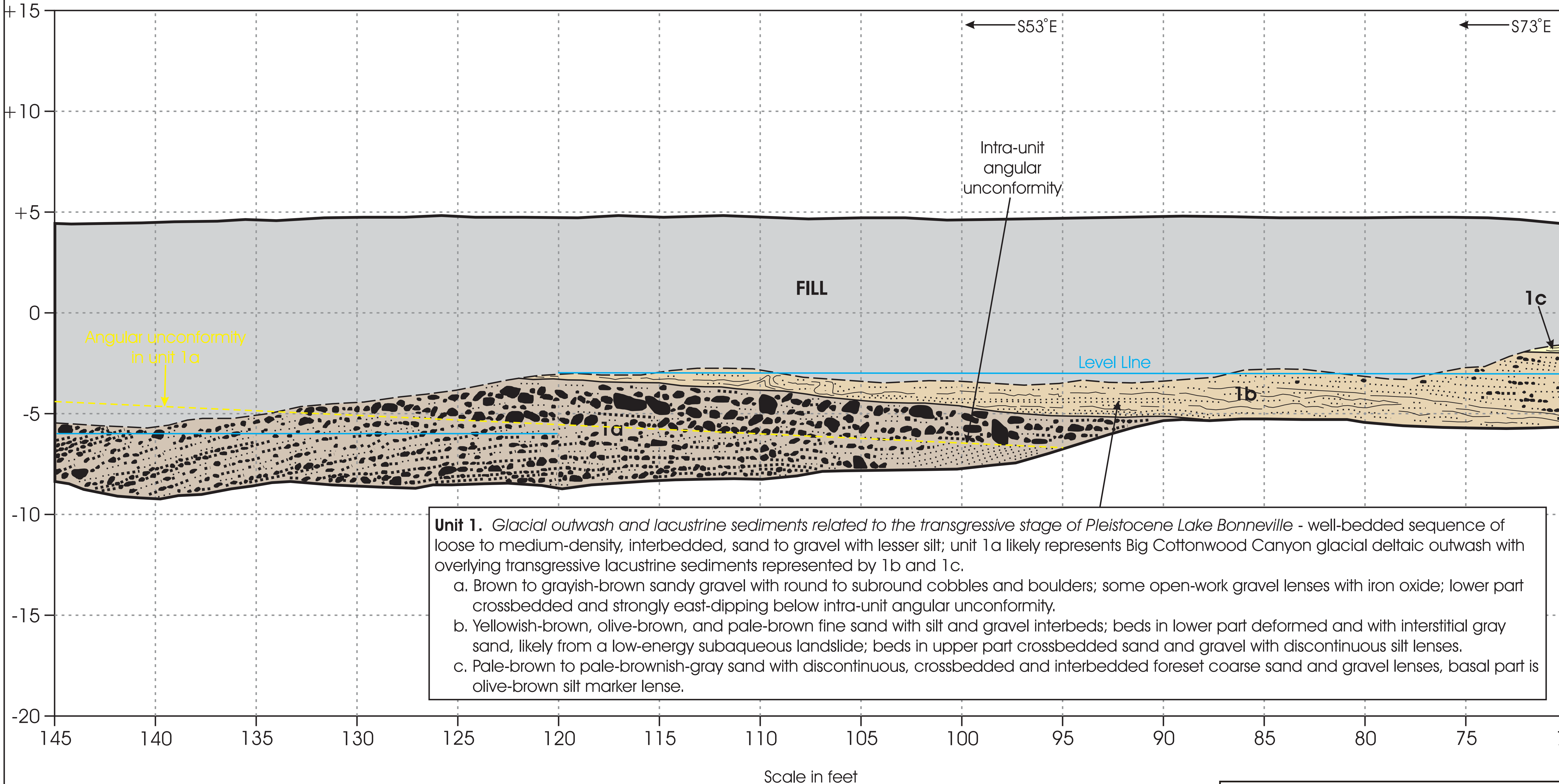
Trench logged by Bill Black, P.G. on
May 16-17 and 24, 2009

WESTERN GEOLOGIC

TRENCH 5 LOG, SHEET 1

GEOLOGIC HAZARDS EVALUATION
AJ Rock LLC Property
6695 South Wasatch Boulevard
Cottonwood Heights, Utah

FIGURE 9A



WESTERN GEOLOGIC

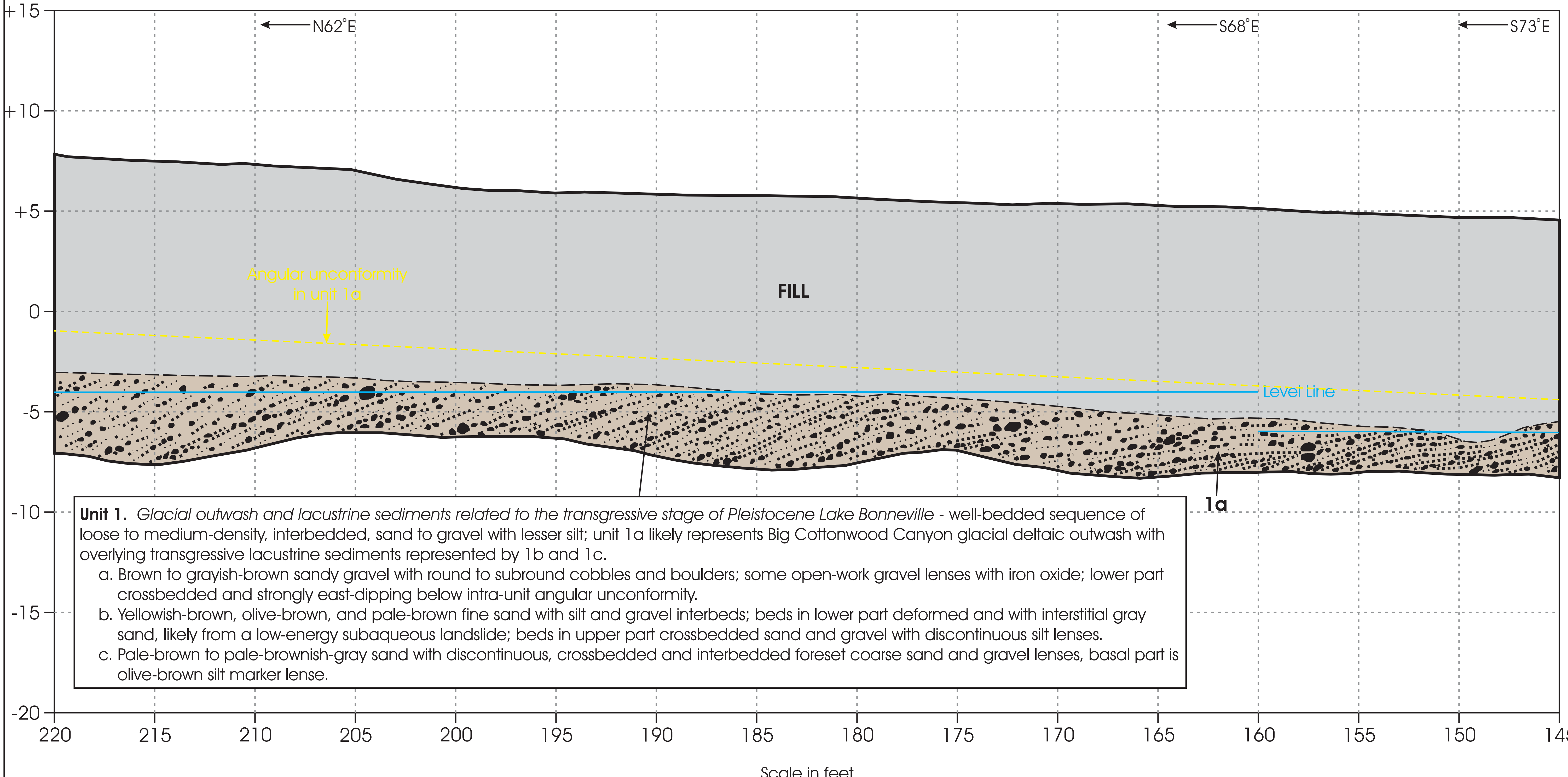
SCALE: 1 inch = 5 feet
(no vertical exaggeration)
South Trench Wall Logged

Trench logged by Bill Black, P.G. on
May 16-17 and 24, 2009

TRENCH 5 LOG, SHEET 2

GEOLOGIC HAZARDS EVALUATION
AJ Rock LLC Property
6695 South Wasatch Boulevard
Cottonwood Heights, Utah

FIGURE 9B



SCALE: 1 inch = 5 feet
(no vertical exaggeration)
South Trench Wall Logged

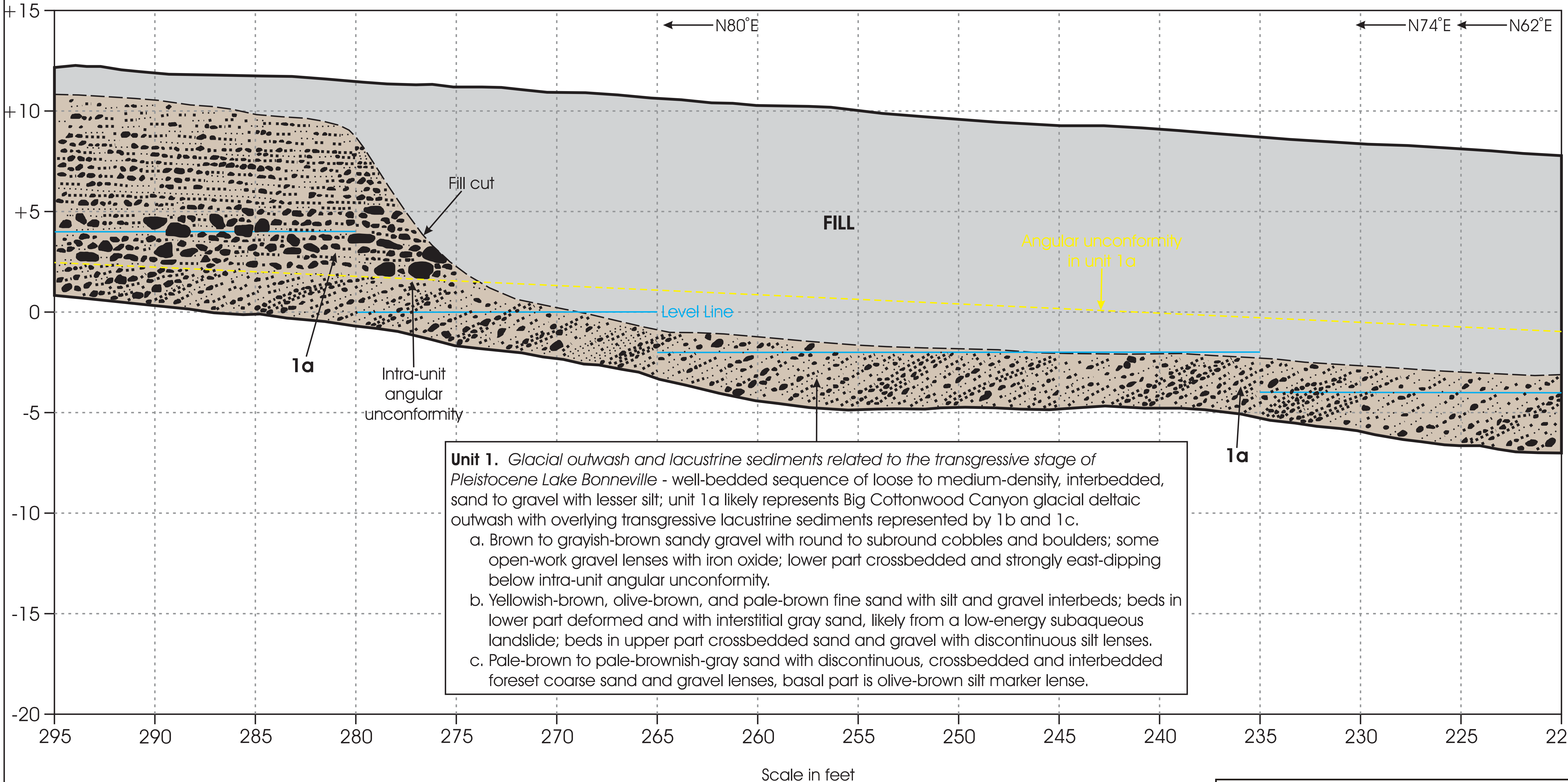
Trench logged by Bill Black, P.G. on
May 16-17 and 24, 2009

WESTERN GEOLOGIC

TRENCH 5 LOG, SHEET 3

GEOLOGIC HAZARDS EVALUATION
AJ Rock LLC Property
6695 South Wasatch Boulevard
Cottonwood Heights, Utah

FIGURE 9C



SCALE: 1 inch = 5 feet
(no vertical exaggeration)
South Trench Wall Logged

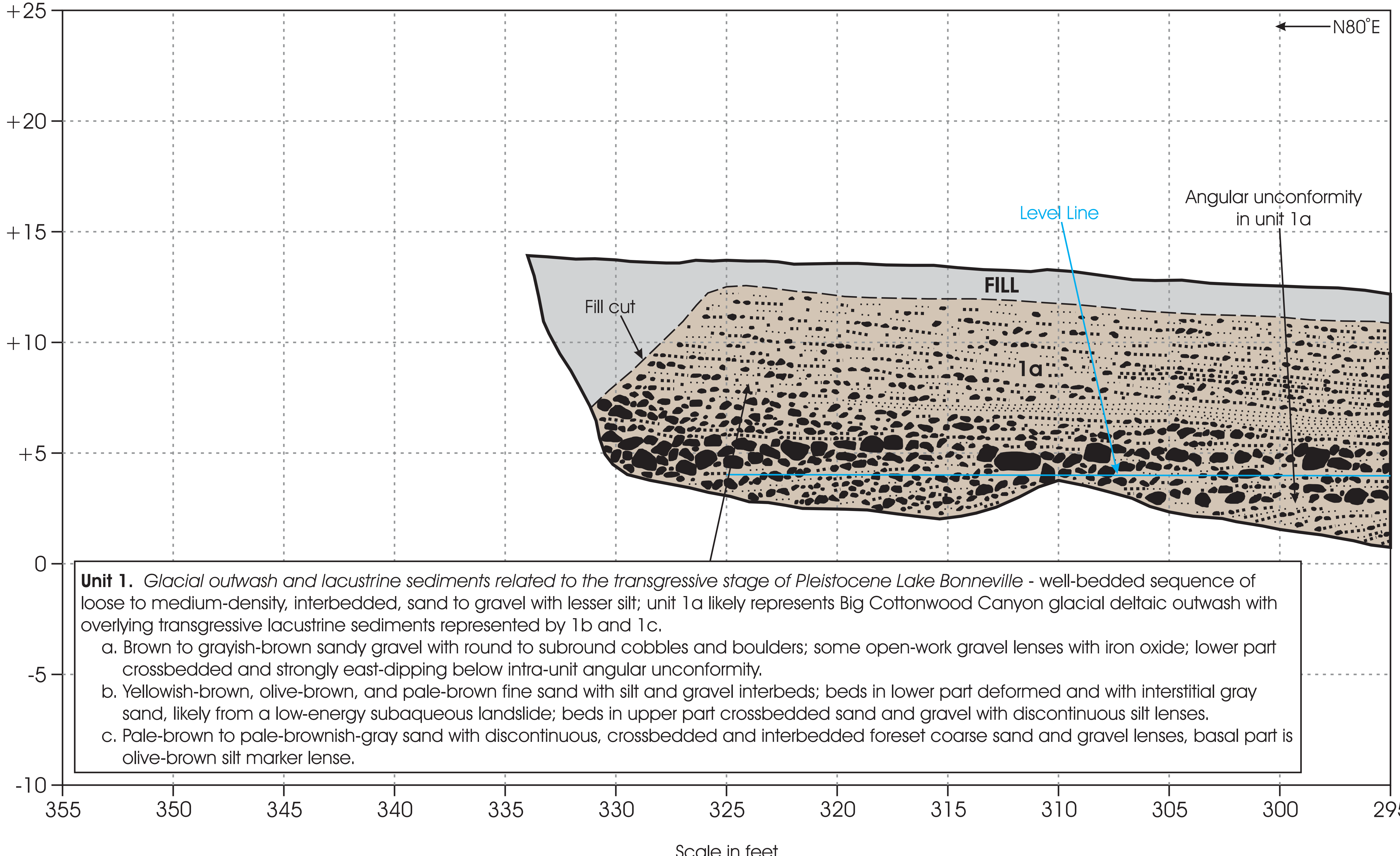
Trench logged by Bill Black, P.G. on
May 16-17 and 24, 2009

TRENCH 5 LOG, SHEET 4

GEOLOGIC HAZARDS EVALUATION
AJ Rock LLC Property
6695 South Wasatch Boulevard
Cottonwood Heights, Utah

FIGURE 9D

WESTERN GEOLOGIC



Unit 1. *Glacial outwash and lacustrine sediments related to the transgressive stage of Pleistocene Lake Bonneville* - well-bedded sequence of loose to medium-density, interbedded, sand to gravel with lesser silt; unit 1a likely represents Big Cottonwood Canyon glacial deltaic outwash with overlying transgressive lacustrine sediments represented by 1b and 1c.

a. Brown to grayish-brown sandy gravel with round to subround cobbles and boulders; some open-work gravel lenses with iron oxide; lower part crossbedded and strongly east-dipping below intra-unit angular unconformity.

b. Yellowish-brown, olive-brown, and pale-brown fine sand with silt and gravel interbeds; beds in lower part deformed and with interstitial gray sand, likely from a low-energy subaqueous landslide; beds in upper part crossbedded sand and gravel with discontinuous silt lenses.

c. Pale-brown to pale-brownish-gray sand with discontinuous, crossbedded and interbedded foreset coarse sand and gravel lenses, basal part is olive-brown silt marker lense.

SCALE: 1 inch = 5 feet
(no vertical exaggeration)
South Trench Wall Logged

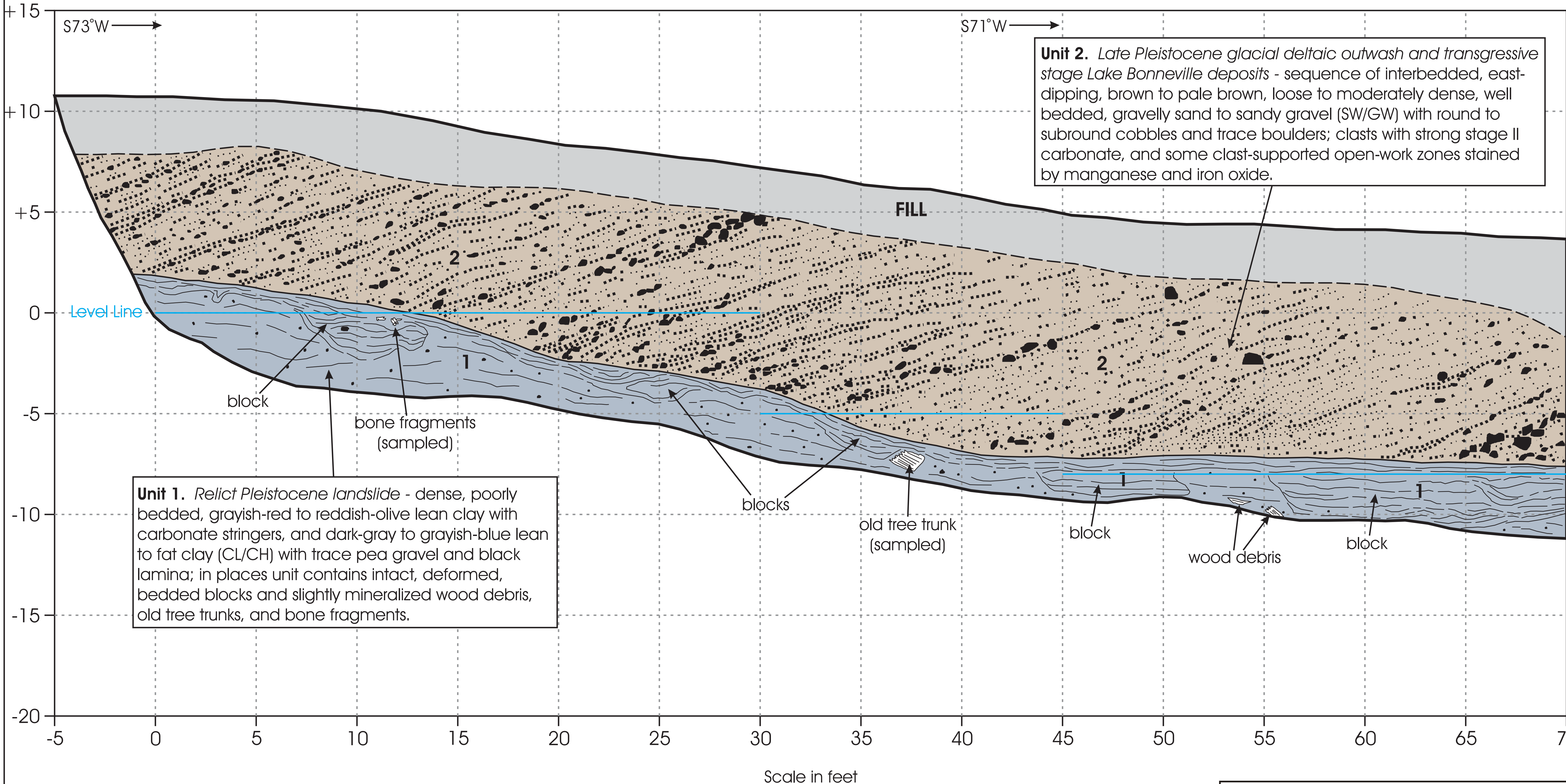
Trench logged by Bill Black, P.G. on
May 16-17 and 24, 2009
Log reviewed by Craig V Nelson, P.G., R.G., C.E.G

WESTERN GEOLOGIC

TRENCH 5 LOG, SHEET 5

GEOLOGIC HAZARDS EVALUATION
AJ Rock LLC Property
6695 South Wasatch Boulevard
Cottonwood Heights, Utah

FIGURE 9E



SCALE: 1 inch = 5 feet
(no vertical exaggeration)
South Trench Wall Logged

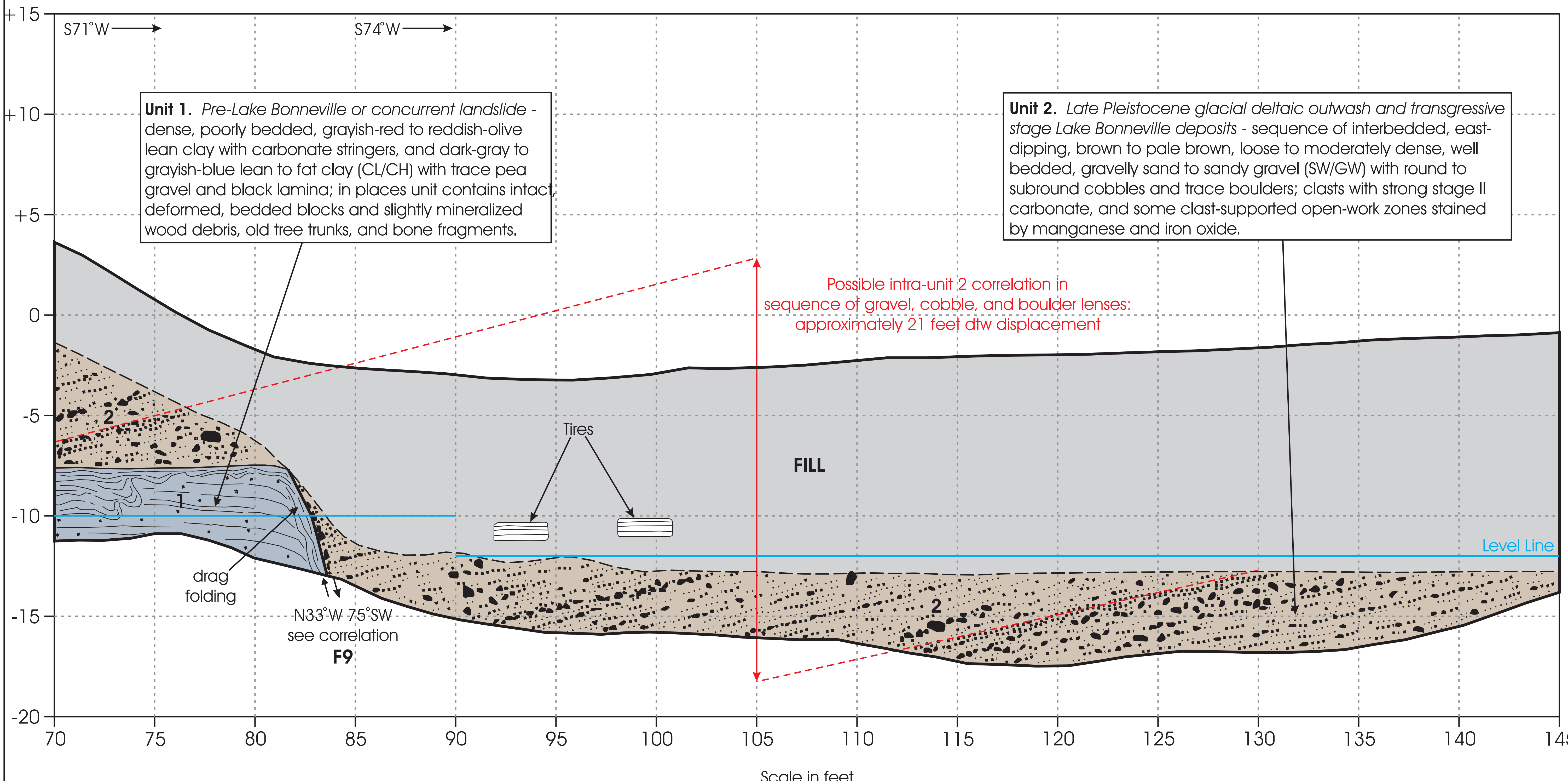
Trench logged by Bill Black, P.G. on
May 23, 2009

TRENCH 6 LOG, SHEET 1

GEOLOGIC HAZARDS EVALUATION
AJ Rock LLC Property
6695 South Wasatch Boulevard
Cottonwood Heights, Utah

FIGURE 10A

WESTERN GEOLOGIC



SCALE: 1 inch = 5 feet
(no vertical exaggeration)
South Trench Wall Logged

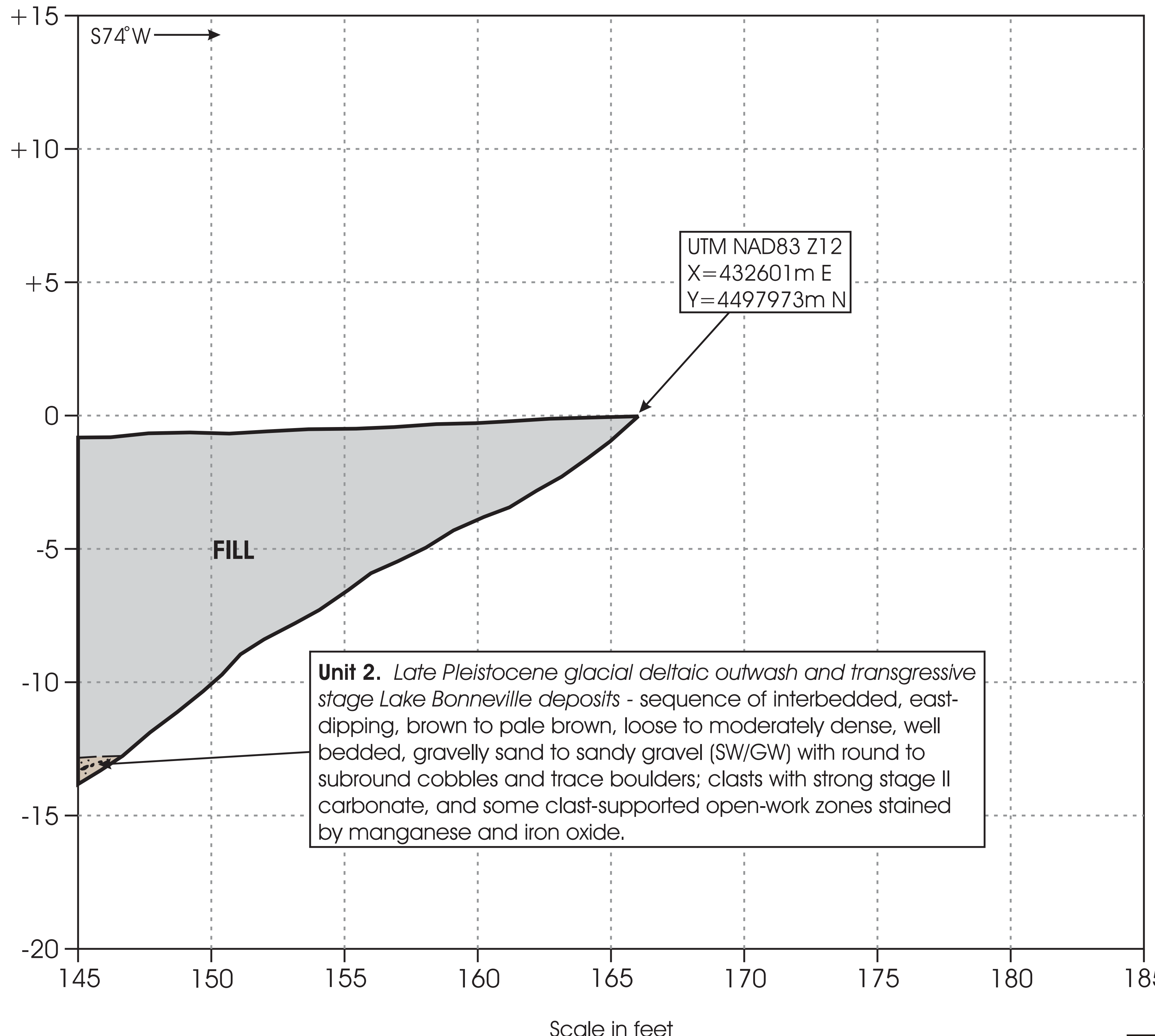
Trench logged by Bill Black, P.G. on May 23, 2009

WESTERN GEOLOGIC

TRENCH 6 LOG, SHEET 2

GEOLOGIC HAZARDS EVALUATION
AJ Rock LLC Property
6695 South Wasatch Boulevard
Cottonwood Heights, Utah

FIGURE 10B



SCALE: 1 inch = 5 feet
(no vertical exaggeration)
South Trench Wall Logged

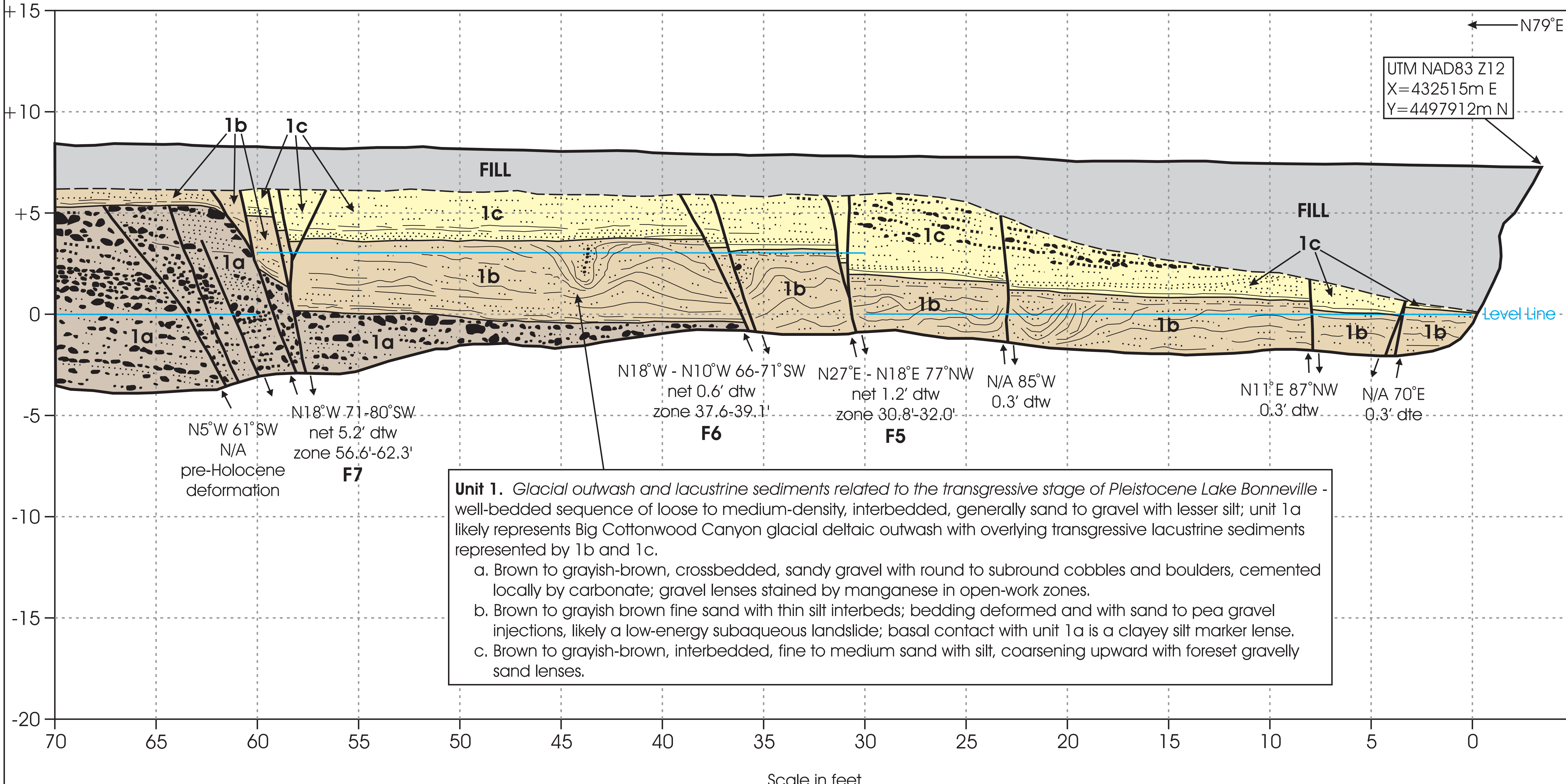
Trench logged by Bill Black, P.G. on
May 23, 2009

WESTERN GEOLOGIC

TRENCH 6 LOG, SHEET 3

GEOLOGIC HAZARDS EVALUATION
AJ Rock LLC Property
6695 South Wasatch Boulevard
Cottonwood Heights, Utah

FIGURE 10C



SCALE: 1 inch = 5 feet
(no vertical exaggeration)
South Trench Wall Logged

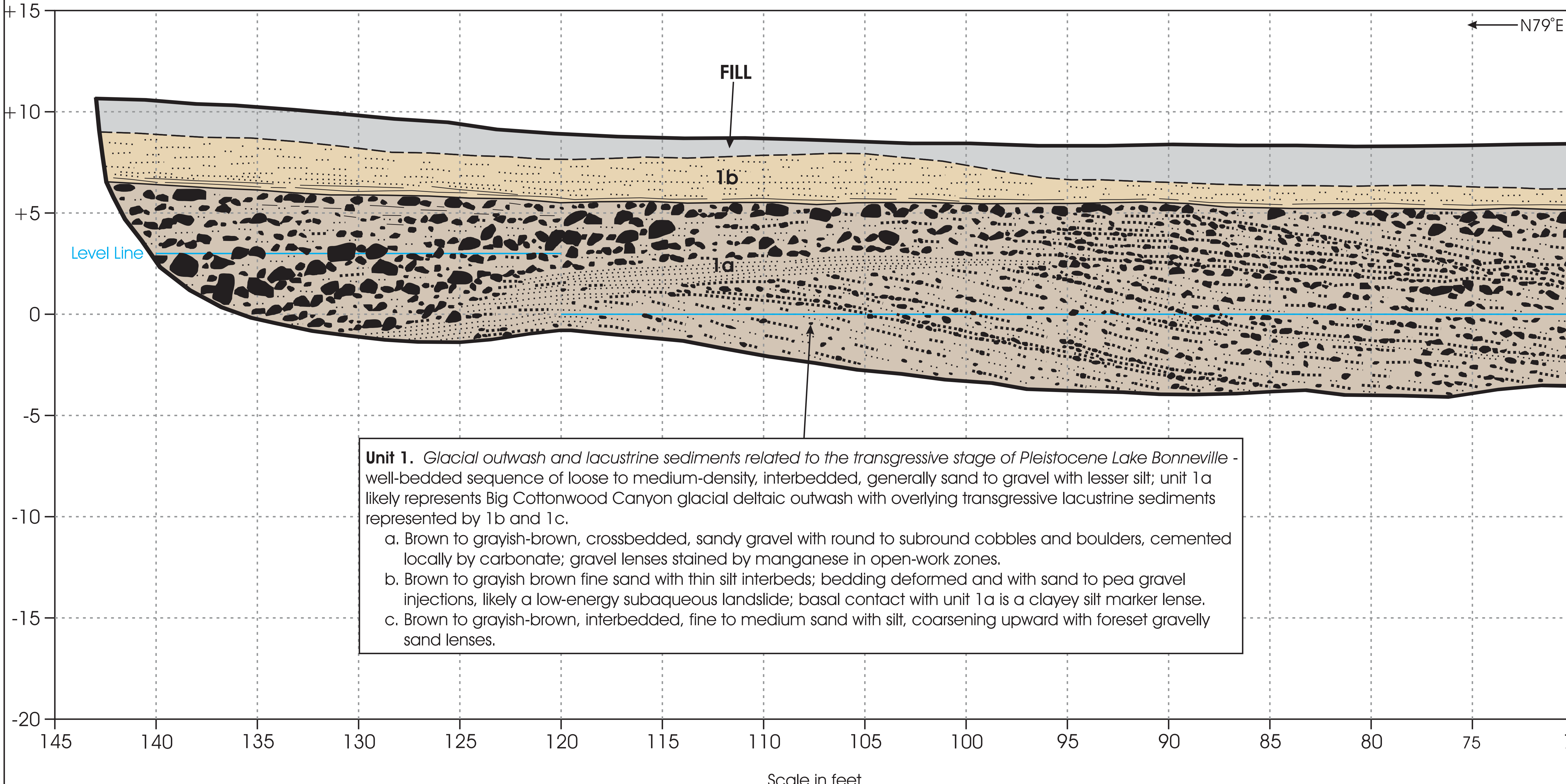
Trench logged by Bill Black, P.G. on
May 30, 2009

WESTERN GEOLOGIC

TRENCH 7 LOG, SHEET 1

GEOLOGIC HAZARDS EVALUATION
AJ Rock LLC Property
6695 South Wasatch Boulevard
Cottonwood Heights, Utah

FIGURE 11A



Unit 1. *Glacial outwash and lacustrine sediments related to the transgressive stage of Pleistocene Lake Bonneville* - well-bedded sequence of loose to medium-density, interbedded, generally sand to gravel with lesser silt; unit 1a likely represents Big Cottonwood Canyon glacial deltaic outwash with overlying transgressive lacustrine sediments represented by 1b and 1c.

a. Brown to grayish-brown, crossbedded, sandy gravel with round to subround cobbles and boulders, cemented locally by carbonate; gravel lenses stained by manganese in open-work zones.

b. Brown to grayish brown fine sand with thin silt interbeds; bedding deformed and with sand to pea gravel injections, likely a low-energy subaqueous landslide; basal contact with unit 1a is a clayey silt marker lense.

c. Brown to grayish-brown, interbedded, fine to medium sand with silt, coarsening upward with foreset gravelly sand lenses.

WESTERN GEOLOGIC

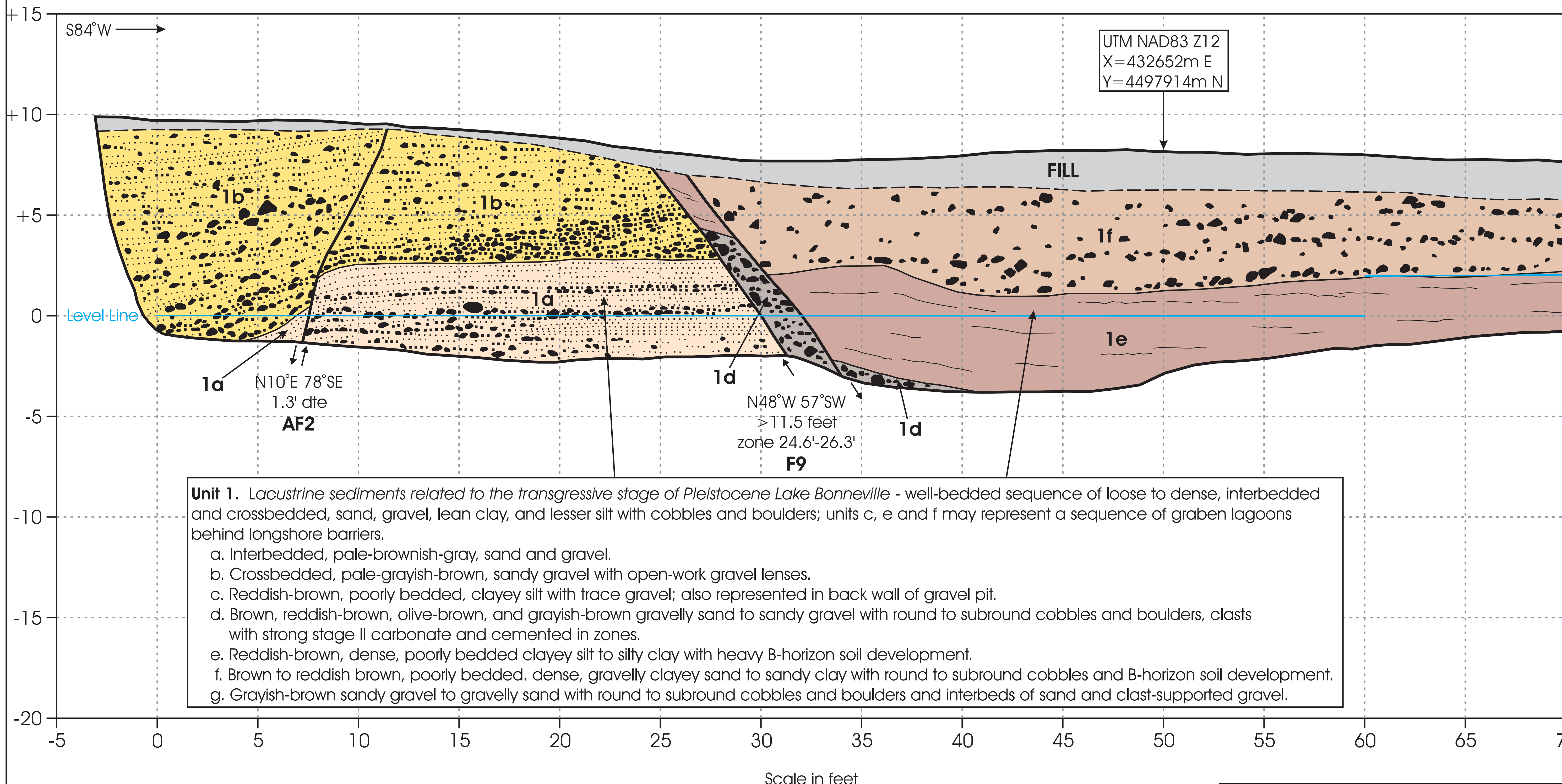
SCALE: 1 inch = 5 feet
(no vertical exaggeration)
South Trench Wall Logged

Trench logged by Bill Black, P.G. on
May 30, 2009

TRENCH 7 LOG, SHEET 2

GEOLOGIC HAZARDS EVALUATION
AJ Rock LLC Property
6695 South Wasatch Boulevard
Cottonwood Heights, Utah

FIGURE 11B



SCALE: 1 inch = 5 feet
(no vertical exaggeration)
South Trench Wall Logged

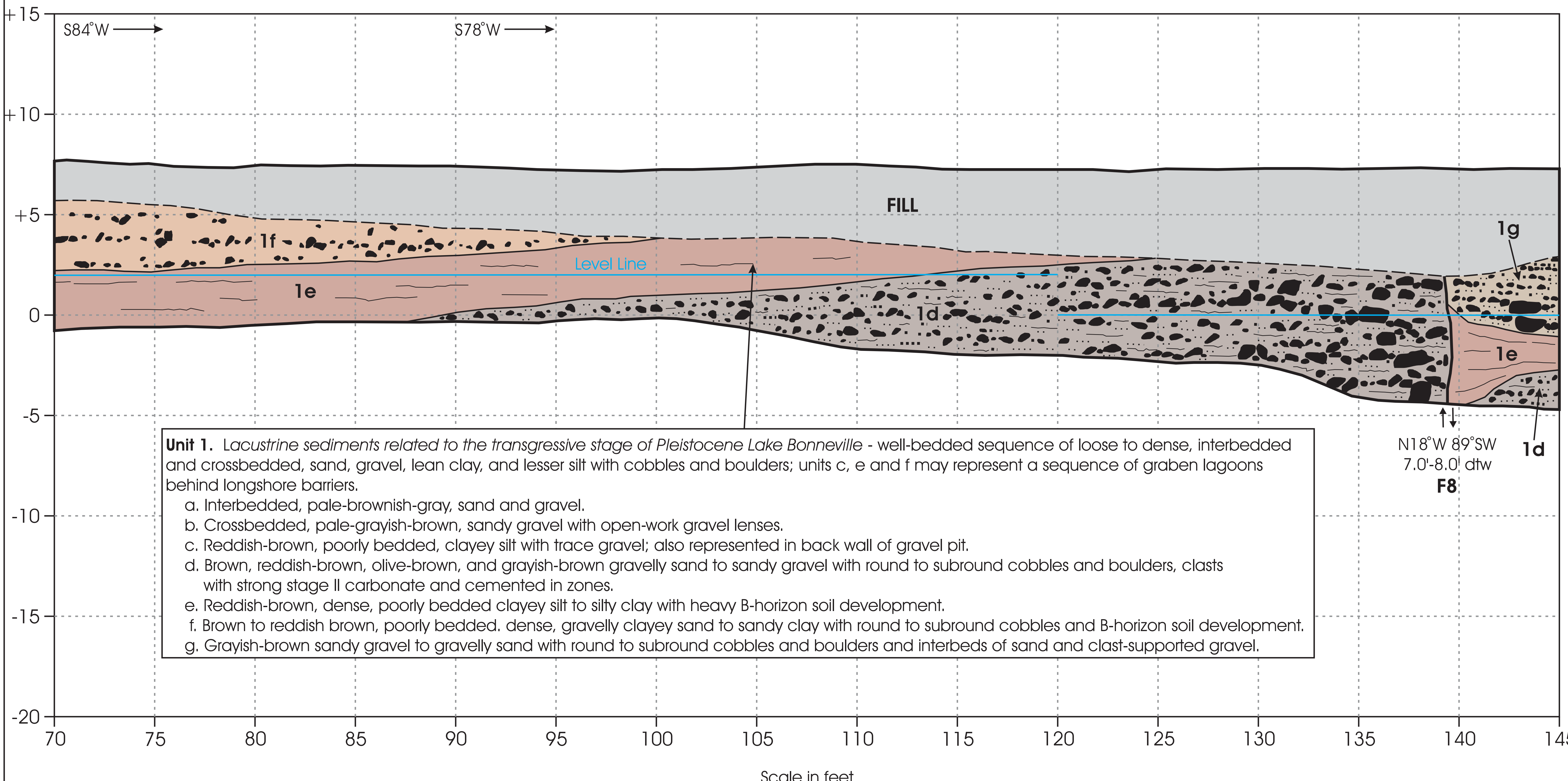
Trench logged by Bill Black, P.G. on
May 30-31, 2009

WESTERN GEOLOGIC

TRENCH 8 LOG, SHEET 1

GEOLOGIC HAZARDS EVALUATION
AJ Rock LLC Property
6695 South Wasatch Boulevard
Cottonwood Heights, Utah

FIGURE 12A



Unit 1. *Lacustrine sediments related to the transgressive stage of Pleistocene Lake Bonneville* - well-bedded sequence of loose to dense, interbedded and crossbedded, sand, gravel, lean clay, and lesser silt with cobbles and boulders; units c, e and f may represent a sequence of graben lagoons behind longshore barriers.

a. Interbedded, pale-brownish-gray, sand and gravel.
b. Crossbedded, pale-grayish-brown, sandy gravel with open-work gravel lenses.
c. Reddish-brown, poorly bedded, clayey silt with trace gravel; also represented in back wall of gravel pit.
d. Brown, reddish-brown, olive-brown, and grayish-brown gravelly sand to sandy gravel with round to subround cobbles and boulders, clasts with strong stage II carbonate and cemented in zones.
e. Reddish-brown, dense, poorly bedded clayey silt to silty clay with heavy B-horizon soil development.
f. Brown to reddish brown, poorly bedded. dense, gravelly clayey sand to sandy clay with round to subround cobbles and B-horizon soil development.
g. Grayish-brown sandy gravel to gravelly sand with round to subround cobbles and boulders and interbeds of sand and clast-supported gravel.

WESTERN GEOLOGIC

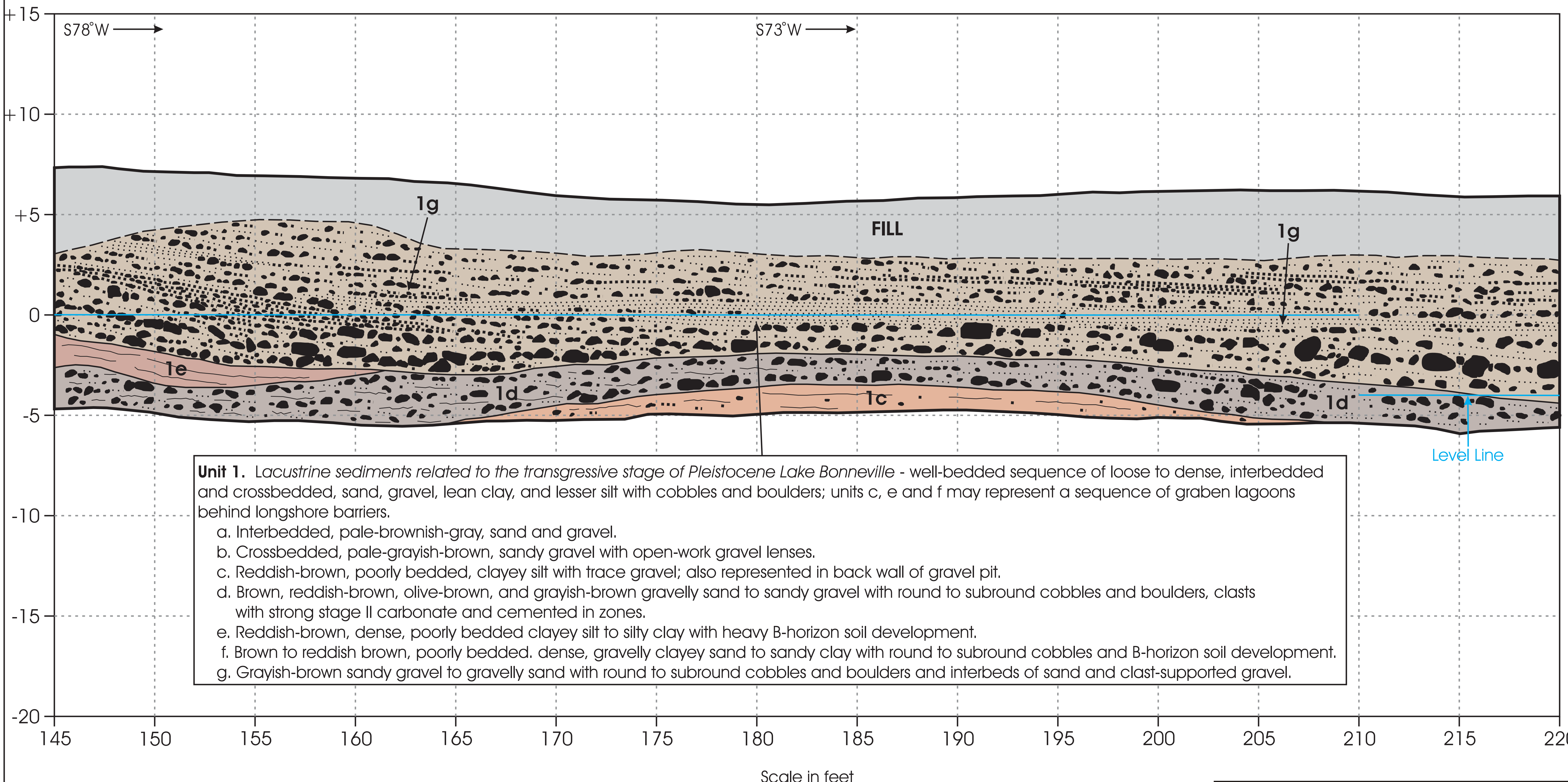
SCALE: 1 inch = 5 feet
(no vertical exaggeration)
South Trench Wall Logged

Trench logged by Bill Black, P.G. on
May 30-31, 2009

TRENCH 8 LOG, SHEET 2

GEOLOGIC HAZARDS EVALUATION
AJ Rock LLC Property
6695 South Wasatch Boulevard
Cottonwood Heights, Utah

FIGURE 12B



WESTERN GeoLogic

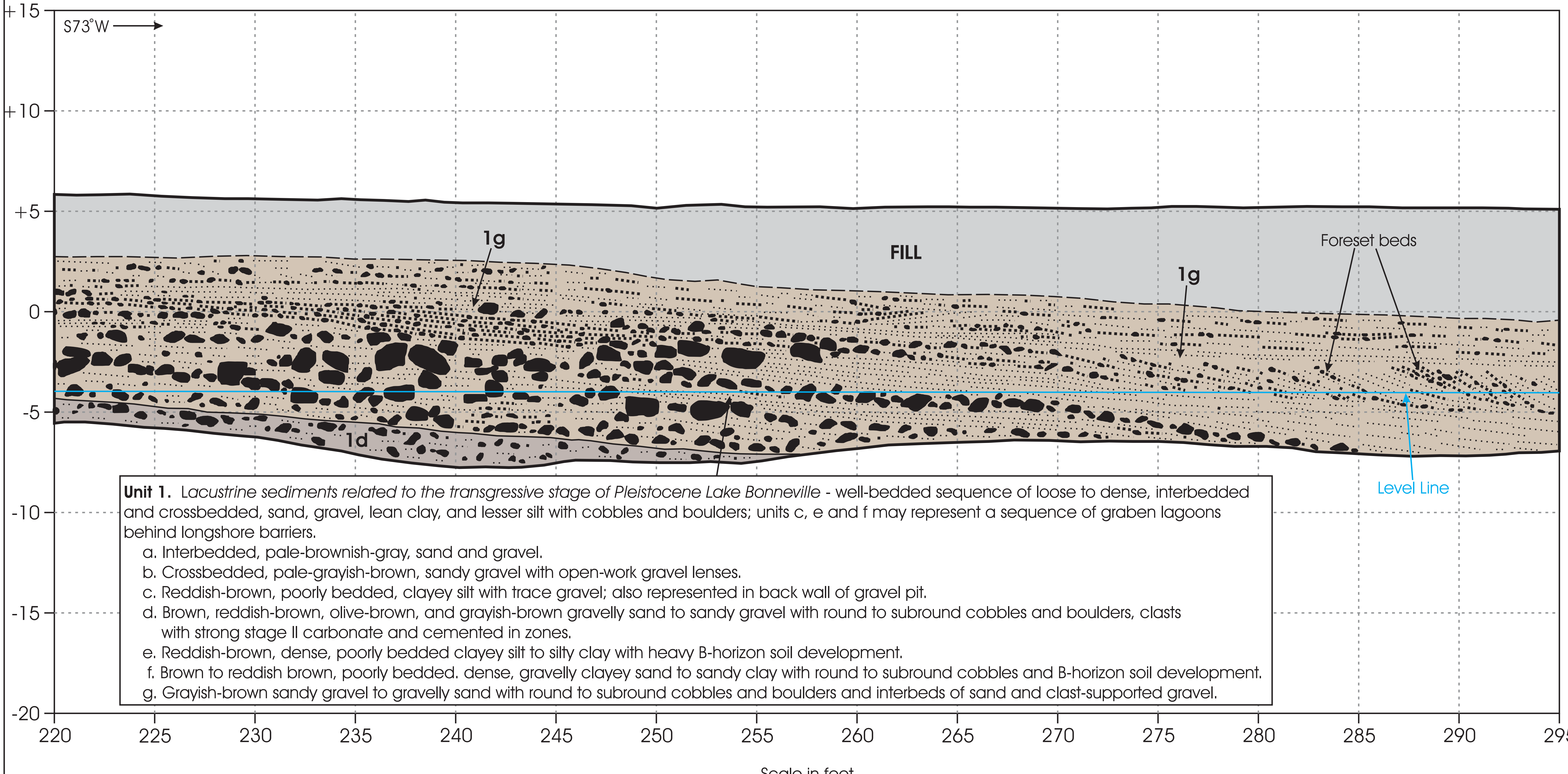
SCALE: 1 inch = 5 feet
(no vertical exaggeration)
South Trench Wall Logged

Trench logged by Bill Black, P.G. on
May 30-31, 2009

TRENCH 8 LOG, SHEET 3

GEOLOGIC HAZARDS EVALUATION
AJ Rock LLC Property
6695 South Wasatch Boulevard
Cottonwood Heights, Utah

FIGURE 12C



Unit 1. *Lacustrine sediments related to the transgressive stage of Pleistocene Lake Bonneville* - well-bedded sequence of loose to dense, interbedded and crossbedded, sand, gravel, lean clay, and lesser silt with cobbles and boulders; units c, e and f may represent a sequence of graben lagoons behind longshore barriers.

a. Interbedded, pale-brownish-gray, sand and gravel.
b. Crossbedded, pale-grayish-brown, sandy gravel with open-work gravel lenses.
c. Reddish-brown, poorly bedded, clayey silt with trace gravel; also represented in back wall of gravel pit.
d. Brown, reddish-brown, olive-brown, and grayish-brown gravelly sand to sandy gravel with round to subround cobbles and boulders, clasts with strong stage II carbonate and cemented in zones.
e. Reddish-brown, dense, poorly bedded clayey silt to silty clay with heavy B-horizon soil development.
f. Brown to reddish brown, poorly bedded. dense, gravelly clayey sand to sandy clay with round to subround cobbles and B-horizon soil development.
g. Grayish-brown sandy gravel to gravelly sand with round to subround cobbles and boulders and interbeds of sand and clast-supported gravel.

WESTERN GEOLOGIC

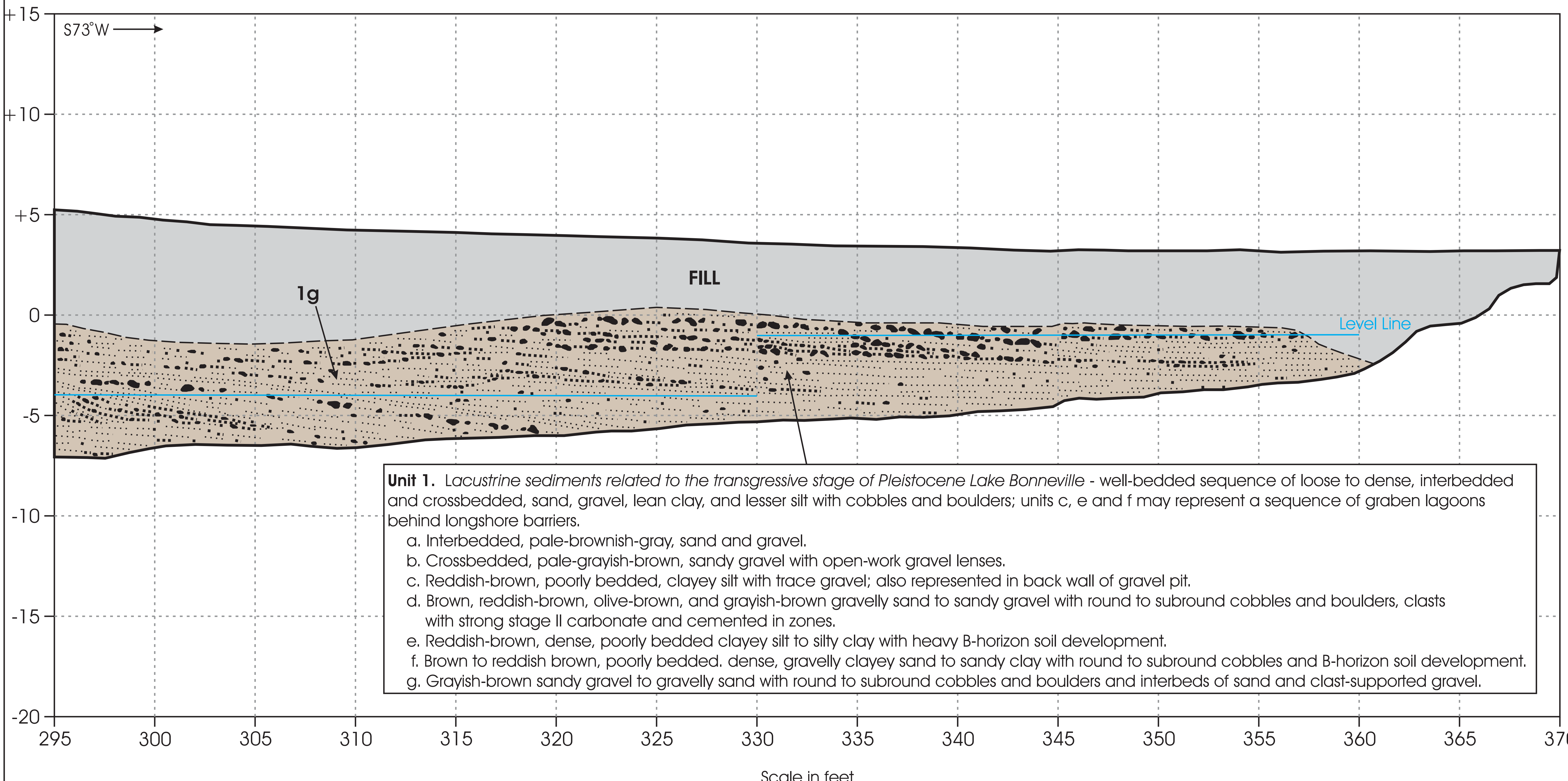
SCALE: 1 inch = 5 feet
(no vertical exaggeration)
South Trench Wall Logged

Trench logged by Bill Black, P.G. on
May 30-31, 2009

TRENCH 8 LOG, SHEET 4

GEOLOGIC HAZARDS EVALUATION
AJ Rock LLC Property
6695 South Wasatch Boulevard
Cottonwood Heights, Utah

FIGURE 12D



WESTERN GEOLOGIC

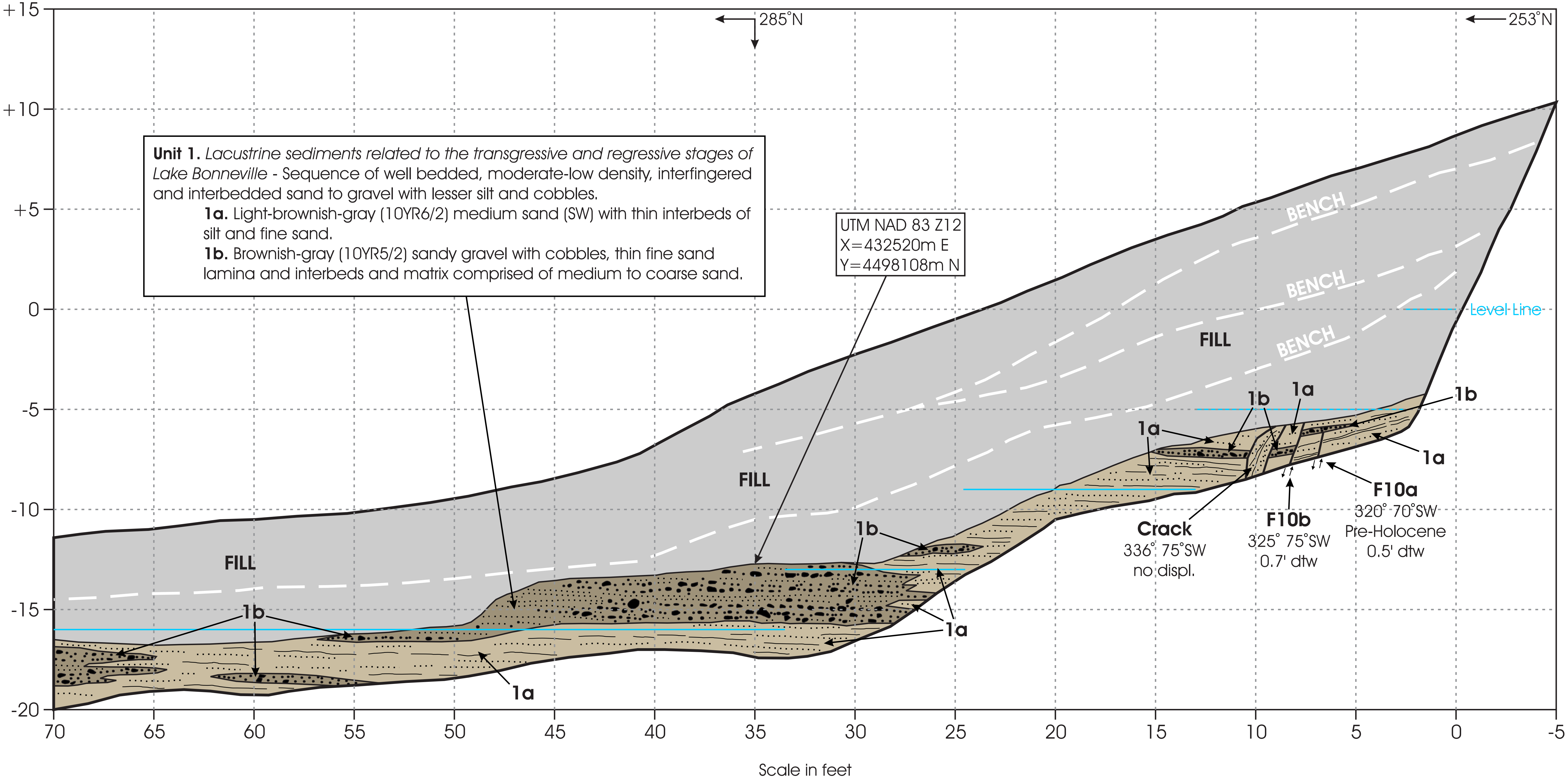
SCALE: 1 inch = 5 feet
(no vertical exaggeration)
South Trench Wall Logged

Trench logged by Bill Black, P.G. on
May 30-31, 2009

TRENCH 8 LOG, SHEET 5

GEOLOGIC HAZARDS EVALUATION
AJ Rock LLC Property
6695 South Wasatch Boulevard
Cottonwood Heights, Utah

FIGURE 12E



SCALE: 1 inch = 5 feet
(no vertical exaggeration)
North Trench Wall Logged

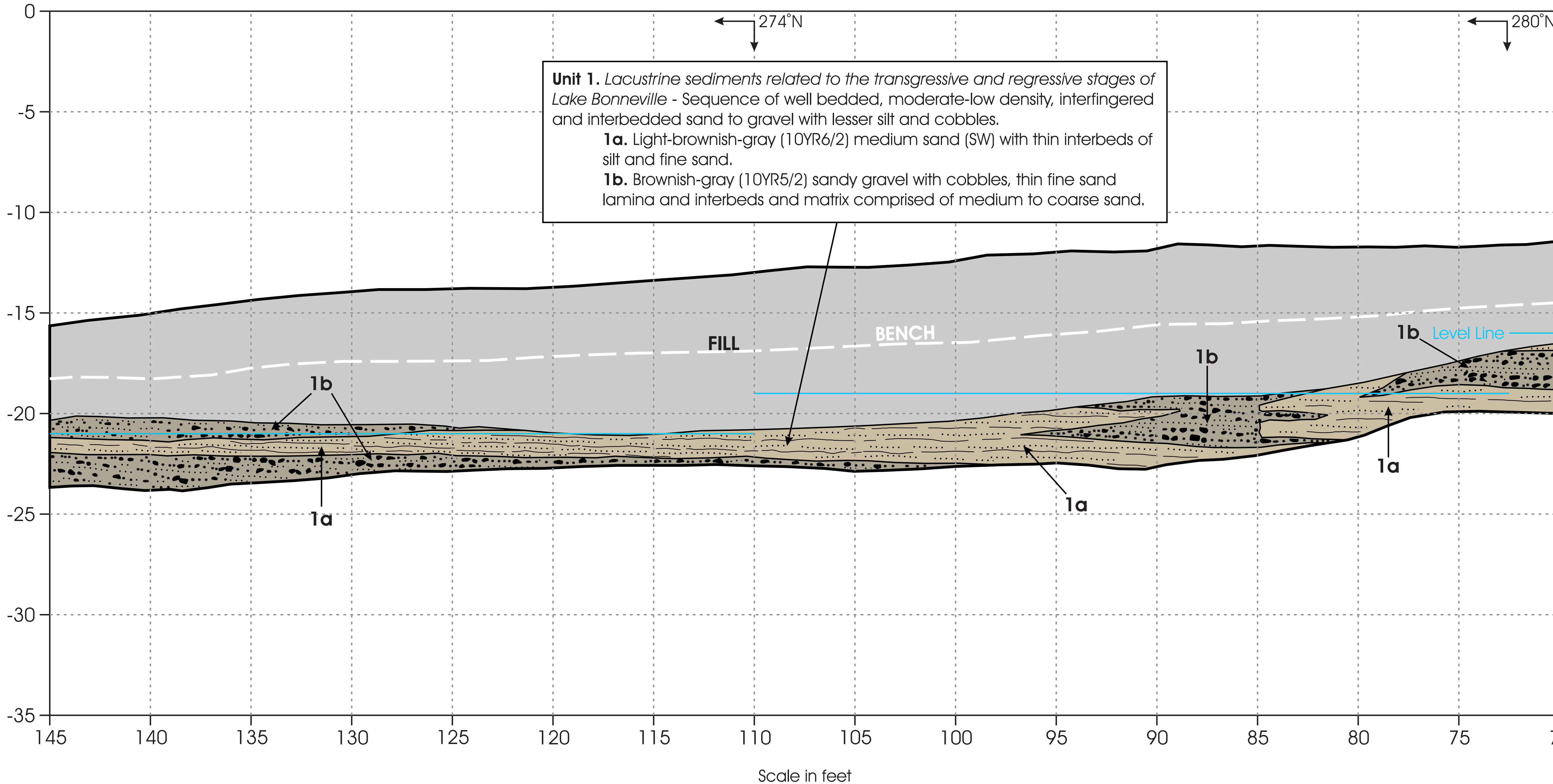
Trench logged by Bill Black, P.G. on
March 25-26, 2020

WESTERN GEOLOGIC

TRENCH 9 LOG, SHEET 1

GEOLOGIC HAZARDS EVALUATION
AJ Rock LLC Property
6695 South Wasatch Boulevard
Cottonwood Heights, Utah

FIGURE 13A



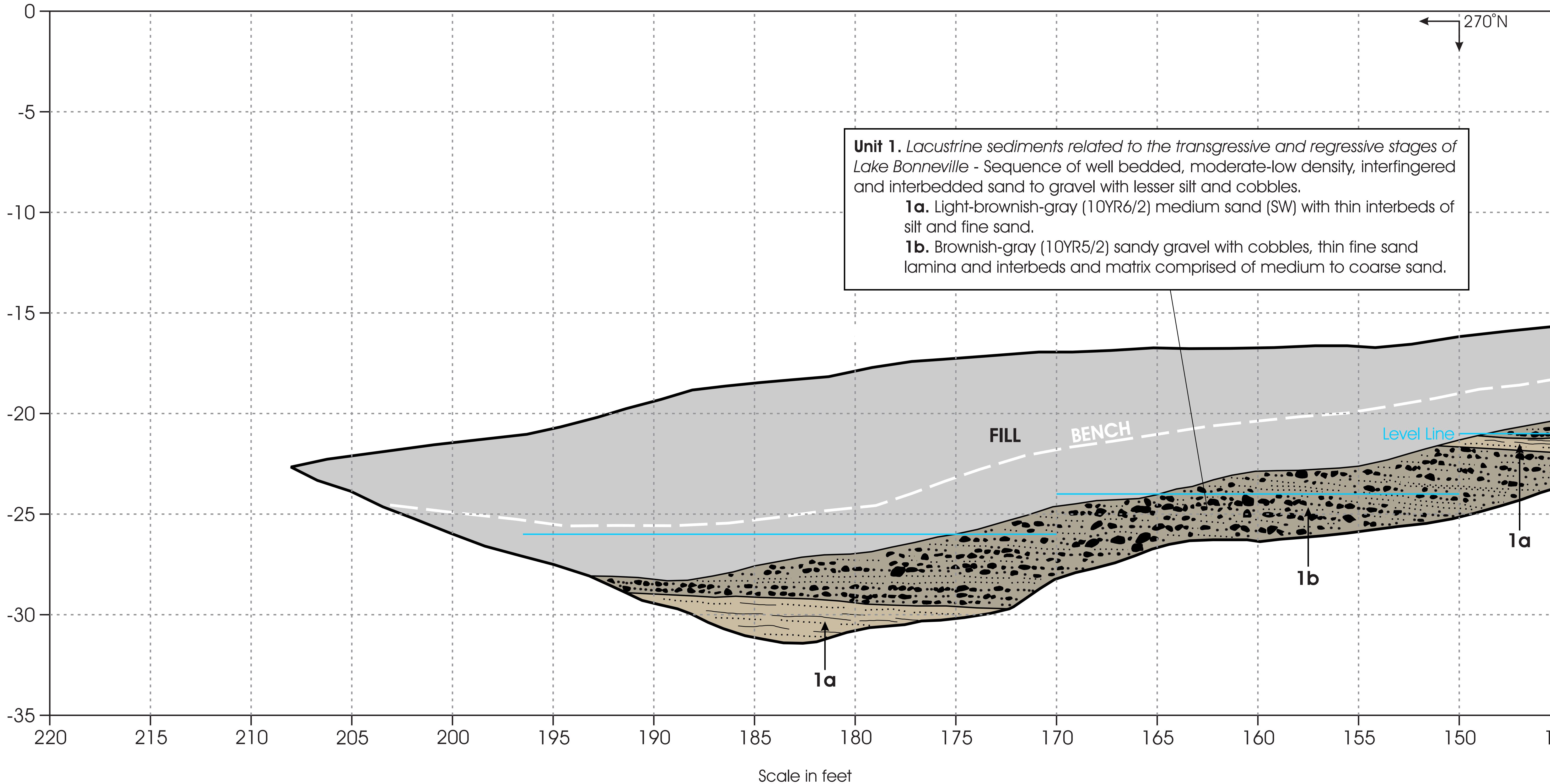
SCALE: 1 inch = 5 feet
(no vertical exaggeration)
North Trench Wall Logged

Trench logged by Bill Black, P.G. on
March 25-26, 2020

TRENCH 9 LOG, SHEET 2

GEOLOGIC HAZARDS EVALUATION
AJ Rock LLC Property
6695 South Wasatch Boulevard
Cottonwood Heights, Utah

FIGURE 13B



SCALE: 1 inch = 5 feet
(no vertical exaggeration)
North Trench Wall Logged

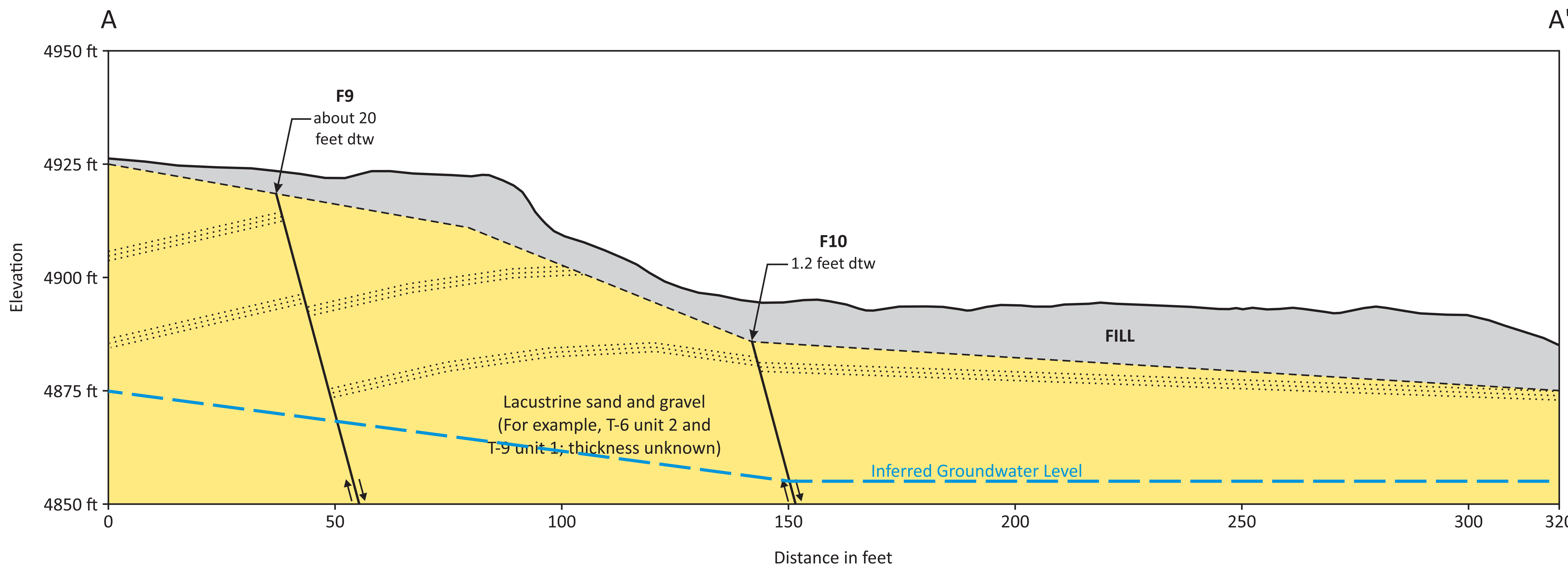
Trench logged by Bill Black, P.G. on March 25-26, 2020

TRENCH 9 LOG, SHEET 3

GEOLOGIC HAZARDS EVALUATION
AJ Rock LLC Property
6695 South Wasatch Boulevard
Cottonwood Heights, Utah

FIGURE 13C

WESTERN GEOLOGIC



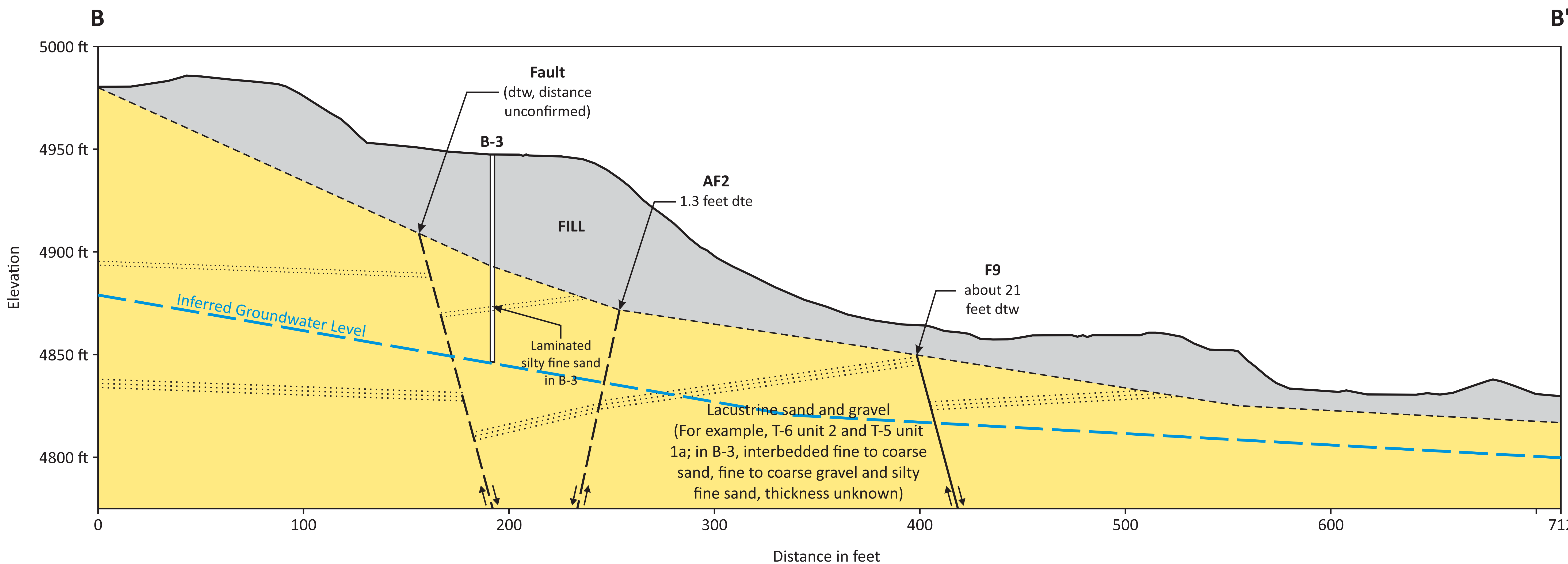
SCALE: 1 inch = 25 feet
(no vertical exaggeration)
East to West trending 228°N
Unit and textural contacts
are approximate and inferred

CROSS SECTION A-A'

GEOLOGIC HAZARDS EVALUATION

AJ Rock LLC Property
6695 South Wasatch Boulevard
Cottonwood Heights, Utah

FIGURE 14



SCALE: 1 inch = 50 feet
(no vertical exaggeration)
East to West trending 226°N
Unit and textural contacts
are approximate and inferred

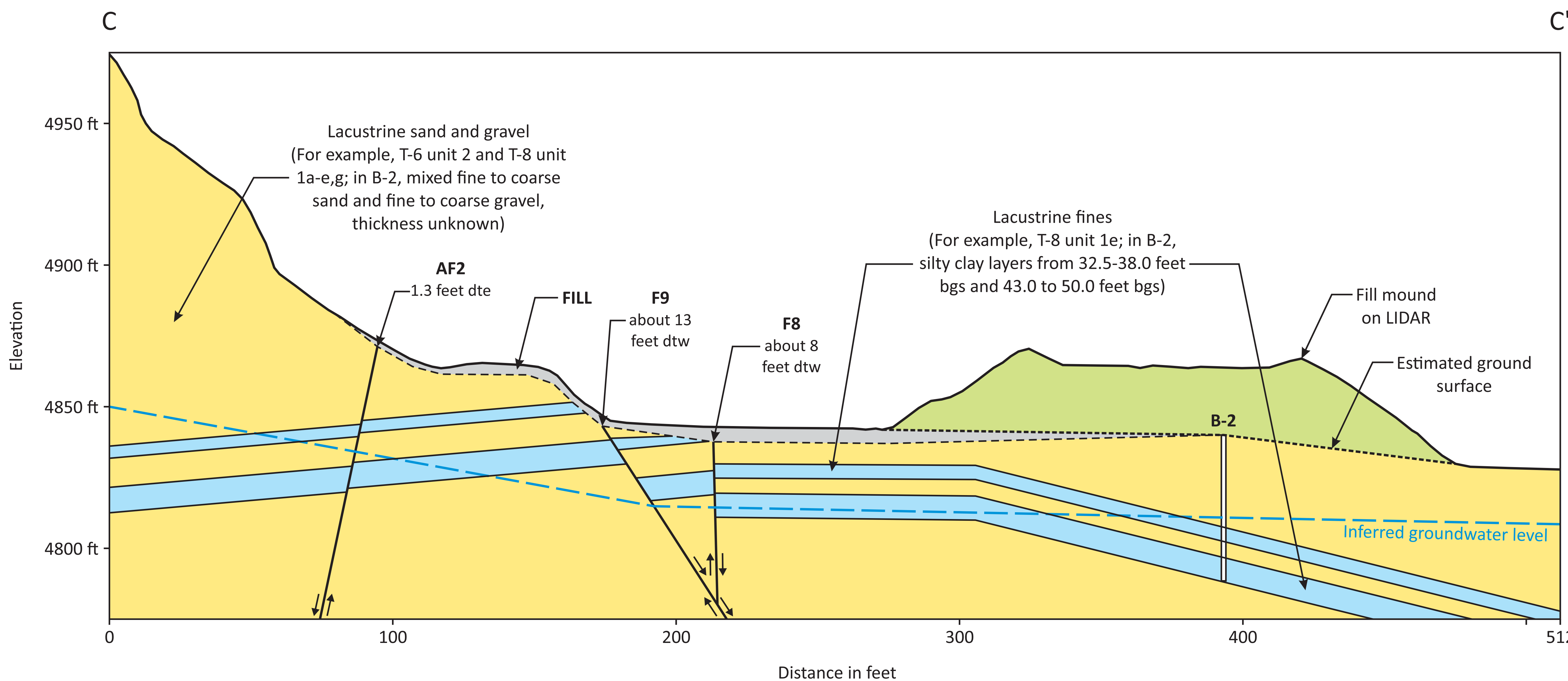
WESTERN GEOLOGIC

CROSS SECTION B-B'

GEOLOGIC HAZARDS EVALUATION

AJ Rock LLC Property
6695 South Wasatch Boulevard
Cottonwood Heights, Utah

FIGURE 15



SCALE: 1 inch = 40 feet
(no vertical exaggeration)
East to West trending 257°N
Unit and textural contacts
are approximate and inferred

WESTERN GEOLOGIC

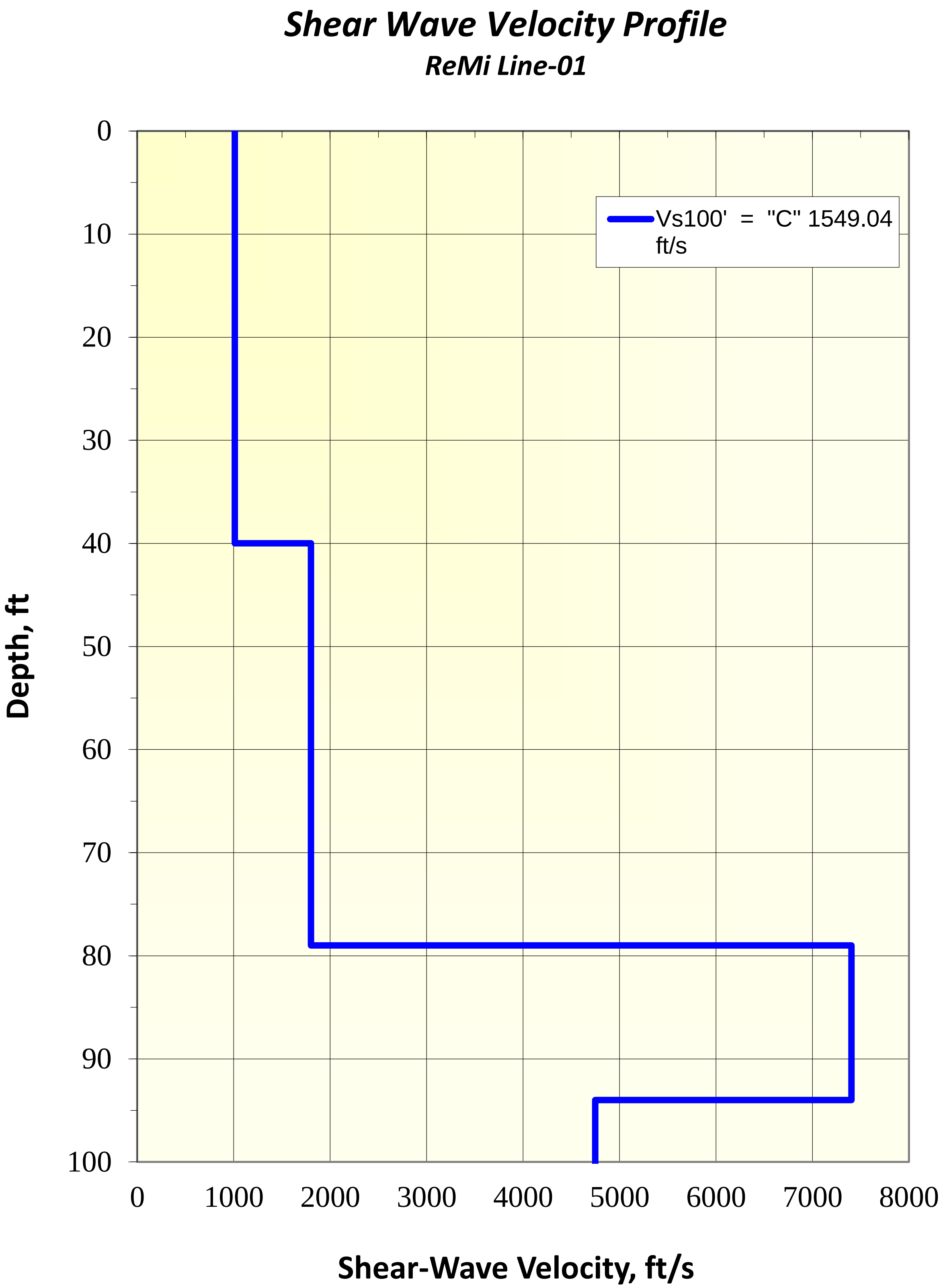
CROSS SECTION C-C'

GEOLOGIC HAZARDS EVALUATION
AJ Rock LLC Property
6695 South Wasatch Boulevard
Cottonwood Heights, Utah

FIGURE 16

APPENDIX B

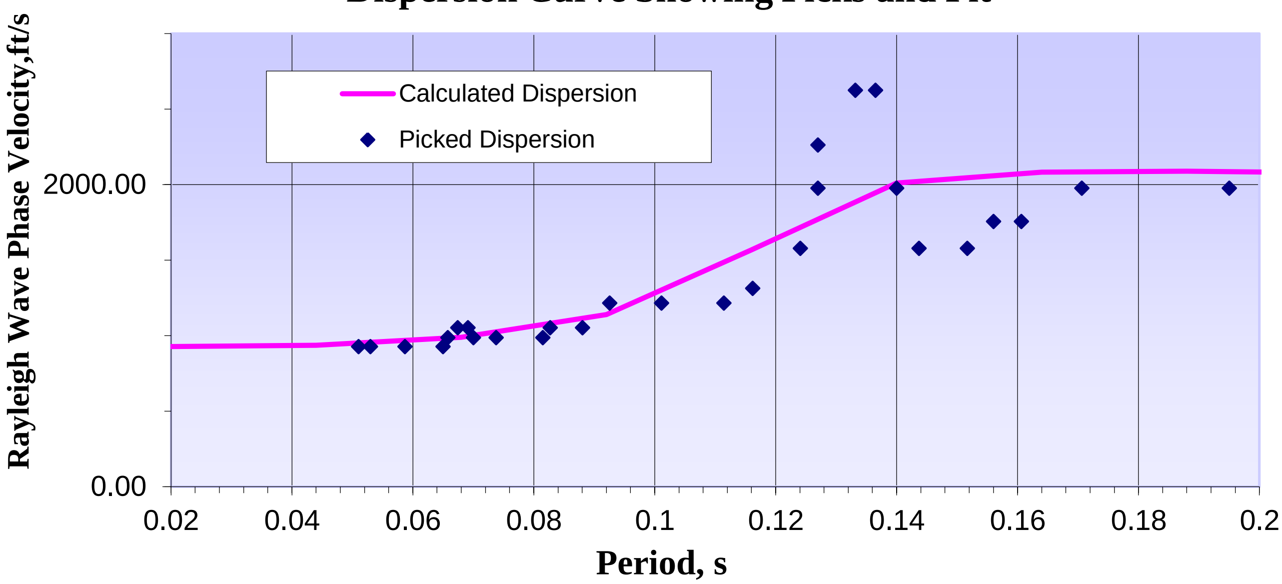
ReMi Survey Results



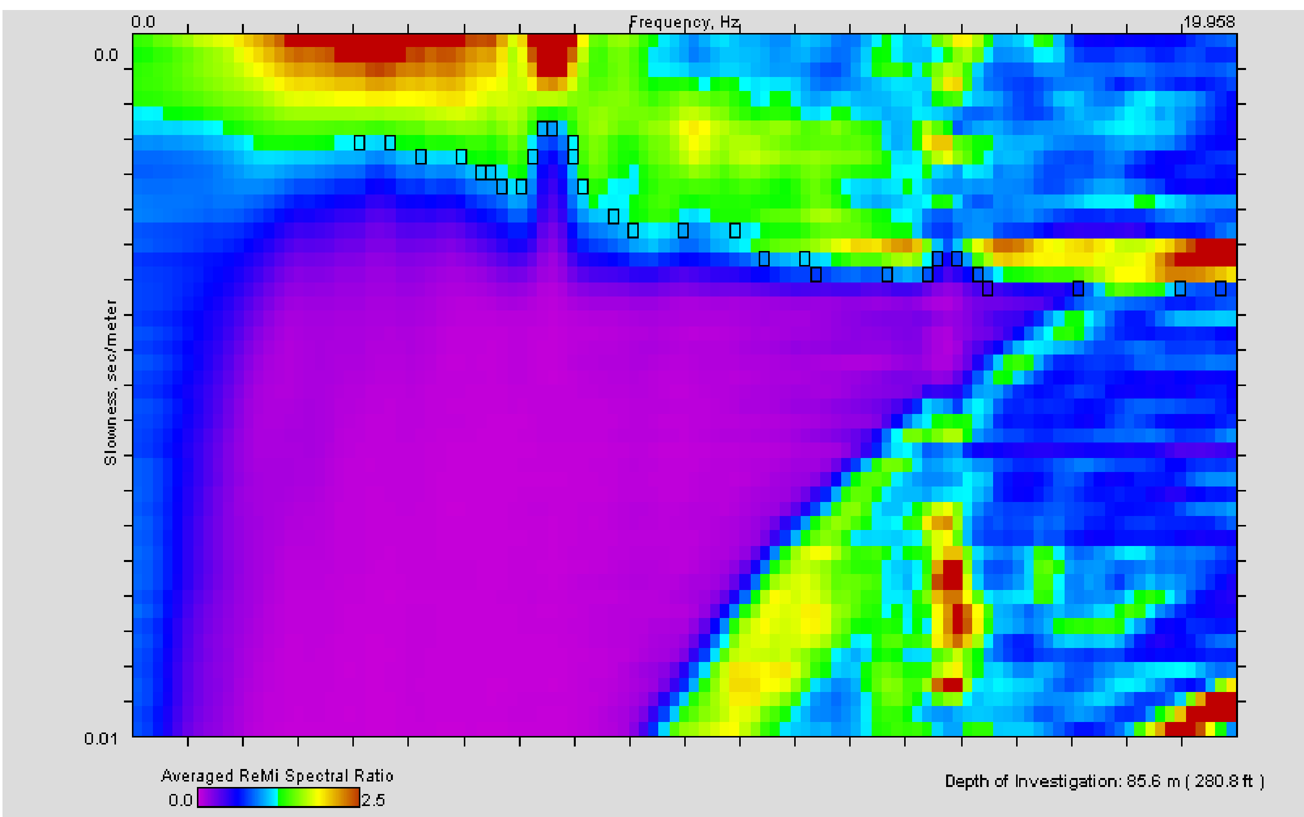
Shear Wave Velocity Profile
ReMi Line-01
Vs100' = "C" 1549.04 ft/s
Depth, ft
Shear-Wave Velocity, ft/s
0
10
20
30
40
50
60
70
80
90
100
0
1000
2000
3000
4000
5000
6000
7000
8000

Dispersion Curve and Slowness Spectrum

Dispersion Curve Showing Picks and Fit



p-f Image with Dispersion Modeling Picks



APPENDIX C

Direct Shear Test Results

2B

Chain of Custody

IGES
Intermountain GeoEnvironmental Services Inc.
2702 South 1030 West, Suite 10, South Salt Lake, UT 84119
Phone: 801.270.9400 Fax: 801.270.9401

Company Name:	Gordon Geotech Engineering
Project Number:	528-005-20
Address:	4426 Century Drive
Contact Name:	Jordan Culp
Phone Number:	801-327-9600 Fax:
Email:	Jordan@gordongeotech.com
Project Name:	Gravel Pit Development
Location:	
Client:	

[shaded box] Required

Special Instructions:
☑ Standard
☐ Rush Service. Number of Days: ______ Approved: ______

* Sample Type:		** Container Type	
S - Soil	C - Concrete	B - Bag	T - Tube
G - Geosynthetic	O - Other	Bk - Bucket	O - Other
R - Rock		J - Jar	

Sample Identification	Depth	Sample Type*	Container Type**	Analysis: Direct Shear										Instructions/Comments
B-2	35'	S	Ring	X										2, 4, 8 ksf
B-2	40'	S	↓	X										2, 4, 8 ksf
B-3	75'	S	↓	X										2.5, 5, 10 ksf

Relinquished By: Jordan Culp	Date: 3-31-20 Time 13:43	Received By: [signature]	Date: 3/31/2020 Time 1343	Results Sent By:
☐ Hazardous Material ☐ Contaminated		IGES Project Number: MA2106-015	☐ Existing Client ☐ New Client	Date: Time

Direct Shear Test for Soils Under Drained Conditions

(ASTM D3080)

Project: Gordon Geotechnical Engineering
No: M02106-015 (528-005-20)
Location: Gravel Pit Development
Date: 4/9/2020
By: EH

Boring No.: B-2
Sample: 8
Depth: 35'
Sample Description: Grey clay
Sample type: Undisturbed-trimmed from ring

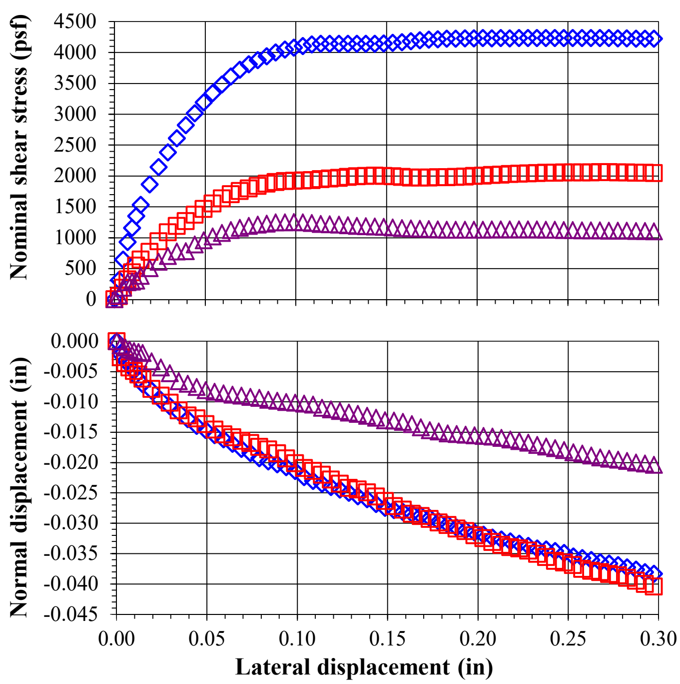
Test type: Inundated
Lateral displacement (in.): 0.3
Shear rate (in./min): 0.0005
Specific gravity, Gs: 2.70 Assumed

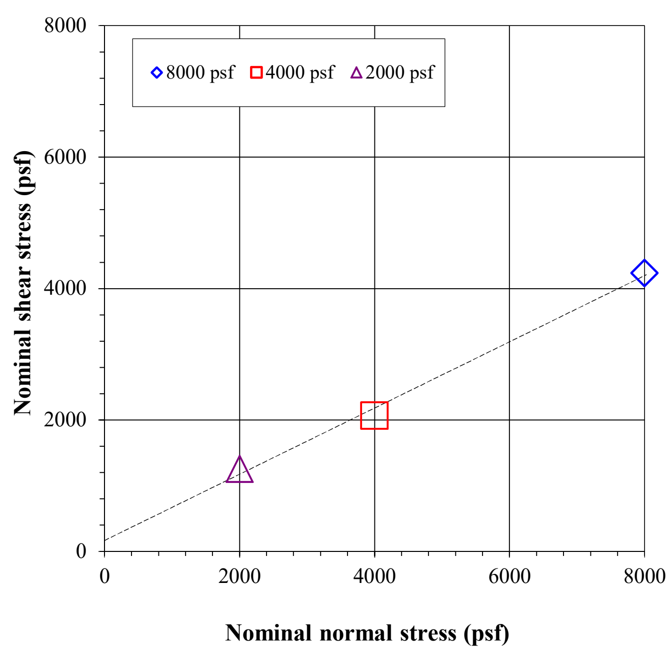
	Sample 1		Sample 2		Sample 3	
Nominal normal stress (psf)	8000		4000		2000	
Peak shear stress (psf)	4237		2061		1254	
Lateral displacement at peak (in)	0.238		0.273		0.099	
Load Duration (min)	2512		2512		2512	
	Initial	Pre-shear	Initial	Pre-shear	Initial	Pre-shear
Sample height (in)	0.994	0.918	0.997	0.950	0.994	0.951
Sample diameter (in)	2.416	2.416	2.413	2.413	2.417	2.417
Wt. rings + wet soil (g)	189.14	182.84	191.38	187.07	189.06	185.56
Wt. rings (g)	43.02	43.02	44.79	44.79	43.36	43.36
Wet soil + tare (g)	288.86		288.86		288.86	
Dry soil + tare (g)	250.46		250.46		250.46	
Tare (g)	121.68		121.68		121.68	
Water content (%)	29.8	24.2	29.8	26.0	29.8	26.7
Dry unit weight (pcf)	94.1	101.9	94.3	99.0	93.7	97.9
Void ratio, e, for assumed Gs	0.79	0.65	0.79	0.70	0.80	0.72
Saturation (%)*	101.7	100.0	102.4	100.0	100.9	100.0

φ' (deg)	27
c' (psf)	166

Average of 3 samples	Initial	Pre-shear
Water content (%)	29.8	25.6
Dry unit weight (pcf)	94.1	99.6

*Pre-shear saturation set to 100% for phase calculations





Comments:
Test specimens swelled at 100 psf load step.

Entered by:___________
Reviewed:___________

Direct Shear Test for Soils Under Drained Conditions

(ASTM D3080)

Project: Gordon Geotechnical Engineering
No: M02106-015 (528-005-20)
Location: Gravel Pit Development

Boring No.: B-2
Sample: 8
Depth: 35'

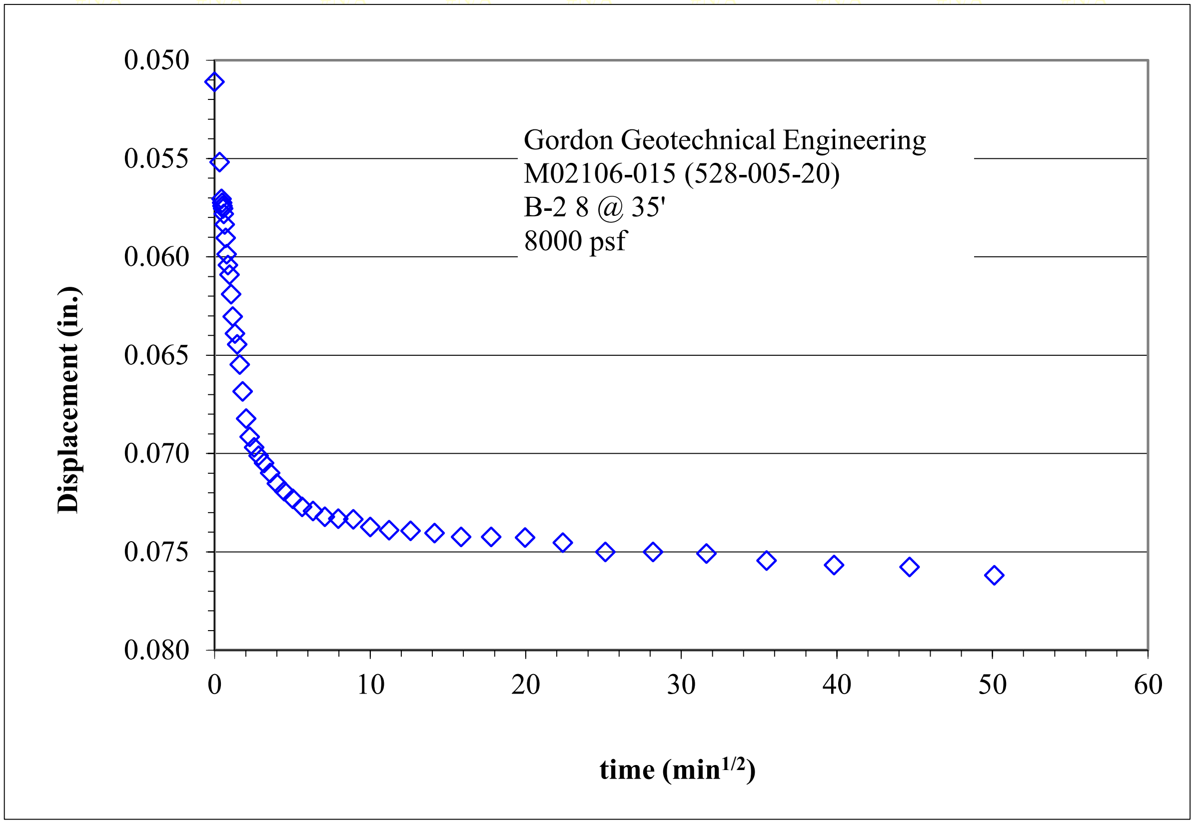
Nominal normal stress = 8000 psf			Nominal normal stress = 4000 psf			Nominal normal stress = 2000 psf		
Lateral Displacement (in.)	Nominal Shear Stress (psf)	Normal Displacement (in.)	Lateral Displacement (in.)	Nominal Shear Stress (psf)	Normal Displacement (in.)	Lateral Displacement (in.)	Nominal Shear Stress (psf)	Normal Displacement (in.)
0.000	0	0.000	0.000	0	0.000	0.000	0	0.000
0.002	312	-0.002	0.002	53	-0.003	0.002	65	-0.001
0.005	646	-0.003	0.005	187	-0.004	0.005	188	-0.001
0.007	928	-0.004	0.007	325	-0.004	0.007	277	-0.001
0.010	1161	-0.005	0.010	439	-0.005	0.010	286	-0.002
0.012	1351	-0.006	0.012	548	-0.006	0.012	304	-0.002
0.014	1530	-0.007	0.014	646	-0.006	0.014	379	-0.002
0.019	1863	-0.008	0.019	768	-0.008	0.019	507	-0.003
0.024	2142	-0.010	0.024	939	-0.009	0.024	609	-0.004
0.029	2380	-0.011	0.029	1085	-0.010	0.029	701	-0.005
0.034	2609	-0.012	0.034	1191	-0.011	0.034	773	-0.007
0.039	2824	-0.013	0.039	1269	-0.012	0.039	780	-0.007
0.044	3017	-0.014	0.044	1369	-0.013	0.044	889	-0.008
0.049	3191	-0.015	0.049	1466	-0.014	0.049	958	-0.008
0.054	3343	-0.015	0.054	1554	-0.015	0.054	1019	-0.008
0.059	3484	-0.016	0.059	1634	-0.015	0.059	1075	-0.009
0.064	3611	-0.017	0.064	1704	-0.016	0.064	1121	-0.009
0.069	3721	-0.018	0.069	1756	-0.016	0.069	1160	-0.009
0.074	3809	-0.018	0.074	1798	-0.017	0.074	1189	-0.009
0.079	3876	-0.019	0.079	1838	-0.017	0.079	1213	-0.009
0.084	3942	-0.020	0.084	1875	-0.018	0.084	1228	-0.010
0.089	4002	-0.020	0.089	1901	-0.018	0.089	1246	-0.010
0.094	4047	-0.021	0.094	1914	-0.019	0.094	1249	-0.010
0.099	4080	-0.021	0.099	1924	-0.020	0.099	1254	-0.010
0.104	4106	-0.022	0.104	1926	-0.021	0.104	1249	-0.010
0.109	4129	-0.023	0.109	1933	-0.021	0.109	1234	-0.010
0.114	4144	-0.023	0.114	1947	-0.022	0.114	1223	-0.011
0.119	4144	-0.024	0.119	1956	-0.023	0.119	1215	-0.011
0.124	4142	-0.024	0.124	1970	-0.024	0.124	1208	-0.012
0.129	4141	-0.025	0.129	1982	-0.024	0.129	1202	-0.012
0.134	4142	-0.026	0.134	1993	-0.024	0.134	1190	-0.012
0.139	4141	-0.026	0.139	1998	-0.025	0.139	1184	-0.012
0.144	4140	-0.027	0.144	2003	-0.026	0.144	1179	-0.013
0.148	4145	-0.027	0.148	1998	-0.026	0.148	1172	-0.013
0.153	4156	-0.028	0.153	1995	-0.027	0.153	1163	-0.013
0.158	4169	-0.028	0.158	1981	-0.028	0.158	1156	-0.013
0.163	4185	-0.028	0.163	1972	-0.028	0.163	1149	-0.014
0.168	4198	-0.029	0.168	1971	-0.029	0.168	1145	-0.014
0.173	4210	-0.029	0.173	1973	-0.029	0.173	1138	-0.015
0.178	4217	-0.030	0.178	1977	-0.030	0.178	1134	-0.015
0.183	4223	-0.030	0.183	1976	-0.030	0.183	1128	-0.015
0.188	4226	-0.031	0.188	1982	-0.031	0.188	1130	-0.015
0.193	4230	-0.031	0.193	1989	-0.031	0.193	1128	-0.015
0.198	4229	-0.032	0.198	1996	-0.032	0.198	1129	-0.016
0.203	4235	-0.032	0.203	2007	-0.032	0.203	1128	-0.016
0.208	4232	-0.032	0.208	2015	-0.033	0.208	1132	-0.016
0.213	4235	-0.033	0.213	2022	-0.034	0.213	1133	-0.016
0.218	4231	-0.033	0.218	2029	-0.034	0.218	1133	-0.016
0.223	4234	-0.033	0.223	2034	-0.034	0.223	1132	-0.016
0.228	4236	-0.034	0.228	2039	-0.035	0.228	1130	-0.017
0.233	4235	-0.034	0.233	2045	-0.035	0.233	1130	-0.017
0.238	4237	-0.034	0.238	2049	-0.036	0.238	1128	-0.017
0.243	4236	-0.035	0.243	2051	-0.036	0.243	1126	-0.018
0.248	4236	-0.035	0.248	2054	-0.036	0.248	1125	-0.018
0.253	4235	-0.035	0.253	2056	-0.037	0.253	1123	-0.018
0.258	4236	-0.036	0.258	2056	-0.038	0.258	1119	-0.019
0.263	4234	-0.036	0.263	2056	-0.038	0.263	1117	-0.019
0.268	4234	-0.036	0.268	2060	-0.038	0.268	1115	-0.019
0.273	4234	-0.037	0.273	2061	-0.038	0.273	1113	-0.019
0.278	4229	-0.037	0.278	2057	-0.039	0.278	1113	-0.020
0.282	4227	-0.037	0.282	2057	-0.039	0.282	1110	-0.020
0.287	4227	-0.038	0.287	2052	-0.039	0.287	1109	-0.020
0.292	4226	-0.038	0.292	2052	-0.040	0.292	1104	-0.020
0.297	4225	-0.038	0.297	2047	-0.040	0.297	1102	-0.020
0.300	4225	-0.038	0.300	2046	-0.041	0.300	1102	-0.020

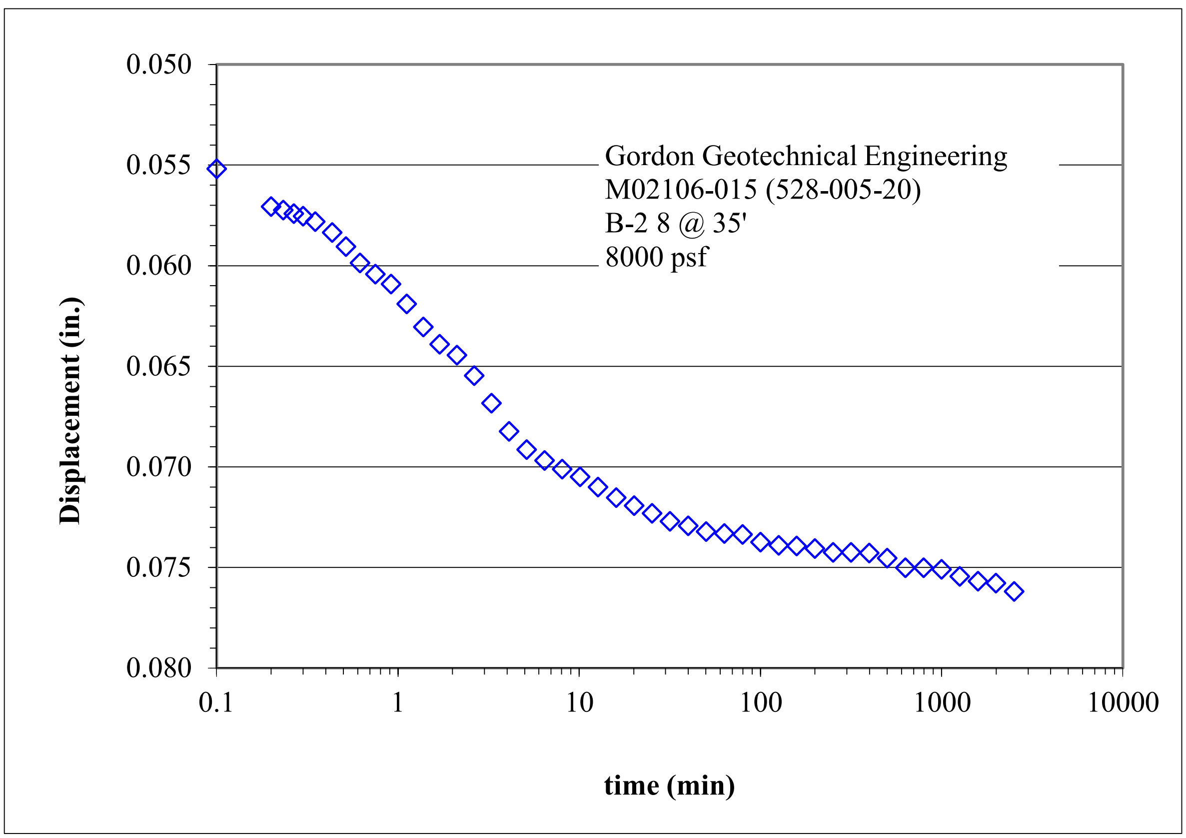
Direct Shear Test for Soils Under Drained Conditions

(ASTM D3080)

Project: Gordon Geotechnical Engineering
No: M02106-015 (528-005-20)
Location: Gravel Pit Development

Boring No.: B-2
Sample: 8
Depth: 35'





Direct Shear Test for Soils Under Drained Conditions

(ASTM D3080)

© IGES 2009, 2020

Project: Gordon Geotechnical Engineering
No: M02106-015 (528-005-20)
Location: Gravel Pit Development
Date: 4/9/2020
By: EH

Boring No.: B-2
Sample: 9
Depth: 40'
Sample Description: Brown sand with clay
Sample type: Undisturbed-trimmed from ring

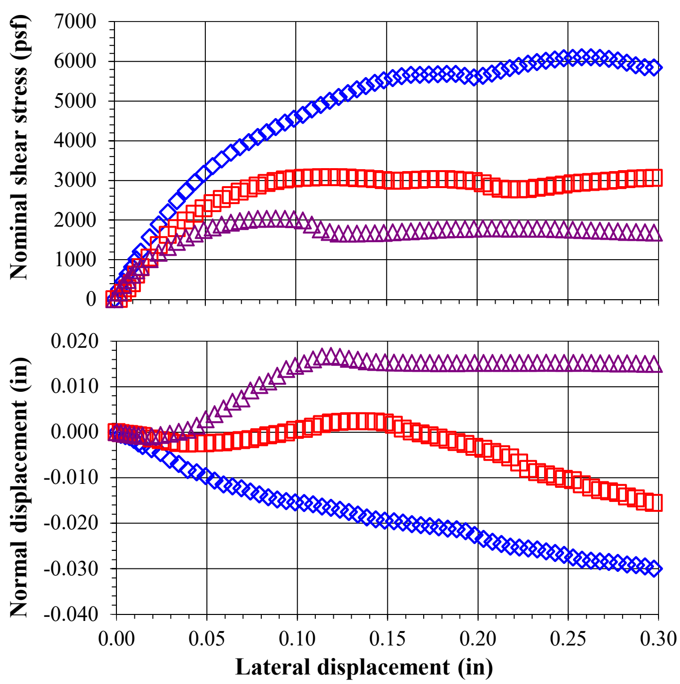
Test type: Inundated
Lateral displacement (in.): 0.3
Shear rate (in./min): 0.0010
Specific gravity, Gs: 2.70 Assumed

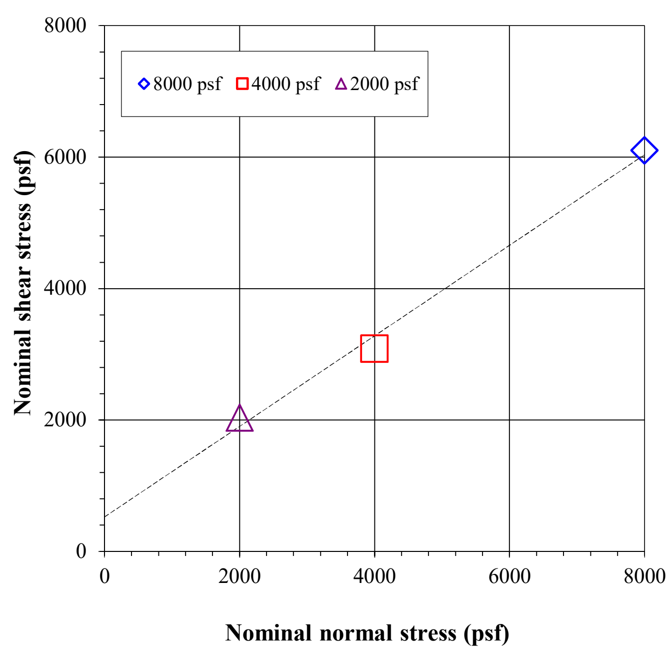
	Sample 1		Sample 2		Sample 3	
Nominal normal stress (psf)	8000		4000		2000	
Peak shear stress (psf)	6103		3080		2035	
Lateral displacement at peak (in)	0.258		0.114		0.089	
Load Duration (min)	1000		1000		1000	
	Initial	Pre-shear	Initial	Pre-shear	Initial	Pre-shear
Sample height (in)	0.992	0.944	0.994	0.966	0.997	0.974
Sample diameter (in)	2.422	2.422	2.414	2.414	2.417	2.417
Wt. rings + wet soil (g)	189.34	189.35	196.76	195.67	197.52	196.65
Wt. rings (g)	41.52	41.52	44.18	44.18	43.77	43.77
Wet soil + tare (g)	316.53		316.53		316.53	
Dry soil + tare (g)	282.93		282.93		282.93	
Tare (g)	127.31		127.31		127.31	
Water content (%)	21.6	21.6	21.6	20.7	21.6	20.9
Dry unit weight (pcf)	101.3	106.4	105.1	108.0	105.3	107.7
Void ratio, e, for assumed Gs	0.66	0.58	0.60	0.56	0.60	0.56
Saturation (%)*	87.9	100.0	96.5	100.0	97.1	100.0

ϕ' (deg)	35
c' (psf)	524

Average of 3 samples	Initial	Pre-shear
Water content (%)	21.6	21.1
Dry unit weight (pcf)	103.9	107.4

*Pre-shear saturation set to 100% for phase calculations





Entered by:___________
Reviewed:___________

Direct Shear Test for Soils Under Drained Conditions

(ASTM D3080)

Project: Gordon Geotechnical Engineering **Boring No.:** B-2
No: M02106-015 (528-005-20) **Sample:** 9
Location: Gravel Pit Development **Depth:** 40'

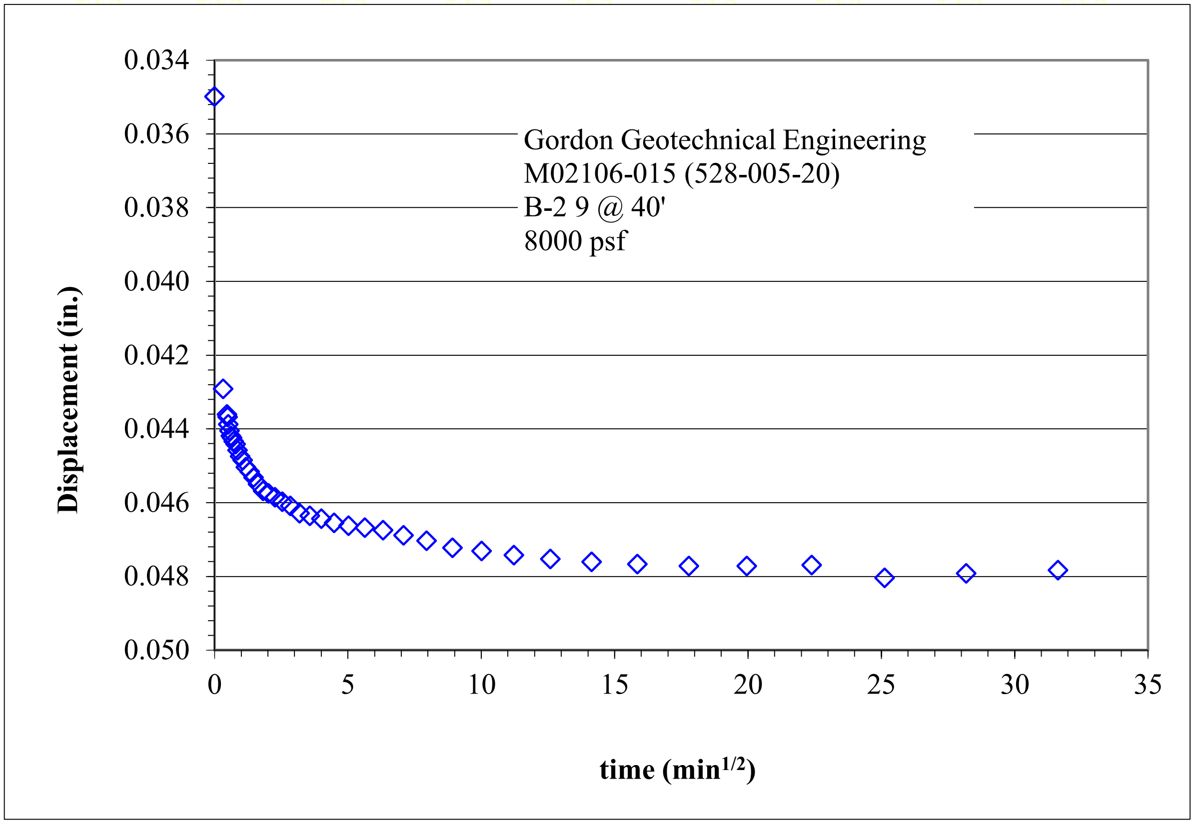
Nominal normal stress = 8000 psf			Nominal normal stress = 4000 psf			Nominal normal stress = 2000 psf		
Lateral Displacement (in.)	Nominal Shear Stress (psf)	Normal Displacement (in.)	Lateral Displacement (in.)	Nominal Shear Stress (psf)	Normal Displacement (in.)	Lateral Displacement (in.)	Nominal Shear Stress (psf)	Normal Displacement (in.)
0.000	0	0.000	0.000	0	0.000	0.000	0	0.000
0.002	253	-0.001	0.002	7	0.000	0.002	174	0.000
0.005	455	-0.001	0.005	164	0.000	0.005	356	0.000
0.007	639	-0.001	0.007	274	0.000	0.007	489	0.000
0.010	818	-0.002	0.010	408	-0.001	0.010	616	-0.001
0.012	1011	-0.002	0.012	620	-0.001	0.012	726	-0.001
0.014	1207	-0.003	0.014	806	-0.001	0.014	820	-0.001
0.019	1565	-0.004	0.019	1048	-0.001	0.019	1008	-0.001
0.024	1887	-0.005	0.024	1369	-0.002	0.024	1173	-0.001
0.029	2195	-0.006	0.029	1623	-0.002	0.029	1320	0.000
0.034	2477	-0.007	0.034	1793	-0.002	0.034	1449	0.000
0.039	2732	-0.008	0.039	1984	-0.003	0.039	1559	0.001
0.044	2960	-0.009	0.044	2154	-0.002	0.044	1657	0.001
0.049	3166	-0.010	0.049	2293	-0.002	0.049	1742	0.003
0.054	3359	-0.011	0.054	2423	-0.002	0.054	1814	0.004
0.059	3532	-0.011	0.059	2531	-0.002	0.059	1879	0.005
0.064	3698	-0.012	0.064	2625	-0.002	0.064	1931	0.007
0.069	3838	-0.012	0.069	2712	-0.002	0.069	1974	0.007
0.074	3967	-0.013	0.074	2798	-0.002	0.074	2001	0.009
0.079	4097	-0.014	0.079	2868	-0.001	0.079	2028	0.010
0.084	4219	-0.014	0.084	2932	-0.001	0.084	2027	0.011
0.089	4341	-0.015	0.089	2983	0.000	0.089	2035	0.012
0.094	4457	-0.015	0.094	3018	0.000	0.094	2030	0.014
0.099	4557	-0.015	0.099	3041	0.000	0.099	2018	0.015
0.104	4654	-0.016	0.104	3063	0.001	0.104	1986	0.015
0.109	4786	-0.016	0.109	3068	0.001	0.109	1883	0.016
0.114	4900	-0.016	0.114	3080	0.002	0.114	1765	0.017
0.119	5004	-0.017	0.119	3078	0.002	0.119	1698	0.017
0.124	5104	-0.017	0.124	3075	0.002	0.124	1659	0.017
0.129	5201	-0.017	0.129	3070	0.002	0.129	1655	0.016
0.134	5293	-0.018	0.134	3056	0.002	0.134	1655	0.016
0.139	5378	-0.019	0.139	3043	0.002	0.139	1662	0.016
0.144	5457	-0.019	0.144	3028	0.002	0.144	1668	0.015
0.148	5524	-0.019	0.148	3004	0.002	0.148	1677	0.015
0.153	5581	-0.020	0.153	2986	0.002	0.153	1688	0.015
0.158	5626	-0.020	0.158	2987	0.001	0.158	1703	0.015
0.163	5662	-0.020	0.163	3002	0.000	0.163	1715	0.015
0.168	5657	-0.020	0.168	3012	0.000	0.168	1730	0.015
0.173	5666	-0.021	0.173	3028	-0.001	0.173	1740	0.015
0.178	5675	-0.021	0.178	3032	-0.001	0.178	1753	0.015
0.183	5688	-0.021	0.183	3029	-0.002	0.183	1761	0.015
0.188	5684	-0.021	0.188	3016	-0.002	0.188	1767	0.015
0.193	5639	-0.022	0.193	2998	-0.003	0.193	1773	0.015
0.198	5593	-0.023	0.198	2978	-0.003	0.198	1779	0.015
0.203	5633	-0.023	0.203	2924	-0.004	0.203	1782	0.015
0.208	5689	-0.024	0.208	2846	-0.004	0.208	1783	0.015
0.213	5762	-0.025	0.213	2789	-0.005	0.213	1784	0.015
0.218	5827	-0.025	0.218	2767	-0.006	0.218	1782	0.015
0.223	5887	-0.025	0.223	2770	-0.007	0.223	1783	0.015
0.228	5941	-0.026	0.228	2782	-0.008	0.228	1780	0.015
0.233	5981	-0.026	0.233	2812	-0.009	0.233	1777	0.015
0.238	6019	-0.026	0.238	2839	-0.009	0.238	1775	0.015
0.243	6050	-0.027	0.243	2865	-0.010	0.243	1769	0.015
0.248	6076	-0.027	0.248	2892	-0.010	0.248	1763	0.015
0.253	6087	-0.028	0.253	2920	-0.011	0.253	1756	0.015
0.258	6103	-0.028	0.258	2938	-0.011	0.258	1747	0.015
0.263	6100	-0.028	0.263	2957	-0.012	0.263	1737	0.015
0.268	6091	-0.028	0.268	2971	-0.013	0.268	1730	0.015
0.273	6064	-0.029	0.273	2990	-0.013	0.273	1720	0.015
0.277	6026	-0.029	0.278	3008	-0.013	0.278	1710	0.015
0.282	5970	-0.029	0.282	3027	-0.014	0.283	1701	0.015
0.287	5905	-0.029	0.287	3041	-0.015	0.287	1697	0.015
0.292	5856	-0.029	0.292	3049	-0.015	0.292	1687	0.015
0.297	5849	-0.030	0.297	3063	-0.016	0.297	1679	0.015
0.300	5852	-0.030	0.300	3066	-0.016	0.300	1676	0.015

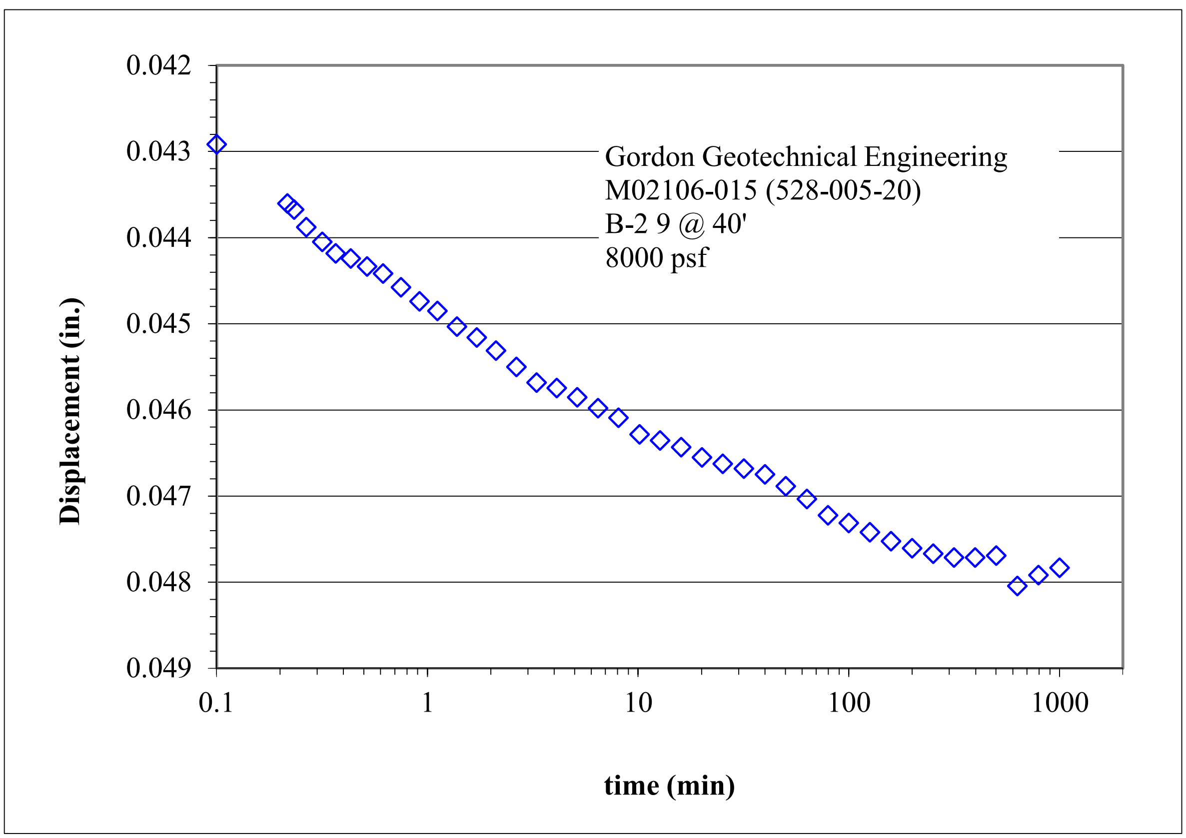
Direct Shear Test for Soils Under Drained Conditions

(ASTM D3080)

Project: Gordon Geotechnical Engineering
No: M02106-015 (528-005-20)
Location: Gravel Pit Development

Boring No.: B-2
Sample: 9
Depth: 40'





Direct Shear Test for Soils Under Drained Conditions

(ASTM D3080)

Project: Gordon Geotechnical Engineering
No: M02106-015 (528-005-20)
Location: Gravel Pit Development
Date: 4/9/2020
By: EH

Boring No.: B-3
Sample:
Depth: 75'
Sample Description: Brown clayey sand
Sample type: Undisturbed-trimmed from ring

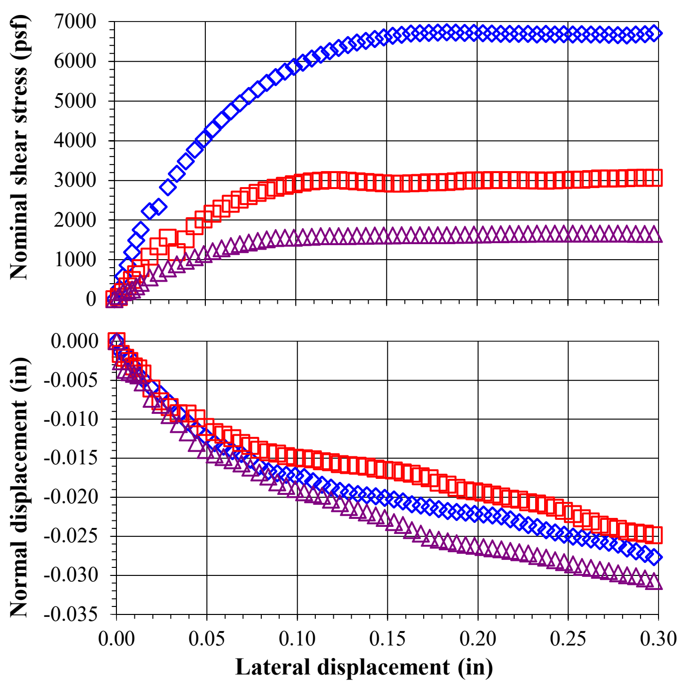
Test type: Inundated
Lateral displacement (in.): 0.3
Shear rate (in./min): 0.0009
Specific gravity, Gs: 2.70 Assumed

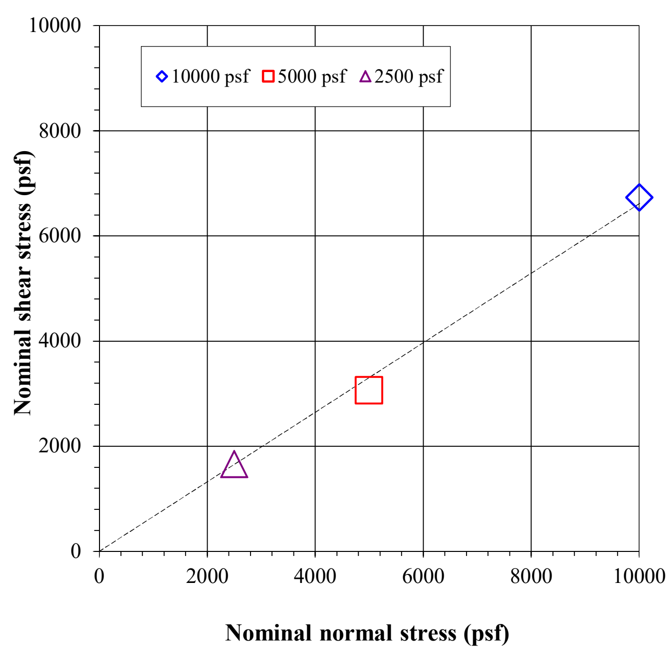
	Sample 1		Sample 2		Sample 3	
Nominal normal stress (psf)	10000		5000		2500	
Peak shear stress (psf)	6735		3062		1659	
Lateral displacement at peak (in)	0.183		0.292		0.268	
Load Duration (min)	1995		1995		1995	
	Initial	Pre-shear	Initial	Pre-shear	Initial	Pre-shear
Sample height (in)	0.995	0.935	0.996	0.938	0.986	0.938
Sample diameter (in)	2.413	2.413	2.414	2.414	2.417	2.417
Wt. rings + wet soil (g)	173.81	187.68	176.37	188.98	179.82	190.10
Wt. rings (g)	44.10	44.10	43.05	43.05	40.73	40.73
Wet soil + tare (g)	264.29		264.29		264.29	
Dry soil + tare (g)	250.55		250.55		250.55	
Tare (g)	127.02		127.02		127.02	
Water content (%)	11.1	23.0	11.1	21.6	11.1	19.3
Dry unit weight (pcf)	97.7	103.9	100.3	106.4	105.4	110.7
Void ratio, e, for assumed Gs	0.72	0.62	0.68	0.58	0.60	0.52
Saturation (%)*	41.4	100.0	44.1	100.0	50.1	100.0

ϕ' (deg)	33
c' (psf)	0

Average of 3 samples	Initial	Pre-shear
Water content (%)	11.1	21.3
Dry unit weight (pcf)	101.1	107.0

*Pre-shear saturation set to 100% for phase calculations





Comments:
Test specimens #1 and #2 contain vertical clay seam.

Entered by:___________
Reviewed:___________

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Direct Shear Test for Soils Under Drained Conditions

(ASTM D3080)

Project: Gordon Geotechnical Engineering **Boring No.:** B-3
No: M02106-015 (528-005-20) **Sample:**
Location: Gravel Pit Development **Depth:** 75'

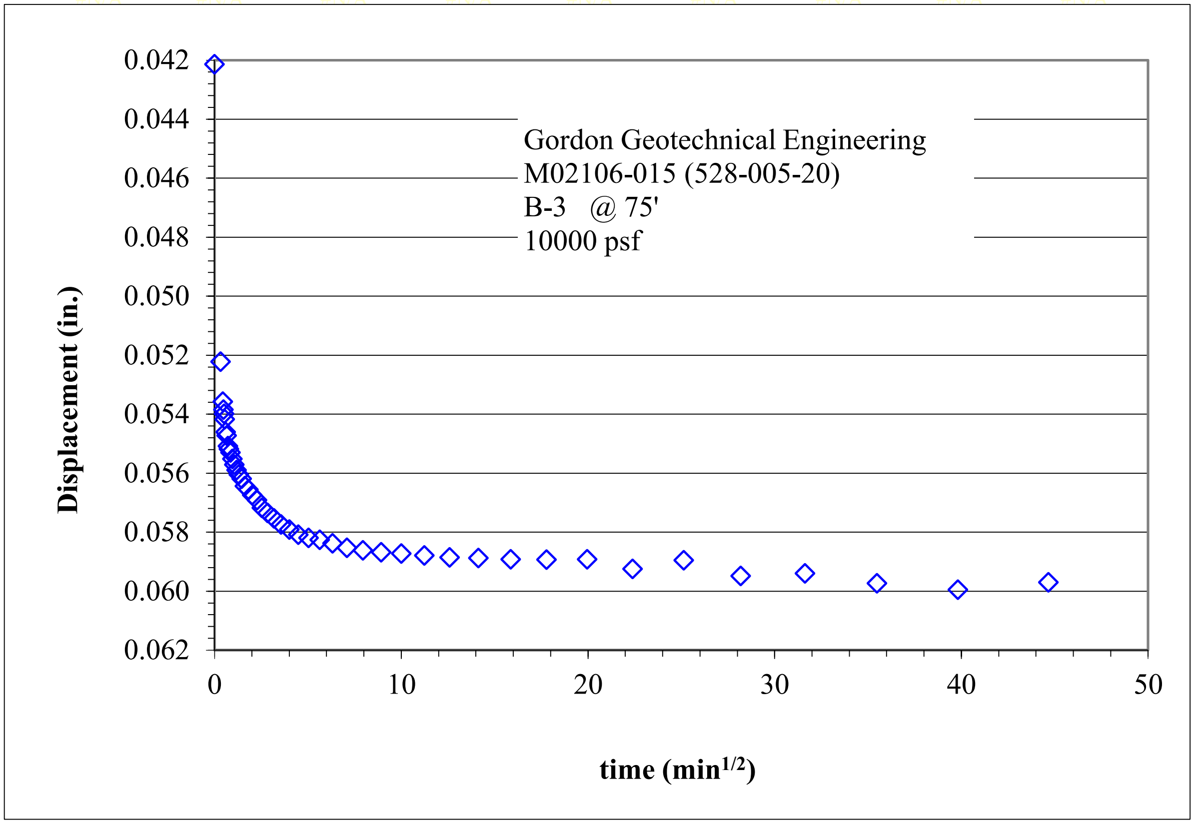
Nominal normal stress = 10000 psf			Nominal normal stress = 5000 psf			Nominal normal stress = 2500 psf		
Lateral Displacement (in.)	Nominal Shear Stress (psf)	Normal Displacement (in.)	Lateral Displacement (in.)	Nominal Shear Stress (psf)	Normal Displacement (in.)	Lateral Displacement (in.)	Nominal Shear Stress (psf)	Normal Displacement (in.)
0.000	0	0.000	0.000	0	0.000	0.000	0	0.000
0.002	257	-0.001	0.002	58	-0.002	0.002	84	-0.003
0.005	586	-0.002	0.005	180	-0.002	0.005	179	-0.004
0.007	863	-0.002	0.007	326	-0.003	0.007	207	-0.004
0.010	1188	-0.003	0.010	484	-0.003	0.010	246	-0.004
0.012	1484	-0.004	0.012	631	-0.004	0.012	321	-0.004
0.014	1755	-0.005	0.014	786	-0.004	0.014	410	-0.005
0.019	2223	-0.006	0.019	1076	-0.006	0.019	552	-0.007
0.024	2338	-0.007	0.024	1331	-0.008	0.024	667	-0.008
0.029	2824	-0.008	0.029	1551	-0.008	0.029	779	-0.009
0.034	3169	-0.009	0.034	1186	-0.009	0.034	882	-0.011
0.039	3482	-0.010	0.039	1513	-0.009	0.039	974	-0.012
0.044	3769	-0.011	0.044	1843	-0.010	0.044	1062	-0.013
0.049	4037	-0.012	0.049	2011	-0.011	0.049	1141	-0.014
0.054	4289	-0.013	0.054	2159	-0.012	0.054	1215	-0.015
0.059	4521	-0.014	0.059	2288	-0.012	0.059	1284	-0.015
0.064	4741	-0.014	0.064	2407	-0.012	0.064	1343	-0.015
0.069	4941	-0.014	0.069	2510	-0.013	0.069	1390	-0.016
0.074	5123	-0.015	0.074	2601	-0.013	0.074	1433	-0.016
0.079	5296	-0.016	0.079	2680	-0.014	0.079	1474	-0.017
0.084	5460	-0.017	0.084	2750	-0.014	0.084	1508	-0.017
0.089	5601	-0.017	0.089	2808	-0.014	0.089	1540	-0.018
0.094	5737	-0.017	0.094	2858	-0.015	0.094	1553	-0.019
0.099	5859	-0.017	0.099	2898	-0.015	0.099	1554	-0.019
0.104	5970	-0.017	0.104	2937	-0.015	0.104	1564	-0.019
0.109	6076	-0.018	0.109	2969	-0.015	0.109	1580	-0.020
0.114	6172	-0.018	0.114	2992	-0.015	0.114	1589	-0.020
0.119	6257	-0.019	0.119	3001	-0.016	0.119	1589	-0.020
0.124	6340	-0.019	0.124	3001	-0.016	0.124	1589	-0.021
0.129	6410	-0.019	0.129	2992	-0.016	0.129	1595	-0.021
0.134	6472	-0.020	0.134	2975	-0.016	0.134	1598	-0.022
0.139	6514	-0.020	0.139	2960	-0.016	0.139	1602	-0.022
0.144	6565	-0.020	0.144	2944	-0.016	0.144	1609	-0.022
0.148	6601	-0.020	0.148	2925	-0.017	0.148	1609	-0.023
0.153	6642	-0.020	0.153	2919	-0.017	0.153	1612	-0.023
0.158	6667	-0.021	0.158	2920	-0.017	0.158	1612	-0.024
0.163	6699	-0.021	0.163	2922	-0.017	0.163	1614	-0.024
0.168	6710	-0.021	0.168	2929	-0.017	0.168	1616	-0.025
0.173	6719	-0.021	0.173	2944	-0.018	0.173	1615	-0.025
0.178	6723	-0.022	0.178	2952	-0.018	0.178	1615	-0.025
0.183	6735	-0.022	0.183	2958	-0.018	0.183	1619	-0.026
0.188	6724	-0.022	0.188	2974	-0.019	0.188	1622	-0.026
0.193	6719	-0.022	0.193	2987	-0.019	0.193	1624	-0.026
0.198	6715	-0.022	0.198	2999	-0.019	0.198	1634	-0.026
0.203	6711	-0.022	0.203	2999	-0.019	0.203	1634	-0.026
0.208	6698	-0.022	0.208	3008	-0.020	0.208	1641	-0.027
0.213	6692	-0.022	0.213	3007	-0.020	0.213	1642	-0.027
0.218	6693	-0.023	0.218	3009	-0.020	0.218	1647	-0.027
0.223	6690	-0.023	0.223	3004	-0.020	0.223	1650	-0.027
0.228	6692	-0.024	0.228	2997	-0.021	0.228	1653	-0.027
0.233	6679	-0.024	0.233	2993	-0.021	0.233	1654	-0.028
0.238	6689	-0.024	0.238	2992	-0.021	0.238	1657	-0.028
0.243	6678	-0.025	0.243	2994	-0.021	0.243	1656	-0.028
0.248	6682	-0.025	0.248	3002	-0.022	0.248	1657	-0.028
0.253	6679	-0.025	0.253	3013	-0.022	0.253	1655	-0.029
0.258	6682	-0.025	0.258	3017	-0.023	0.258	1658	-0.029
0.263	6676	-0.025	0.263	3033	-0.023	0.263	1657	-0.029
0.268	6678	-0.026	0.268	3042	-0.024	0.268	1659	-0.029
0.273	6672	-0.026	0.273	3048	-0.024	0.273	1655	-0.029
0.278	6659	-0.026	0.278	3047	-0.024	0.278	1657	-0.030
0.282	6655	-0.027	0.282	3052	-0.024	0.282	1654	-0.030
0.287	6675	-0.027	0.287	3058	-0.025	0.287	1649	-0.030
0.292	6687	-0.027	0.292	3062	-0.025	0.292	1648	-0.030
0.297	6712	-0.028	0.297	3059	-0.025	0.297	1648	-0.031
0.300	6729	-0.028	0.300	3062	-0.025	0.300	1649	-0.031

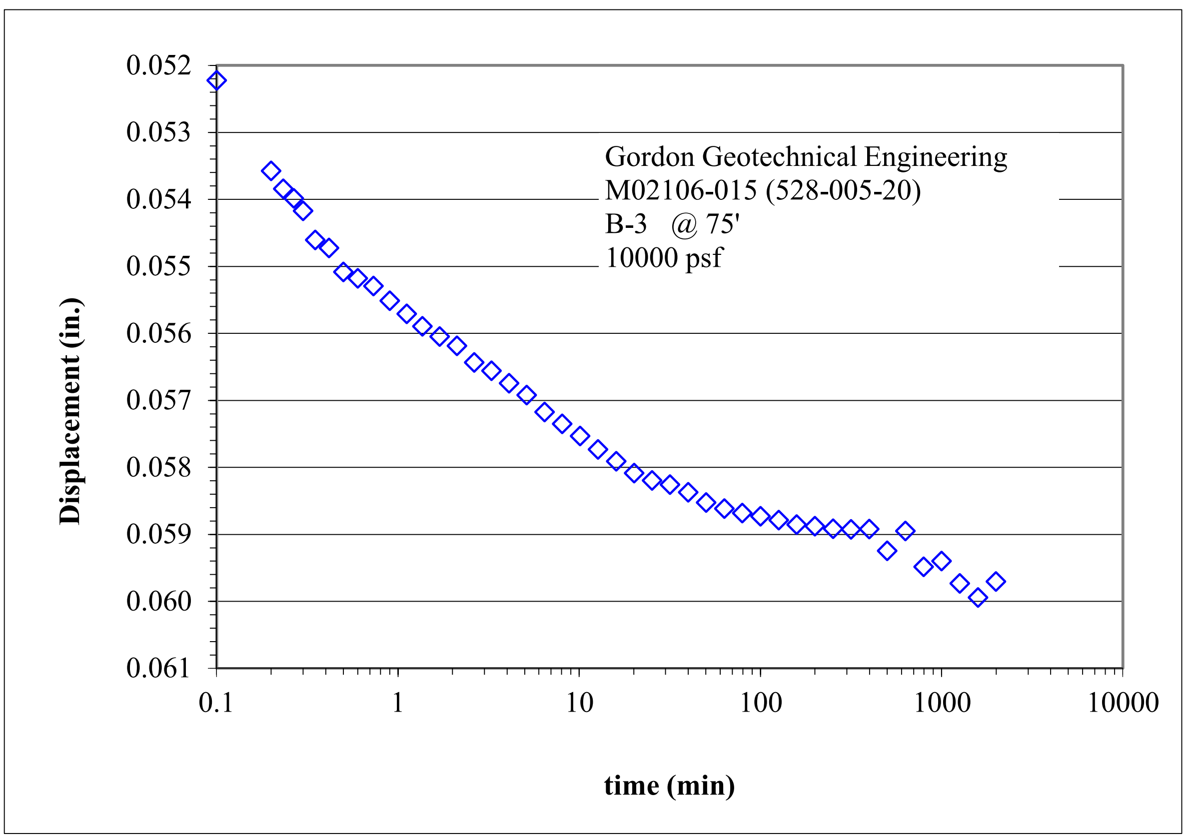
Direct Shear Test for Soils Under Drained Conditions

(ASTM D3080)

Project: Gordon Geotechnical Engineering
No: M02106-015 (528-005-20)
Location: Gravel Pit Development

Boring No.: B-3
Sample:
Depth: 75'





Direct Shear Test for Soils Under Drained Conditions

(ASTM D3080)

Project: Gordon Geotechnical Engineering
No: M02106-006 (528-002-18)
Location: View 62
Date: 4/2/2018
By: JDF

Boring No.:
Sample: Sample C
Depth:
Sample Description: Brown sand
Sample type: Laboratory compacted
Dry unit weight 120.5 pcf
at 6.5 (%) w
Compaction specifications: 95% of $\gamma_d$max

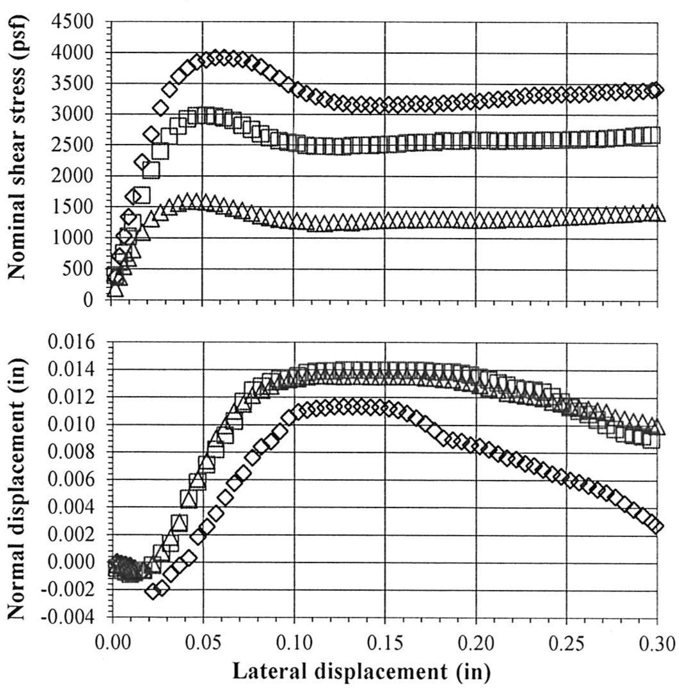
Test type: Inundated
Lateral displacement (in.): 0.3
Shear rate (in./min): 0.0086
Specific gravity, Gs: 2.65 Assumed

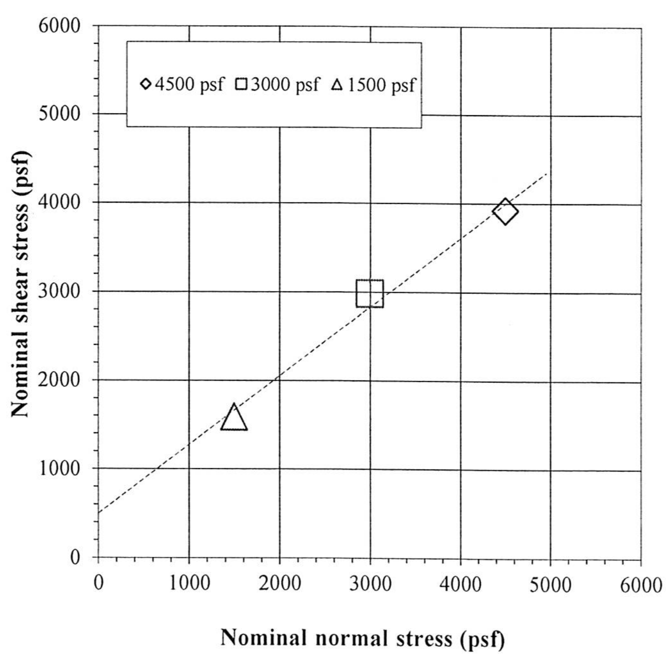
	Sample 1		Sample 2		Sample 3	
Nominal normal stress (psf)	4500		3000		1500	
Peak shear stress (psf)	3919		2980		1589	
Lateral displacement at peak (in)	0.057		0.052		0.042	
Load Duration (min)	79		84		59	
	Initial	Pre-shear	Initial	Pre-shear	Initial	Pre-shear
Sample height (in)	0.995	0.976	1.002	0.982	0.995	0.980
Sample diameter (in)	2.409	2.409	2.414	2.414	2.423	2.423
Wt. rings + wet soil (g)	197.49	207.07	199.36	209.02	195.44	205.97
Wt. rings (g)	44.63	44.63	44.79	44.79	41.95	41.95
Wet soil + tare (g)	313.38		313.38		313.38	
Dry soil + tare (g)	302.13		302.13		302.13	
Tare (g)	122.19		122.19		122.19	
Water content (%)	6.3	12.9	6.3	12.9	6.3	13.5
Dry unit weight (pcf)	120.8	123.2	120.8	123.2	119.9	121.7
Void ratio, e, for assumed Gs	0.37	0.34	0.37	0.34	0.38	0.36
Saturation (%)*	44.9	100.0	44.9	100.0	43.7	100.0

ϕ' (deg)	38
c' (psf)	499

Average of 3 samples	Initial	Pre-shear
Water content (%)	6.3	13.1
Dry unit weight (pcf)	120.5	122.7

*Pre-shear saturation set to 100% for phase calculations





Entered by: JDF
Reviewed: [signature]

Direct Shear Test for Soils Under Drained Conditions

(ASTM D3080)

IGES

Project: Gordon Geotechnical Engineering **Boring No.:**

No: M02106-006 (528-002-18) **Sample: Sample C**

Location: View 62 **Depth:**

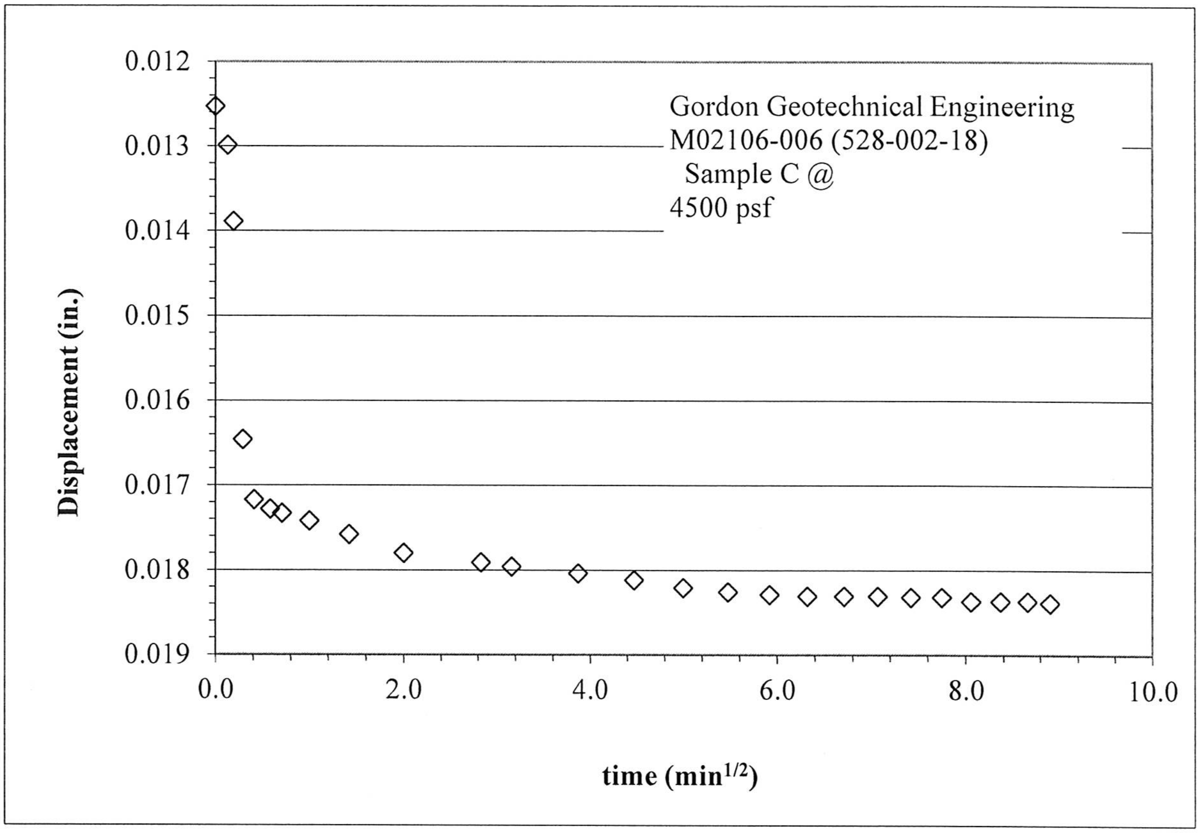
Nominal normal stress = 4500 psf			Nominal normal stress = 3000 psf			Nominal normal stress = 1500 psf		
Lateral Displacement (in.)	Nominal Shear Stress (psf)	Normal Displacement (in.)	Lateral Displacement (in.)	Nominal Shear Stress (psf)	Normal Displacement (in.)	Lateral Displacement (in.)	Nominal Shear Stress (psf)	Normal Displacement (in.)
0.002	366	0.000	0.002	397	0.000	0.002	183	0.000
0.005	702	0.000	0.005	605	-0.001	0.005	364	0.000
0.007	1029	0.000	0.007	747	-0.001	0.007	538	0.000
0.010	1337	0.000	0.010	1018	-0.001	0.010	669	-0.001
0.012	1663	0.000	0.012	1237	-0.001	0.012	803	-0.001
0.017	2220	-0.001	0.017	1680	-0.001	0.017	1086	-0.001
0.022	2676	-0.002	0.022	2085	0.000	0.022	1306	0.000
0.027	3097	-0.002	0.027	2397	0.001	0.027	1407	0.001
0.032	3400	-0.001	0.032	2636	0.001	0.032	1496	0.002
0.037	3614	0.000	0.037	2803	0.003	0.037	1553	0.003
0.042	3752	0.000	0.042	2924	0.005	0.042	1589	0.005
0.047	3844	0.002	0.047	2973	0.006	0.047	1585	0.006
0.052	3883	0.003	0.052	2980	0.007	0.052	1572	0.007
0.057	3919	0.004	0.057	2964	0.008	0.057	1552	0.009
0.062	3917	0.005	0.062	2937	0.009	0.062	1513	0.010
0.067	3901	0.006	0.067	2897	0.010	0.067	1473	0.011
0.072	3888	0.006	0.072	2819	0.012	0.072	1438	0.011
0.077	3836	0.008	0.077	2752	0.013	0.077	1396	0.012
0.082	3776	0.008	0.082	2681	0.013	0.082	1355	0.013
0.087	3674	0.009	0.087	2617	0.013	0.087	1326	0.013
0.092	3585	0.010	0.092	2569	0.013	0.092	1299	0.013
0.097	3476	0.010	0.097	2546	0.013	0.097	1284	0.013
0.102	3400	0.011	0.102	2526	0.014	0.102	1273	0.013
0.107	3337	0.011	0.107	2490	0.014	0.107	1266	0.013
0.112	3288	0.011	0.112	2479	0.014	0.112	1230	0.014
0.117	3243	0.011	0.117	2480	0.014	0.117	1233	0.014
0.122	3196	0.011	0.122	2478	0.014	0.122	1254	0.014
0.127	3175	0.011	0.127	2472	0.014	0.127	1263	0.014
0.132	3152	0.011	0.132	2493	0.014	0.132	1248	0.014
0.137	3165	0.011	0.137	2496	0.014	0.137	1265	0.014
0.142	3152	0.011	0.142	2497	0.014	0.142	1279	0.014
0.147	3141	0.011	0.147	2508	0.014	0.147	1285	0.014
0.152	3160	0.011	0.152	2513	0.014	0.152	1288	0.014
0.157	3154	0.011	0.157	2517	0.014	0.157	1291	0.014
0.162	3173	0.011	0.162	2537	0.014	0.162	1303	0.014
0.167	3175	0.010	0.167	2543	0.014	0.167	1295	0.014
0.172	3175	0.010	0.172	2548	0.014	0.172	1303	0.013
0.177	3154	0.010	0.177	2550	0.014	0.177	1303	0.013
0.182	3188	0.009	0.182	2573	0.014	0.182	1304	0.013
0.187	3186	0.009	0.187	2569	0.014	0.187	1308	0.013
0.192	3214	0.009	0.192	2570	0.014	0.192	1298	0.013
0.197	3214	0.009	0.197	2589	0.014	0.197	1295	0.013
0.202	3220	0.008	0.202	2579	0.013	0.202	1295	0.013
0.207	3238	0.008	0.207	2583	0.013	0.207	1301	0.013
0.212	3256	0.008	0.212	2572	0.013	0.212	1300	0.013
0.217	3261	0.008	0.217	2578	0.013	0.217	1313	0.012
0.222	3288	0.008	0.222	2574	0.013	0.222	1314	0.012
0.227	3314	0.007	0.227	2583	0.013	0.227	1316	0.012
0.232	3321	0.007	0.232	2579	0.013	0.232	1322	0.012
0.237	3321	0.007	0.237	2591	0.012	0.237	1327	0.012
0.242	3324	0.006	0.242	2589	0.012	0.242	1338	0.012
0.247	3332	0.006	0.247	2592	0.012	0.247	1345	0.012
0.252	3335	0.006	0.252	2602	0.011	0.252	1351	0.011
0.257	3332	0.006	0.257	2596	0.011	0.257	1363	0.011
0.262	3345	0.006	0.262	2609	0.011	0.262	1368	0.011
0.267	3371	0.005	0.267	2608	0.010	0.267	1376	0.011
0.272	3376	0.005	0.272	2619	0.010	0.272	1386	0.011
0.277	3376	0.005	0.277	2631	0.010	0.277	1390	0.011
0.282	3402	0.004	0.282	2639	0.009	0.282	1398	0.010
0.287	3371	0.004	0.287	2659	0.009	0.287	1408	0.010
0.292	3389	0.003	0.292	2674	0.009	0.292	1421	0.010
0.297	3405	0.003	0.297	2680	0.009	0.297	1426	0.010
0.299	3418	0.003	0.300	2692	0.009	0.300	1420	0.010

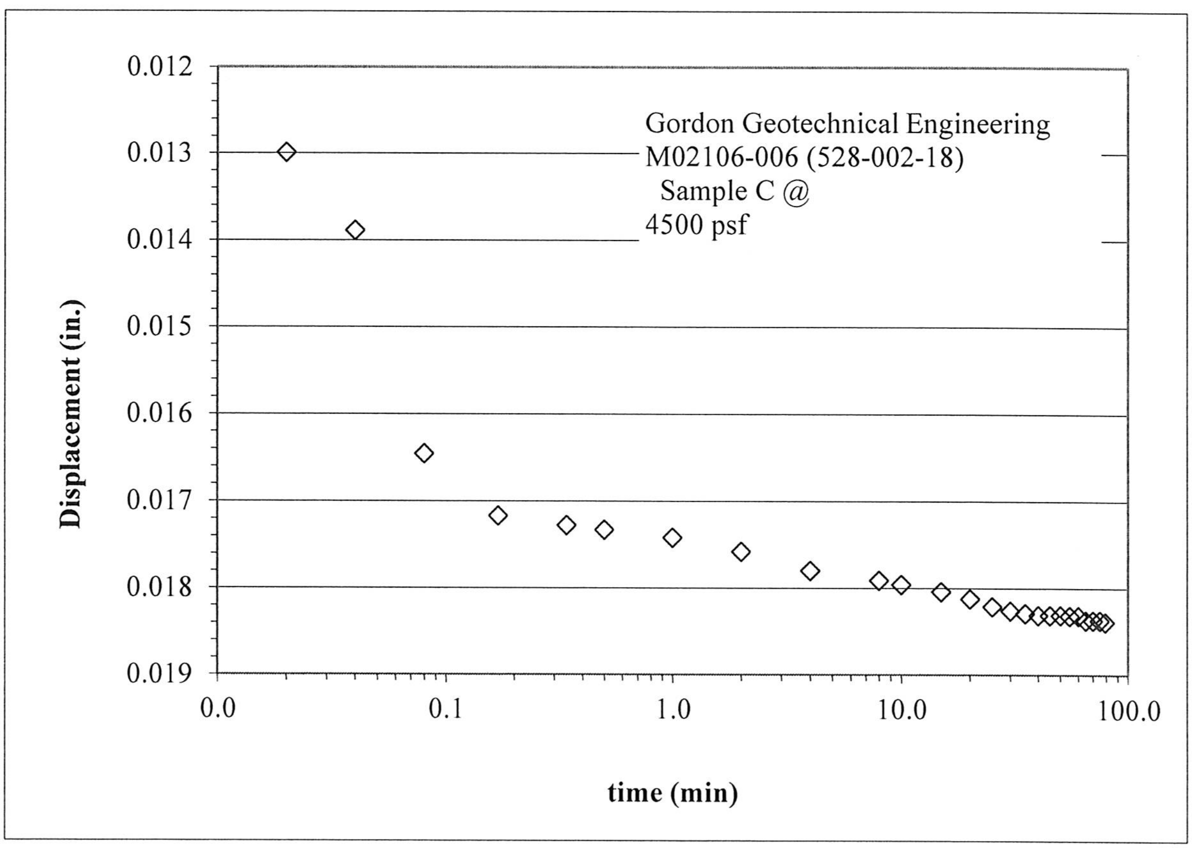
Direct Shear Test for Soils Under Drained Conditions

(ASTM D3080)

Project: Gordon Geotechnical Engineering
No: M02106-006 (528-002-18)
Location: View 62

Boring No.:
Sample: Sample C
Depth:





Direct Shear Test for Soils Under Drained Conditions

(ASTM D3080)

IGES

Project: Gordon Geotechnical Engineering
No: M02106-006 (528-002-18)
Location: View 62
Date: 4/5/2018
By: EH

Boring No.: TP-5
Sample:
Depth:
Sample Description: Brown clay
Sample type: Laboratory compacted
Dry unit weight 118.1 pcf
at 10.8 (%) w
Compaction specifications: 95% of $\gamma_d$max

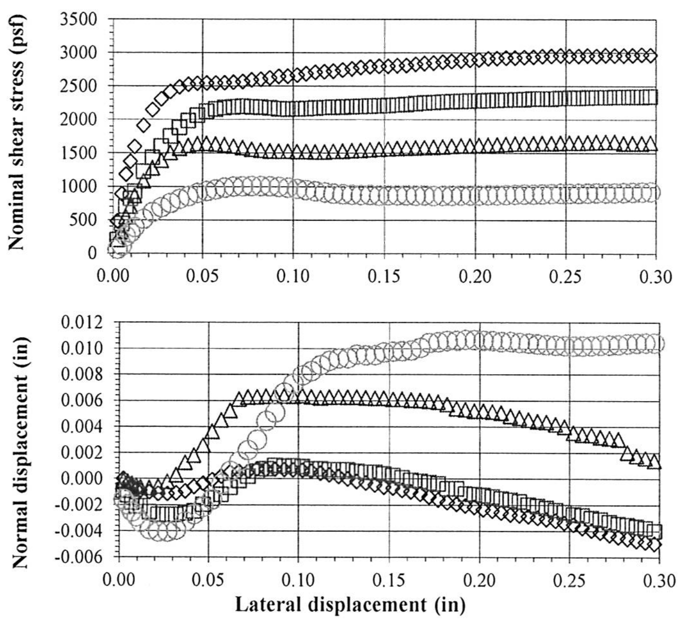
Test type: Inundated
Lateral displacement (in.): 0.3
Shear rate (in./min): 0.0007
Specific gravity, Gs: 2.70 Assumed

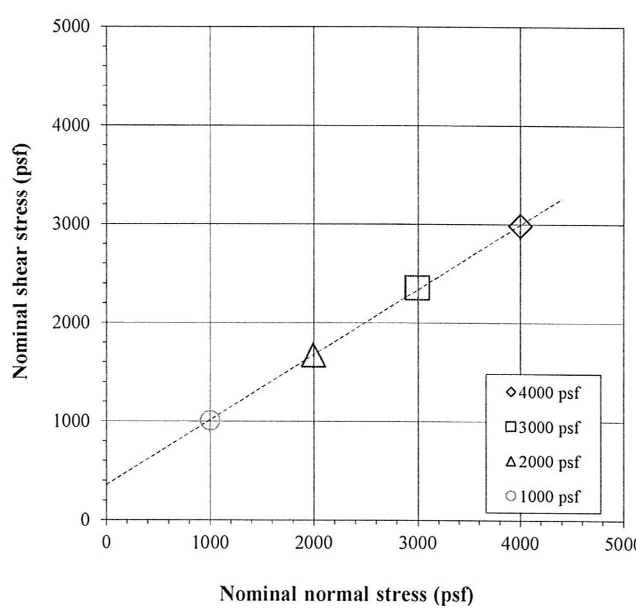
	Sample 1		Sample 2		Sample 3		Sample 4	
Nominal normal stress (psf)	4000		3000		2000		1000	
Peak shear stress (psf)	2984		2355		1672		1012	
Lateral displacement at peak (in)	0.301		0.301		0.277		0.077	
Load Duration (min)	981		931		991		46	
	Initial	Pre-shear	Initial	Pre-shear	Initial	Pre-shear	Initial	Pre-shear
Sample height (in)	1.002	0.984	0.993	0.946	0.998	0.995	1.002	0.992
Sample diameter (in)	2.423	2.423	2.416	2.416	2.422	2.422	2.417	2.417
Wt. rings + wet soil (g)	201.88	207.81	201.98	205.62	200.49	207.51	203.84	210.44
Wt. rings (g)	43.21	43.21	45.58	45.58	42.54	42.54	46.11	46.11
Wet soil + tare (g)	277.93		277.93		277.93		277.93	
Dry soil + tare (g)	263.50		263.50		263.50		263.50	
Tare (g)	128.39		128.39		128.39		128.39	
Water content (%)	10.7	14.8	10.7	13.3	10.7	15.6	10.7	15.3
Dry unit weight (pcf)	118.2	120.3	118.3	124.1	118.2	118.6	118.1	119.2
Void ratio, e, for assumed Gs	0.43	0.40	0.43	0.36	0.43	0.42	0.43	0.41
Saturation (%)*	67.7	100.0	67.8	100.0	67.8	100.0	67.5	100.0

ϕ' (deg)	33
c' (psf)	356

Average of 4 samples	Initial	Pre-shear
Water content (%)	10.7	14.7
Dry unit weight (pcf)	118.2	120.5

*Pre-shear saturation set to 100% for phase calculations





Comments:
Test specimens swelled upon inundation.

Entered by: EH
Reviewed: NB

C:\Users\nickb\Desktop\Lab_Temp\[DS_GC_4-point_v4.xlsm]1

Direct Shear Test for Soils Under Drained Conditions

(ASTM D3080)

IGES

Project: Gordon Geotechnical Engineering
No: M02106-006 (528-002-18)
Location: View 62

Boring No.: TP-5
Sample:
Depth:

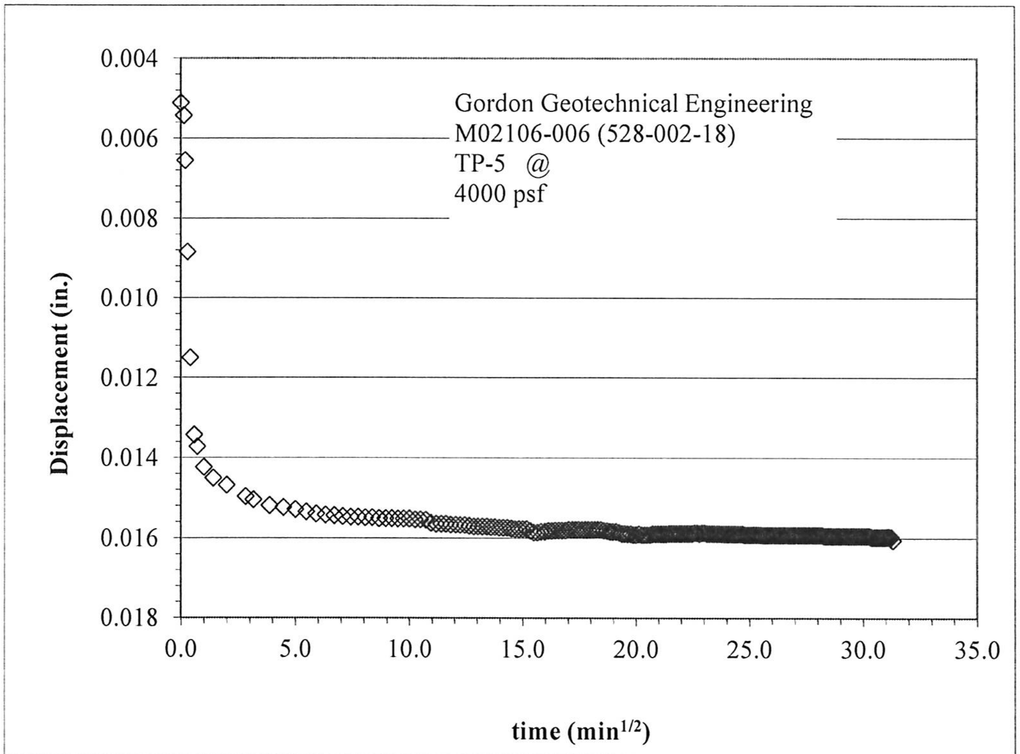
Nominal normal stress = 4000 psf			Nominal normal stress = 3000 psf			Nominal normal stress = 2000 psf			Nominal normal stress = 1000 psf		
Lateral Displacement (in.)	Nominal Shear Stress (psf)	Normal Displacement (in.)	Lateral Displacement (in.)	Nominal Shear Stress (psf)	Normal Displacement (in.)	Lateral Displacement (in.)	Nominal Shear Stress (psf)	Normal Displacement (in.)	Lateral Displacement (in.)	Nominal Shear Stress (psf)	Normal Displacement (in.)
0.002	480	0.000	0.002	205	-0.001	0.002	203	0.000	0.002	67	-0.002
0.005	888	0.000	0.005	442	-0.001	0.005	327	0.000	0.005	120	-0.002
0.007	1182	-0.001	0.007	704	-0.002	0.007	545	0.000	0.007	254	-0.003
0.010	1373	-0.001	0.010	821	-0.002	0.010	704	-0.001	0.010	311	-0.003
0.012	1595	-0.001	0.012	926	-0.002	0.012	860	-0.001	0.012	391	-0.003
0.017	1913	-0.001	0.017	1223	-0.003	0.017	1083	-0.001	0.017	514	-0.004
0.022	2147	-0.001	0.022	1435	-0.003	0.022	1274	-0.001	0.022	617	-0.004
0.027	2310	-0.001	0.027	1606	-0.003	0.027	1392	0.000	0.027	689	-0.004
0.032	2419	-0.001	0.032	1754	-0.003	0.032	1505	0.000	0.032	755	-0.004
0.037	2488	-0.001	0.037	1884	-0.003	0.037	1572	0.001	0.037	812	-0.003
0.042	2527	-0.001	0.042	1984	-0.002	0.042	1614	0.002	0.042	857	-0.003
0.047	2542	0.000	0.047	2067	-0.002	0.047	1638	0.003	0.047	904	-0.002
0.052	2548	0.000	0.052	2124	-0.001	0.052	1643	0.004	0.052	933	-0.002
0.057	2550	0.000	0.057	2160	-0.001	0.057	1636	0.005	0.057	961	0.000
0.062	2553	0.001	0.062	2182	-0.001	0.062	1625	0.005	0.062	984	0.001
0.067	2560	0.001	0.067	2196	0.000	0.067	1604	0.006	0.067	1002	0.001
0.072	2568	0.001	0.072	2201	0.000	0.072	1582	0.006	0.072	1007	0.002
0.077	2594	0.001	0.077	2195	0.001	0.077	1558	0.006	0.077	1012	0.003
0.082	2602	0.001	0.082	2188	0.001	0.082	1543	0.006	0.082	1009	0.004
0.087	2625	0.001	0.087	2175	0.001	0.087	1532	0.006	0.087	1006	0.005
0.092	2646	0.001	0.092	2164	0.001	0.092	1527	0.006	0.092	998	0.007
0.097	2653	0.001	0.097	2160	0.001	0.097	1526	0.006	0.097	985	0.007
0.102	2669	0.001	0.102	2163	0.001	0.102	1525	0.006	0.102	967	0.008
0.107	2690	0.001	0.107	2167	0.001	0.107	1522	0.006	0.107	952	0.008
0.112	2710	0.000	0.112	2177	0.001	0.112	1519	0.006	0.112	934	0.009
0.117	2720	0.000	0.117	2184	0.001	0.117	1521	0.006	0.117	917	0.009
0.122	2728	0.000	0.122	2189	0.001	0.122	1526	0.006	0.122	900	0.009
0.127	2746	0.000	0.127	2195	0.001	0.127	1533	0.006	0.127	892	0.009
0.132	2764	0.000	0.132	2197	0.001	0.132	1540	0.006	0.132	883	0.010
0.137	2785	0.000	0.137	2203	0.001	0.137	1545	0.006	0.137	880	0.010
0.142	2793	0.000	0.142	2205	0.001	0.142	1553	0.006	0.142	878	0.010
0.147	2801	-0.001	0.147	2209	0.000	0.147	1560	0.006	0.147	872	0.010
0.152	2801	-0.001	0.152	2217	0.000	0.152	1566	0.006	0.152	874	0.010
0.157	2808	-0.001	0.157	2224	0.000	0.157	1573	0.006	0.157	874	0.010
0.162	2813	-0.001	0.162	2233	0.000	0.162	1578	0.006	0.162	874	0.010
0.167	2829	-0.001	0.167	2244	0.000	0.167	1585	0.006	0.167	872	0.010
0.172	2844	-0.001	0.172	2254	0.000	0.172	1586	0.006	0.172	874	0.010
0.177	2852	-0.002	0.177	2261	0.000	0.177	1592	0.006	0.177	867	0.011
0.182	2865	-0.002	0.182	2269	-0.001	0.182	1596	0.006	0.182	871	0.011
0.187	2873	-0.002	0.187	2274	-0.001	0.187	1606	0.005	0.187	872	0.011
0.192	2883	-0.002	0.192	2279	-0.001	0.192	1611	0.005	0.192	874	0.011
0.197	2893	-0.002	0.197	2282	-0.001	0.197	1614	0.005	0.197	876	0.011
0.202	2899	-0.002	0.202	2288	-0.001	0.202	1621	0.005	0.202	876	0.011
0.207	2914	-0.002	0.207	2292	-0.001	0.207	1626	0.005	0.207	878	0.011
0.212	2919	-0.003	0.212	2297	-0.002	0.212	1631	0.005	0.212	879	0.011
0.217	2927	-0.003	0.217	2300	-0.002	0.217	1636	0.005	0.217	883	0.011
0.222	2930	-0.003	0.222	2303	-0.002	0.222	1641	0.005	0.222	887	0.010
0.227	2935	-0.003	0.227	2308	-0.002	0.227	1643	0.005	0.227	889	0.010
0.232	2942	-0.003	0.232	2318	-0.002	0.232	1647	0.004	0.232	891	0.010
0.237	2948	-0.003	0.237	2318	-0.002	0.237	1651	0.004	0.237	897	0.010
0.242	2955	-0.003	0.242	2318	-0.002	0.242	1652	0.004	0.242	900	0.010
0.247	2961	-0.003	0.247	2325	-0.003	0.247	1656	0.004	0.247	902	0.010
0.252	2955	-0.004	0.252	2330	-0.003	0.252	1661	0.004	0.252	902	0.010
0.257	2955	-0.004	0.257	2329	-0.003	0.257	1661	0.003	0.257	905	0.010
0.262	2961	-0.004	0.262	2335	-0.003	0.262	1664	0.003	0.262	907	0.010
0.267	2955	-0.004	0.267	2338	-0.003	0.267	1667	0.003	0.267	911	0.010
0.272	2966	-0.004	0.272	2340	-0.003	0.272	1671	0.003	0.272	913	0.010
0.277	2963	-0.004	0.277	2343	-0.003	0.277	1672	0.003	0.277	914	0.010
0.282	2961	-0.005	0.282	2343	-0.004	0.282	1651	0.002	0.282	919	0.010
0.287	2966	-0.005	0.287	2346	-0.004	0.287	1652	0.002	0.287	920	0.010
0.292	2976	-0.005	0.292	2347	-0.004	0.292	1653	0.002	0.292	925	0.010
0.297	2973	-0.005	0.297	2353	-0.004	0.297	1663	0.001	0.297	930	0.010
0.301	2984	-0.005	0.301	2355	-0.004	0.300	1660	0.001	0.300	931	0.010

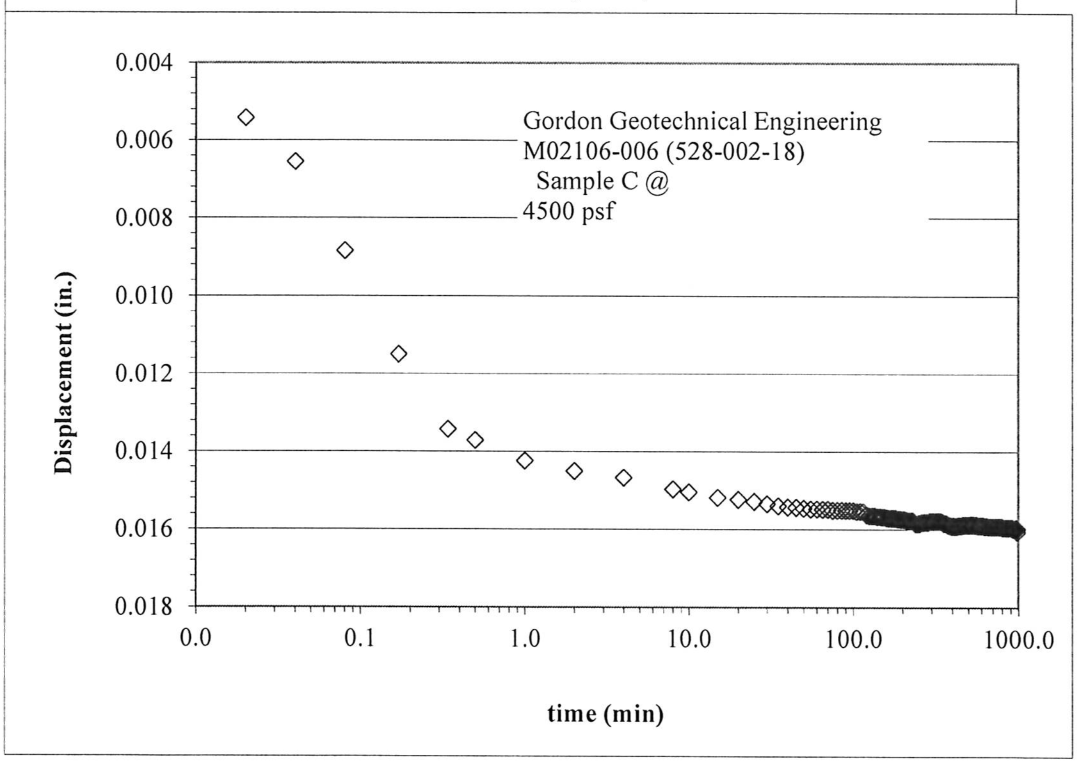
Direct Shear Test for Soils Under Drained Conditions

(ASTM D3080)

Project: Gordon Geotechnical Engineering
No: M02106-006 (528-002-18)
Location: View 62

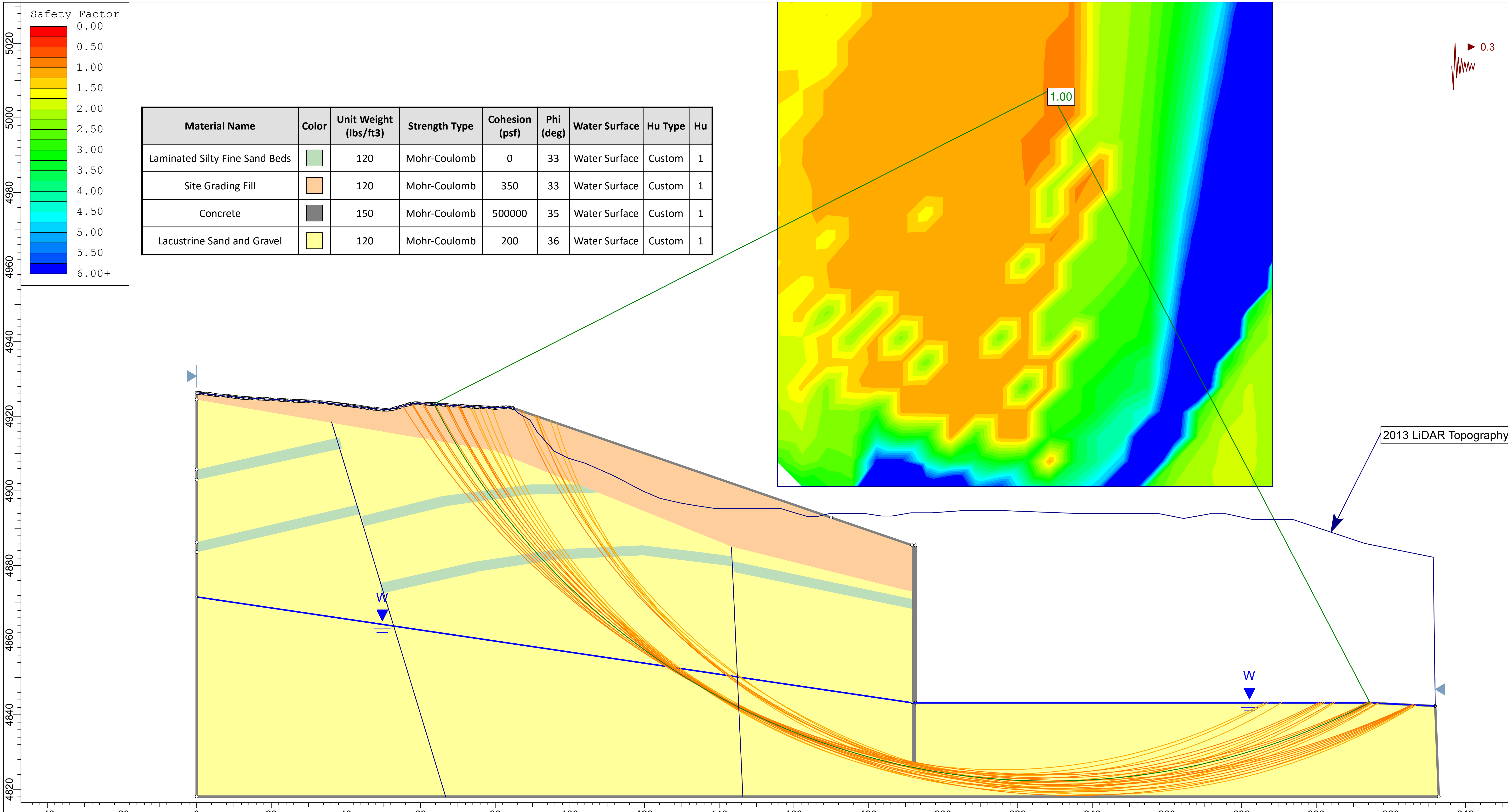
Boring No.: TP-5
Sample:
Depth:





APPENDIX D

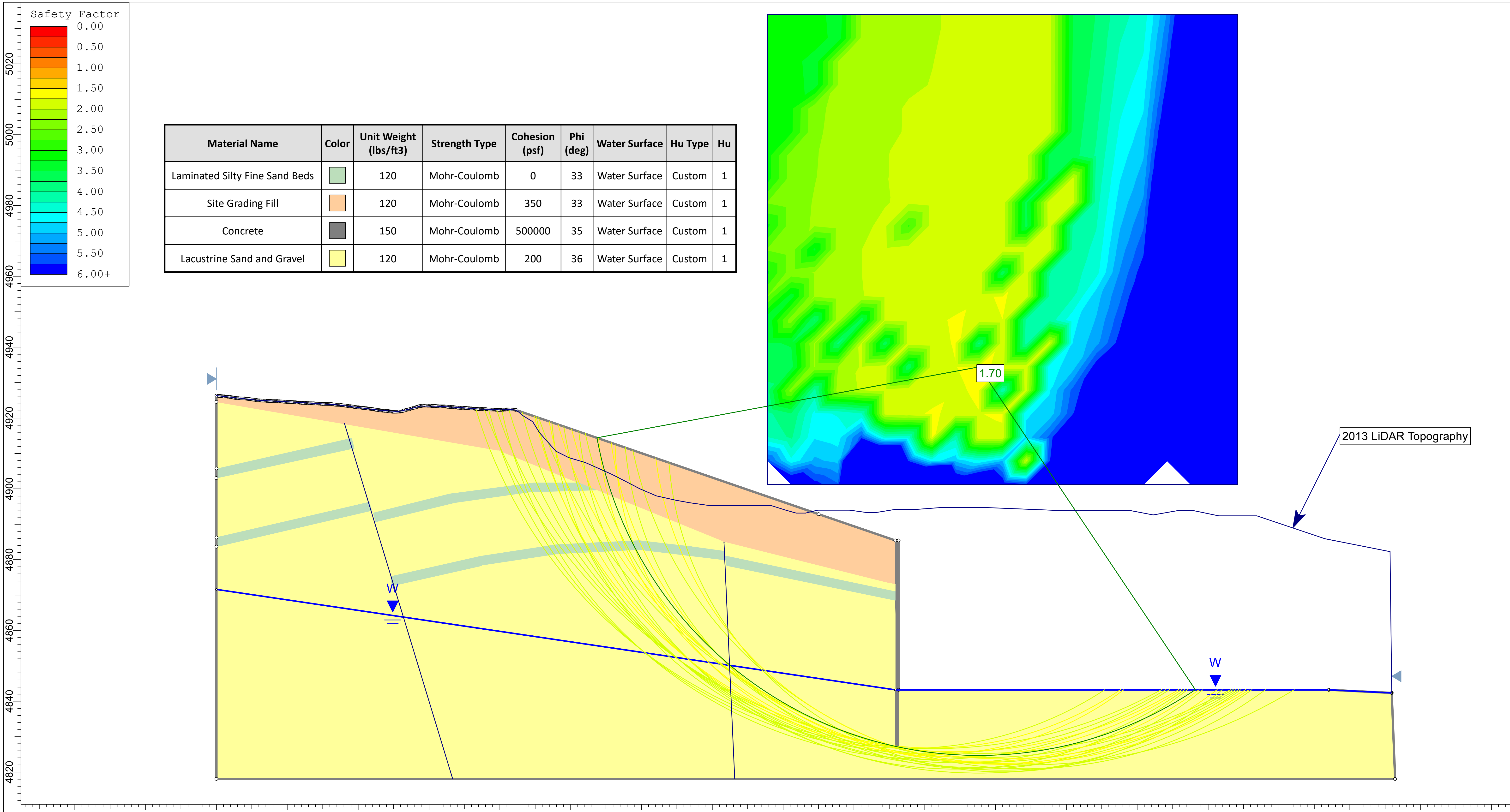
Slope Stability Analysis Results



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu Type	Hu
Laminated Silty Fine Sand Beds		120	Mohr-Coulomb	0	33	Water Surface	Custom	1
Site Grading Fill		120	Mohr-Coulomb	350	33	Water Surface	Custom	1
Concrete		150	Mohr-Coulomb	500000	35	Water Surface	Custom	1
Lacustrine Sand and Gravel		120	Mohr-Coulomb	200	36	Water Surface	Custom	1

SLIDEINTERPRET 6.039

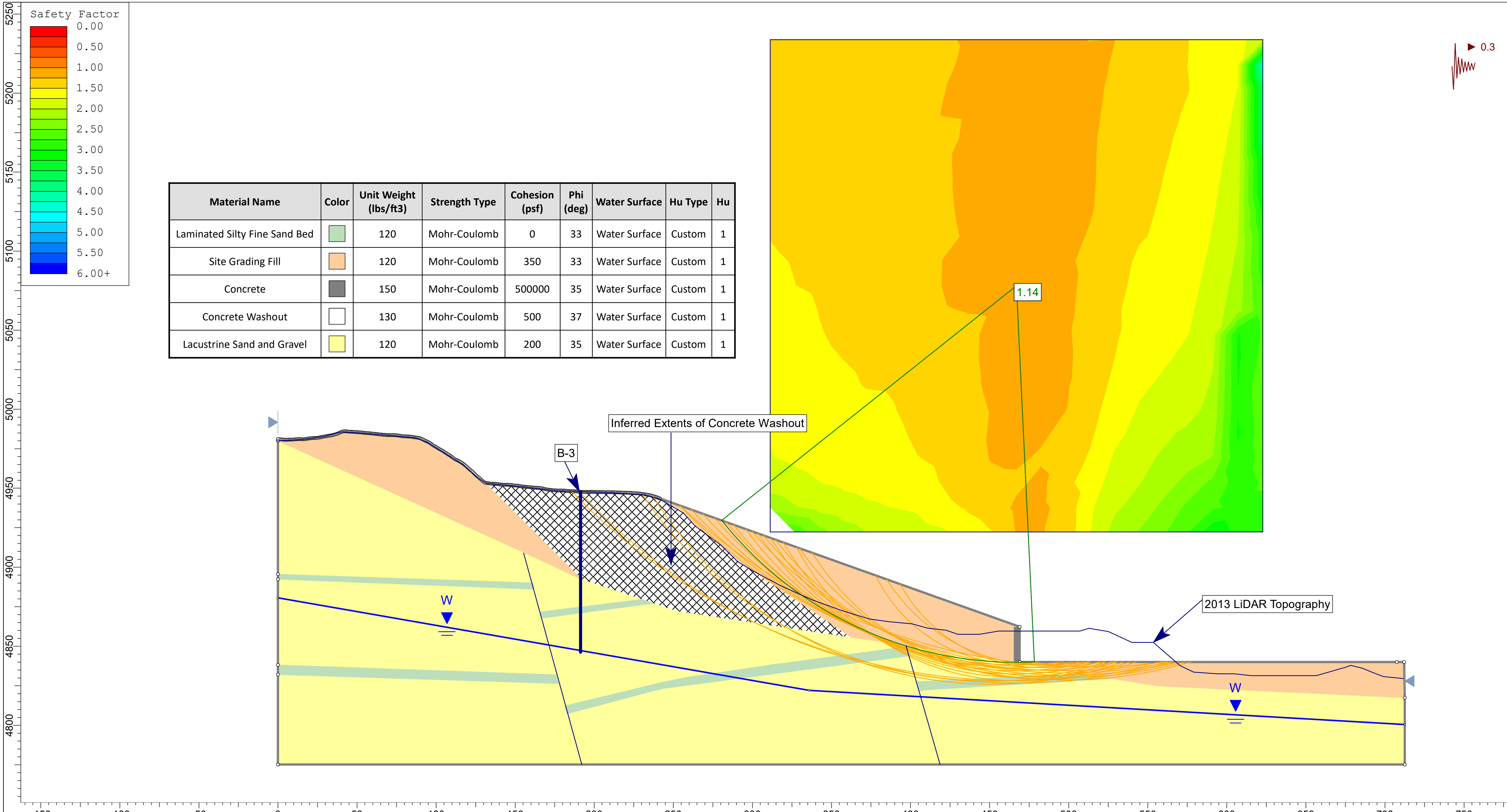
Project	Gravel Pit Development
Analysis Description	A-A'
Drawn By	JKC
Scale	1:296
Company	G2
Date	5/11/2020, 4:50:55 PM
File Name	A-A' Grading.slim



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu Type	Hu
Laminated Silty Fine Sand Beds		120	Mohr-Coulomb	0	33	Water Surface	Custom	1
Site Grading Fill		120	Mohr-Coulomb	350	33	Water Surface	Custom	1
Concrete		150	Mohr-Coulomb	500000	35	Water Surface	Custom	1
Lacustrine Sand and Gravel		120	Mohr-Coulomb	200	36	Water Surface	Custom	1

SLIDEINTERPRET 6.039

Project: Gravel Pit Development			
Analysis Description: A-A'			
Drawn By: JKC	Scale: 1:312	Company: G2	
Date: 5/11/2020, 4:50:55 PM		File Name: A-A' Grading.slim	



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu Type	Hu
Laminated Silty Fine Sand Bed		120	Mohr-Coulomb	0	33	Water Surface	Custom	1
Site Grading Fill		120	Mohr-Coulomb	350	33	Water Surface	Custom	1
Concrete		150	Mohr-Coulomb	500000	35	Water Surface	Custom	1
Concrete Washout		130	Mohr-Coulomb	500	37	Water Surface	Custom	1
Lacustrine Sand and Gravel		120	Mohr-Coulomb	200	35	Water Surface	Custom	1

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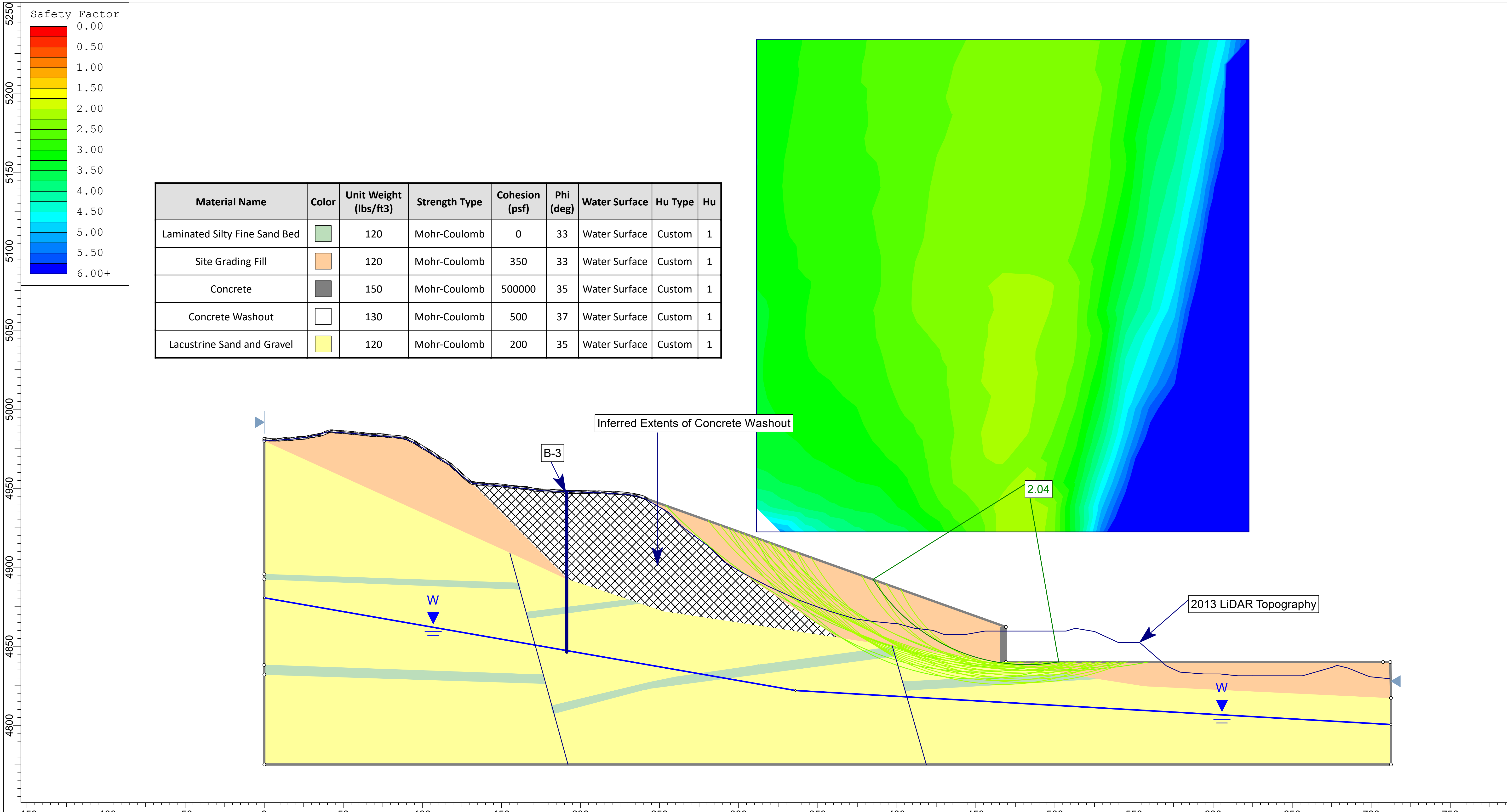
SLIDEINTERPRET 6.039

Project	Gravel Pit Development
Analysis Description	B-B'
Drawn By	JKC
Scale	1:698
Company	G2
Date	5/11/2020, 5:21:49 PM
File Name	B-B' Grading.slim



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu Type	Hu
Laminated Silty Fine Sand Bed		120	Mohr-Coulomb	0	33	Water Surface	Custom	1
Site Grading Fill		120	Mohr-Coulomb	350	33	Water Surface	Custom	1
Concrete		150	Mohr-Coulomb	500000	35	Water Surface	Custom	1
Concrete Washout		130	Mohr-Coulomb	500	37	Water Surface	Custom	1
Lacustrine Sand and Gravel		120	Mohr-Coulomb	200	35	Water Surface	Custom	1

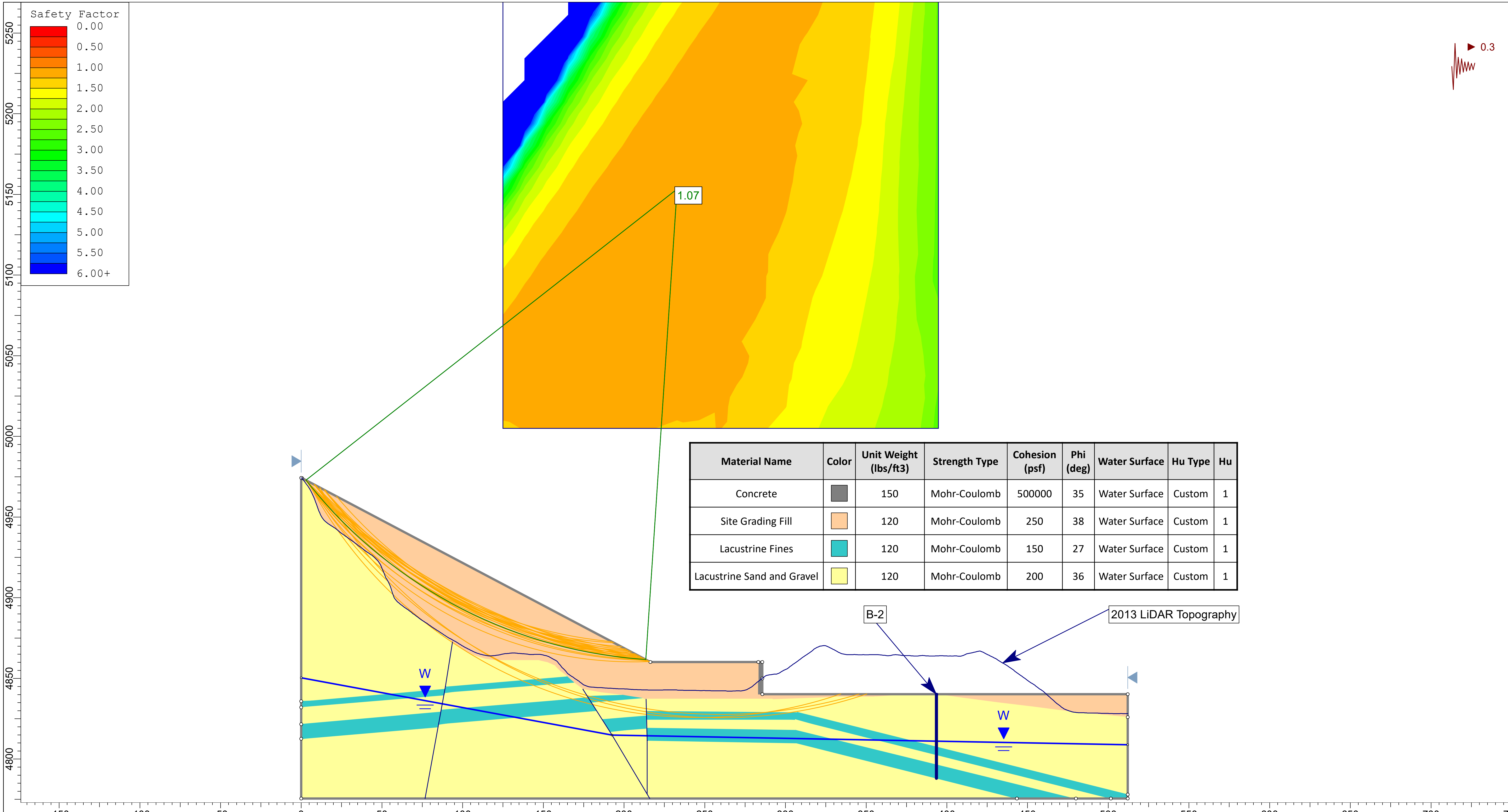
SLIDEINTERPRET 6.039

Project Gravel Pit Development

Analysis Description B-B'

Drawn By JKC | *Scale* 1:698 | *Company* G2

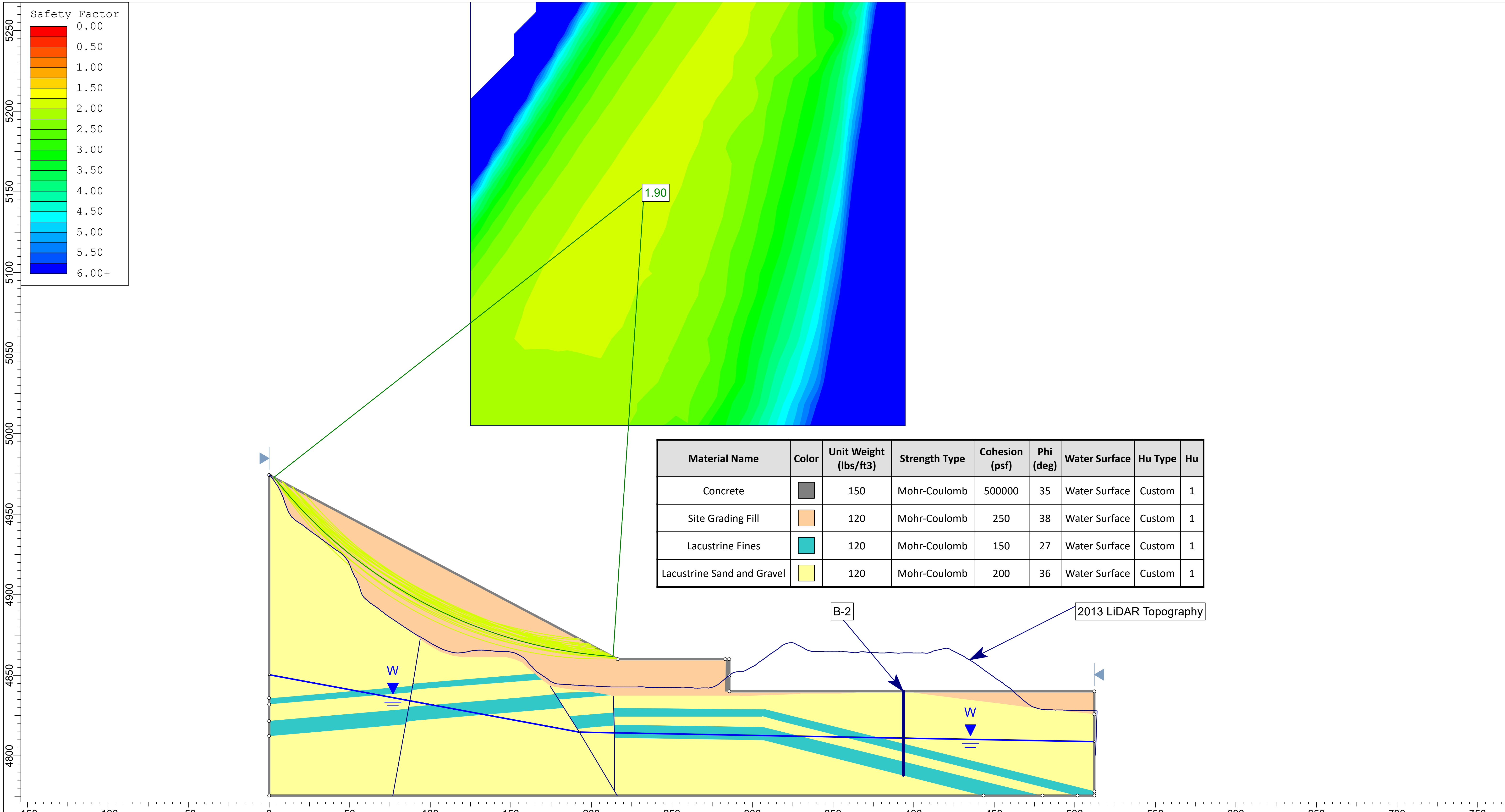
Date 5/11/2020, 5:21:49 PM | *File Name* B-B' Grading.slim



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu Type	Hu
Concrete		150	Mohr-Coulomb	500000	35	Water Surface	Custom	1
Site Grading Fill		120	Mohr-Coulomb	250	38	Water Surface	Custom	1
Lacustrine Fines		120	Mohr-Coulomb	150	27	Water Surface	Custom	1
Lacustrine Sand and Gravel		120	Mohr-Coulomb	200	36	Water Surface	Custom	1

SLIDEINTERPRET 6.039

Project	Gravel Pit Development
Analysis Description	C-C'
Drawn By	JKC
Scale	1:684
Company	G2
Date	5/11/2020, 5:40:35 PM
File Name	C-C' Grading.slim



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu Type	Hu
Concrete		150	Mohr-Coulomb	500000	35	Water Surface	Custom	1
Site Grading Fill		120	Mohr-Coulomb	250	38	Water Surface	Custom	1
Lacustrine Fines		120	Mohr-Coulomb	150	27	Water Surface	Custom	1
Lacustrine Sand and Gravel		120	Mohr-Coulomb	200	36	Water Surface	Custom	1

SLIDEINTERPRET 6.039

Project	Gravel Pit Development		
Analysis Description	C-C'		
Drawn By	JKC	*Scale*	1:684
Company	G2		
Date	5/11/2020, 5:40:35 PM	*File Name*	C-C' Grading.slim