REPORT

GEOLOGIC HAZARDS EVALUATION
PROPOSED COBABE RANCH DEVELOPMENT
ABOUT 2720 NORTH 5100 EAST
EDEN, WEBER COUNTY, UTAH

Prepared for

Lewis Homes
3718 North Wolf Creek Drive
Eden, Utah 84310

February 28, 2022

Prepared by

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February 28, 2022

Lewis Homes
Taylor Lewis
3718 North Wolf Creek Drive
Eden, Utah 84310

Letter of Transmittal: REPORT
Geologic Hazards Evaluation
Proposed Cobabe Ranch Development
About 2720 North 5100 East
Eden, Weber County, Utah

Dear Mr. Lewis:

Western Geologic & Environmental has completed a Geologic Hazards Evaluation for the Proposed Cobabe Ranch Development at about 2700 North 5100 East in Eden, 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

LICENSED PROFESSIONAL GEOLOGIST
02/28/2022
BILL DUANE BLACK
NO. 5224898-2250
STATE OF UTAH

Bill. D. Black, P.G.
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Reviewed By:

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WG&E Project No. 5850

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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 Proposed Cobabe Ranch Development located at about 2720 North 5100 East in Eden, Utah (Figure 1 – Project Location). The Project consists of five contiguous parcels comprising a total of 176.7 acres north-northeast of the north end of Pineview Reservoir in Ogden Valley in Sections 26 and 27, Township 7 North, Range 1 East (Salt Lake Base Line and Meridian; Figure 1). Elevation of the Project ranges between about 4,978 feet to 5,330 feet above sea level. Based on a Gardner Engineering site plan (preliminary plan sheet SP1 dated June 15, 2021), the Project is currently proposed for development of 56 townhomes and 48 lots for residential homes with sizes of from 1.11 to 3.13 acres. The site plan is currently preliminary and no site grading or home locations are indicated. The Project land is currently undeveloped.

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 Christensen Geotechnical.

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 35 onsite walk-in test pits to assess subsurface conditions;
- Preparation of two geologic cross sections 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) and current generally accepted professional engineering geologic principles and practice in Utah, and meets specifications provided in Chapter 27 of the Weber County Land Use Code within the above stated scope. 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 Lewis Homes (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 HYDROLOGY

The U.S. Geological Survey (USGS) topographic map of the Huntsville Quadrangle shows the site is in eastern Ogden Valley northeast of the north arm of Pineview Reservoir (Figure 1). One perennial stream (Heinz Canyon Creek) and one unnamed intermittent drainage cross the western half of the Project and flow to the south, as identified on sheet SP1 in the June 15, 2021, Gardner Engineering preliminary plan. No ponds or springs are mapped on Figure 1 at the site, but are found nearby.

Ogden Valley is dominated in the valley bottom by unconsolidated lacustrine and alluvial basin-fill deposits. Slopes in the site area are mainly in weathered Tertiary-age tuffaceous bedrock overlain by a veneer of unconsolidated Quaternary alluvial and colluvial deposits. Avery (1994) indicates groundwater in Ogden Valley occurs under perched, confined, and unconfined conditions in the valley fill to depths of 750 feet or more. A well-stratified lacustrine silt layer forms a leaky confining bed in the upper part of the valley-fill aquifer. The aquifer below the confining beds is the principal aquifer, which is in primarily fluvial and alluvial-fan deposits. The principal aquifer is recharged from precipitation, seepage from surface water, and subsurface inflow from bedrock into valley fill along the valley margins (Avery, 1994). The confined aquifer is typically overlain by a shallow, unconfined aquifer recharged from surface flow and upward leakage. Groundwater flow is generally from the valley margins into the valley fill, and then toward the head of Ogden Canyon (Avery, 1994).

No site-specific groundwater information was available for the Project, but the Utah Department of Water Rights Well Driller's database shows eight water wells in the site area (Figure 1). The drillers' logs for these wells report depths to static groundwater of from 15 to 40 feet, with a mean depth of 32.6 feet and a median depth of 35 feet. Based on these data, groundwater at the Project appears to be from 21 to 33 feet deep. However, groundwater depths at the site likely vary locally with topography, seasonally from snowmelt runoff, and annually from climatic fluctuations. Such variations would be typical for the area. Perched conditions above less-permeable, clay-rich layers may also be present in the subsurface that cause locally shallower groundwater levels. Our geologic cross sections (Section 5.4) assume a secondary perched groundwater zone is in the upper 5 feet of weathered bedrock to account for possible localized perching. We anticipate groundwater flow at the site to generally southward depending on topography.

Except for test pits TP-34 and TP-35 (Plate 1), no groundwater was encountered during our field investigation at the site. Groundwater was observed at a depth of 10 feet in TP-34 and 9 feet in TP-35. Both of these test pits are adjacent to Heinz Canyon Creek (Plate 1), which suggests this area has localized shallow groundwater. TP-3 further south is similarly located, but encountered no groundwater to its explored depth (nearly 11 feet).

4.0 GEOLOGY

4.1 Surficial Geology

The site is located in eastern Ogden Valley, a sediment-filled intermontane valley within the Wasatch Range, a major north-south trending mountain range marking the eastern boundary of the Basin and Range physiographic province (Stokes; 1977, 1986). Surficial geology of the site is mapped by Coogan and King (2016; Figure 2A) and McDonald (2020; Figure 2B). Coogan and King (2016) is a regional geologic map, whereas McDonald (2020) is a surficial geologic map for the Huntsville quadrangle. Coogan and King (2016; Figure 2A) map the site as underlain by landslide deposits, lacustrine deposits from Lake Bonneville, and post-Lake Bonneville alluvium. McDonald (2020; Figure 2B) maps the site as underlain by landslide deposits, pre-Lake Bonneville alluvial fan deposits, lacustrine deposits from Lake Bonneville, and post-Lake Bonneville alluvium.

Coogan and King (2016) describe surficial geologic units in the site area on Figure 2A (from youngest to oldest) as follows:

Qh, Qh? *– Human disturbances (Historical).* Mapped disturbances obscure original deposits or rocks by cover or removal; only larger disturbances that pre-date the 1984 aerial photographs used to map the Ogden 30 x 60- minute quadrangle are shown; includes engineered fill, particularly along Interstate Highways 80 and 84, the Union Pacific Railroad, and larger dams, as well as aggregate operations, gravel pits, sewage-treatment facilities, cement plant quarries and operations, brick plant and clay pit, Defense Depot Ogden (Browning U.S. Army Reserve Center), gas and oil field operations (for example drill pads) including gas plants, and low dams along several creeks, including a breached dam on Yellow Creek.

Qal, Qal1, Qal2, Qal2? *– Stream alluvium and flood-plain deposits (Holocene and uppermost Pleistocene).* Sand, silt, clay, and gravel in channels, flood plains, and terraces typically less than 16 feet (5 m) above river and stream level; moderately sorted; unconsolidated; along the same drainage Qal2 is lower than Qat2 and has likely been subject to flooding, at least prior to dam building; present in broad plains along the Bear, Ogden, and Weber Rivers and larger tributaries like Deep, Cottonwood, East Canyon, Lost, and Saleratus Creeks, along Box Elder, Heiners, and Yellow Creeks, and in narrower plains of larger tributary streams; locally includes muddy, organic overbank and oxbow lake deposits; composition depends on source area, so in back valleys typically contains many quartzite cobbles recycled from the Wasatch Formation; mostly Holocene, but deposited after regression of Lake

Bonneville from the late Pleistocene Provo shoreline; width in Morgan Valley is combined flood plain of Weber River and East Canyon and Deep Creeks; 6 to 20 feet (2-6 m) thick and possibly as much as 50 feet (15 m) along Weber River and thinner in the Kaysville quadrangle; greater thicknesses (>50 feet [15 m]) are reported in Morgan Valley (Utah Division of Water Rights, well drilling database), but likely include Lake Bonneville and older Pleistocene deposits.

Suffixes 1 and 2 indicate ages where they can be separated, with 1 including active channels and 2 including low terraces 10 to 20 feet (3-6 m) above the Weber and Ogden Rivers, and the South Fork Ogden River that may have been in the flood plain prior to damming of these waterways. Qal2 queried in low terraces above Bear River, Saleratus Creek, and Dry Creek where deposits may not be in the flood plain.

Qaf, Qafy, Qaf3, Qaf3?, Qaf4, Qaf4?, Qaf5 – *Alluvial-fan deposits (Holocene and Pleistocene).* Mostly sand, silt, and gravel that is poorly bedded and poorly sorted and that is not close to late Pleistocene Lake Bonneville and is geographically in the Huff Creek and upper Bear River drainages; variably consolidated; includes debris flows, particularly in drainages and at drainage mouths (fan heads); generally less than 60 feet (18 m) thick. Qaf with no suffix used where age uncertain or for composite fans where portions of fans with multiple ages cannot be shown separately at map scale; toes of some fans have been removed by human disturbances, so their age cannot be determined.

Where possible, subdivided into relative ages, indicated by letter and number suffixes (like Qa and Qat suffixes) and relative ages only apply to the local drainage, with unit Qafy being the lowest (youngest) fans and unit 3 may or may not post-date Lake Bonneville. Relative ages of these fans are partly based on heights above present drainages at drainage-eroded edge of fan. The relative age is queried where the age is uncertain, generally due to the height not fitting into the typical order of surfaces. The various deposits listed, Qafy and Qaf3 through Qaf5, are 20 to 140 feet (6-40 m) above and west of Saleratus Creek, and also above Yellow Creek and the Bear River. Qafy fans are active, impinge on present-day floodplains, divert active streams, and overlie low terraces.

Qac – *Alluvium and colluvium (Holocene and Pleistocene).* Unsorted to variably sorted gravel, sand, silt, and clay in variable proportions; includes stream and fan alluvium, colluvium, and, locally, mass-movement deposits too small to show at map scale; typically mapped along smaller drainages that lack flat bottoms; more extensive east of Henefer where Wasatch Formation (Tw) strata easily weather to debris that "chokes" drainages; 6 to 20 feet (2-6 m) thick. Some deposits are "perched" on benches 80 feet (25 m) and more above present-day drainages like Left Fork Heiners Creek (Heiners Creek quadrangle) and Harris Canyon (Henefer quadrangle). In the Devils Slide quadrangle, some deposits are "perched" on benches about 60 to 130 feet (18-40 m) above Quarry Cottonwood Canyon indicating the alluvium is at least partly Lake Bonneville age and older (see Qab and Qao in tables 1 and 2).

***Qay, Qa2, Qa2?, Qa3, Qa3?, Qa4, Qa4?, Qa4-5, Qa5, Qa6** – Alluvium (Holocene and Pleistocene).* Sand, silt, clay, and gravel in stream and alluvial-fan deposits that are not close to late Pleistocene Lake Bonneville and are geographically in the Huff Creek and upper Bear River drainages; variably sorted; variably consolidated; composition depends on source area; deposits lack fan shape of Qaf and are distinguished from terraces (Qat) based on upper surface sloping toward adjacent streams from sides of drainage, or are shown where fans and terraces are too small to show separately at map scale; Qay is at to slightly above present drainages and not incised by active drainages, so is the youngest unit; generally 6 to 20 feet (2-6 m) thick.

Age-number and letter suffixes on alluvium (undivided, channel, flood plain, terrace, and fan) that is not close to late Pleistocene Lake Bonneville are relative and only apply to the local drainage, with suffix 2 being the second youngest; the relative age is queried where age uncertain, generally due to the height not fitting into the typical order of surfaces. The various numbered deposits listed, Qa2 through Qa6, are 20 to 180 feet (6-55 m) above the Bear River, Saleratus Creek, and Yellow Creek. Qa5 and Qa3? are only used in stacked units (Qa5/Tfb and Qa3?/Tfb).

***Qafp, Qafp?, Qafb, Qafb?, Qafpb, Qafpb?** – Lake Bonneville-age alluvial-fan deposits (upper Pleistocene).* Like undivided alluvial fans, but height above present drainages appears to be related to shorelines of Lake Bonneville and is within certain limits (see table 1); these fans are inactive, unconsolidated to weakly consolidated, and locally dissected; fans labeled Qafp and Qafb are related to the Provo (and slightly lower) and Bonneville shorelines of late Pleistocene Lake Bonneville, respectively, while unit Qafpb is used where fans may be related to the Provo or Bonneville shoreline (for example Qafpb is ~40 feet [12 m] above Lost Creek Valley), or where fans of different ages cannot be shown separately at map scale; Qafp fans typically contain well-rounded, recycled Lake Bonneville gravel and sand and are moderately well sorted; generally 10 to less than 60 feet (3-18 m) thick. Lake Bonneville-age fans are queried where relative age is uncertain (see Qaf for details); fans labeled Qafpb? are above the Bonneville shoreline and might be Qafo or like Qafm; see the note under Qao about two possible ages of older alluvium (Qao, Qato, and Qafo).

Most of the Lake Bonneville-age fans in the James Peak quadrangle are far from the Bonneville shoreline and their age is inferred from their stratigraphic relationship(s) to coeval Pinedale glacial outwash (see age equality in Table 3).

The channels (Qafp/Qdlb) on the Weber River delta and Lake Bonneville fines (Qafp on Qlfb) probably record scour and fill during the rapid drawdown of the lake as it fell from the Bonneville shoreline to the Provo shoreline.

***Qmc** – Landslide and colluvial deposits, undivided (Holocene and Pleistocene).* Poorly sorted to unsorted clay- to boulder-sized material; mapped where landslide deposits are difficult to distinguish from colluvium (slope wash and soil creep) and where mapping separate, small, intermingled areas of landslide and colluvial deposits is not possible at map scale; locally includes talus and debris flow and flood deposits; typically mapped where landslides are thin ("shallow"); also mapped where the blocky or rumpled morphology that is characteristic of landslides has been diminished ("smoothed") by slope wash and soil creep; composition depends on local sources; 6 to 40 feet (2-12 m) thick. These deposits are as unstable as other landslide units (Qms, Qmsy, Qmso).

Qms, Qms?, Qmsy, Qmsy?, Qmso, Qmso? *– Landslide deposits (Holocene and upper and middle? Pleistocene).* Poorly sorted clay- to boulder sized material; includes slides, slumps, and locally flows and floods; generally characterized by hummocky topography, main and internal scarps, and chaotic bedding in displaced blocks; composition depends on local sources; morphology becomes more subdued with time and amount of water in material during emplacement; Qms may be in contact with Qms when landslides are different/distinct; thickness highly variable, up to about 20 to 30 feet (6-9 m) for small slides, and 80 to 100 feet (25-30 m) thick for larger landslides. Qmsy and Qmso queried where relative age uncertain; Qms queried where classification uncertain. Numerous landslides are too small to show at map scale and more detailed maps shown in the index to geologic mapping should be examined.

Qms without a suffix is mapped where the age is uncertain (though likely Holocene and/or late Pleistocene), where portions of slide complexes have different ages but cannot be shown separately at map scale, or where boundaries between slides of different ages are not distinct. Estimated time of emplacement is indicated by relative-age letter suffixes with: Qmsy mapped where landslides deflect streams or failures are in Lake Bonneville deposits, and scarps are variably vegetated; Qmso typically mapped where deposits are "perched" above present drainages, rumpled morphology typical of mass movements has been diminished, and/or younger surficial deposits cover or cut Qmso. Lower perched Qmso deposits are at Qao heights above drainages (95 ka and older) and the higher perched deposits may correlate with high level alluvium (QTa) (likely older than 780 ka) (see table 1). Suffixes y and o indicate probable Holocene and Pleistocene ages, respectively, with all Qmso likely emplaced before Lake Bonneville transgression. These older deposits are as unstable as other slides, and are easily reactivated with the addition of water, be it irrigation or septic tank drain fields.

Qmdf, Qmdf? *– Debris- and mud-flow deposits (Holocene and upper and middle? Pleistocene).* Very poorly sorted, clay- to boulder-sized material in unstratified deposits characterized by rubbly surface and debris-flow levees with channels, lobes, and mounding; variably vegetated; in drainages typically form mounds, an indication of more viscous Qmdf, rather than being flat like unit Qac; Qmdf queried where may not be mostly debris- and mud-flow deposits; many debris flows cannot be shown separately from alluvial fans at map scale; 0 to 40 feet (0-12 m) thick. Age(s) uncertain; deposits in drainages likely post-date the Provo shoreline of Lake Bonneville, while deposits above drainages, like north of the Right Hand Fork Peterson Creek, are likely as old as Bull Lake glaciation, but could pre-date Bull Lake glaciation and be middle Pleistocene.

***Qls, Qls?, Qlsp, Qlsb, Qlsb?** – Lake Bonneville sand (upper Pleistocene).* Mostly sand with some silt and gravel deposited nearshore below and near the Provo shoreline (Qlsp) and between the Provo and Bonneville shorelines (Qlsb); Qls mapped downslope from slope break below Provo shoreline beach deposits where thin Lake Bonneville regressional sand may overlie transgressional sand; grades downslope into unit Qlf with decreasing sand content and laterally with more gravel into units Qdlp, Qdlb, and upslope with more gravel into unit Qlgb; Qls and Qlsb queried where grain size or unit identification uncertain; may be as much as 75 feet (25 m) thick, and thickest near Ogden; typically less than 20 feet (6 m) thick in Morgan Valley; may include small deltas and deltas that lack typical delta shape.

***Qla, Qla?** – Lake Bonneville lacustrine deposits and post- and pre-Lake Bonneville alluvial deposits, undivided (Holocene and upper? Pleistocene).* Mostly poorly sorted and poorly bedded sand, silt, and clay, with some gravel; mapped where Lake Bonneville deposits are reworked by later stream action or covered by thin stream and fan deposits, and where lake deposits are thin and overlie older alluvial deposits; unit queried where may be dominantly alluvium; deposits typically eroded from shallow Norwood Formation; mostly mapped near Bonneville shoreline; also mapped in Peterson quadrangle along upper Deep Creek above Bonneville shoreline where lake deposits seem to indicate landslide dam of creek; thickness uncertain.

***Qdlb, Qdlb?** – Transgressive and Bonneville-shoreline deltaic and lacustrine deposits (upper Pleistocene)*. Mostly sand, silty sand, and gravelly sand deposited near shore in Lake Bonneville; extensive at mouth of Weber Canyon; related to transgression to and occupation of the Bonneville shoreline with lacustrine deposits covering deltaic deposits; in Morgan Valley and near mouth of Coldwater Canyon (North Ogden quadrangle) contain more cobbles and overall more gravel; 0 to at least 40 feet (12 m) thick in Ogden and Morgan Valleys; about 400 feet (120 m) thick in bluff at the mouth of Weber Canyon. These deposits are prone to slope failures.

***Qadb, Qadb?** – Transgressive and Bonneville-shoreline alluvial and deltaic deposits (upper Pleistocene).* Cobbly gravel, sand, silt, and clay deposited above (subaerial) and in Lake Bonneville (subaqueous); typically mapped where shorelines are obscure, so that line cannot be drawn between alluvial fan and delta; include rounded to subangular clasts in a matrix of sand and silt with interbeds of sand and silt; mapped above the Provo shoreline and deposited as lake transgressed to and was at the Bonneville shoreline; typically better sorted delta and lake deposits over poorly sorted alluvial-fan deposits; Qadb prominent along Deep Creek (Morgan quadrangle) and Strawberry Creek (Snow Basin quadrangle); 0 to at least 40 feet (0-12+ m) thick.

Note that the Bonneville-shoreline fan-delta unit (Qadb), at 80 to 100 feet (24-30 m) above present drainages, is typically higher than the related alluvial units (Qab, Qafb) (see table 1). A fan-delta is built when an alluvial fan enters a lake or ocean, and includes both the fan and the delta.

Qafp, Qafp?, Qafb, Qafb?, Qafpb, Qafpb? – *Lake Bonneville-age alluvial-fan deposits (upper Pleistocene)*. Like undivided alluvial fans, but height above present drainages appears to be related to shorelines of Lake Bonneville and is within certain limits (see table 1); these fans are inactive, unconsolidated to weakly consolidated, and locally dissected; fans labeled Qafp and Qafb are related to the Provo (and slightly lower) and Bonneville shorelines of late Pleistocene Lake Bonneville, respectively, while unit Qafpb is used where fans may be related to the Provo or Bonneville shoreline (for example Qafpb is ~40 feet [12 m] above Lost Creek Valley), or where fans of different ages cannot be shown separately at map scale; Qafp fans typically contain well-rounded, recycled Lake Bonneville gravel and sand and are moderately well sorted; generally 10 to less than 60 feet (3-18 m) thick. Lake Bonneville-age fans are queried where relative age is uncertain (see Qaf for details); fans labeled Qafpb? are above the Bonneville shoreline and might be Qafo or like Qafm; see the note under Qao about two possible ages of older alluvium (Qao, Qato, and Qafo).

Most of the Lake Bonneville-age fans in the James Peak quadrangle are far from the Bonneville shoreline and their age is inferred from their stratigraphic relationship(s) to coeval Pinedale glacial outwash (see age equality in Table 3).

The channels (Qafp/Qdlb) on the Weber River delta and Lake Bonneville fines (Qafp on Qlfb) probably record scour and fill during the rapid drawdown of the lake as it fell from the Bonneville shoreline to the Provo shoreline.

Qao, Qao? – *Older alluvium (mostly upper Pleistocene).* Sand, silt, clay, and gravel above and likely older than the Bonneville shoreline; mapped on surfaces above Lake Bonneville-age alluvium (Qap, Qab, Qapb); deposits lack fan shape (Qaf) and are distinguished from terraces (Qat) based on upper surface sloping toward adjacent streams from sides of drainage; also shown where areas of fans and terraces are too small to show separately at map scale; composition depends on source area; at least locally up to 110 feet (34 m) thick. Queried where classification or relative age is uncertain (see Qa for details); for example near head of Saleratus Creek.

Qafo, Qafo? – *Older alluvial-fan deposits (mostly upper Pleistocene).* Incised and at least locally dissected fans of mostly sand, silt, and gravel that is poorly bedded and poorly sorted; includes debris flows, particularly in drainages and at drainage mouths (fan heads); older fans are typically above the Bonneville shoreline, with an eroded bench at the shoreline; upstream and above the Bonneville shoreline, unit Qafo is topographically higher than fans graded to the Bonneville shoreline (Qafb), and is typically dissected; generally less than 60 feet (18 m) thick. In Mantua Valley, exposed thickness up to about 100 feet (30 m), but water wells (sections 26 and 27, T. 9 N., R. 1 W.) were still in gravelly to bouldery valley fill at depths of 505 and 467 feet (154 and 142 m), respectively, and red coloration that may indicate Wasatch Formation bedrock was not noted (see Bjorklund and McGreevy, 1973, p. 16).

Qafo queried where relative age is uncertain (see Qaf for details), for example in Mantua quadrangle where it is as high as Qafoe in Morgan Valley (see table 1). Qafo queried in East Canyon graben because the deposits are not dissected and some deposits mantle Qafoe (see also unit Qafm above), resulting in a reversal of relative height and only local incision. These irregular deposits are likely the result of salt movement in the East Canyon graben. Our Qafo is roughly shown to south by Bryant (1990) as Qgp (pediment gravel); farther south he showed Qoa (dissected alluvium) adjacent to the East Canyon fault, which may be the QTaf or Qafoe we mapped.

Amino-acid age estimates presented in Sullivan and Nelson (1992) imply Qafo north of Morgan considerably predates Lake Bonneville and is middle Pleistocene in age (>400 ka). However, the Bonneville shoreline is obscure on this fan, and soil-carbonate age estimates (>70-100 ka) and other amino-acid age estimates (~98-155 ka) in Sullivan and others (1988) imply these older fans are related to Bull Lake glaciation (95,000 to 130,000 years old; see Chadwick and others, 1997; Phillips and others, 1997). As noted under Qao, Qafo deposits may contain two ages (levels) of alluvial surfaces that are not easily recognized in Morgan Valley but are recognized upstream in the Henefer and Lost Creek Valleys (Devils Slide quadrangle) and along the North and South Forks of Ogden River.

***Tn, Tn?** – Norwood Formation (lower Oligocene and upper Eocene).* Typically light-gray to light-brown altered tuff (claystone), altered tuffaceous siltstone and sandstone, and conglomerate; unaltered tuff, present in type section south of Morgan, is rare; locally colored light shades of red and green; variable calcareous cement and zeolitization; involved in numerous landslides of various sizes; estimate 2000-foot (600 m) thick in exposures on west side of Ogden Valley (based on bedding dip, outcrop width, and topography). Norwood Formation queried where poor exposures may actually be surficial deposits. For detailed Norwood Formation information see description under heading "Sub-Willard Thrust - Ogden Canyon Area" since most of this unit is in and near Morgan Valley and covers the Willard thrust, Ogden Canyon, and Durst Mountain areas.

***Zpu, Zpu?** – Formation of Perry Canyon, Upper member (Neoproterozoic).* Olive drab to gray, thin-bedded slate to argillite to phyllite to micaceous meta-siltstone to meta-graywacke to meta-sandstone in variable proportions such that unit looks like both the "greywacke-sandstone" and "mudstone" members of previous workers; unit identification based on underlying diamictite in Mantua quadrangle; rare meta-gritstone and meta-diamictite (actually conglomerate?); locally schistose; meta-sandstone contains poorly sorted lithic, quartz, and feldspar grains in silty to micaceous matrix; meta-sandstone is quartzose in outcrops on west margin of Mantua quadrangle (Crittenden and Sorensen, 1985a) and medial zone of sandstone is feldspathic east of Ogden Valley, where mapped and described as argillite member of Maple Canyon Formation by Crittenden (1972) and Sorensen and Crittenden (1979); thickness uncertain, but appears to be about 600 feet (180 m) thick on west flank of Grizzly Peak in the Mantua quadrangle and about 1000 feet (300 m) thick between Ogden Canyon and North Ogden divide. In Ogden Valley typically non-resistant and tan weathering such that gray to green to dark-gray fresh color is seldom seen except in cut slopes and excavations. This unit is prone to slope failures.

Zmcg, Zmcg? *– Maple Canyon Formation, Lower (green arkose) member (Neoproterozoic).* Grayish-green, fine-grained arkosic (feldspathic) meta-sandstone and sandy argillite (meta-graywacke), with local quartzite lenses up to 200 feet (60 m) thick; weathers darker gray to brown to greenish-gray and greenish-brown; 500 to 1000 feet (150-305 m) thick and lower thickness would eliminate the need for faulting in southwest part of Huntsville quadrangle. This unit is prone to slope failures.

McDonald (2020) describes surficial geologic units in the site area on Figure 2B (from youngest to oldest) as follows:

Qmsh *– Landslide deposits, historical (Holocene).* Poorly sorted clay- to boulder-sized material in slides, slumps, flows, and landslide complexes; generally characterized by hummocky topography, head, lateral, and/or internal scarps, and chaotic bedding in displaced blocks; composition depends on local sources; morphology becomes more subdued with increasing age and/or rate of movement; includes landslides having historical movement that has been observed, documented, or is apparent on aerial imagery; thickness highly variable.

Qaly *– Stream alluvium and floodplain deposits (Holocene to upper Pleistocene).* Poorly to moderately sorted, pebble to cobble gravel with a matrix of sand, silt, and clay in channels and floodplains and low terraces typically less than 10 feet (3 m) above modern channel level; angular to subangular grains; composition depends on source area; moderately sorted within beds; locally includes muddy overbank and organic-rich marsh deposits; present along the major valley-bottom streams including the North, Middle, and South Forks of the Ogden River, and Wolf Creek; 0 to 20 feet (0–6 m) thick.

Qat1 *– Stream terrace deposits (middle Holocene? to upper Pleistocene?).* Poorly to well sorted pebble to cobble gravel in a matrix of sand, silt and clay in terraces above modern streams and/or floodplains; subangular to subrounded grains; poorly to moderately bedded; typically about 5 to 10 feet (1–3 m) above modern channels; 0 to 10 feet (0–3 m) thick.

Qafy *– Younger alluvial-fan deposits (Holocene to upper Pleistocene).* Poorly to moderately sorted pebble to cobble gravel with silt, sand and minor clay matrix; angular to subangular grains; poorly to moderately bedded; composition depends on source area; includes debris flows, debris floods, and channel deposits on large alluvial fans notably at the mouth of Geertzen Canyon where a large, nearly 1.5-mile-wide (2.5 km) by over 1-mile-long (1.5 km) fan exists; elsewhere, smaller alluvial fans grade into active stream channels or lacustrine surfaces; the Geertzen Canyon fan contains abundant cobbles and boulders derived from Paleozoic quartzites and Paleogene conglomeratic surface deposits above and flanking the northeast margin of Ogden Valley; 0 to 30 feet (0–6 m) thick.

***Qmsy** – Landslide deposits, younger (Holocene to upper Pleistocene?)* – Poorly sorted clay- to boulder-sized material in slides, slumps, flows, and landslide complexes; generally characterized by hummocky topography, head, lateral, and/or internal scarps, and chaotic bedding in displaced blocks; composition depends on local sources; morphology becomes more subdued with increasing age and/or rate of movement; morphology suggests likely post-Lake Bonneville movement with relatively sharp and pronounced landslide deformation features and may include parts that are historic and active; thickness highly variable.

***Qla** – Lacustrine and alluvial deposits, undivided (Holocene to upper Pleistocene).* Poorly to moderately sorted silt, sand, clay, and gravel; subangular to rounded clasts; moderately to well-bedded; includes Lake Bonneville-age transgressional deposits below and near the highstand shoreline and post-Bonneville stream alluvium overlain by, interbedded with, and/or reworked by streams; includes alluvial deposits aggraded to the Provo shoreline that are likely time equivalent to the overflowing and regressive phases of Lake Bonneville; 1 to 10 feet (0.3–3 m) thick.

***Qac** – Alluvium and colluvium (Holocene to middle Pleistocene?).* Unsorted to variably sorted silt, sand, gravel, clay, cobble and boulder in variable proportions and roundness; includes stream and fan alluvium, colluvium, sheetwash deposits, and locally mass-movement deposits that are too small to map separately at map scale; typically mapped along drainages bounded by hillslopes where colluvium grades into alluvium without distinct break in slope and in smaller drainages lacking flat bottoms or too small to subdivide at map scale; 0 to 20 feet (0–6 m) thick.

***Qms** – Landslide deposits, undifferentiated (Holocene to middle Pleistocene?).* Poorly sorted clay- to boulder-sized material in slides, slumps, flows, and landslide complexes; generally characterized by hummocky topography, head, lateral, and/or internal scarps, and chaotic bedding in displaced blocks; composition depends on local sources; morphology becomes more subdued with increasing age and/or rate of movement; mapped where relative age cannot be distinguished or where landslide complexes have portions with different ages and/or rates of activity; thickness highly variable.

***Qmc** – Mass-movement and colluvial deposits, undivided (Holocene to middle Pleistocene?).* Poorly sorted to unsorted, mostly clay, silt, sand, gravel, cobble, and boulder; angular to rounded clasts; nonbedded; mapped on slopes where individual landslides, slumps, slope wash, and soil creep are difficult to distinguish from one another; often characterized by hummocky slopes composed of numerous slumps of various sizes and ages includes soil creep, sappy areas, talus, slope wash, and debris-flow deposits but lack clear landslide scarps and lateral margins to allow separate mapping; typically forms on slopes overlying clay-bearing, landslide prone bedrock units—notably Neogene volcaniclastics and argillic Proterozoic formations; 0 to 40 feet (0–12 m) thick.

***Qafb** – Younger alluvial-fan deposits (upper Pleistocene).* Poorly sorted pebble to cobble gravel with silt, sand and minor clay matrix; angular to subangular grains; poorly to moderately bedded; composition depends on source area; includes debris flows, debris floods, and channel deposits that grade into Lake Bonneville transgressive or highstand shoreline deposits or at a height above modern fan surfaces consistent with correlative deposits; 0 to 30 feet (0–6 m) thick.

***Qls** – Lake Bonneville sand and gravel deposits (upper Pleistocene).* Moderately to poorly sorted, moderately to well-bedded sand and gravel with silt and clay; subangular to rounded clasts; deposited in transgressive Lake Bonneville nearshore environments; includes thin clay and silt interbeds deposited off shore; may grade laterally into Qlf or Qdl; typically less than 20 feet (6 m) thick.

***Qlf** – Lake Bonneville fine-grained deposits (upper Pleistocene)*. Moderately to well-sorted and moderately bedded to thinly laminated clay, silt, and sand deposited during the transgression and highstand of Lake Bonneville; rounded to well-rounded clasts; deposited in shallow to moderately deep water; typically overlies pre-Bonneville alluvium and may overlie middle Pleistocene Little Valley lake cycle (Scott and others, 1983; Oviatt and others, 1999) fine-grained deposits in the central part of the valley; 5 feet (2 m) thick or greater.

***Qao** – Older alluvium (upper to middle Pleistocene?).* Poorly to moderately sorted sand, silt, clay, and gravel on surfaces; subangular to subrounded grains; poorly to moderately bedded; deposits are typically isolated remnants in the valley or along valley margin drainages; located above and presumed older than Lake Bonneville-age alluvium and likely same age as Qafo but lacking alluvial-fan morphology; 10 to 50 feet (3–15 m) thick.

***Qafo** – Older alluvial-fan deposits (upper to middle Pleistocene?).* Poorly to moderately sorted pebble to cobble gravel with a matrix of silt, sand and clay; subangular to subrounded clasts; poorly bedded; fans are typically eroded and incised locally with isolated fan remnants, deposits may be somewhat lithified, and characterized by a reddish, clay-rich matrix; deposits are likely early to middle Pleistocene-age and may include deposits previously mapped as Huntsville Fanglomerate (Eardley, 1955; Lofgren; 1955; Coody, 1957) and may include deposits where fan age is uncertain, or for composite fans, where parts of fans with different ages cannot be shown separately at map scale; 10 to 50 feet (3–15 m) thick.

***Qmso** – Landslide deposits, older (upper to middle Pleistocene?)* – Poorly sorted clay- to boulder-sized material in slides, slumps, flows, and landslide complexes; generally characterized by hummocky topography, head, lateral, and/or internal scarps, and chaotic bedding in displaced blocks; composition depends on local sources; morphology becomes more subdued with increasing age and/or rate of movement; mapped where deposits generally have a more subdued morphology and are likely early Holocene and Pleistocene in age; include very large complexes underlain by argillite-rich bedrock where entire hillsides appear to be part of a landslide complex but where defining their boundaries are often difficult; thickness highly variable.

BR *– Rock (Tertiary to Precambrian)*. Mapping of bedrock structure and stratigraphy is beyond the scope of this project. Sorenson and Crittenden (1979) provide the most recent published 1:24,000-scale geologic map of the Huntsville quadrangle. Coogan and King (2016) performed a cursory revision of the bedrock of Sorenson and Crittenden (1979) in compiling the Ogden 30′ x 60′ quadrangle. For more information, refer to these maps and other maps and studies cited in the Previous Work section of this report.

Citations, tables, and figures above are not provided herein, but are in Coogan and King (2016) or McDonald (2020).

4.2 Seismotectonic Setting

The property is located in Ogden Valley, a roughly 40 square-mile back valley described by Gilbert (1928) as a structural trough similar to Cache and Morgan Valleys to the north and south, respectively. The back valleys of the northern Wasatch Range are in a transition zone between the Basin and Range and Middle Rocky Mountains physiographic provinces (Stokes, 1977, 1986). The Basin and Range 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 marked by the Wasatch fault zone (WFZ) at the base of the Wasatch Range. Late Cenozoic normal faulting, a characteristic of the Basin and Range, began between about 17 and 10 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 back valleys are morphologically similar to valleys in the Basin and Range, but exhibit less structural relief (Sullivan and others 1986).

Ogden Valley occupies a structural trough created by up to 2,000 feet of vertical displacement on normal faults bounding the east and west sides of the valley. The Utah Geological Survey Quaternary Fault Database (Black and others, 2003; 2020 update) maps the Ogden Valley Southwestern Margin fault about 1.7 miles southwest of the Project and the Ogden Valley Northeastern Margin fault about 1.4 miles to the northeast. Sullivan and others (1986) indicate the most recent movement on these faults is pre-Holocene. The nearest active (Holocene-age) fault to the site is the Weber section of the WFZ about 5.4 miles to the west.

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 WFZ 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 Magna earthquake[1] reportedly showed a style, location, and slip depth consistent with an earthquake on the WFZ system. Despite being less than magnitude 6.0, this earthquake damaged multiple buildings and was felt from southern Idaho to south-central Utah[2]. The University of Utah Seismograph Stations indicates the Magna earthquake[3] was weakly felt in Ogden Valley, with a peak acceleration of about 0.005 g and an instrument intensity of II-III (on a Roman numeral scale of I-X).

4.3 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 are mapped underlying parts of the Project.

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 shoreline, 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). The highest Bonneville shoreline is mapped southeast of the Project on Figures 2A and 2B at an elevation of between 5,180 and 5,200 feet.

Following the Bonneville flood, Lake Bonneville retreated from Ogden Valley and stabilized at a lower level referred to as the Provo shoreline (which is mapped in Ogden Canyon to the west). The lake occupied this level up to about 16,000 years ago, after which climatic factors caused it to recede even further. By about 13,000 years ago, the lake had receded below historic levels of Great Salt Lake, which Oviatt and others (1992) deem to be 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).

[1] https://earthquake.usgs.gov/earthquakes/eventpage/uu60363602/executive
[2] https://www.ksl.com/article/46731630/
[3] https://earthquakes.utah.gov/magna-quake/#

5.0 SITE CHARACTERIZATION

Site conditions and geology were interpreted through an integrated compilation of data, including a review of literature and mapping from previous studies conducted in the area (Coogan and King, 2016; and McDonald, 2020); excavation, logging and field interpretation of 35 test pits; field reconnaissance of the site in conjunction with the subsurface exploration; photogeologic analyses of 2012 high-resolution aerial imagery; and GIS analyses of geoprocessed 2016 and 2020 LIDAR terrain data.

5.1 Subsurface Investigation

Thirty-five walk-in test pits (short trenches) were excavated at the Project to assess subsurface conditions. The test pits were logged by Bill D. Black, P.G., of Western Geologic between December 8-14, 2021, concurrently with the Project geotechnical investigation conducted by Christensen Geotechnical. Locations of the test pits are shown on Plate 1. The test pit locations were measured using a hand-held GPS unit and by trend and distance methods. The test pits were logged at a scale of 1-inch equals five feet (1:60) following methodology in McCalpin (1996), and digitally photographed at 5-foot intervals to document the exposures. The photos are not provided herein, but are available on request. Logs of the test pits are provided on Figures 3A-3R. Stratigraphic interpretations and descriptions are provided on the logs. Except for test pits TP-34 and TP-35, no groundwater was encountered during our field investigation. Groundwater was observed at a depth of 10 feet in TP-34 and 9 feet in TP-35.

5.2 Empirical Observations

On December 8-14, Mr. Bill D. Black, P.G., of Western Geologic conducted a reconnaissance of the property to observe geomorphic and surficial conditions. Weather conditions varied. The site is in Ogden Valley on slopes overlooking Pineview Reservoir to the south. Native vegetation consists of scattered trees, various brush, and grasses. Heinz Canyon Creek and an unnamed intermittent drainage cross the western half of the Project, but no other significant drainages were observed. No seeps, springs or ponds were also observed, but several areas of possible seasonal seepage were observed, including the area of test pit TP-31 (Plate 1). Slopes at the site appeared to be relatively gentle. No evidence for recent or ongoing landslides or other geologic hazards was observed.

5.3 Air Photo Observations

High-resolution color orthophotography from 2012 and bare earth DEM LIDAR imagery from 2016 and 2020 were reviewed to obtain information about the geomorphology of the Project area. The 2012 aerial imagery and LIDAR analysis are provided on Plates 1 and 2 at a scale of 1 inch equals 200 feet (1:2,400). Surficial geology of the Project is shown on Plate 3 based on the mapping in Coogan and King (2016, Figure 2A), McDonald (2020, Figure 2B), and our onsite subsurface data, empirical observations, and air photo interpretation. Surficial geologic units generally follow the naming convention of

McDonald (2020), except that we designate his unit Qls as unit Qlb because the onsite lacustrine deposits appeared to include both sandy and clayey sediments. Unit Qla generally consists of Holocene- to upper Pleistocene alluvium overlying Lake Bonneville deposits, rather than mixed or interfingered deposits. Plate 2 shows slope steepness and aspect varies across at the site, though much of the site is on slopes gentler than 15 percent (unshaded areas).

The Project is in an area underlain by Tertiary-age Norwood Formation bedrock with a veneer of Lake Bonneville sediments and pre- and post-Lake Bonneville alluvium and colluvium. The southwest part of the site is mainly on Lake Bonneville transgressive-stage deposits and post-lake alluvium and slope colluvium (units Qlb, Qla, and Qac). The northeast part is on pre-Lake Bonneville alluvial-fan deposits (unit Qafo) that have been impacted by two overlapping landslides (units Qmso and Qms, Plate 3). The toe of the younger landslide overlies the older landslide. The bedrock is comprised of a northeast-dipping sequence of claystone, tuffaceous sandstone and conglomerate, and siltstone. The older landslide predates Lake Bonneville and is crossed by the highest lake shoreline (dashed blue line and B, Plate 3), whereas the younger landslide truncates the shoreline. No evidence for other geologic hazards was observed on the air photos at the site or in the area.

5.4 Cross Sections

Figures 4A-4B show two geologic cross sections (A-A’ and B-B’; Plates 1-3) across the overall steepest slope sections at the site. Units and contacts are inferred based on subsurface data from the test pits (Figures 3A-R), and the surficial geologic mapping on Plate 3. The topographic profiles are based on geoprocessed 2016 and 2020 LIDAR data. The LIDAR data provide a snapshot of topographic conditions at the time of acquisition; past, present and future surficial topography may vary. Bedding dips were determined using https://app.visiblegeology.com/apparentDip.html based on the cross section trend and test pit strike/dip data. We caution that the cross sections are based on limited subsurface data, particularly given the depth of exploration. Units and contacts should therefore be considered approximate and inferred, and variations should be expected at depth and laterally. Groundwater in the cross sections is inferred to be at a depth of about 22 to 29 feet based on nearby well data, though a perched groundwater zone is conservatively shown in the upper 5 feet of the weathered bedrock to reflect possible localized perching.

6.0 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.

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	

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.

6.1 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 (Default), and a risk category of II, calculated seismic values for the site (centered on 41.313999° N, -111.815894° W) are summarized below:

Table 2. *Seismic hazards summary.*

Type	Value
S_S	*0.918 g*
S_1	*0.325 g*
S_{MS} (F_a x S_S)	*1.101 g*
S_{M1} (F_v x S_1)	*See ASCE 7-16 Section 11.4.8*
S_{DS} (2/3 x S_{MS})	*0.734 g*
S_{D1} (2/3 x S_{M1})	*See ASCE 7-16 Section 11.4.8*
Seismic Design Category, SDC	*See ASCE 7-16 Section 11.4.8*
Site Coefficient, F_a	*= 1.2*
Site Coefficient, F_v	*See ASCE 7-16 Section 11.4.8*
Site-Modified Peak Ground Acceleration, PGA_M	*= 0.488 g*

The PGA_M for the site in Table 2 is nearly 100 times that reportedly experienced in Ogden Valley (0.005 g) from the March 18, 2020, M 5.7 Magna earthquake. Given the above information, we rate the hazard from earthquake ground shaking as high. Earthquake ground shaking is a regional hazard common to all Wasatch Front areas. The hazard is mitigated by design and construction of homes in accordance with the current adopted building code. We note that 2018 IBC (ASCE 7-16) provisions require calculation of the spectral acceleration value (S_{M1}), seismic design value (S_{D1}), seismic design category (SDC) 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.

6.2 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.

No active faults are mapped crossing the site or were observed during our reconnaissance or on air photos. The nearest active (Holocene-age) fault to the site is the Weber section of the WFZ about 5.4 miles to the west. Given all the above, we rate the existing risk from surface faulting as low. No additional investigation regarding surface faulting appears needed given the proposed development and current paleoseismic information.

6.3 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 test pits and the site-specific geologic mapping on Plate 3, we rate the risk from liquefaction as low. Weber County GIS mapping shows the site is in an area of very low liquefaction potential (code 1).

6.4 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 is not in close proximity to and on the downthrown side of any mapped active (Holocene) faults. Based on this, we rate the risk from tectonic subsidence as low.

6.5 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.

6.6 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.

Federal Emergency Management Agency flood insurance rate mapping (Map Numbers 49057C0229F, 49057C0233F, 49057C0237F and 49057C0241F, effective 06/02/2015) classifies the Project in "Zone X" (areas of minimal flood hazards). However, a perennial drainage (Heinz Canyon Creek) flows across the western part of the Project. Sheet SP1 in the June 15, 2021 Gardner Engineering preliminary plan set shows a roughly 40-foot wide exclusion area around the creek.

Based on the FEMA mapping and current civil engineering design for the development, we rate the risk from stream flooding as low. Care should be taken that proper surface drainage is maintained.

6.7 Shallow Groundwater

Except for TP-34 and TP-35, no groundwater was encountered in the test pits at the site. Both of these test pits are near Heinz Canyon Creek. Eight water wells are also near the Project (Figure 1). Utah Division of Water Rights data for these wells indicate depths to static groundwater of from 15 to 40 feet, with a mean depth of 32.6 feet and a median depth of 35 feet. Based on these data, groundwater at the Project appears to be from 21 to 33 feet deep, though depths may vary locally and seasonally from snowmelt runoff and annually from climatic fluctuations, which would be typical for the area. Our test pit data indicate perched conditions above less-permeable, clay-rich bedrock layers may also be locally present in the subsurface. Given all the above, we rate the risk from shallow groundwater as moderate. The Project geotechnical engineer should evaluate the need for a foundation drainage system to ensure that proper subsurface drainage is maintained.

6.8 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.

The Project is in an area underlain mainly by Tertiary-age Norwood Formation bedrock with a veneer of alluvium, colluvium and Lake Bonneville sediments. Two pre- and post-Lake Bonneville landslides are in the north part of the site. The landslide morphology appeared subdued and no evidence for recent or ongoing landslides or slope instability was observed. Colluvial thicknesses are shown on the test pit logs (Figures 3A-3R). Plate 2 shows slopes at the site vary in aspect and steepness, though much of the site appears to be on gentle slopes with a steepness less than 15 percent (unshaded).

Given the above, we rate the risk from landslides and slope instability as high. We 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 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.

6.9 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 caused significant damage in the Wasatch Front area.

Heinz Canyon Creek flows across the Project, but the alluvial fan for this creek is further east. No active alluvial fans are mapped at the Project, and no evidence for characteristic debris flow morphology was observed at the site on air photos or during our reconnaissance. Given the above, we rate the risk from debris flows and floods as low.

6.10 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.

6.11 Problem Soil and Rock

Clay-rich surficial soils and weathered bedrock possibly susceptible to shrinking/swelling were observed in numerous test pits at the Project. Given the above, we rate the risk from problem soil and rock as moderate. Soil conditions and specific recommendations for site grading, subgrade preparation, and footing and foundation design should be provided in the Project geotechnical engineering evaluation.

7.0 CONCLUSIONS AND RECOMMENDATIONS

Earthquake ground shaking and landslides are identified as posing a high relative risk to the Project. Shallow groundwater and problem soil pose a moderate (equivocal) 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. Earthquake ground shaking is a hazard that is common for all development along the Wasatch Front.

- ***Geotechnical Evaluation*** **–** The Project geotechnical engineer should assess soil foundation conditions, provide recommendations regarding subsurface drainage, 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. We recommend that final site drainage and grading plans be reviewed by a licensed geologist and geotechnical engineer.

- ***Excavation Backfill Considerations*** **–** The test pits 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.

- ***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.

8.0 REFERENCES

Anderson, R.E., 1989, Tectonic evolution of the intermontane system--Basin and Range, Colorado Plateau, and High Lava Plains, *in* Pakiser, L.C., and Mooney, W.D., editors, Geophysical framework of the continental United States: Geological Society of America Memoir 172, p. 163-176.

Arabasz, W.J., Pechmann, J.C., and Brown, E.D., 1992, Observational seismology and evaluation of earthquake hazards and risk in the Wasatch Front area, Utah, *in* Gori, P.L. and Hays, W.W., editors, Assessment of Regional Earthquake Hazards and Risk along the Wasatch Front, Utah: Washington, D.C, U.S. Geological Survey Professional Paper 1500-D, Government Printing Office, p. D1-D36.

Avery, Charles, 1994, Ground-water hydrology of Ogden Valley and surrounding area, eastern Weber County, Utah and simulation of ground-water flow in the valley-fill aquifer system: Utah Department of Natural Resources, Technical Publication no.99, 84 p.

Black, B.D., Hecker, Suzanne, Hylland, M.D., Christenson, G.E., and McDonald, G.N., 2003, Quaternary fault and fold database and map of Utah: Utah Geological Survey Map 193DM, CD-ROM.

Boore, D.M., Joyner, W.B., and Fumal, T.E., 1993, Estimation of Response Spectra and Peak Acceleration from Western North America Earthquakes--An interim report: U.S. Geological Survey Open-File Report 93-509.

Bowman, S.D., and Lund, W.R., 2016, Guidelines for conducting engineering-geology investigations and preparing engineering-geology reports in Utah, *in* Bowman, S.D., and Lund, W.R., editors, Guidelines for investigating geologic hazards and preparing engineering-geology reports, with a suggested approach to geologic-hazard ordinances in Utah: Utah Geological Survey Circular 122, p. 15–30.

Coogan, J.C., and King, J.K., 2016, Interim Geologic Map of the Ogden 30' x 60' Quadrangle, Box Elder, Cache, Davis, Morgan, Rich, and Summit Counties, Utah, and Uinta County, Wyoming: Utah Geological Survey Open-File Report 653DM, scale 1:100,000, 141 p. with appendices.

Gilbert, G.K., 1928, Studies of Basin and Range Structure: U.S. Geological Survey Professional Paper 153, 89 p.

Gwynn, J.W. (Editor), 1980, Great Salt Lake--A scientific, historical, and economic overview: Utah Geological Survey Bulletin 166, 400 p.

Jarrett, R.D., and Malde, H.E., 1987, Paleodischarge of the late Pleistocene Bonneville flood, Snake River, Idaho, computed from new evidence: Geological Society of America Bulletin, v. 99, p. 127-134.

Lund, W.R. (Editor), 1990. Engineering geology of the Salt Lake City metropolitan area, Utah: Utah Geological and Mineral Survey Bulletin 126, 66 p.

McCalpin, J.P., 1996, Paleoseismology: San Diego, California, Academic Press Inc., Volume 62 of the International Geophysical Series, 588 p.

McDonald, G.N., 2020, Interim geologic map of surficial deposits in the Huntsville Quadrangle, Weber and Cache Counties, Utah: Utah Geological Survey Contract Deliverable, USGS STATEMAP award number G19AC00228 (2019–20), 21 p., scale 1:24,000.

Miller, D.M., 1990, Mesozoic and Cenozoic tectonic evolution of the northeastern Great Basin, *in* Shaddrick, D.R., Kizis, J.R., and Hunsaker, E.L. III, editors, Geology and Ore Deposits of the Northeastern Great Basin: Geological Society of Nevada Field Trip No. 5, p. 43-73.

O'Connor, J.E., 1993, Hydrology, hydraulics, and geomorphology of the Bonneville flood: Geological Society of America Special Paper 274, 83 p.

Oviatt, C.G., 2015, Chronology of Lake Bonneville, 30,000 to 10,000 yr B.P.: Quaternary Science Reviews, v. 110 (2015), p. 166-171.

Oviatt, C.G., Currey, D.R., and Sack, Dorothy, 1992, Radiocarbon chronology of Lake Bonneville, Eastern Great Basin, USA: Paleogeography, Paleoclimatology, Paleoecology, v. 99, p. 225-241.

Sbar, M.L., Barazangi, M., Dorman, J., Scholz, C.H., and Smith, R.B., 1972, Tectonics of the Intermountain Seismic Belt, western United States--Microearthquake seismicity and composite fault plane solutions: Geological Society of America Bulletin, v. 83, p. 13-28.

Smith, R.B., and Arabasz, W.J., 1991, Seismicity of the Intermountain Seismic Belt, *in* Slemmons, D.B., Engdahl, E.R., Zoback, M.D., and Blackwell, D.D., editors, Neotectonics of North America: Geological Society of America, Decade of North American Geology Map v. 1, p. 185-228.

Smith, R.B. and Sbar, M.L., 1974, Contemporary tectonics and seismicity of the western United States with emphasis on the Intermountain Seismic Belt: Geological Society of America Bulletin, v. 85, p. 1205-1218.

Stewart, J.H., 1978, Basin-range structure in western North America, a review, *in* Smith, R.B., and Eaton, G.P., editors, Cenozoic tectonics and regional geophysics of the western Cordillera: Geological Society of America Memoir 152, p. 341-367.

____, 1980, Geology of Nevada: Nevada Bureau of Mines and Geology Special Publication 4.

Stokes, W.L., 1977, Physiographic subdivisions of Utah: Utah Geological and Mineral Survey Map 43, scale 1:2,400,000.

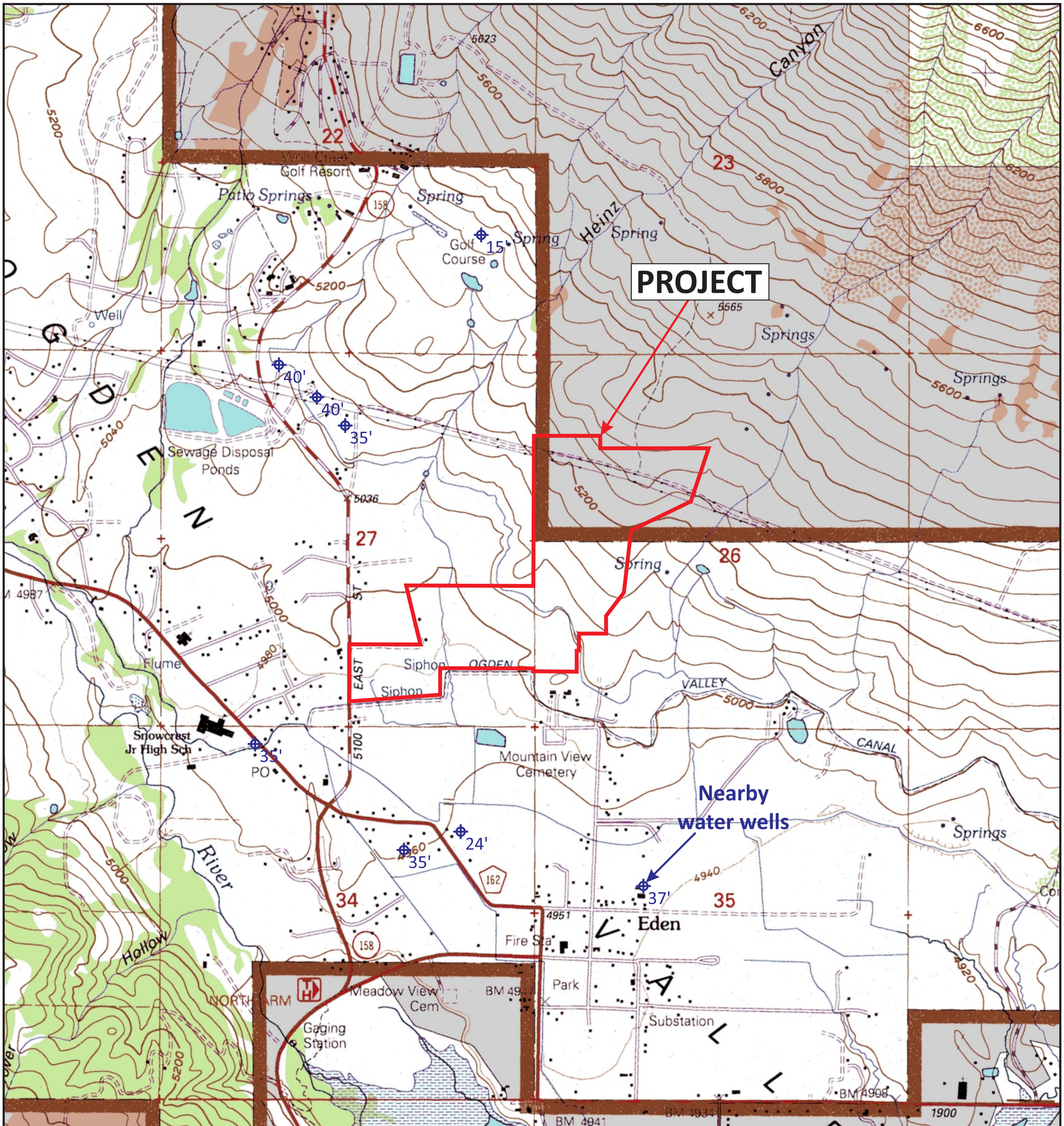
____, 1986, Geology of Utah: Salt Lake City, University of Utah Museum of Natural History and Utah Geological and Mineral Survey, 280 p.

Sullivan, J.T., Nelson, A.R., LaForge, R.C., Wood, C.K., and Hansen, R.A., 1986, Regional seismotectonic study for the back valleys of the Wasatch Mountains in northeastern Utah: Denver, Colorado, U.S. Bureau of Reclamation, Seismotectonic Section, Division of Geology, Engineering and Research Center, unpublished report, 317 p.

Zoback, M.L., 1989. State of stress and modern deformation of the northern Basin and Range province: Journal of Geophysical Research, v. 94, p. 7105-7128.

Zoback, M.L. and Zoback, M.D., 1989. Tectonic stress field of the conterminous United States: Boulder, Colorado, Geological Society of America Memoir, v. 172, p. 523-539.

FIGURES



Source: U.S. Geological Survey 7.5 Minute Series Topographic Maps, Utah - Huntsville, 1998; Project location Sections 26 and 27, Township 7 North, Range 1 East (SLBM).

WESTERN GEOLOGIC

N
W E
S

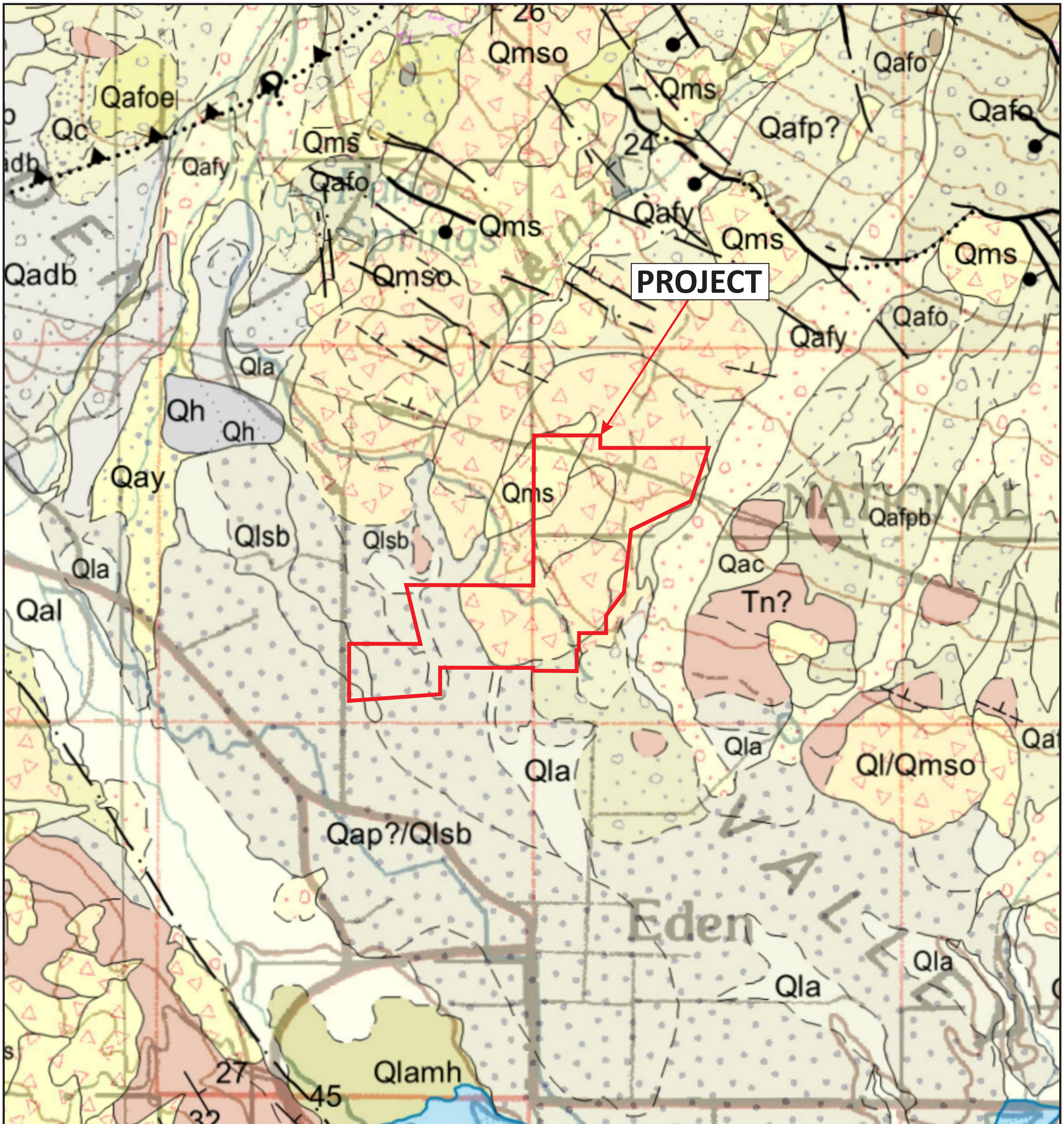
0 1000 2000 feet

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

LOCATION MAP

GEOLOGIC HAZARDS EVALUATION
Proposed Cobabe Ranch Development
About 2720 North 5100 East
Eden, Weber County, Utah

FIGURE 1



Source: Coogan and King (2016), original map scale 1:100,000. See text for explanation of nearby surficial geologic units.

0 1000 2000 feet

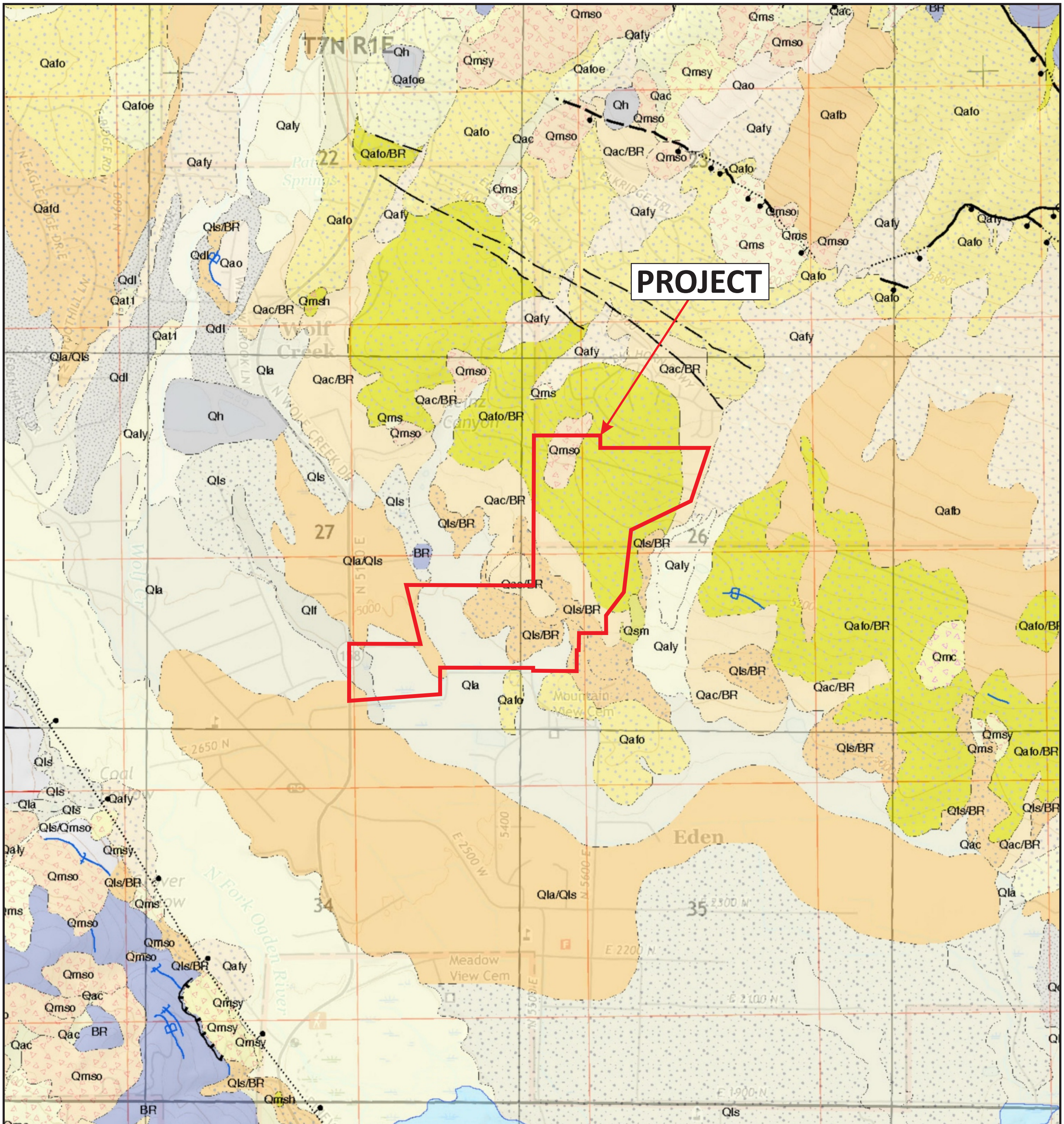
Scale 1:24,000
(1 inch = 2000 feet)

REGIONAL GEOLOGIC MAP

GEOLOGIC HAZARDS EVALUATION

Proposed Cobabe Ranch Development
About 2720 North 5100 East
Eden, Weber County, Utah

FIGURE 2A



Source: McDonald (2020), original map scale 1:24,000. See text for explanation of onsite surficial geologic units.

WESTERN GEOLOGIC

N W E S

0 1000 2000 feet

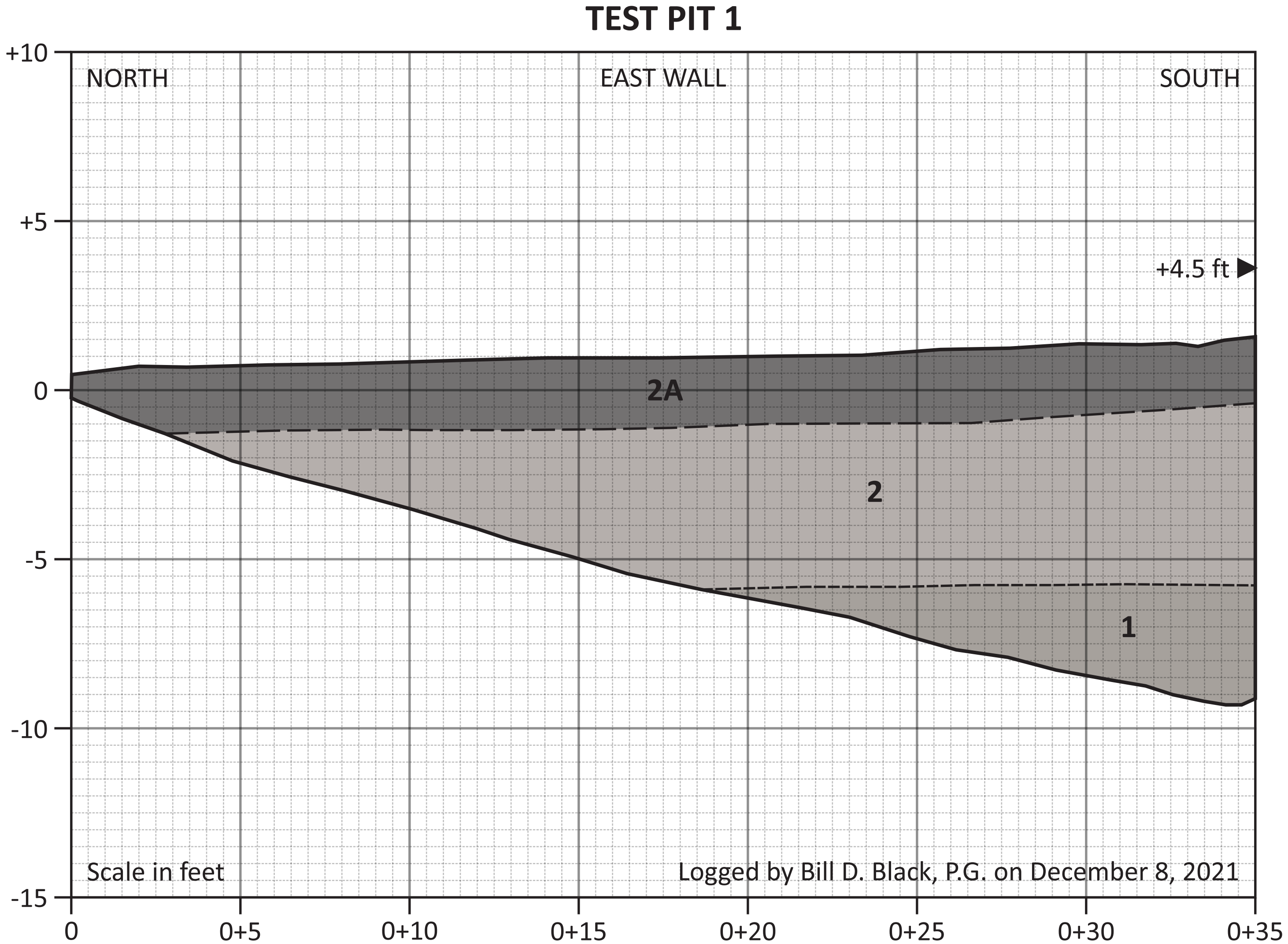
Scale 1:24,000
(1 inch = 2000 feet)

SURFICIAL GEOLOGIC MAP

GEOLOGIC HAZARDS EVALUATION

Proposed Cobabe Ranch Development
About 2720 North 5100 East
Eden, Weber County, Utah

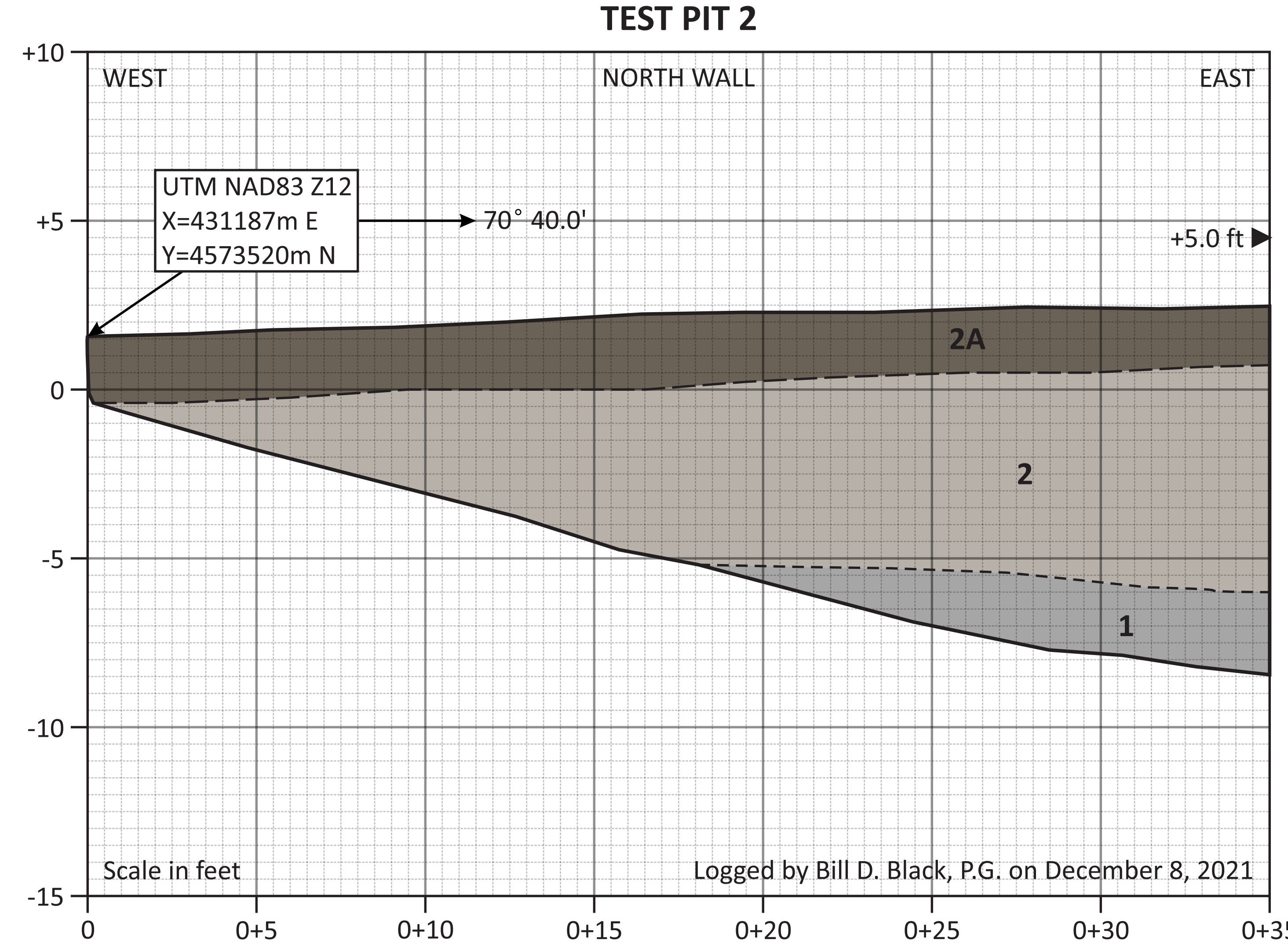
FIGURE 2B



UNIT DESCRIPTIONS

Unit 1. *Upper Pleistocene lacustrine deposits related to Lake Bonneville* - dark grayish-brown, poorly bedded, medium dense to dense, iron-oxide stained, clayey gravel with cobbles grading upward to clayey sand (GC/SC); clasts round to subround with stage II carbonate.

Unit 2. *Holocene alluvium* - brown to dark brown, poorly bedded, dense to stiff, clayey sand to sandy clay with trace gravel (SC/CL); soil A horizon formed in unit (2A).



UNIT DESCRIPTIONS

Unit 1. *Upper Pleistocene lacustrine deposits related to Lake Bonneville* - reddish-brown to dark grayish-brown, poorly bedded, medium dense to dense, iron-oxide stained, clayey gravel with sand (GC).

Unit 2. *Holocene alluvium* - dark brown, poorly bedded to massive, stiff, sandy clay with trace gravel (CL); soil A horizon formed in unit (2A).

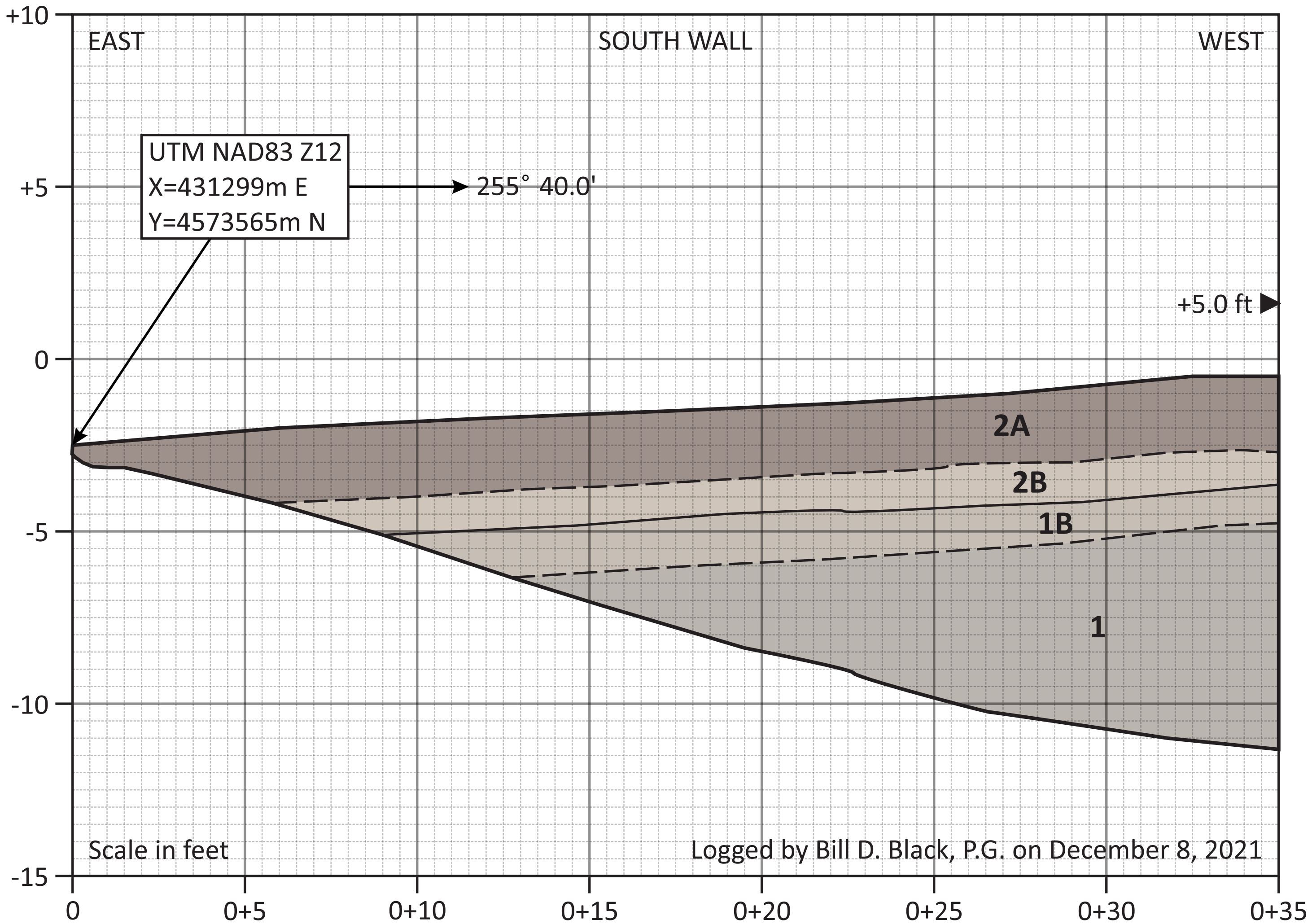
WESTERN GEOLOGIC

TEST PIT LOGS, 1 AND 2

GEOLOGIC HAZARDS EVALUATION
Proposed Cobabe Ranch Development
About 2720 North 5100 East
Eden, Weber County, Utah

FIGURE 3A

TEST PIT 3

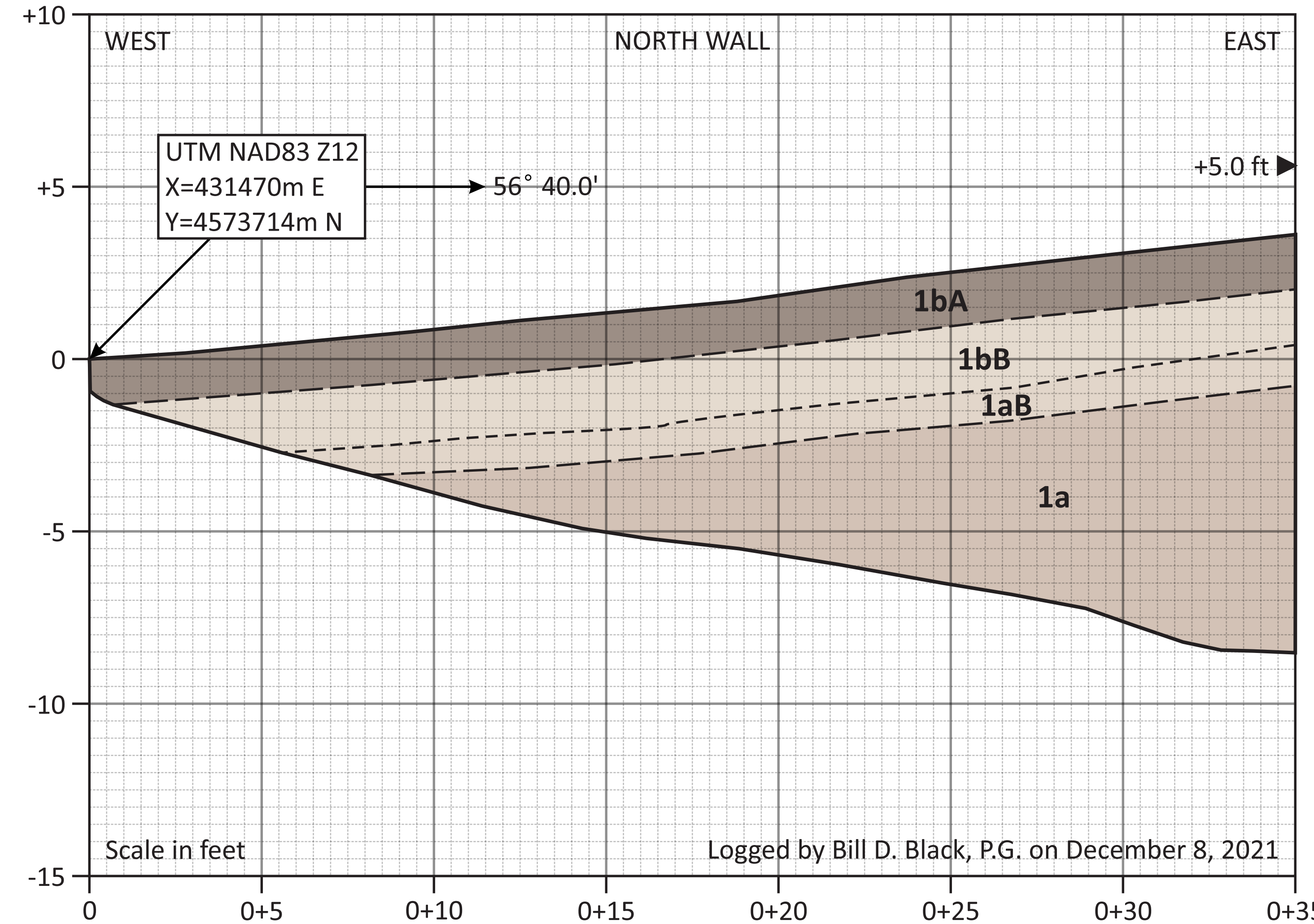


UNIT DESCRIPTIONS

Unit 1. *Upper Pleistocene lacustrine deposits related to Lake Bonneville* - light brown, reddish-brown, and dark brown; well bedded; dense to stiff; clayey sand to sandy clay (SC/CL); soil B horizon formed in unit (1B).

Unit 2. *Upper Pleistocene to Holocene alluvium* - dark brown, massive, stiff, sandy clay with silt (CL); soil A and B horizons formed in unit (2A and 2B).

TEST PIT 4



UNIT DESCRIPTIONS

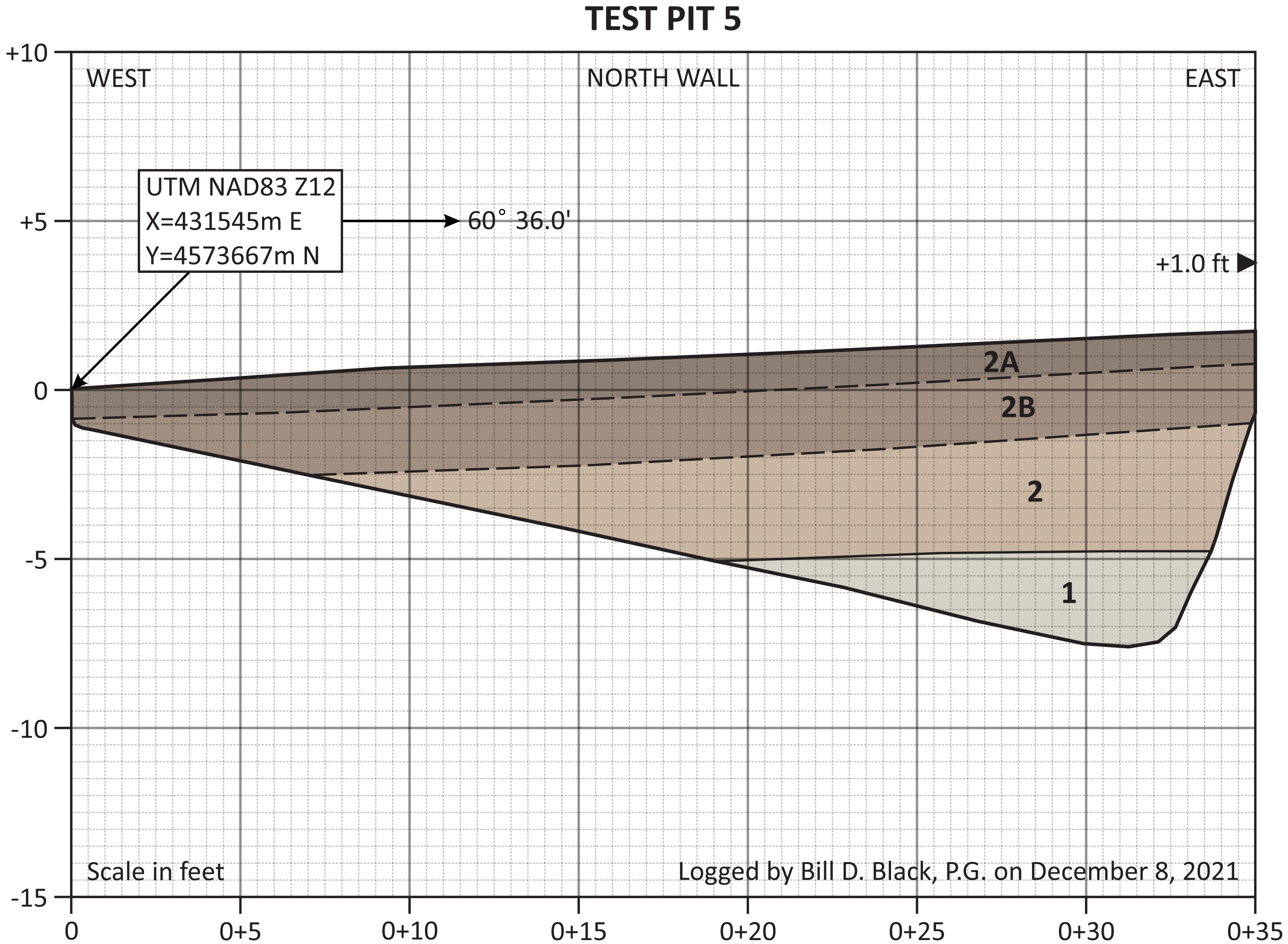
Unit 1. *Upper Pleistocene lacustrine deposits related to Lake Bonneville* - sequence comprised of a lower (1a) brown to reddish-brown, well bedded, dense to medium dense, sand (SW) with thin silt and clay lamina grading upward to sandy clay (CL): and an upper (1b) dark brown, poorly bedded to massive, stiff, silty clay with sand (CL); soil A and B horizons formed in unit (1aB, 1bB and 1bA).

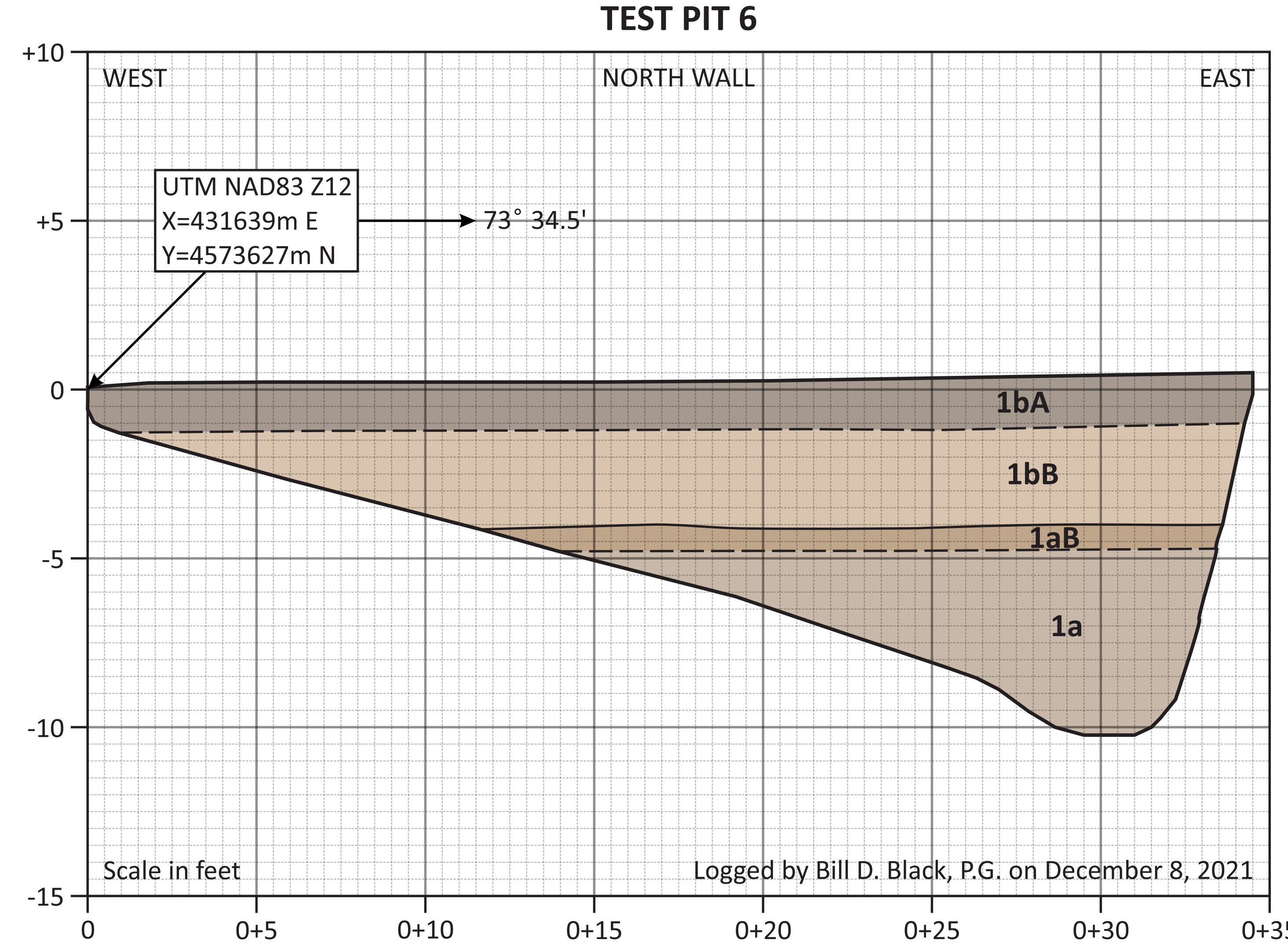
TEST PIT LOGS, 3 AND 4

GEOLOGIC HAZARDS EVALUATION
Proposed Cobabe Ranch Development
About 2720 North 5100 East
Eden, Weber County, Utah

FIGURE 3B

WESTERN GEOLOGIC





UNIT DESCRIPTIONS

Unit 1. *Tertiary Norwood Formation?* - olive to brownish-olive, poorly bedded, strong, weathered siltstone with carbonate nodules; bedding indistinct.

Unit 2. *Upper Pleistocene lacustrine deposits related to Lake Bonneville* - reddish-brown to dark brown, poorly bedded, stiff, sandy clay (CL); soil A and B horizons formed in unit (2A and 2B).

UNIT DESCRIPTIONS

Unit 1. *Upper Pleistocene lacustrine deposits related to Lake Bonneville* - sequence comprised of a lower (1a) light brown to reddish-brown, poorly to well bedded, dense, silty sand to poorly graded fine sand with silt (SM/SP); and an upper (1b) brown, reddish-brown and dark brown, poorly bedded, dense to stiff, clayey sand to sandy clay (SC/CL); soil A and B horizons formed in unit (1aB, 1bB and 1bA).

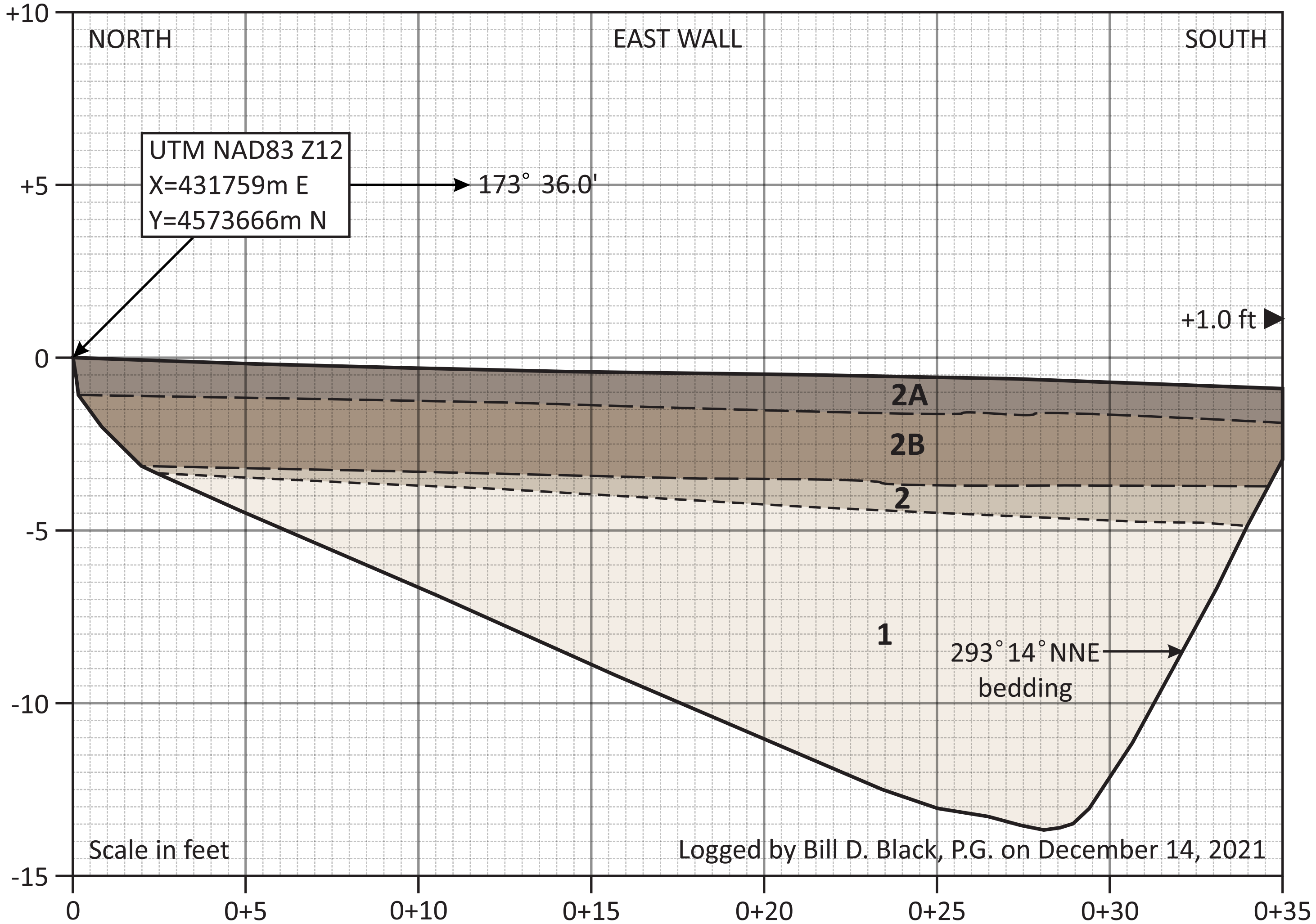
WESTERN GeoLogic

TEST PIT LOGS, 5 AND 6

GEOLOGIC HAZARDS EVALUATION
Proposed Cobabe Ranch Development
About 2720 North 5100 East
Eden, Weber County, Utah

FIGURE 3C

TEST PIT 7

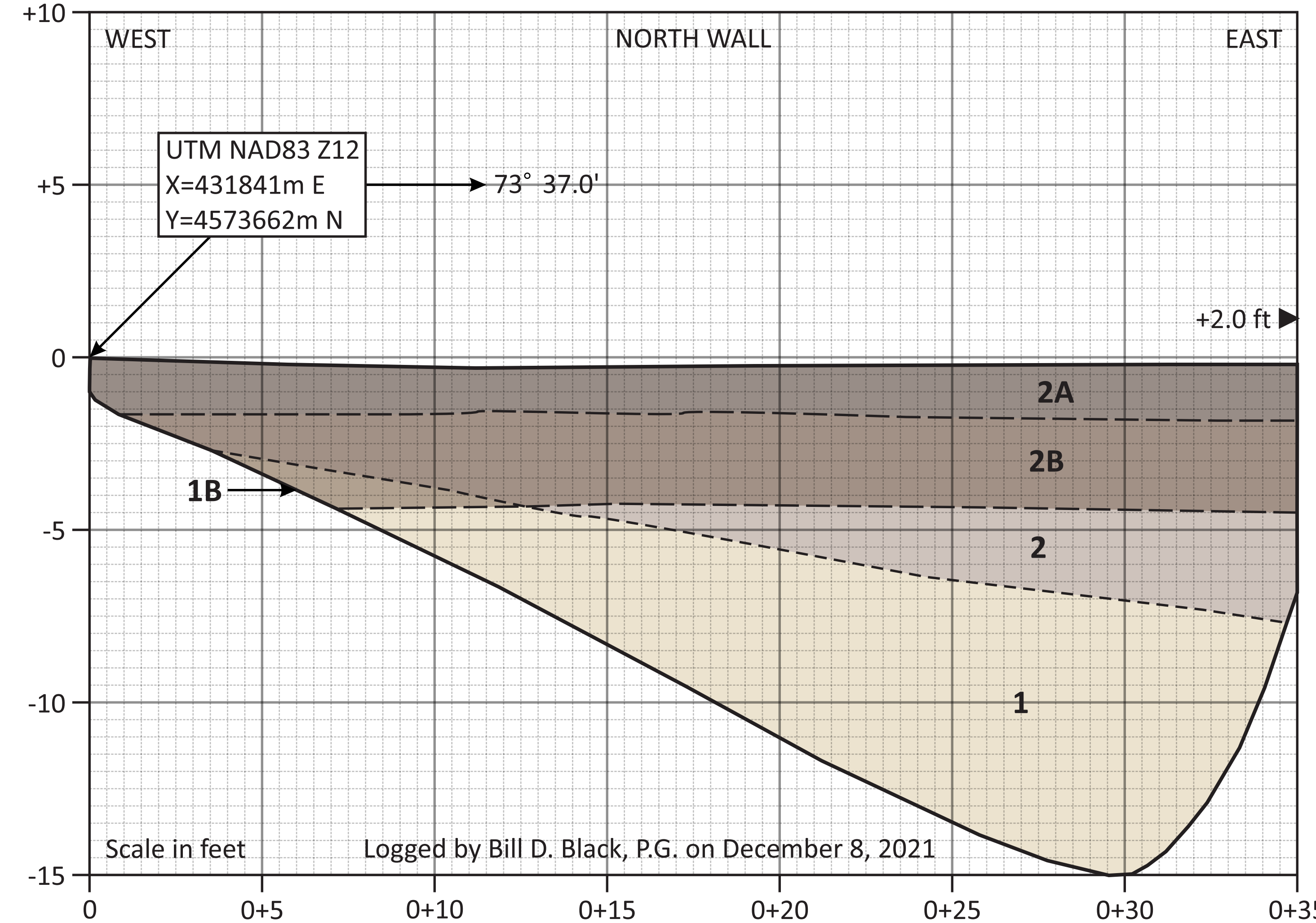


UNIT DESCRIPTIONS

Unit 1. *Tertiary Norwood Formation* - brown to light brown, poorly to well bedded, strong to medium strong, weathered tuffaceous sandstone with 1-2" claystone interbeds and topset carbonate lamina.

Unit 2. *Upper Pleistocene alluvium* - brown to dark brown, medium stiff to dense, massive to poorly bedded, gravelly clay to clayey gravel (CL/GC) with a layer of round to subround cobbles with stage II carbonate at base; soil A and B horizons formed in unit (2A and 2B).

TEST PIT 8



UNIT DESCRIPTIONS

Unit 1. *Tertiary Norwood Formation* - pink to olive, poorly bedded, strong to medium strong, weathered claystone; soil B horizon formed in unit (1B).

Unit 2. *Upper Pleistocene alluvial fan deposits* - olive-gray, brown and dark grayish-brown, massive, stiff, sandy lean clay to clayey gravel with sand (CL/GC); contains subround to subangular cobbles and boulders up to 36" across with stage II carbonate; soil A and B horizons formed in unit (2A and 2B); 2.5 to 7.5 feet thick in exposure.

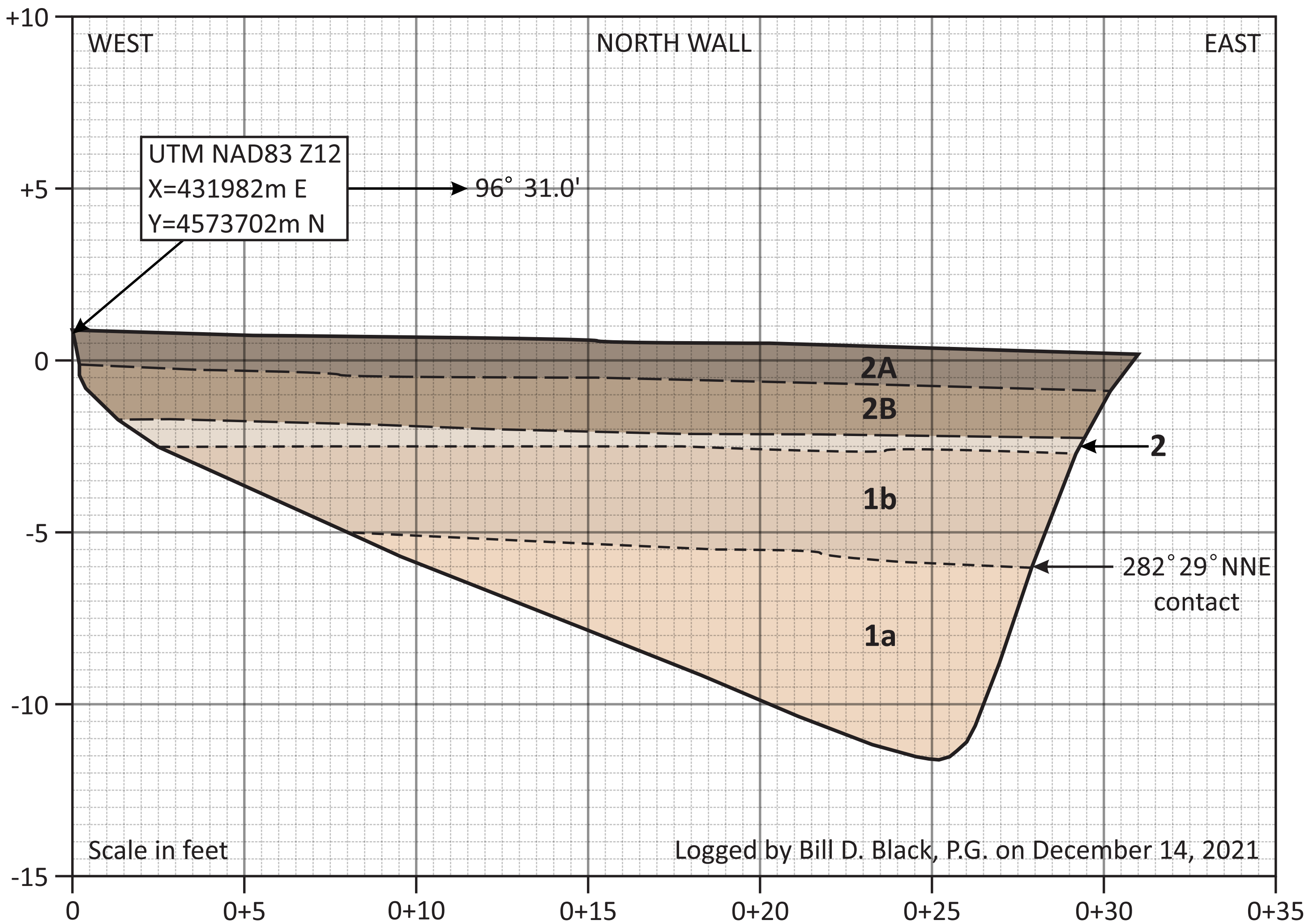
WESTERN GEOLOGIC

TEST PIT LOGS, 7 AND 8

GEOLOGIC HAZARDS EVALUATION
Proposed Cobabe Ranch Development
About 2720 North 5100 East
Eden, Weber County, Utah

FIGURE 3D

TEST PIT 9

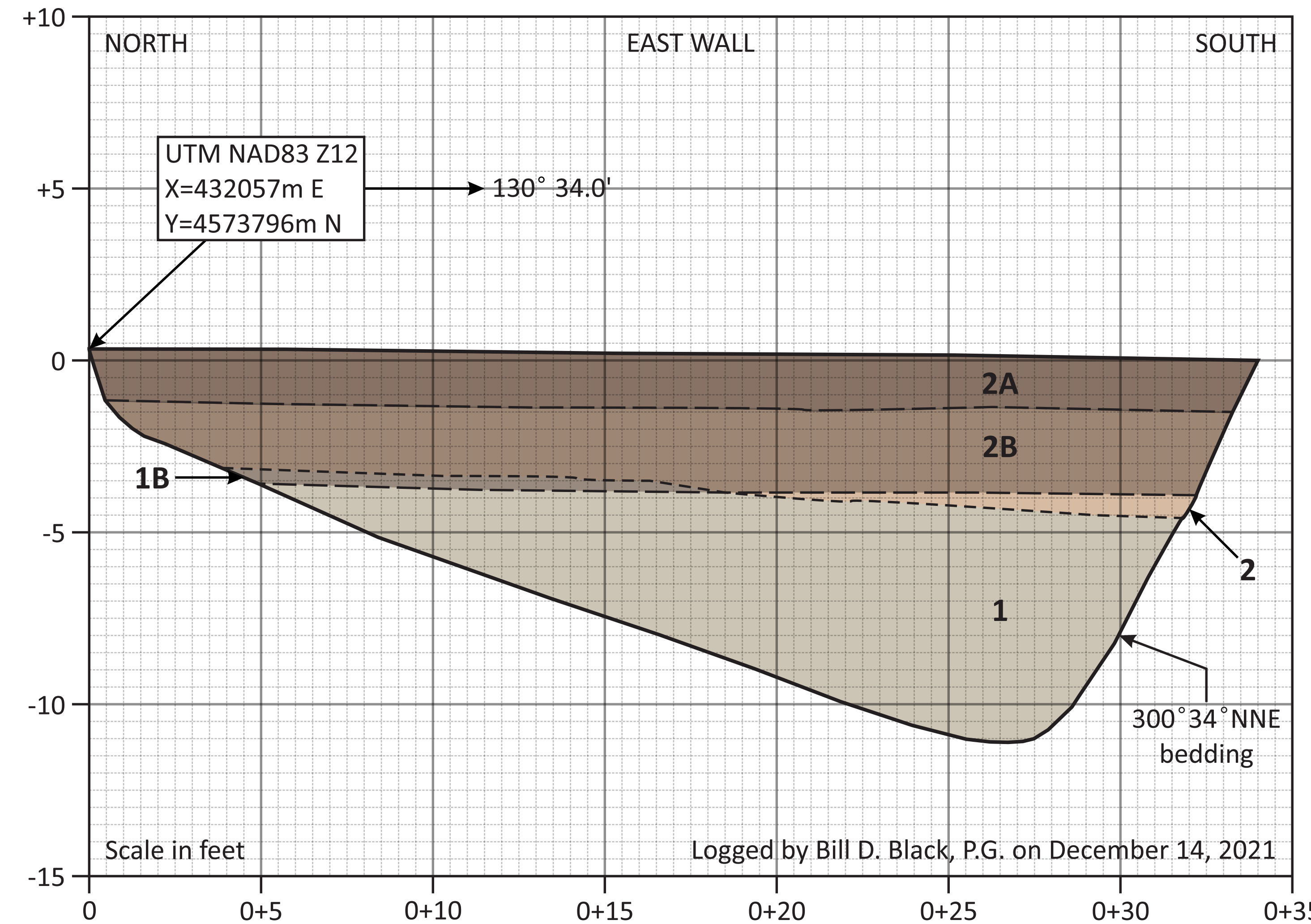


UNIT DESCRIPTIONS

Unit 1. *Tertiary Norwood Formation* - sequence comprised of a lower (1a) light reddish-brown, poorly bedded to massive, strong, weathered tuffaceous sandstone; and an upper (1b) brown to dark reddish-brown, massive, strong, weathered tuffaceous conglomerate.

Unit 2. *Upper Pleistocene alluvial fan deposits* - dark brown, massive, medium stiff to dense, sandy clay to clayey sand (CL/SC) with trace gravel and subangular to subround cobbles with stage II carbonate; soil A and B horizons formed in unit (2A and 2B); about 3.0 feet thick in exposure.

TEST PIT 10



UNIT DESCRIPTIONS

Unit 1. *Tertiary Norwood Formation* - olive to reddish-brown, poorly to well bedded, medium strong, weathered, interbedded tuffaceous sandstone and claystone; soil B horizon formed in unit (1B).

Unit 2. *Upper Pleistocene alluvial fan deposits* - brownish-red to dark brown, massive, medium dense to dense, clayey gravel (GC) with subangular to subround cobbles with stage II carbonate; soil A and B horizons formed in unit (2A and 2B); 3.5 to 4.5 feet thick in exposure.

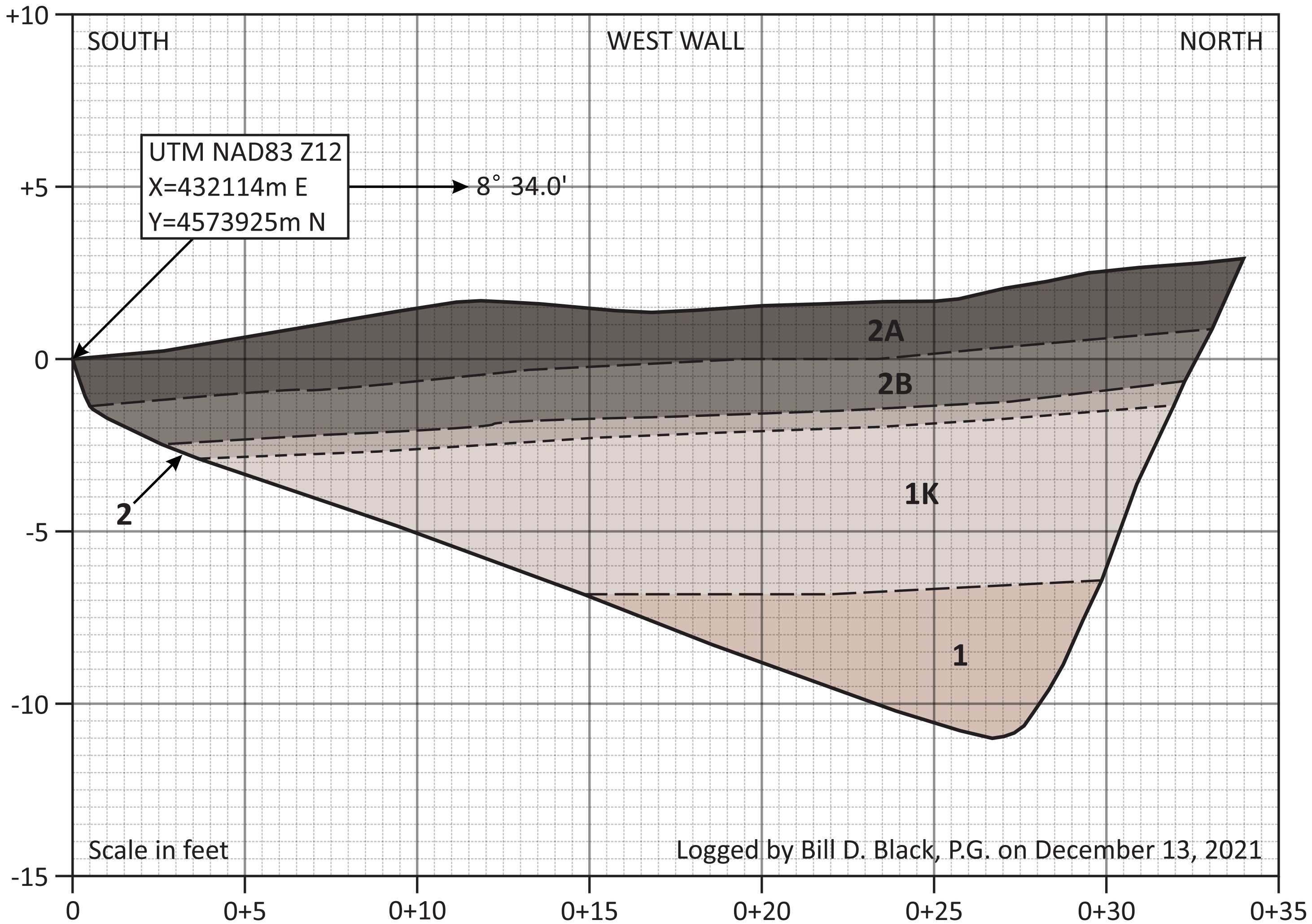
WESTERN GEOLOGIC

TEST PIT LOGS, 9 AND 10

GEOLOGIC HAZARDS EVALUATION
Proposed Cobabe Ranch Development
About 2720 North 5100 East
Eden, Weber County, Utah

FIGURE 3E

TEST PIT 11

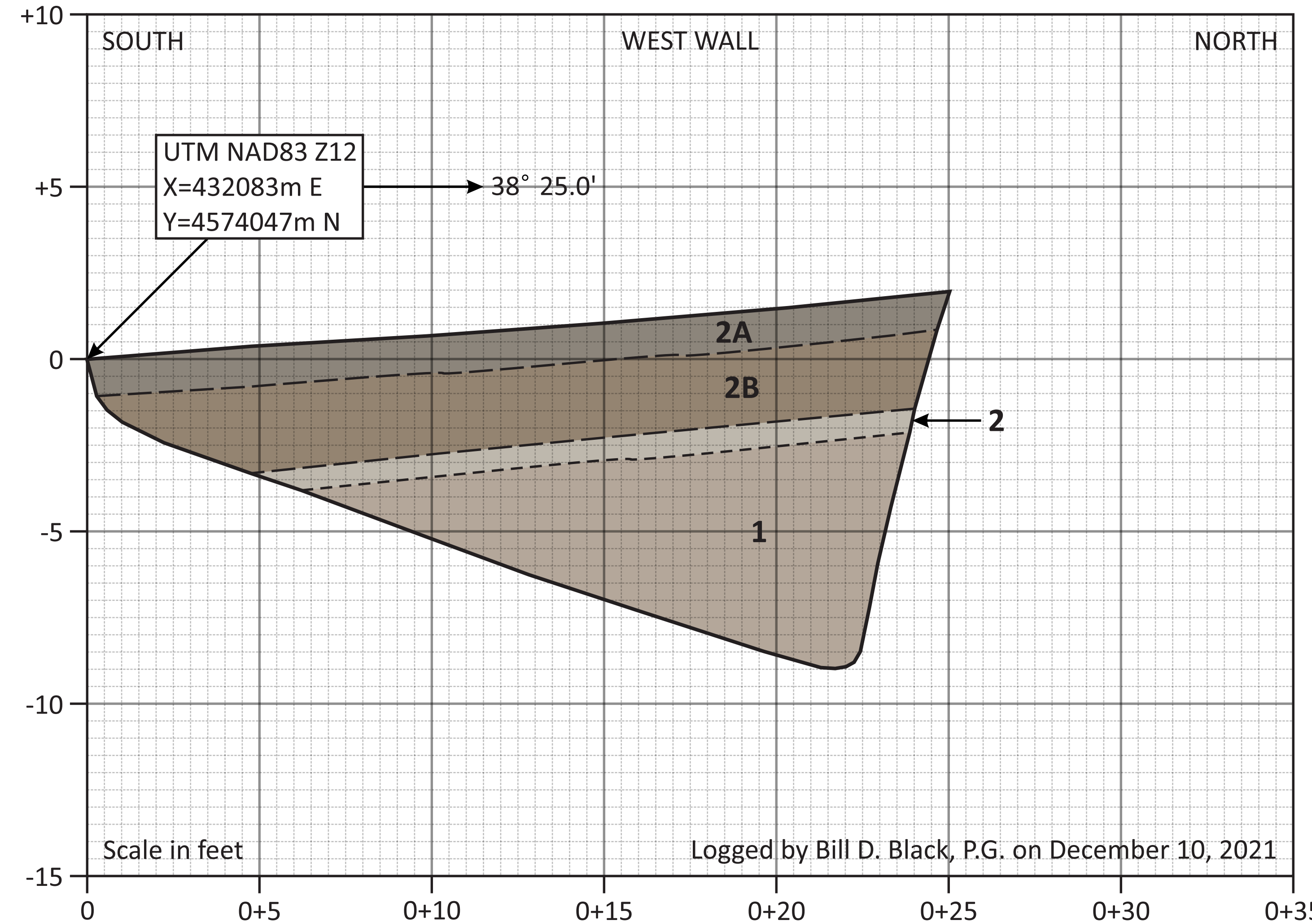


UNIT DESCRIPTIONS

Unit 1. *Tertiary Norwood Formation?* - reddish-brown to white, massive, medium strong to strong, carbonate-enriched, weathered tuffaceous conglomerate; soil K horizon formed in unit (1K).

Unit 2. *Upper Pleistocene alluvial fan deposits* - dark brown, massive, dense, clayey gravel (GC) with subangular to subround cobbles and trace boulders with stage II carbonate; soil A and B horizons formed in unit (2A and 2B); 3.5 to 3.0 feet thick in exposure.

TEST PIT 12



UNIT DESCRIPTIONS

Unit 1. *Tertiary Norwood Formation?* - brownish-red to light brown, massive, medium strong to strong, weathered tuffaceous conglomerate; stage III+ carbonate in upper part of unit.

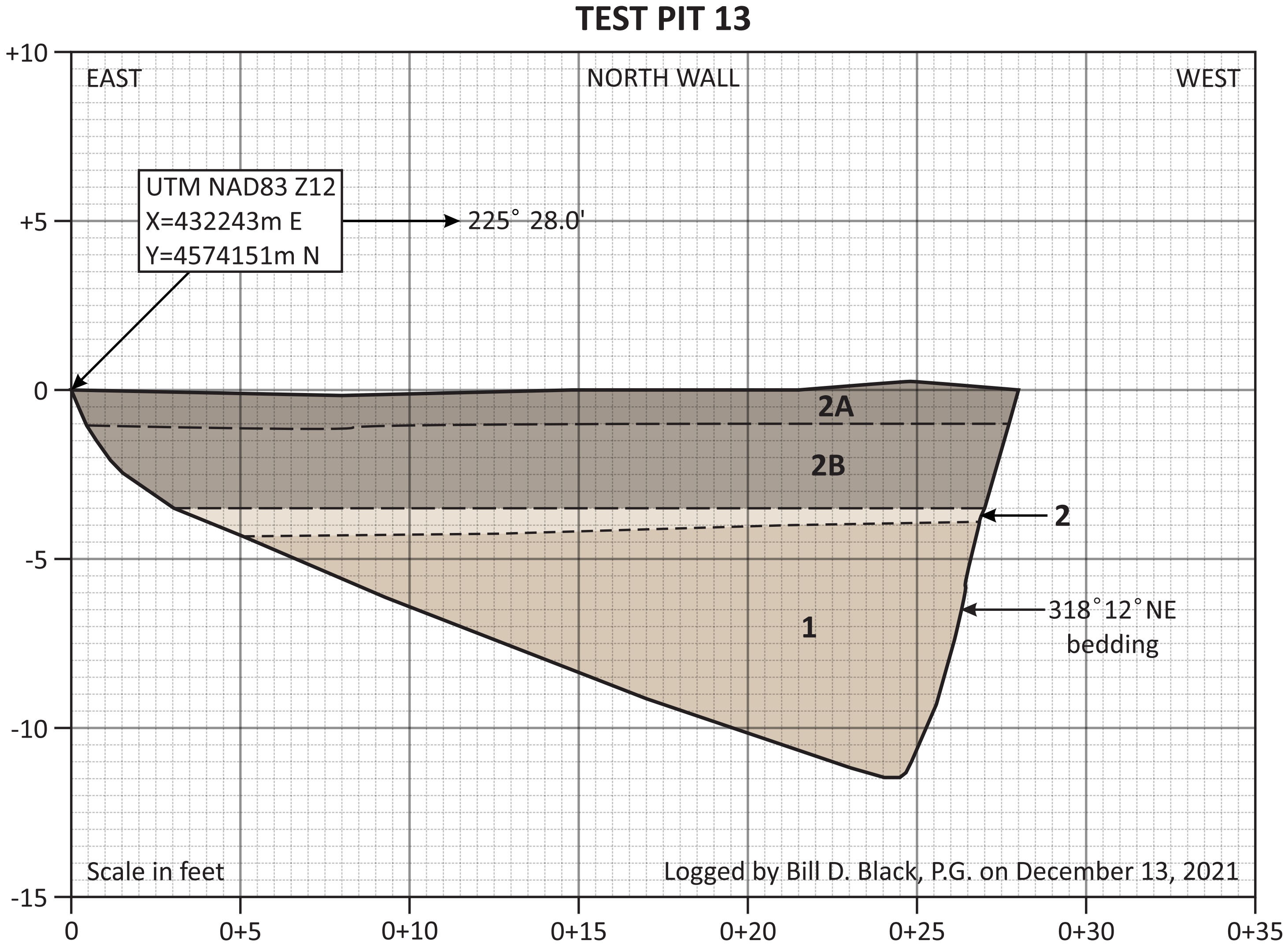
Unit 2. *Upper Pleistocene alluvial fan deposits* - grayish-olive to dark grayish-brown, massive, dense to stiff, clayey gravel to gravelly clay (GC/CL) with subangular to subround cobbles and boulders up to 2.5 feet with stage II carbonate; soil A and B horizons formed in unit (2A and 2B); about 4.0 feet thick.

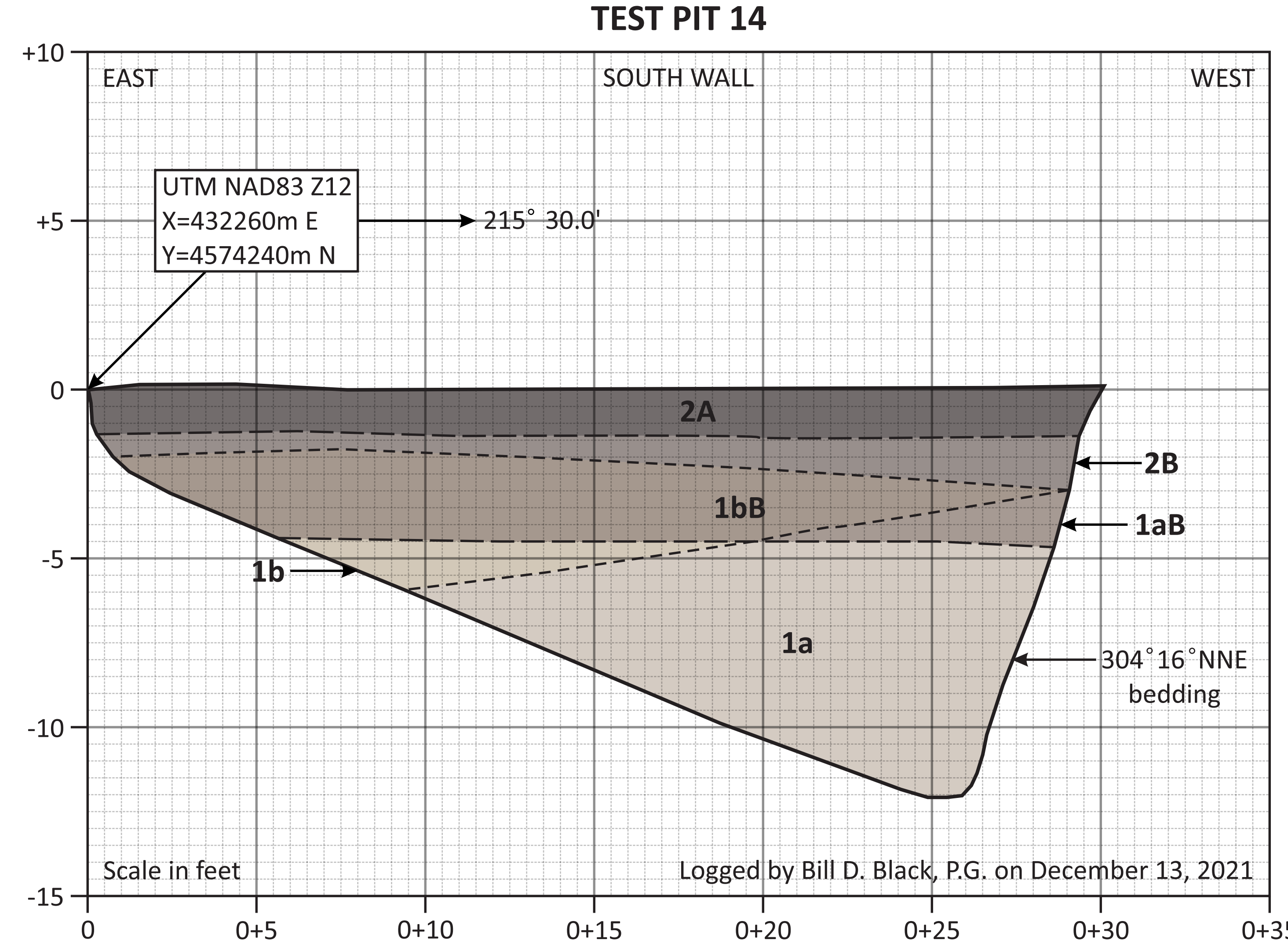
WESTERN GEOLOGIC

TEST PIT LOGS, 11 AND 12

GEOLOGIC HAZARDS EVALUATION
Proposed Cobabe Ranch Development
About 2720 North 5100 East
Eden, Weber County, Utah

FIGURE 3F





UNIT DESCRIPTIONS

Unit 1. *Tertiary Norwood Formation* - light reddish-brown, well bedded, medium strong, weathered tuffaceous sandstone to siltstone with claystone interbeds up to 3" thick.

Unit 2. *Upper Pleistocene alluvial fan deposits* - dark brown to dark grayish-brown, massive, stiff, lean clay (CL) with sand and gravel; soil A and B horizons formed in unit (2A and 2B); 4.0 to 4.5 feet thick in exposure.

UNIT DESCRIPTIONS

Unit 1. *Tertiary Norwood Formation* - sequence comprised of a lower (1a) light brown, poorly to well bedded, medium strong, weathered tuffaceous sandstone to siltstone with claystone interbeds up to 2" thick; and an upper (1b) yellowish-brown to brown, poorly bedded, medium strong, weathered claystone; soil B horizon formed in unit (1aB and 1bB).

Unit 2. *Upper Pleistocene alluvial fan deposits* - dark brown to dark grayish-brown, massive, dense, clayey gravel (GC) with sand and subangular to subround cobbles and small boulders with stage II carbonate; soil A and B horizons formed in unit (2A and 2B); 2.0 to 3.0 feet thick in exposure.

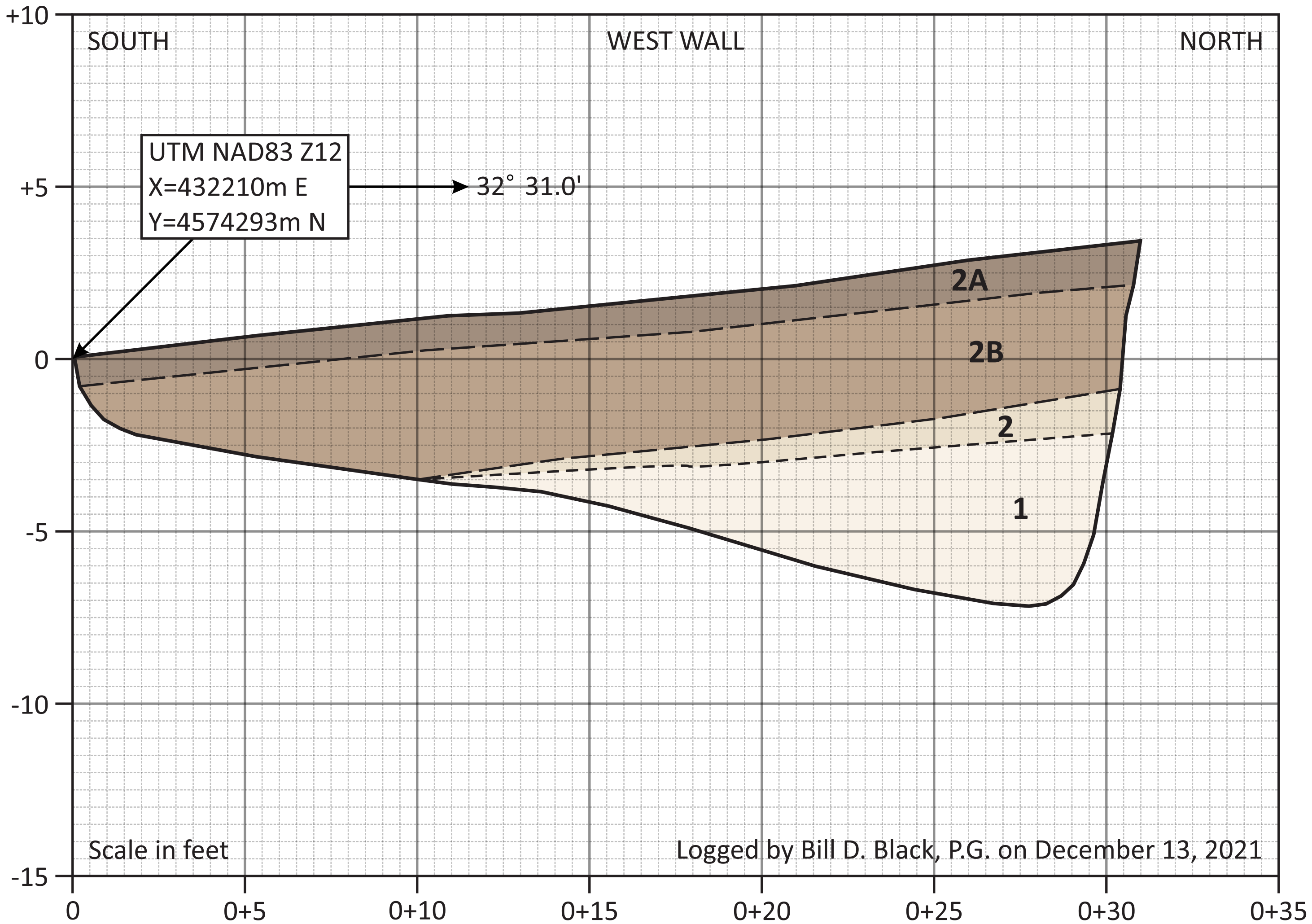
WESTERN GEOLOGIC

TEST PIT LOGS, 13 AND 14

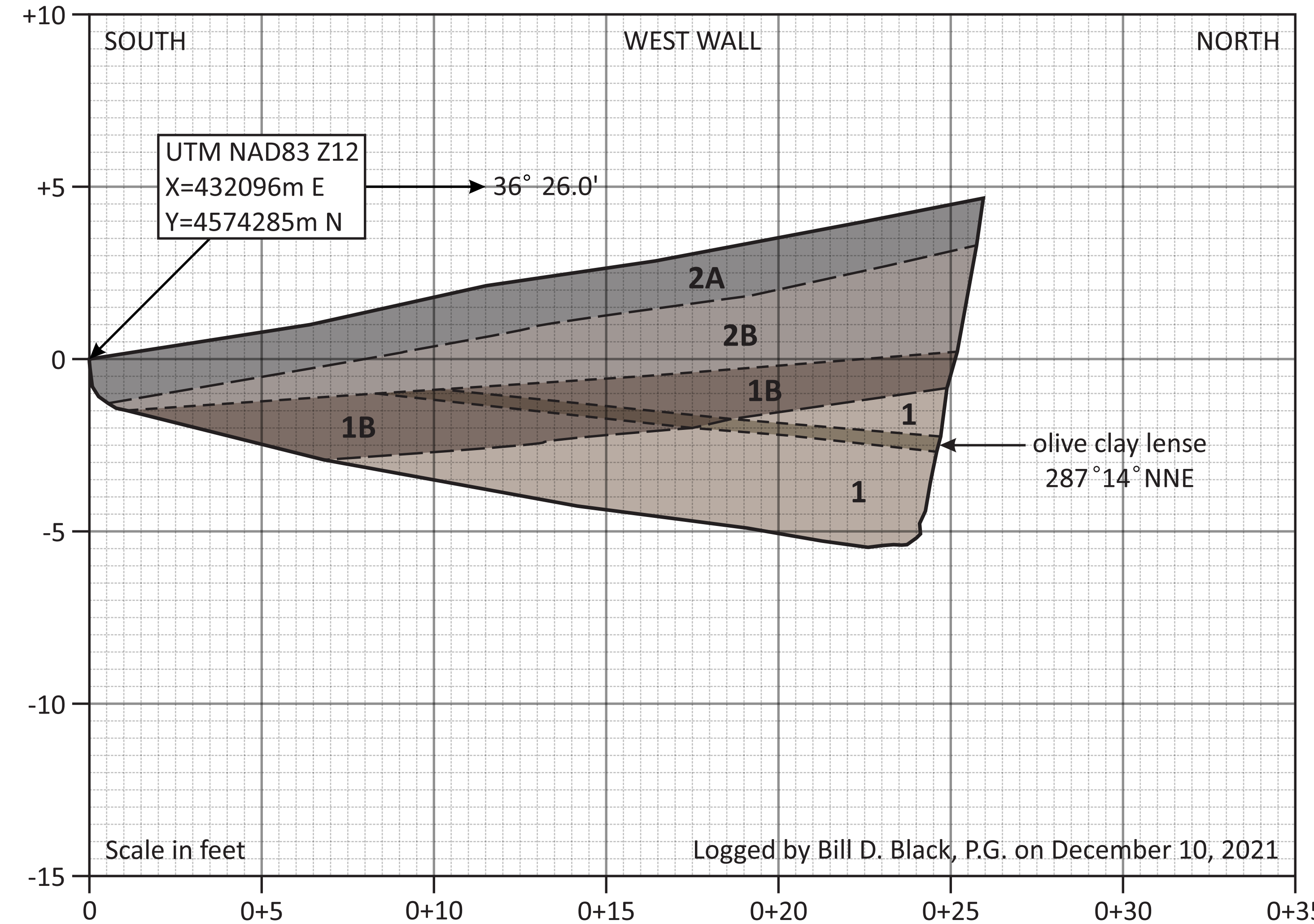
GEOLOGIC HAZARDS EVALUATION
Proposed Cobabe Ranch Development
About 2720 North 5100 East
Eden, Weber County, Utah

FIGURE 3G

TEST PIT 15



TEST PIT 16



UNIT DESCRIPTIONS

Unit 1. *Tertiary Norwood Formation* - light brown, poorly bedded to massive, strong, weathered tuffaceous conglomerate with olive lean clay lamina.

Unit 2. *Upper Pleistocene alluvial fan deposits* - olive-brown to dark brown, massive, medium dense to dense, clayey gravel to clayey sand (GC/SC) with sand and subangular to subround cobbles with stage II carbonate; soil A and B horizons formed in unit (2A and 2B); 4.5 to 5.5 feet thick in exposure.

UNIT DESCRIPTIONS

Unit 1. *Tertiary Norwood Formation* - brown, light brown and light reddish-brown; well bedded; stiff; weathered siltstone with olive claystone interbeds; soil B horizon formed in unit (1B).

Unit 2. *Upper Pleistocene alluvial fan deposits* - dark grayish-olive to dark grayish-brown, massive, dense, clayey gravel (GC) with subangular cobbles and boulders up to 24" with stage II carbonate; soil A and B horizons formed in unit (2A and 2B); 1.5 to 4.5 feet thick in exposure.

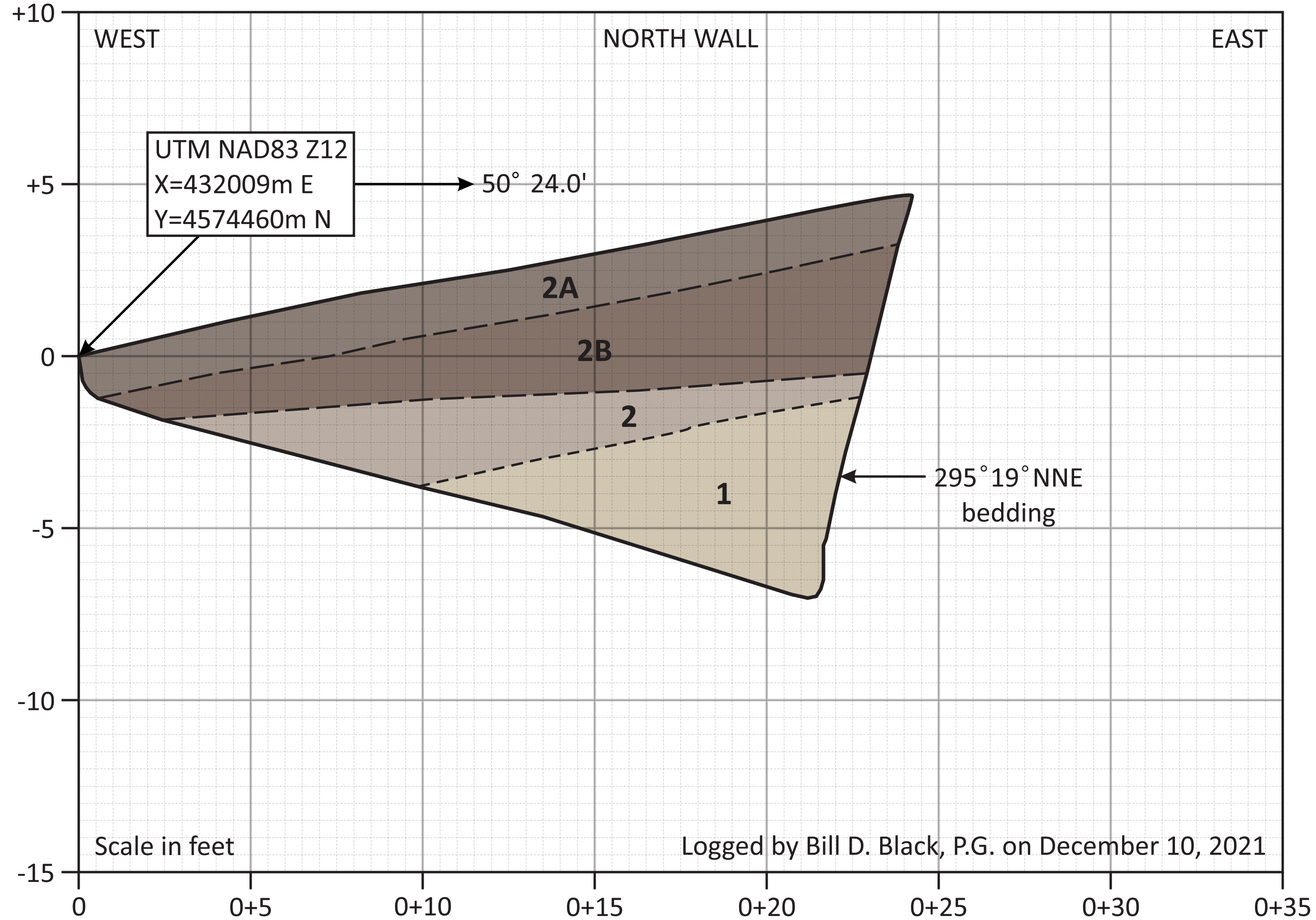
WESTERN GeoLogic

TEST PIT LOGS, 15 AND 16

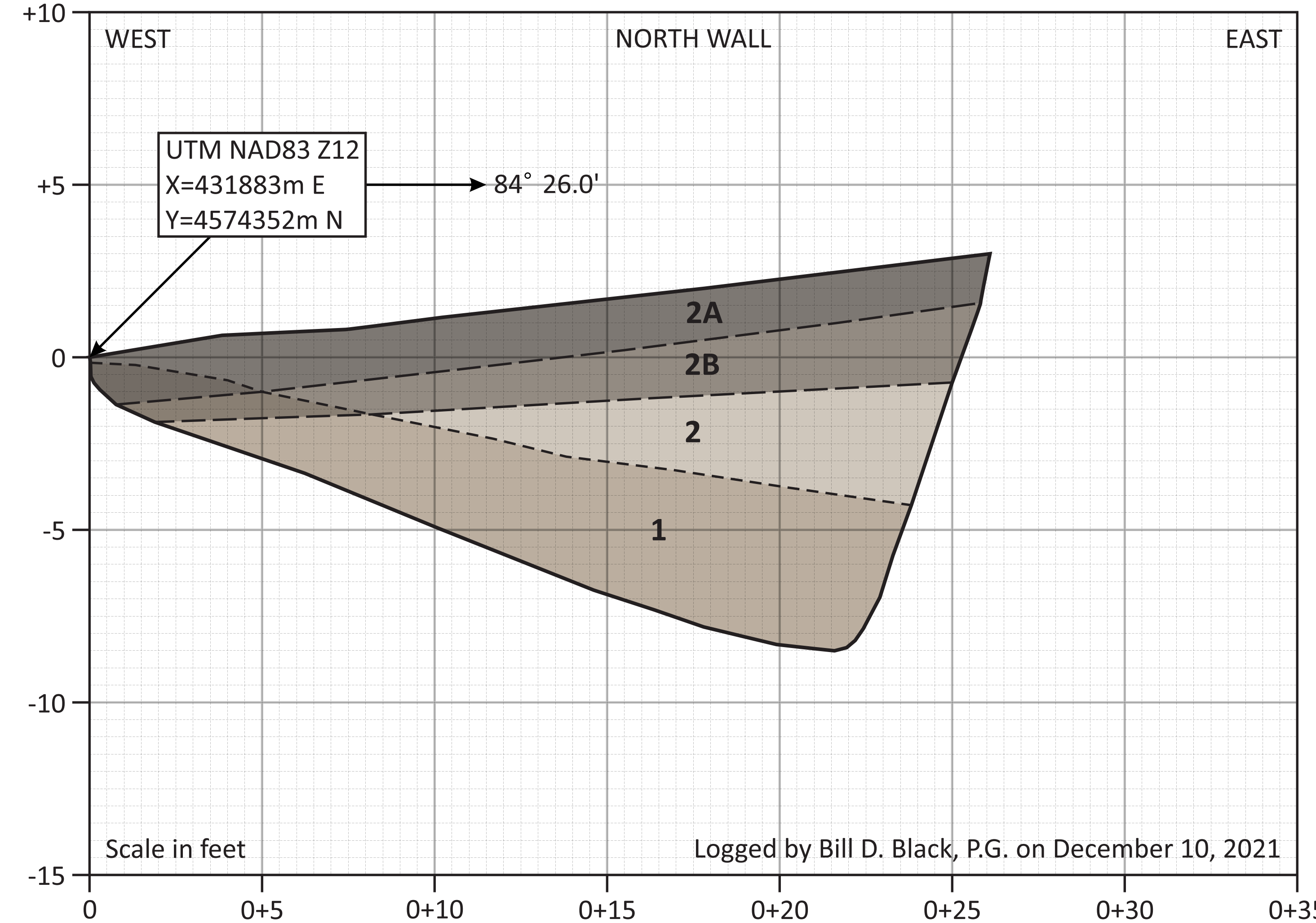
GEOLOGIC HAZARDS EVALUATION
Proposed Cobabe Ranch Development
About 2720 North 5100 East
Eden, Weber County, Utah

FIGURE 3H

TEST PIT 17



TEST PIT 18



UNIT DESCRIPTIONS (Test Pit 17)

Unit 1. *Tertiary Norwood Formation* - light brown, well bedded, stiff to very stiff, weathered claystone with thin clayey sand lamina.

Unit 2. *Upper Pleistocene alluvial fan deposits* - brown, olive-brown and dark grayish-brown; massive, stiff to dense, gravelly clay to clayey gravel (CL/GC) with subround to subangular cobbles and boulders with stage II carbonate; soil A and B horizons formed in unit (2A and 2B); about 5.5 feet thick.

UNIT DESCRIPTIONS (Test Pit 18)

Unit 1. *Middle to Upper Pleistocene mass wasting colluvium* - reddish-brown, massive, dense, clayey gravel with sand (GC) and subangular to subround cobbles with stage II carbonate, trace small boulders; soil A and B horizons formed in unit (1A and 1B); 4.5+ feet thick in exposure.

Unit 2. *Upper Pleistocene mass wasting colluvium* - grayish-olive, olive-brown and dark grayish-brown; massive; stiff to dense; gravelly clay to clayey gravel (CL/GC) with sand and subangular to subround cobbles with stage II carbonate; soil A and B horizons formed in unit (2A and 2B); 0 to more than 7.0 feet thick in exposure, thickening eastward.

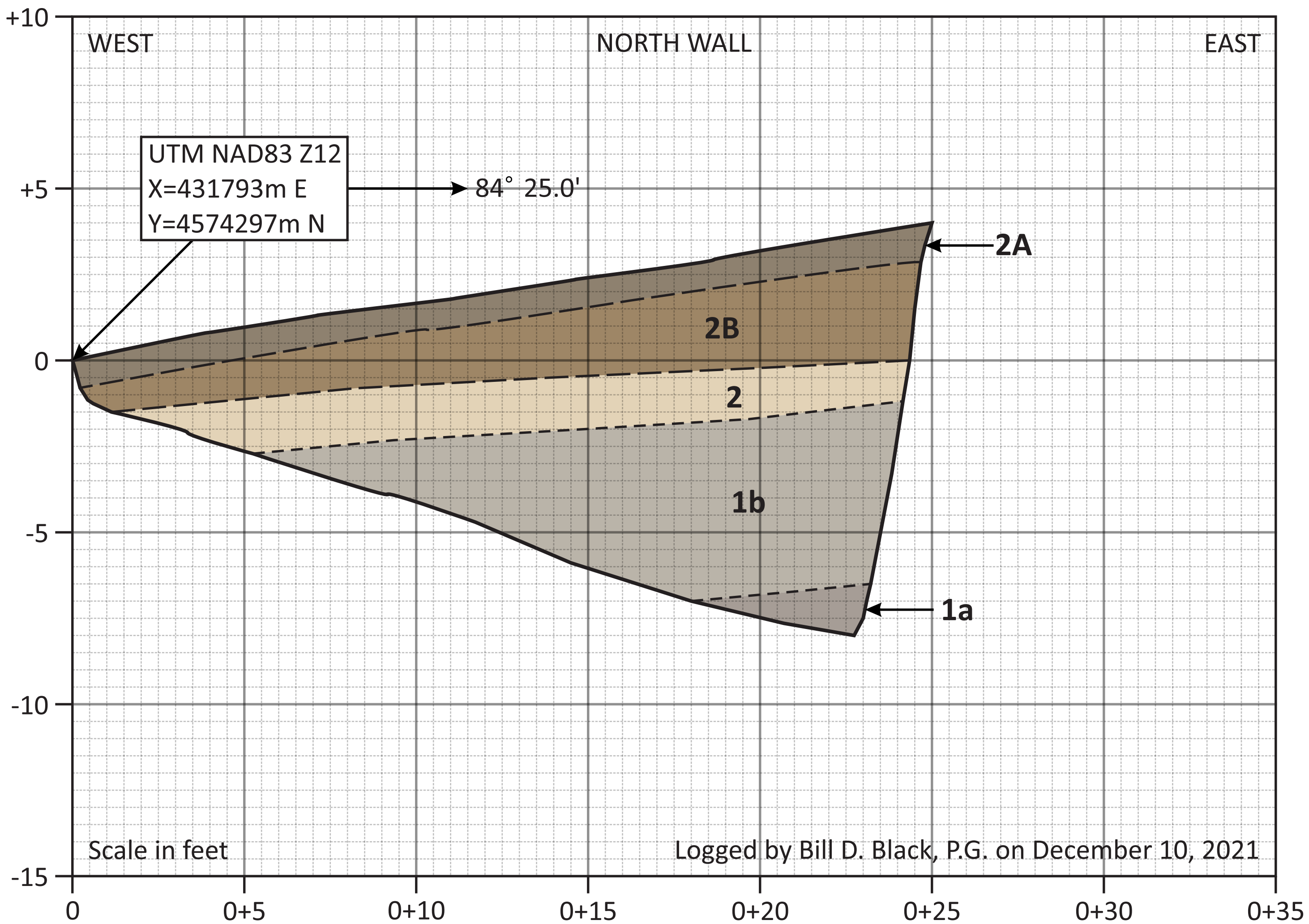
WESTERN GEOLOGIC

TEST PIT LOGS, 17 AND 18

GEOLOGIC HAZARDS EVALUATION
Proposed Cobabe Ranch Development
About 2720 North 5100 East
Eden, Weber County, Utah

FIGURE 3I

TEST PIT 19

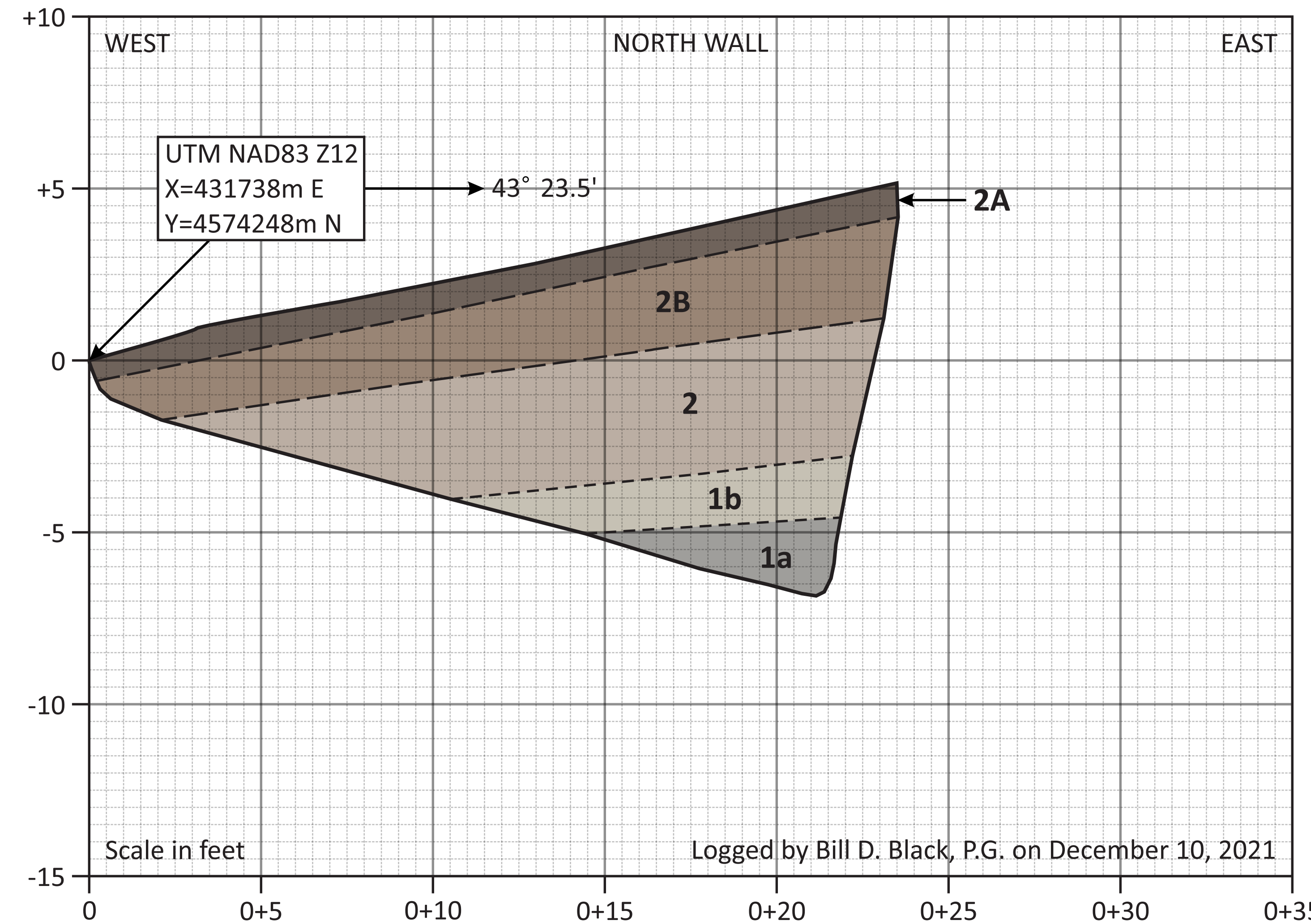


UNIT DESCRIPTIONS

Unit 1. *Middle to Upper Pleistocene mass wasting colluvium* - sequence comprised of a lower (1a) olive-brown, massive, stiff to very stiff, lean clay (CL) and an upper (1b) light brown, olive-brown and reddish-brown, massive, stiff, clayey silt to silty clay (ML/CL) with sand, trace gravel, siltstone and carbonate-rich claystone blocks; more than 5.5 feet thick in exposure.

Unit 2. *Upper Pleistocene mass wasting colluvium* - brown to dark brown, massive, stiff to dense, clay with gravel to clayey gravel (CL/GC) with subround to subangular cobbles in upper part with stage II carbonate; soil A and B horizons formed in unit (2A and 2B); 3.5 to 5.0 feet thick.

TEST PIT 20



UNIT DESCRIPTIONS

Unit 1. *Middle to Upper Pleistocene mass wasting colluvium* - sequence comprised of a lower (1a) olive, poorly bedded, very stiff, sandy clay (CL) with contorted bedding and topset carbonate; and an upper (1b) olive-brown to reddish-brown, massive, stiff, clayey gravel (GC) with subround to subangular cobbles with stage II carbonate; more than 3.5 feet thick in exposure.

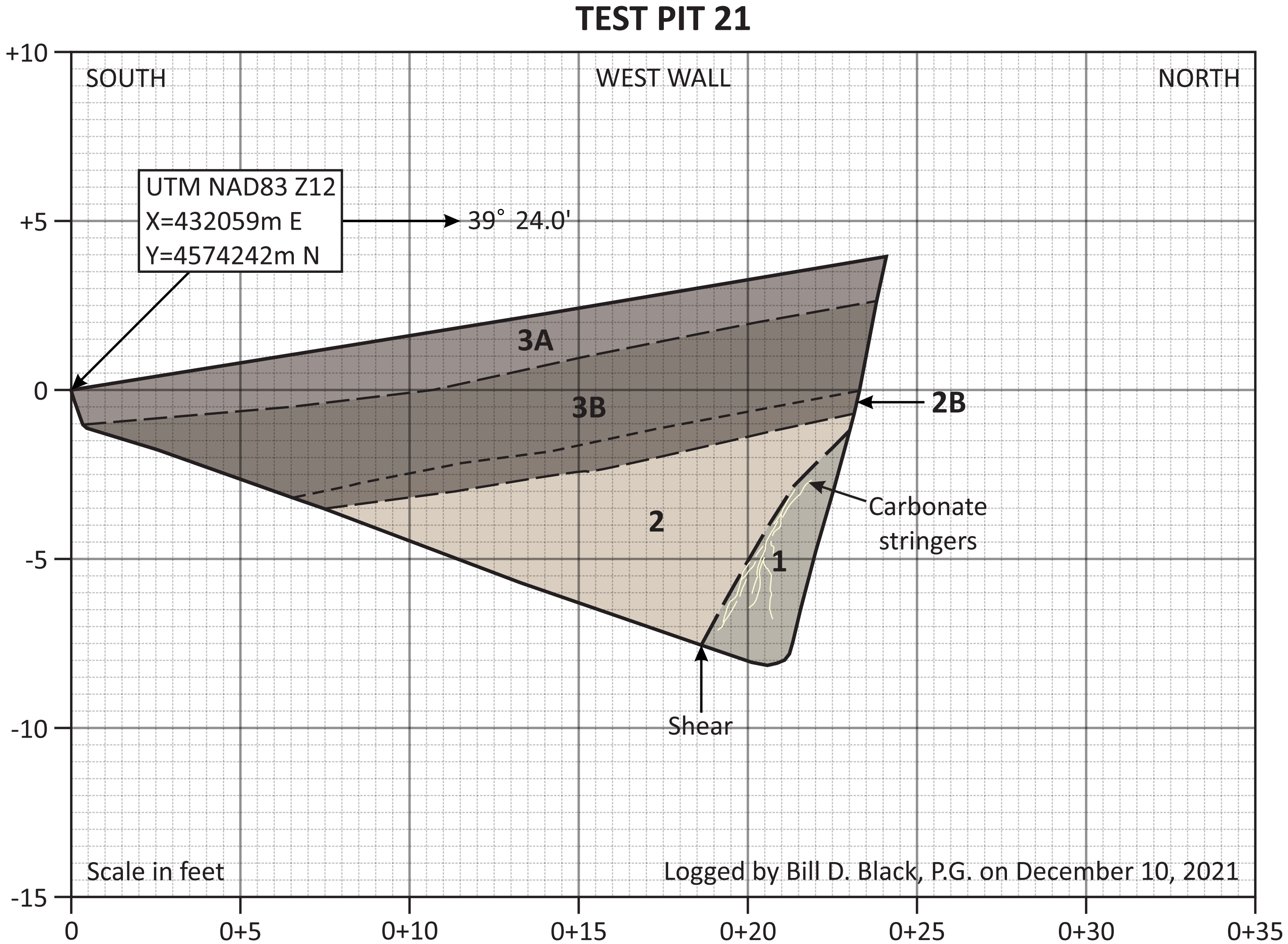
Unit 2. *Upper Pleistocene mass wasting colluvium* - brown to dark brown, massive, stiff, sandy clay (CL) with gravel, subround to subangular cobbles in upper part with stage II carbonate, and blocks of olive clay in upper part; soil A and B horizons formed in unit (2A and 2B); 6.5 to 7.5 feet thick.

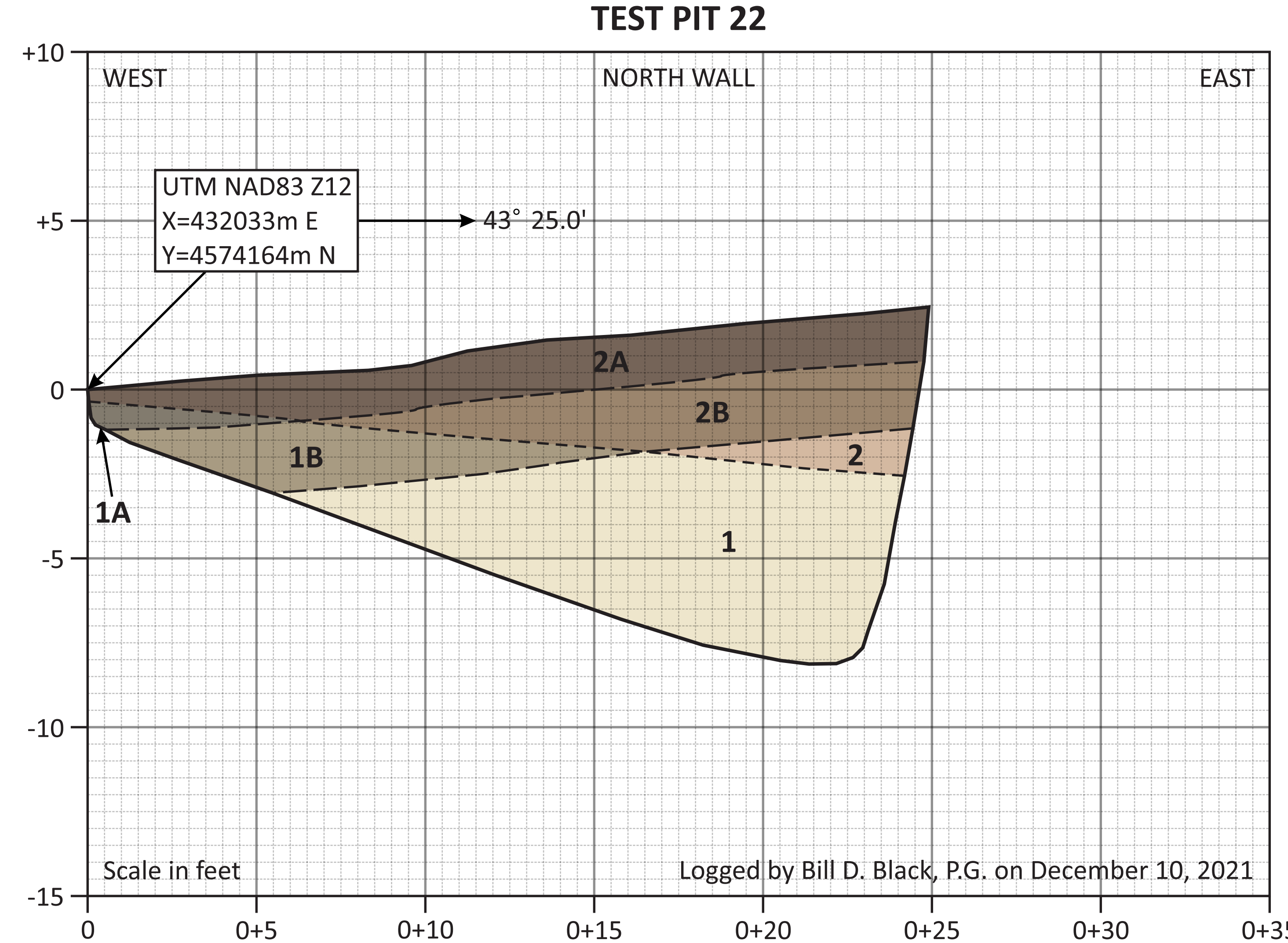
WESTERN GEOLOGIC

TEST PIT LOGS, 19 AND 20

GEOLOGIC HAZARDS EVALUATION
Proposed Cobabe Ranch Development
About 2720 North 5100 East
Eden, Weber County, Utah

FIGURE 3J





UNIT DESCRIPTIONS

Unit 1. *Tertiary Norwood Formation* - olive, poorly bedded to massive, stiff, highly weathered claystone with carbonate stringers and nodules.

Unit 2. *Middle to Upper Pleistocene mass wasting colluvium* - light reddish-brown; massive; dense, clayey gravel with sand (GC) and subangular to subround cobbles and boulders with stage II carbonate; soil B horizon formed in unit (2B); more than 6.5 feet thick in exposure.

Unit 3. *Upper Pleistocene alluvial fan deposits* - dark grayish-olive to dark grayish-brown, massive, dense to stiff, clayey gravel to gravelly clay (GC/CL) with subangular to subround cobbles and boulders up to 24" with stage II carbonate; soil A and B horizons formed in unit (3A and 3B); 4.0 feet thick.

UNIT DESCRIPTIONS

Unit 1. *Middle to Upper Pleistocene mass wasting colluvium* - grayish-brown, olive-brown and reddish-brown; massive; medium dense to stiff, clayey gravel to gravelly clay (GC/CL) with silt and subangular to subround cobbles and boulders with stage II carbonate; soil A and B horizons formed in unit (1A and 1B); 6.5 feet thick or more in exposure.

Unit 2. *Upper Pleistocene alluvial fan deposits* - brown to dark grayish-brown, massive, dense to stiff, clayey gravel to gravelly clay (GC/CL) with subangular to subround cobbles and small boulders with stage II carbonate; soil A and B horizons formed in unit (2A and 2B); 0.5 feet to more than 5.0 feet thick in exposure.

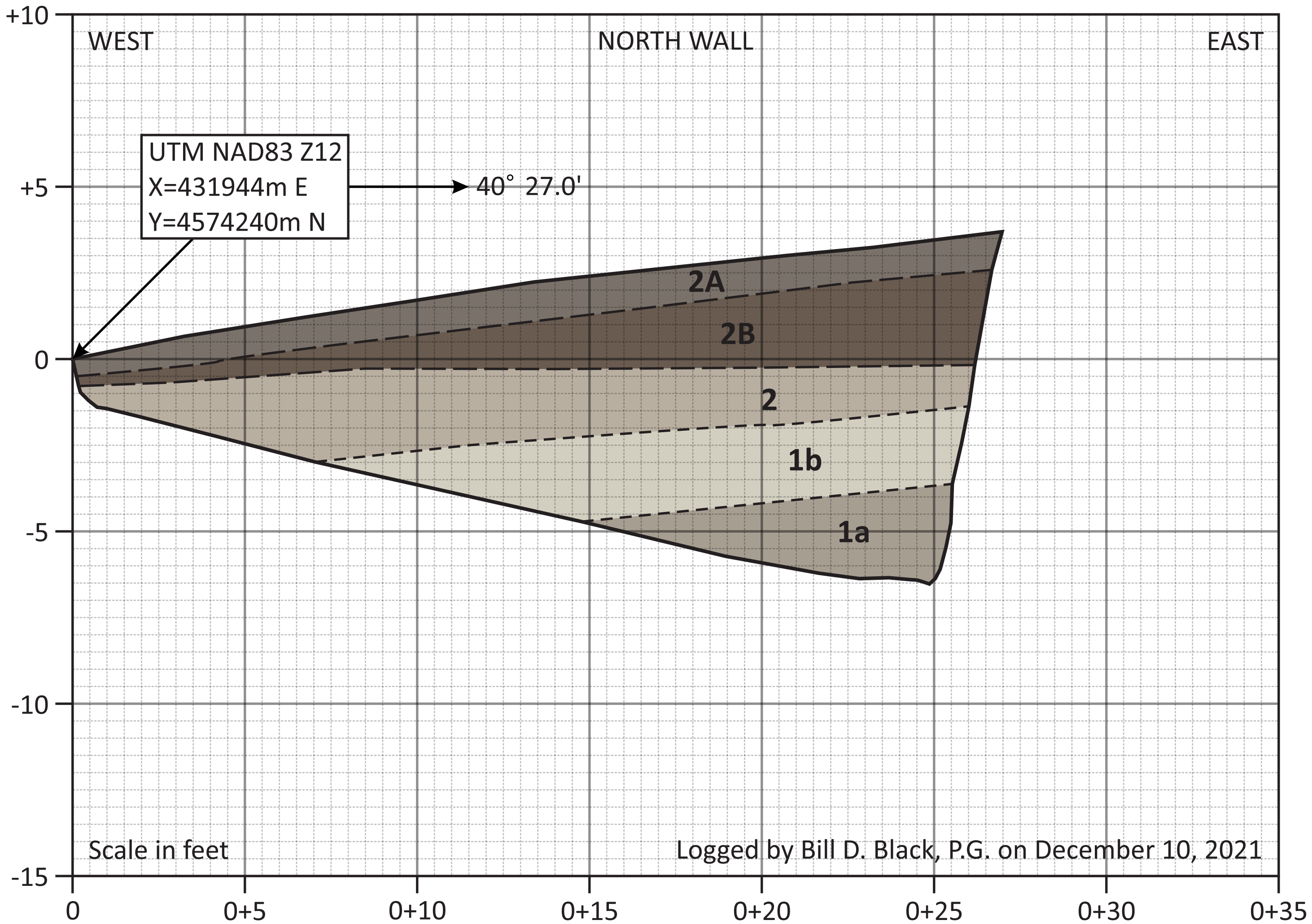
WESTERN GEOLOGIC

TEST PIT LOGS, 21 AND 22

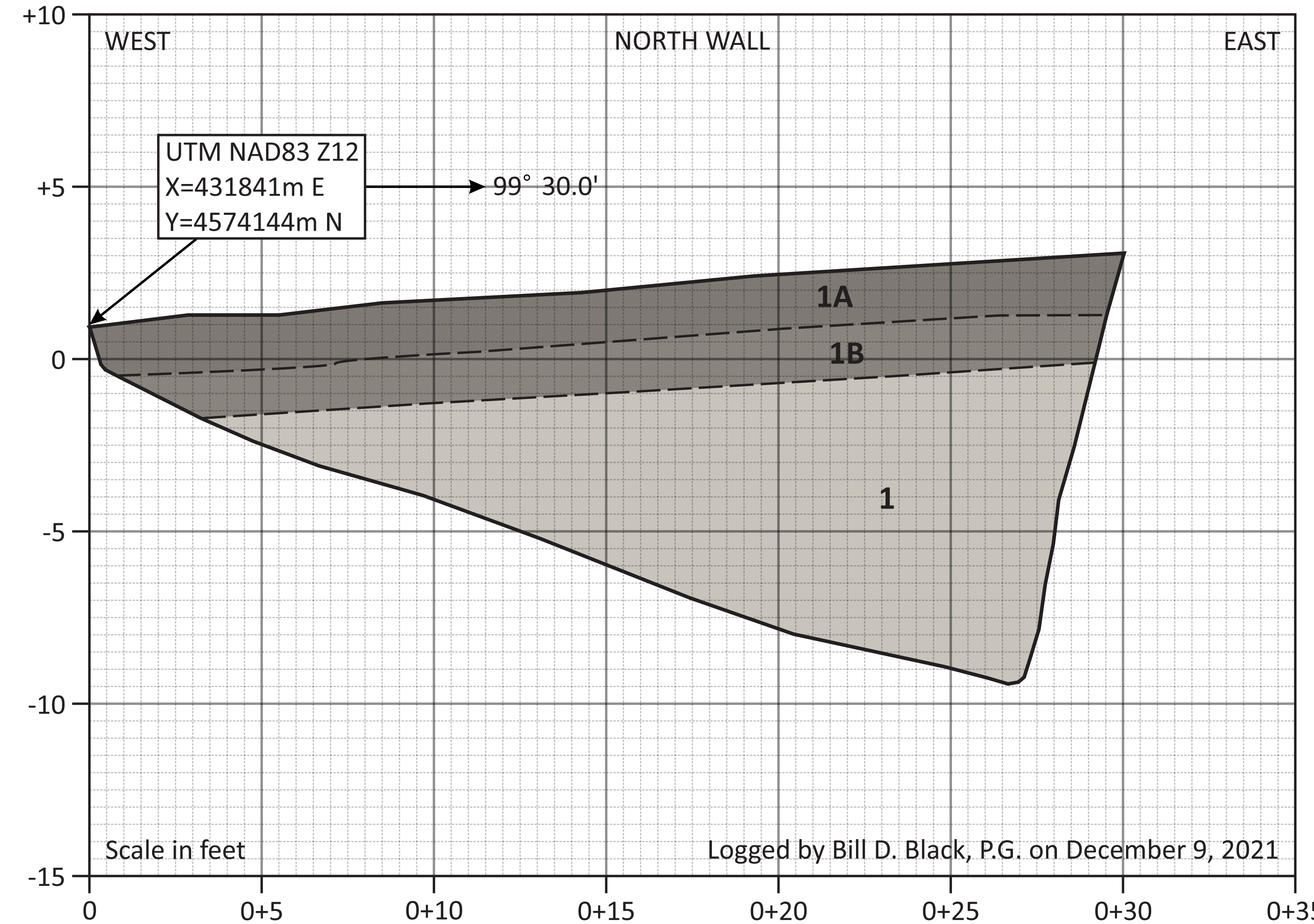
GEOLOGIC HAZARDS EVALUATION
Proposed Cobabe Ranch Development
About 2720 North 5100 East
Eden, Weber County, Utah

FIGURE 3K

TEST PIT 23



TEST PIT 24



UNIT DESCRIPTIONS

Unit 1. *Middle to Upper Pleistocene mass wasting colluvium* - sequence comprised of a lower (1a) reddish-brown, massive, stiff, sandy clay (CL); and an upper (1b) carbonate-enriched, light brown, olive and orange-brown, massive, stiff, sandy silt (ML) with jumbled siltstone blocks; more than 5.0 feet thick in exposure.

Unit 2. *Upper Pleistocene alluvial fan deposits* - olive to dark brown, massive, medium dense, clayey sand (SC) grading upward to medium stiff to stiff, sandy clay (CL) with gravel and subangular to subround cobbles and small boulders with stage II carbonate; contains blocks of lean to fat clay; soil A and B horizons formed in unit (2A and 2B); 4.0 to 4.5 feet thick in exposure.

UNIT DESCRIPTIONS

Unit 1. *Upper Pleistocene alluvial fan deposits* - reddish-brown, olive-brown and dark grayish-brown; massive, medium dense to stiff, silty to clayey gravel (GM/GC) in lower part; grading upward to clayey sand to sandy clay (SC/CL); soil A and B horizons formed in unit (1A and 1B); more than 12.0 feet thick in exposure.

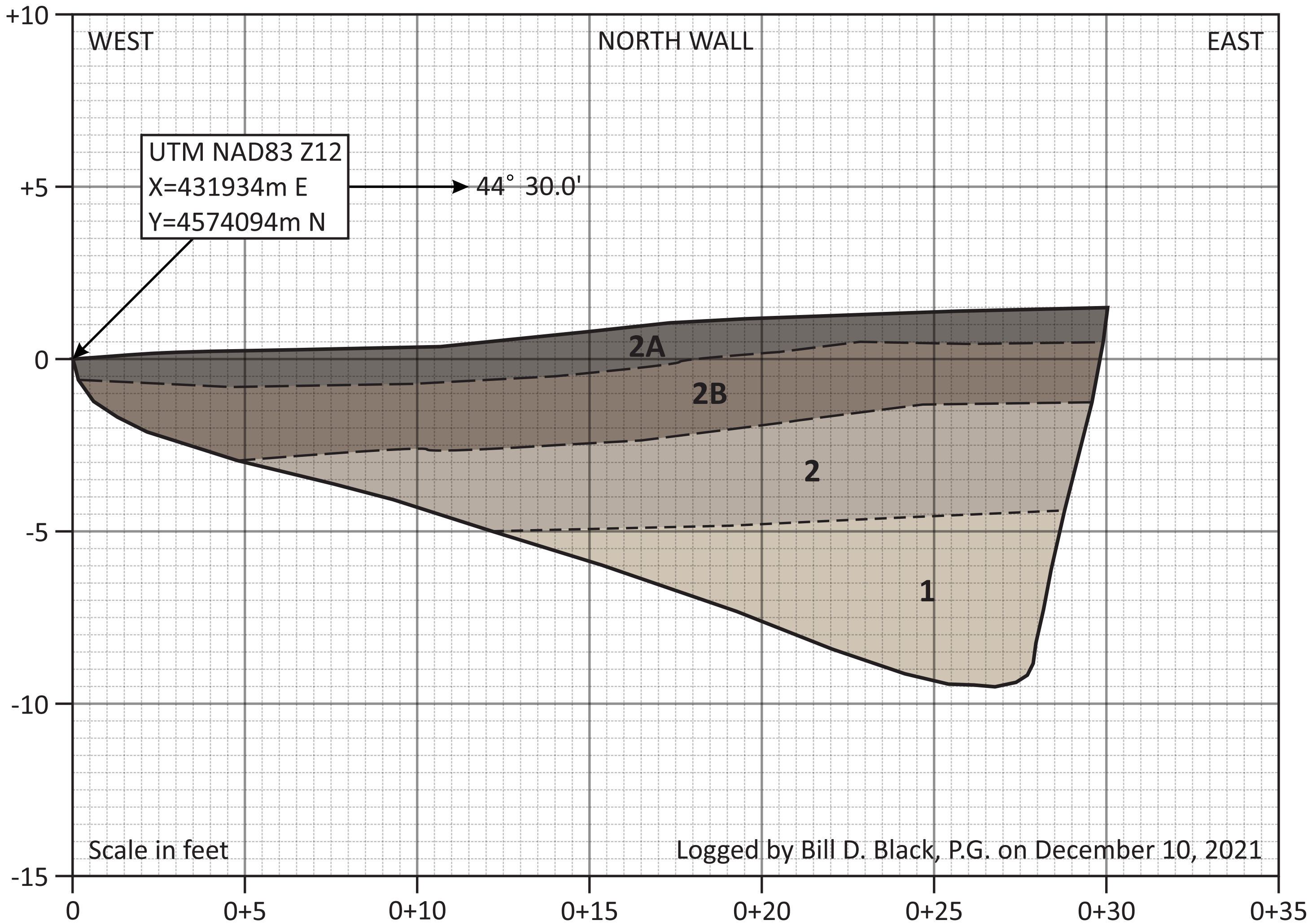
WESTERN GEOLOGIC

TEST PIT LOGS, 23 AND 24

GEOLOGIC HAZARDS EVALUATION
Proposed Cobabe Ranch Development
About 2720 North 5100 East
Eden, Weber County, Utah

FIGURE 3L

TEST PIT 25

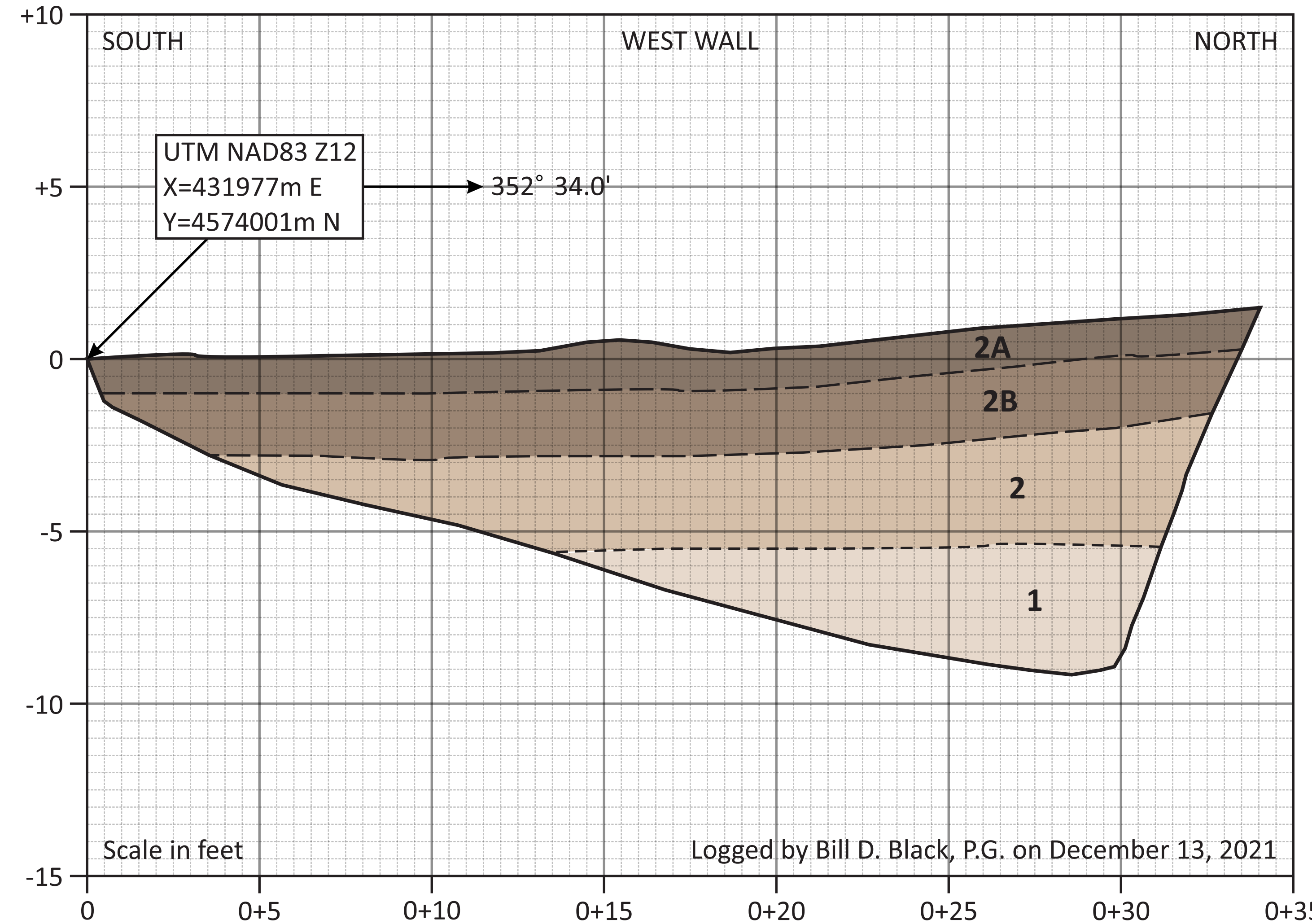


UNIT DESCRIPTIONS

Unit 1. *Middle to Upper Pleistocene mass wasting colluvium* - light brown, massive, stiff to dense, sandy silt to silty sand (ML/SM) with topset carbonate and siltstone blocks; more than 5.0 feet thick in exposure.

Unit 2. *Upper Pleistocene alluvial fan deposits* - brownish-olive, orange-brown and dark brown; massive, stiff, sandy clay (CL) with gravel, and trace subangular to subround cobbles and small boulders with stage II carbonate; contains zones of fat clay; soil A and B horizons formed in unit (2A and 2B); about 6.0 feet thick.

TEST PIT 26



UNIT DESCRIPTIONS

Unit 1. *Tertiary Norwood Formation?* - brown to orange-brown, massive, strong, weathered tuffaceous conglomerate; stage III+ carbonate in upper part of unit.

Unit 2. *Upper Pleistocene alluvial fan deposits* - brownish-olive, massive, medium dense, clayey sand (SC) with gravel and cobbles in lower part, grading upward to dark brown, massive, dense, clayey gravel (GC) with sand; subround to subangular cobbles throughout and boulders up to 36" with stage II carbonate; soil A and B horizons formed in unit (2A and 2B); about 6.0 to 6.5 feet thick in exposure.

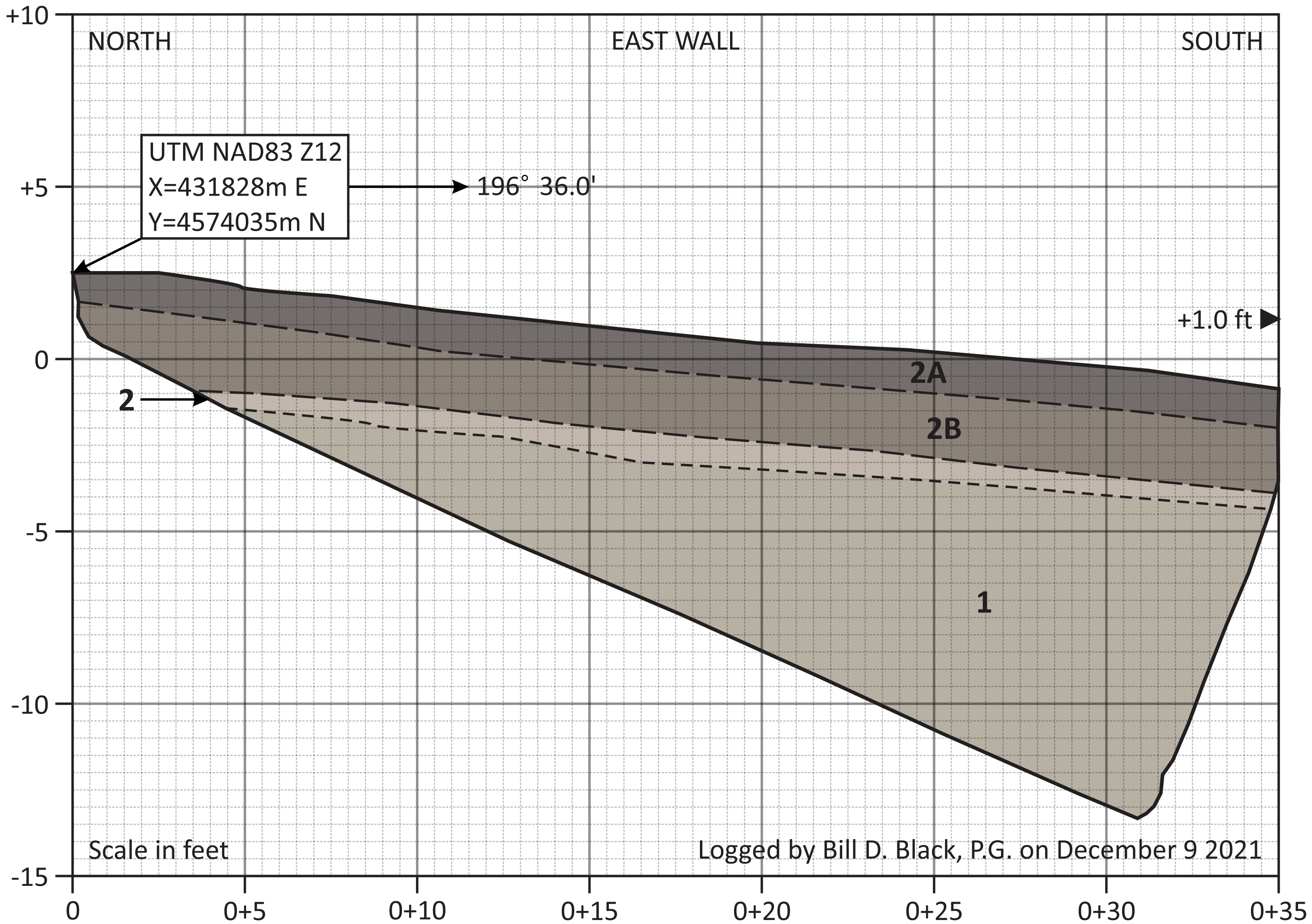
WESTERN GEOLOGIC

TEST PIT LOGS, 25 AND 26

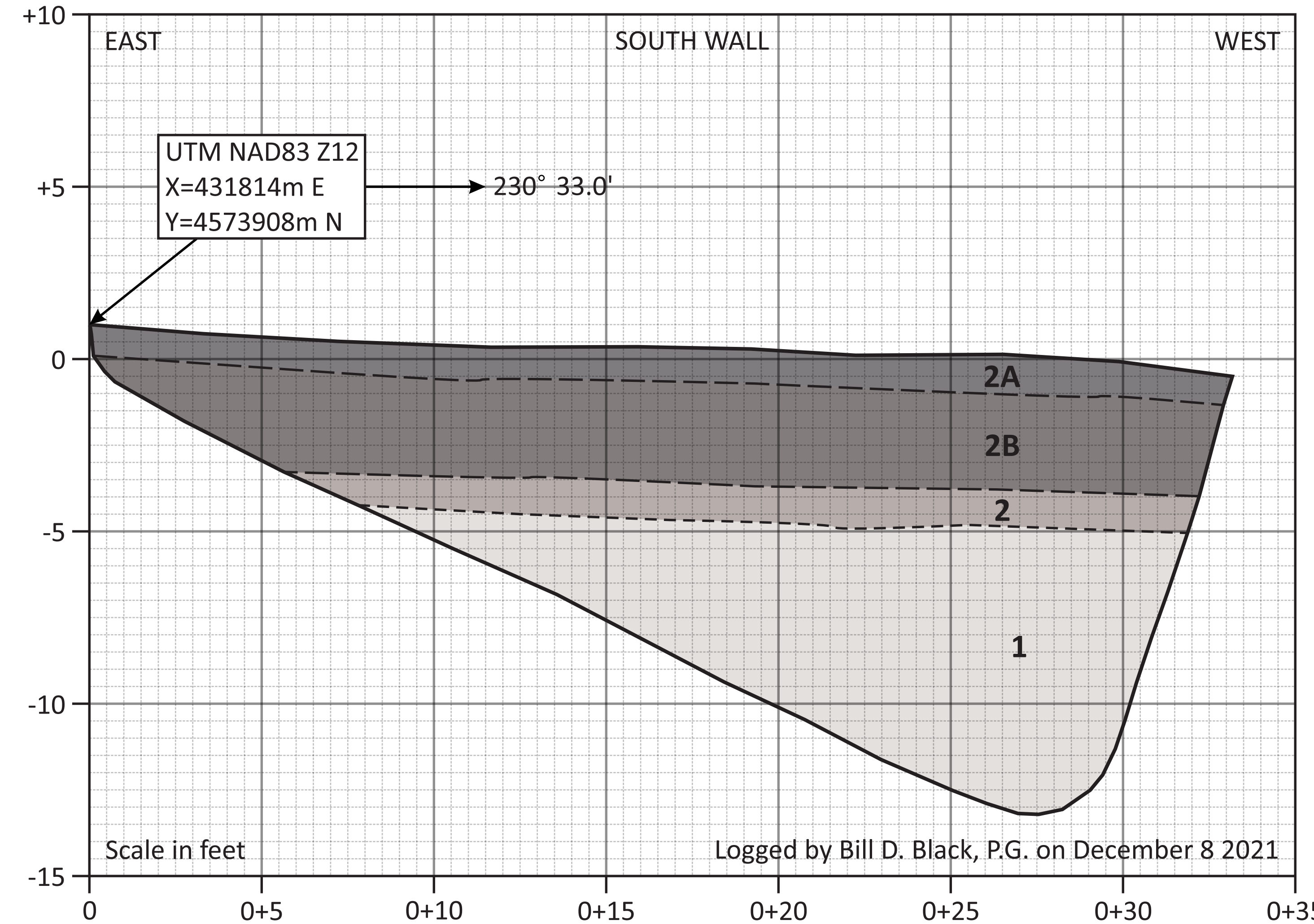
GEOLOGIC HAZARDS EVALUATION
Proposed Cobabe Ranch Development
About 2720 North 5100 East
Eden, Weber County, Utah

FIGURE 3M

TEST PIT 27



TEST PIT 28



UNIT DESCRIPTIONS (Test Pit 27)

Unit 1. *Middle to Upper Pleistocene mass wasting colluvium* - brown to reddish-brown, massive, stiff, sandy clay (CL); more than 9.0 feet thick in exposure.

Unit 2. *Upper Pleistocene alluvial fan deposits* - dark grayish-olive to dark grayish-brown, massive, dense to stiff, clayey gravel to gravelly clay (GC/CL) with subangular to subround cobbles and boulders up to 36" with stage II carbonate; soil A and B horizons formed in unit (2A and 2B); about 3.5 feet thick.

UNIT DESCRIPTIONS (Test Pit 28)

Unit 1. *Tertiary Norwood Formation* - light olive, olive and reddish-brown; poorly bedded; strong; weathered sandy claystone in lower part grading upward to carbonate-enriched, tuffaceous conglomerate.

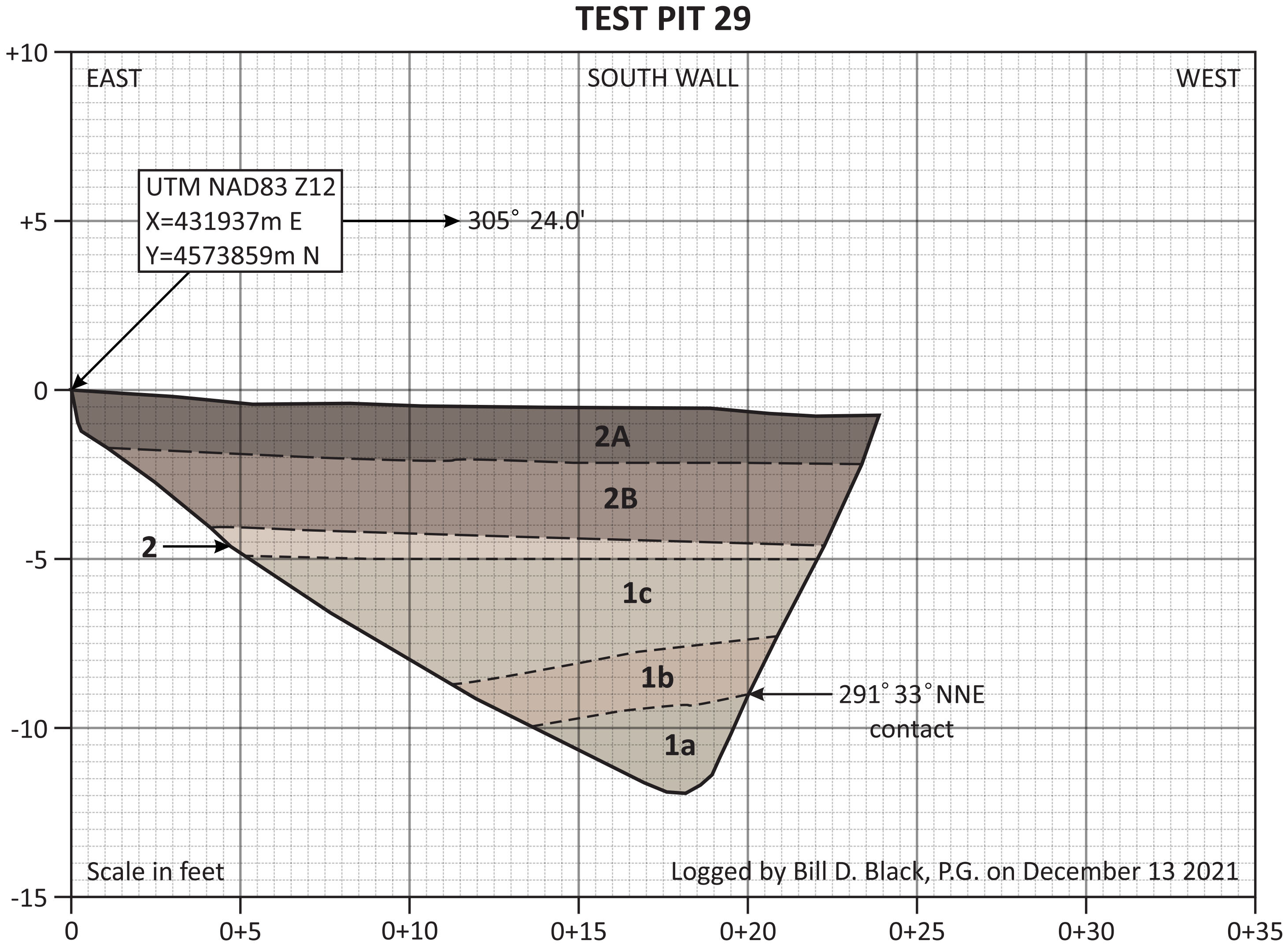
Unit 2. *Upper Pleistocene alluvial fan deposits* - dark olive-brown to dark grayish-brown, massive, dense to stiff, clayey gravel to gravelly clay (GC/CL) with subangular to subround cobbles and boulders with stage II carbonate; soil A and B horizons formed in unit (2A and 2B); about 4.5 feet thick.

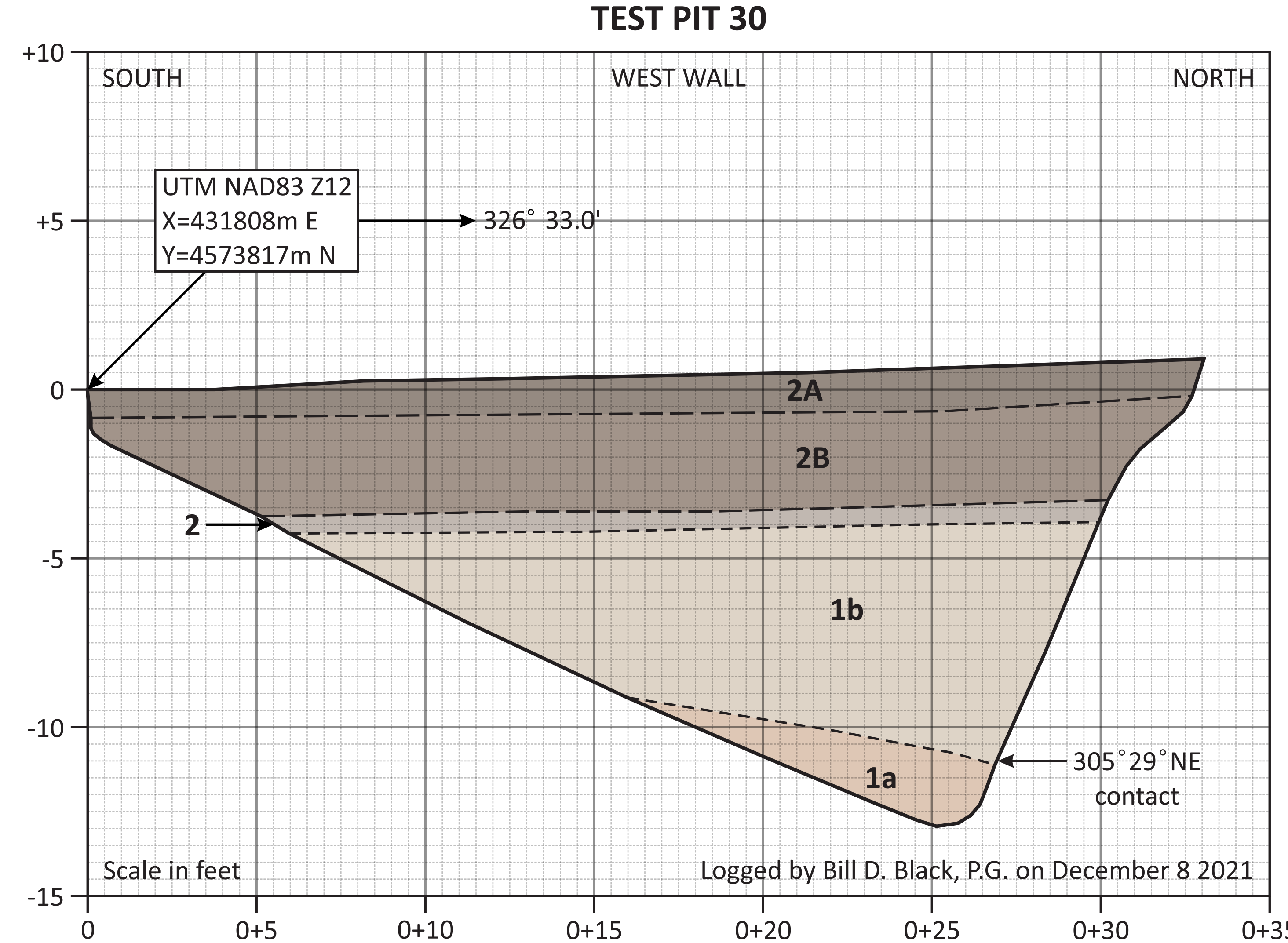
WESTERN GEOLOGIC

TEST PIT LOGS, 27 AND 28

GEOLOGIC HAZARDS EVALUATION
Proposed Cobabe Ranch Development
About 2720 North 5100 East
Eden, Weber County, Utah

FIGURE 3N





UNIT DESCRIPTIONS

Unit 1. *Tertiary Norwood Formation* - sequence comprised of a lower (1a) olive, poorly bedded, strong, weathered claystone; a middle (1b) reddish-brown, poorly bedded, strong, weathered tuffaceous sandstone; and an upper (1c) brownish-olive, massive, strong, weathered claystone with carbonate; soil B horizon formed in upper unit (1cB).

Unit 2. *Upper Pleistocene alluvial fan deposits* - brown to dark brown, massive, medium stiff to medium dense, gravelly clay to clayey gravel (CL/GC) with subangular to subround cobbles and trace boulders with stage II carbonate; soil A and B horizons formed in unit (2A and 2B); about 3.5 feet thick.

UNIT DESCRIPTIONS

Unit 1. *Tertiary Norwood Formation* - sequence comprised of a lower (1a) reddish-brown, poorly bedded, strong, weathered sandy claystone; and an upper (1b) olive, light brown and reddish-brown, poorly bedded, strong, weathered tuffaceous conglomerate; stage III+ carbonate in upper unit.

Unit 3. *Upper Pleistocene alluvial fan deposits* - dark olive-brown to dark grayish-brown, massive, dense to stiff, clayey gravel to gravelly clay (GC/CL) with subangular to subround cobbles and boulders with stage II carbonate; soil A and B horizons formed in unit (2A and 2B); about 4.5 feet thick.

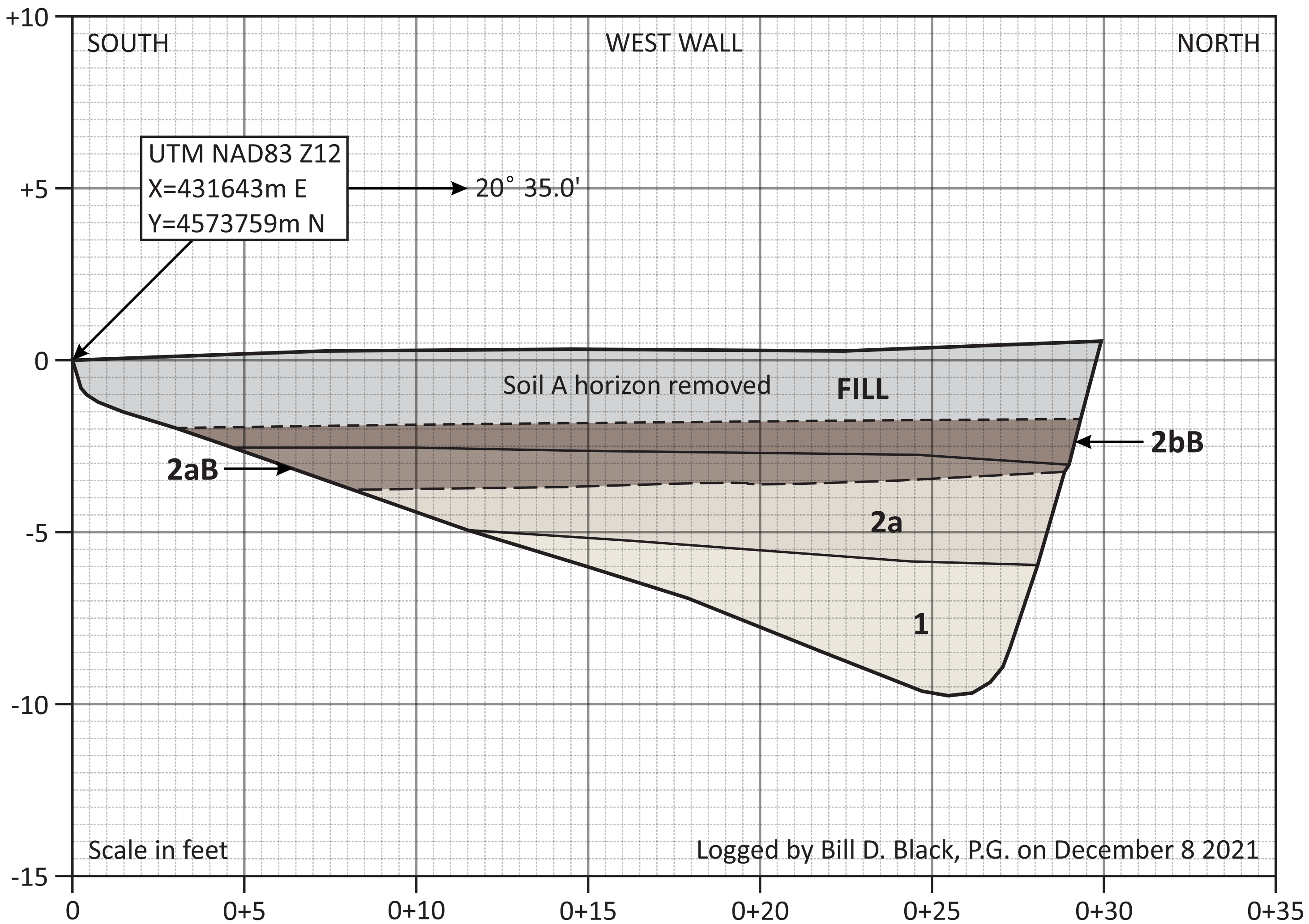
WESTERN GEOLOGIC

TEST PIT LOGS, 29 AND 30

GEOLOGIC HAZARDS EVALUATION
Proposed Cobabe Ranch Development
About 2720 North 5100 East
Eden, Weber County, Utah

FIGURE 30

TEST PIT 31

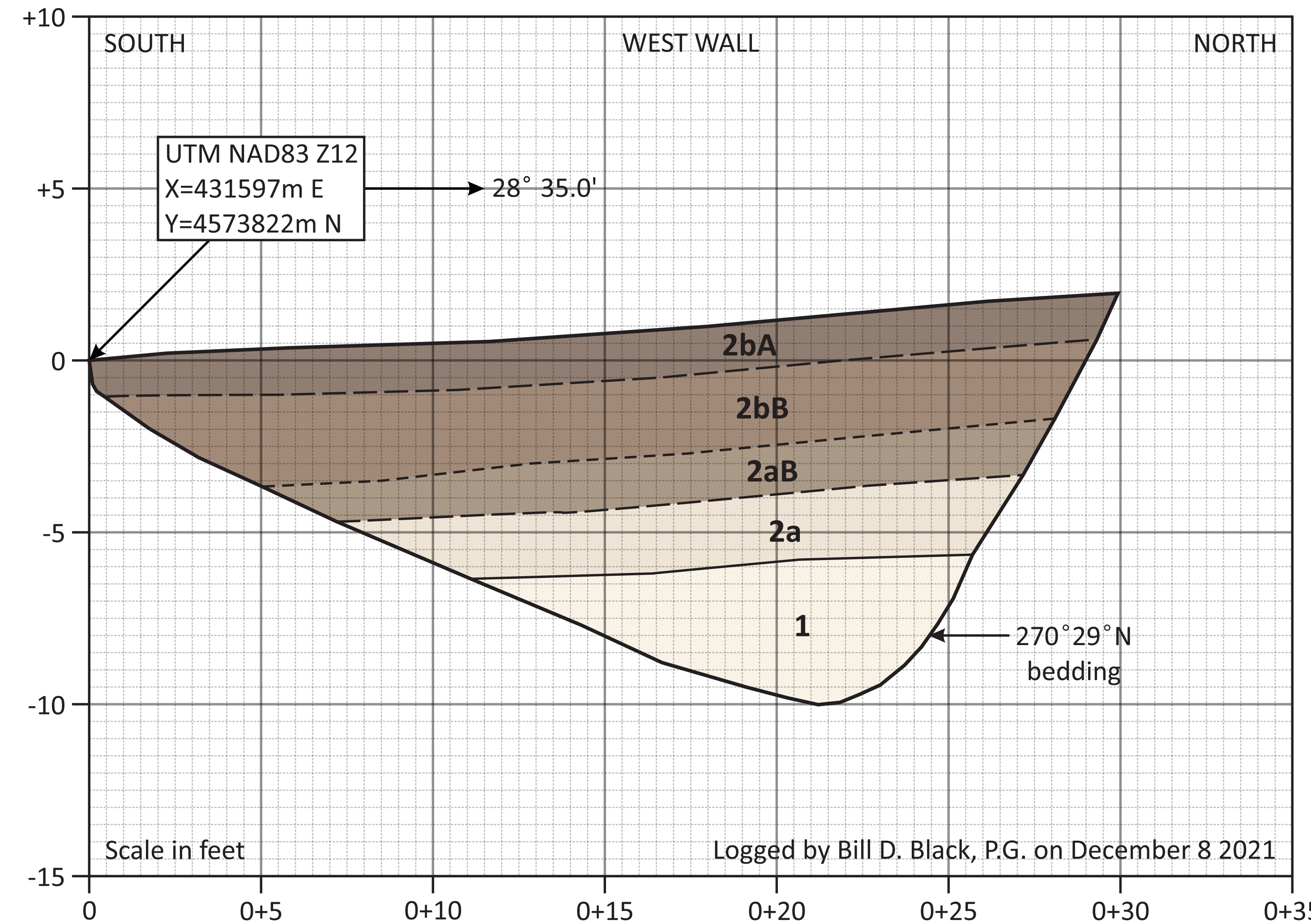


UNIT DESCRIPTIONS

Unit 1. *Tertiary Norwood Formation* - olive to pale olive, well bedded, strong, weathered claystone with very strong, carbonate-cemented layers.

Unit 2. *Upper Pleistocene lacustrine deposits related to Lake Bonneville* - sequence comprised of a lower (2a) light olive-brown, well bedded, dense, clayey to silty sand (SC/SM); and an upper (2b) dark brown, massive, stiff, sandy clay (CL) with pebble gravel; disturbed soil B horizon formed in unit (2aB and 2bB); A-horizon soil removed and replaced by fill with trash.

TEST PIT 32



UNIT DESCRIPTIONS

Unit 1. *Tertiary Norwood Formation* - light brownish-olive, well bedded, strong, weathered claystone with very strong, carbonate-cemented layers.

Unit 2. *Upper Pleistocene lacustrine deposits related to Lake Bonneville* - sequence comprised of a lower (2a) light reddish-brown, poorly to well bedded, dense, clayey sand (SC) with round to subround cobbles along base and increasing clay upward; and an upper (2b) dark brown; massive, stiff, sandy clay with trace gravel (CL); soil A and B horizons formed in unit (2aB, 2bB and 2bA).

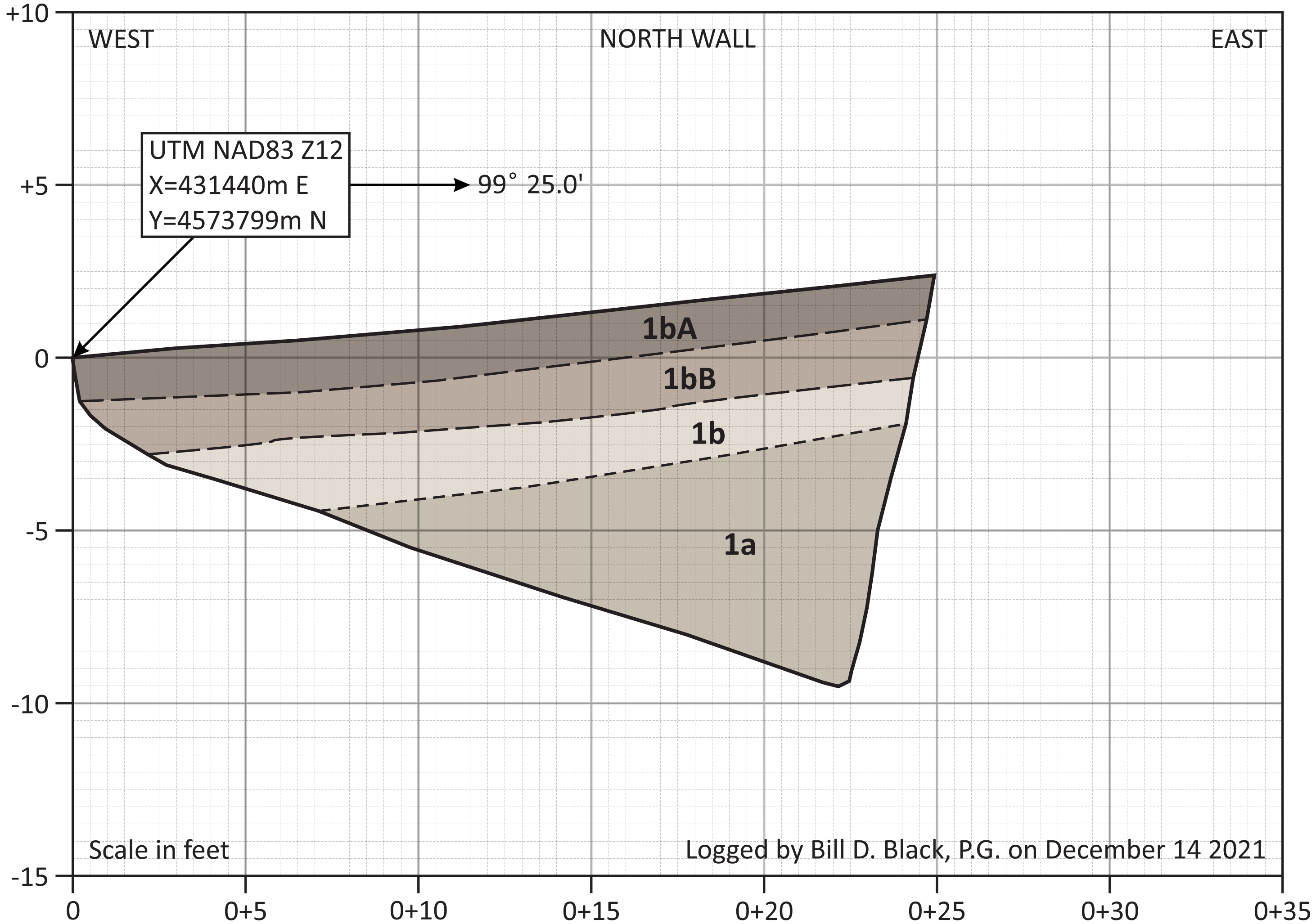
WESTERN GEOLOGIC

TEST PIT LOGS, 31 AND 32

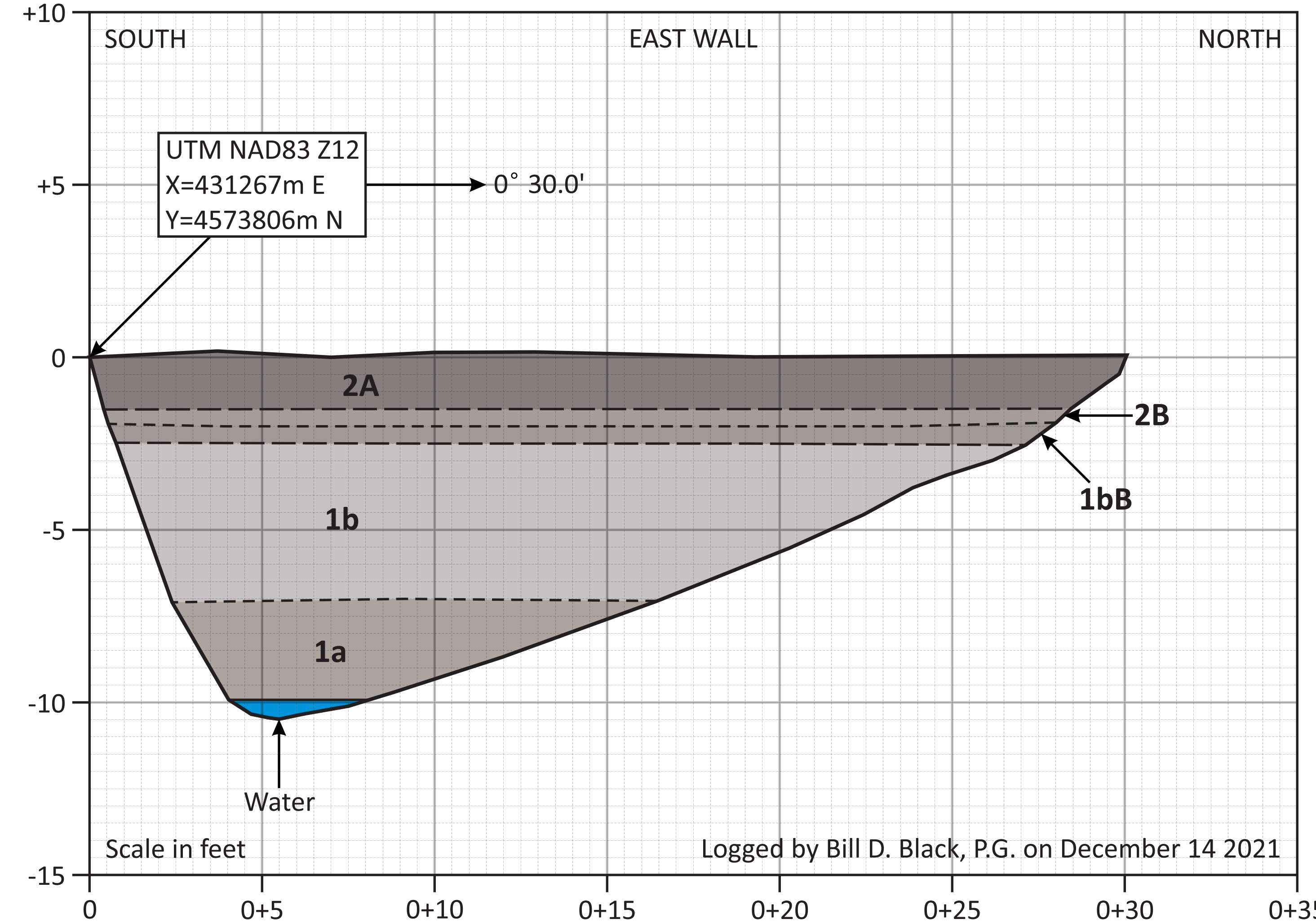
GEOLOGIC HAZARDS EVALUATION
Proposed Cobabe Ranch Development
About 2720 North 5100 East
Eden, Weber County, Utah

FIGURE 3P

TEST PIT 33



TEST PIT 34



UNIT DESCRIPTIONS (Test Pit 33)

Unit 1. *Upper Pleistocene lacustrine deposits related to Lake Bonneville* - sequence comprised of a lower (1a) light brown to olive-brown; poorly to well bedded; stiff to dense; lean clay (CL) with 3-4" thick interbeds of sand (CL/SW), round to subround cobbles and carbonate in upper part; and an upper (1b) brown to dark brown, poorly bedded to massive, stiff, sandy clay (CL) with pebble gravel; soil A and B horizons formed in upper unit (1bA and 1bB).

UNIT DESCRIPTIONS (Test Pit 34)

Unit 1. *Upper Pleistocene lacustrine deposits related to Lake Bonneville* - sequence comprised of a lower (1a) reddish-brown to grayish-brown, poorly to well bedded, stiff to medium stiff, lean clay (CL) with interbeds of sand (SW); and an upper (1b) dark brown to dark grayish-brown, poorly bedded, stiff, sandy clay (CL) with interbeds of sandy silt (ML); soil B horizon formed in upper unit (1bB).

Unit 2. *Upper Pleistocene to Holocene alluvium* - dark grayish-brown, massive, medium stiff, sandy clay (CL) with trace gravel; soil A and B horizons formed in unit (2A and 2B).

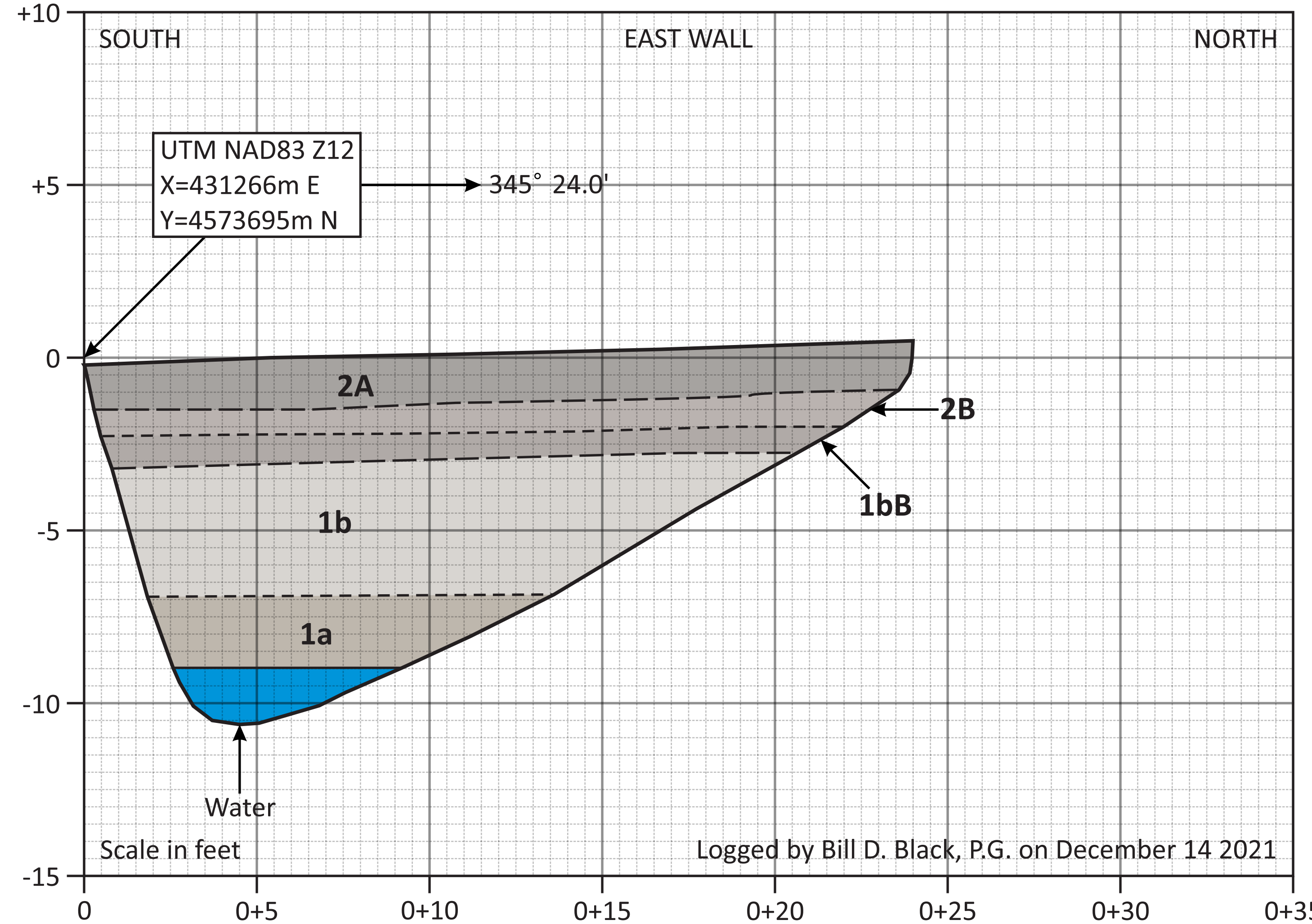
WESTERN GEOLOGIC

TEST PIT LOGS, 33 AND 34

GEOLOGIC HAZARDS EVALUATION
Proposed Cobabe Ranch Development
About 2720 North 5100 East
Eden, Weber County, Utah

FIGURE 3Q

TEST PIT 35



UNIT DESCRIPTIONS

Unit 1. *Upper Pleistocene lacustrine deposits related to Lake Bonneville* - sequence comprised of a lower (1a) reddish-brown to brown, poorly to well bedded, stiff, lean clay (CL) with interbeds of sand (SW); and an upper (1b) dark brown to dark grayish-brown, poorly bedded, stiff, sandy clay (CL) with silt and carbonate; soil B horizon formed in upper unit (1bB).

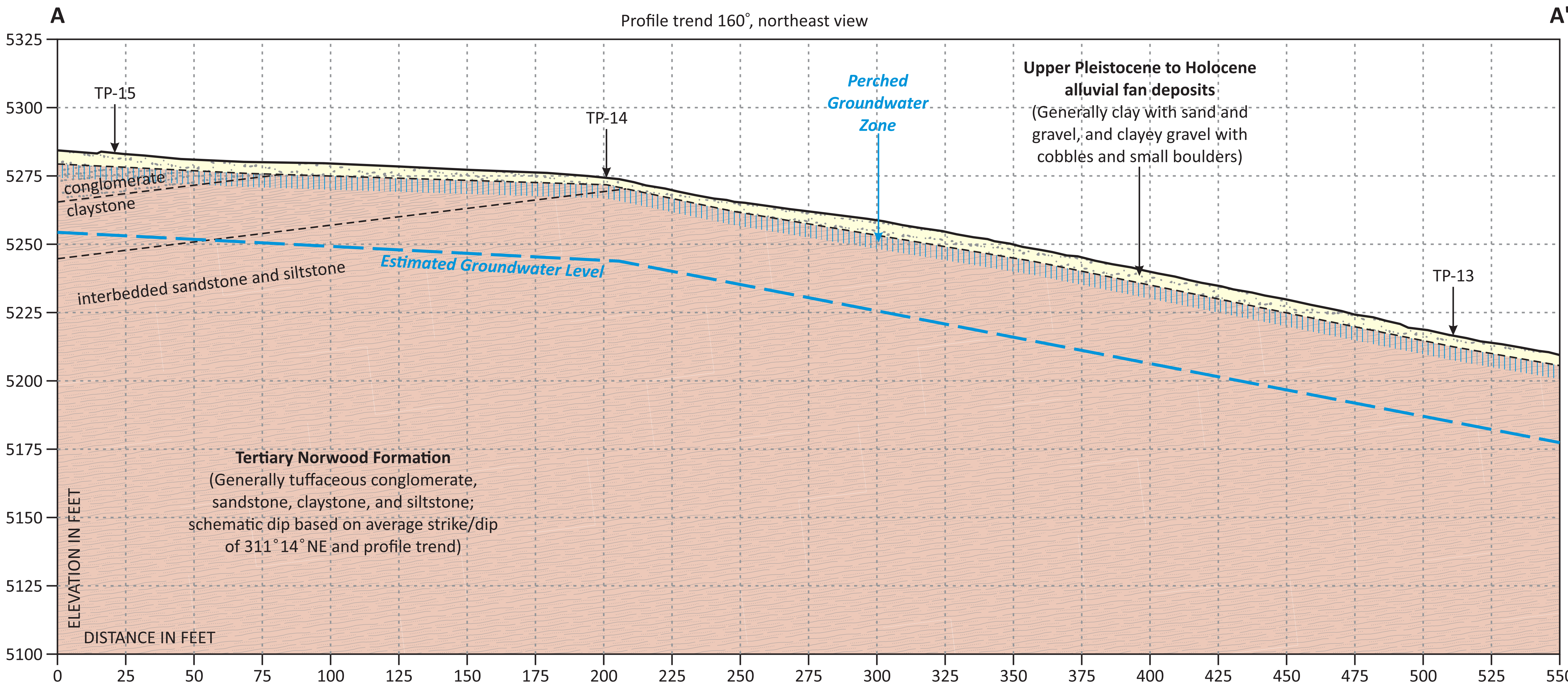
Unit 2. *Upper Pleistocene to Holocene alluvium* - dark grayish-brown, stiff, massive, lean clay with sand and pebble gravel (CL); soil A and B horizons formed in unit (2A and 2B).

TEST PIT LOGS, 35

GEOLOGIC HAZARDS EVALUATION
Proposed Cobabe Ranch Development
About 2720 North 5100 East
Eden, Weber County, Utah

FIGURE 3R

WESTERN GEOLOGIC



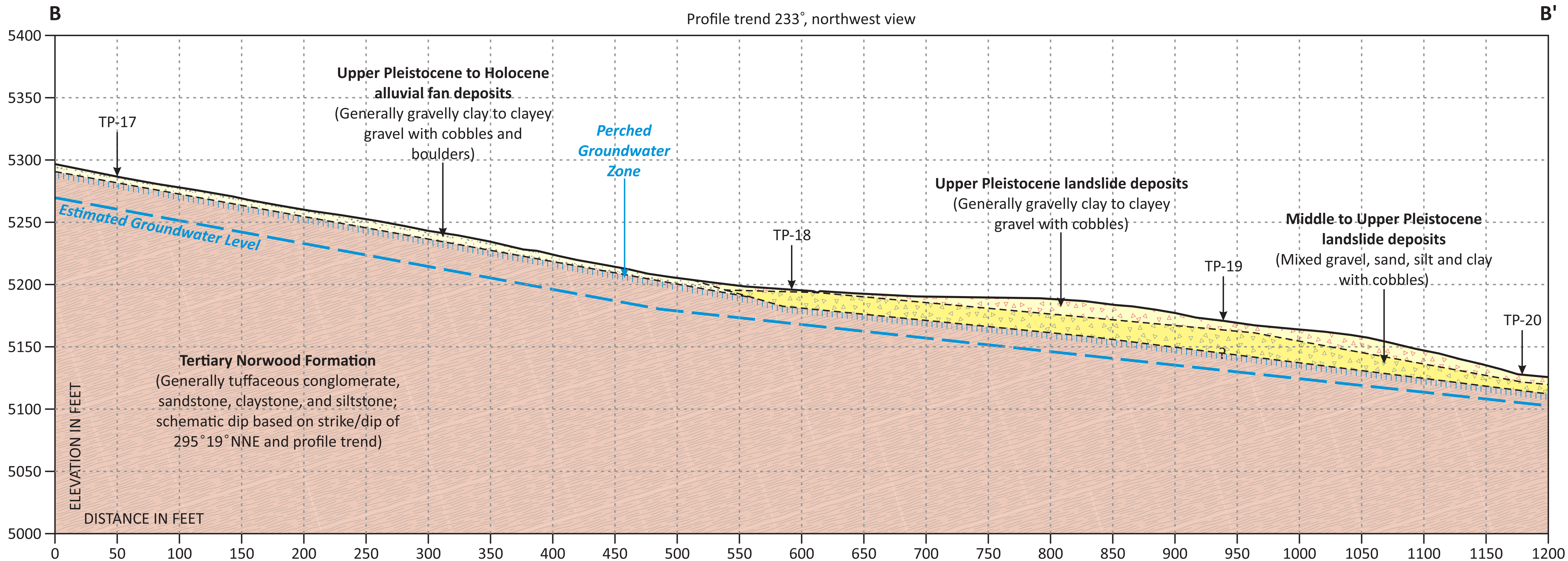
Scale 1 inch equals 40 feet (1:480) with no vertical exaggeration.
All units and contacts are approximate and inferred based on available subsurface data; variations may occur laterally, at depth and within units.
Topographic profile based on geoprocessed 2016 and 2020 LIDAR data.

WESTERN GEOLOGIC

GEOLOGIC CROSS SECTION A-A'

GEOLOGIC HAZARDS EVALUATION
Proposed Cobabe Ranch Development
About 2720 North 5100 East
Eden, Weber County, Utah

FIGURE 4A



Scale 1 inch equals 80 feet (1:960) with no vertical exaggeration.
All units and contacts are approximate and inferred based on available subsurface data; variations may occur laterally, at depth and within units.
Topographic profile based on geoprocessed 2016 and 2020 LIDAR data.

WESTERN GEOLOGIC

GEOLOGIC CROSS SECTION B-B'

GEOLOGIC HAZARDS EVALUATION
Proposed Cobabe Ranch Development
About 2720 North 5100 East
Eden, Weber County, Utah

FIGURE 4B

Air photo base from Utah Geographic Resource Center, 2012 high resolution orthophoto, 12.5 cm resolution. Surficial geology modified from Coogan and King (2016) and McDonald (2020). Site plan modified from Gardner Engineering preliminary plan sheet SP1 dated 06-15-2021.

WESTERN GeoLogic

0 200 400 feet

Scale 1:2,400 (1 inch equals 200 feet)

SITE EVALUATION

GEOLOGIC HAZARDS EVALUATION

Proposed Cobabe Ranch Development

About 2720 North 5100 East

Eden, Weber County, Utah

PLATE 1

LIDAR base from Utah Geographic Resource Center, 2020 and 2016 LIDAR bare earth DEM, 50 cm resolution. Surficial geology modified from Coogan and King (2016) and McDonald (2020). Site plan modified from Gardner Engineering preliminary plan sheet SP1 dated 06-15-2021.
Contours generated by Global Mapper from geoprocessed LIDAR data, 4 foot interval. Slopes < 15% gradient unshaded, 15-25% shaded in yellow, and > 25% shaded in red.

N W E S

0 200 400 feet
Scale 1:2,400 (1 inch equals 200 feet)

WESTERN GEOLOGIC

LIDAR ANALYSIS

GEOLOGIC HAZARDS EVALUATION
Proposed Cobabe Ranch Development
About 2720 North 5100 East
Eden, Weber County, Utah

PLATE 2

Surficial geology modified from Coogan and King (2016) and McDonald (2020). Site plan modified from Gardner Engineering preliminary plan sheet SP1 dated 06-15-2021. Contours generated by Global Mapper from geoprocessed 2020 and 2016 LIDAR data, 4 foot interval.

N W E S

0 200 400 feet
Scale 1:2,400 (1 inch equals 200 feet)

WESTERN GEOLOGIC

SURFICIAL GEOLOGY

GEOLOGIC HAZARDS EVALUATION
Proposed Cobabe Ranch Development
About 2720 North 5100 East
Eden, Weber County, Utah

PLATE 3