# BYER GEOTECHNICAL, INC.

April 18, 2018
BG 21103

Mr. Albert Davityan
8160 McGroarty Street
Sunland, California 91040-3333

Subject

Transmittal of Addendum Geologic and Soils Engineering Exploration Update
Response to City of Los Angeles Review Letter
Proposed Tentative Tract Map # 73957
Thirteen-Lot Subdivision, Eleven New Residences
Western Empire Tract (MP 18-162/163 [SHT 4]), Lot 202½ (Arb. 2)
8100, 8150, and 8160 West McGroarty Street (aka 10000 North McVine Trail)
Sunland, California

Dear Mr. Davityan:

Byer Geotechnical has completed our addendum geologic and soils engineering exploration update, which provides the information requested in the City of Los Angeles, Department of Building and Safety (LADBS), Geology and Soils Report Review Letter, dated December 5, 2017. The reviewing agency for this document is the LADBS. The reviewing agency requires two unbound copies, one with wet signatures, a CD (PDF format), an application form, and a filing fee. Three copies of the report are enclosed.

It is our understanding that you will file the report with the LADBS. Any questions concerning the report should be directed to the undersigned. Byer Geotechnical appreciates the opportunity to continue to offer our consultation and advice on this project.

Very truly yours,
**BYER GEOTECHNICAL, INC.**

James E. Tucker
Project Consultant

BYER GEOTECHNICAL, INC.

April 18, 2018
BG 21103

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8160 McGroarty Street
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Subject

Addendum Geologic and Soils Engineering Exploration Update
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8100, 8150, and 8160 West McGroarty Street (aka 10000 North McVine Trail)
Sunland, California

**References: Reports by Byer Geotechnical, Inc.:**

*Geologic and Soils Engineering Exploration Update, Proposed Tentative Tract Map # 73957, Thirteen-Lot Subdivision, Ten New Residences, Arb. 2, Portion of Lot 202½, Western Empire Tract, 8200 West McGroarty Street, Sunland, California,* dated March 3, 2016; and

*Addendum Geologic and Soils Engineering Exploration Update, Response to City of Los Angeles Correction Letter, Proposed Tentative Tract Map # 73957, Thirteen-Lot Subdivision, Eleven New Residences, Western Empire Tract (MP 18-162/163 [SHT 4]), Lot 202½ (Arb. 2), 8100, 8150, and 8160 West McGroarty Street (aka 10000 North McVine Trail), Sunland, California,* dated November 13, 2017.

**Responses by the City of Los Angeles, Department of Building and Safety (LADBS):**

Inter-Departmental Correspondence, Geology and Soils Report Correction Letter, dated August 18, 2016; and

Geology and Soils Report Review Letter, Log # 93472-01, dated December 5, 2017.

Dear Mr. Davityan:

This addendum geologic and soils engineering exploration update has been prepared to provide the additional information requested by the LADBS in the Geology and Soils Report Review Letter, dated

December 5, 2017, and clarified during a meeting with the LADBS reviewers on December 13, 2017. A copy of the review letter is enclosed. The items requested in the City letter are listed below, followed by Byer Geotechnical's item-by-item response.

Item 1. *It is unclear how the existing site will be graded to current code conformance. Provide a geologic map that is based upon the detailed grading or site development plans in accordance to the Department of City Planning Instruction for Filing Tentative Tract Maps including the Hillside area provisions.*

*As previously requested, the geologic map shall illustrate all proposed and existing contours relative to the planned grading and/or construction; show the proposed cut/fill limits (provide a cut/fill line); show and label the location of all existing cut slopes; all temporary excavations; all proposed retaining walls (label location and height); location and dimensions of all debris basins, along with all off-site slopes and conditions which could adversely affect the stability or safety of the site. In addition, the geologic map based on a revised tentative tract map shall show all erosion control and drainage devises* [devices] *per section 7013 of the code.*

Response: A revised grading plan has been prepared by Techna Land Company, dated January 5 and January 30, 2018. The enclosed Revised Geologic Map utilizes the current plan and the enclosed revised cross sections reflect the current plan.

Item 2. *The consultants proposed a 1:1 street cut, offsite cut slopes adjacent to the subject lots are steeper than 1:1 (Sections H and M), and other slopes 1:1 or steeper existing* [exist] *on the subject lots. As previously requested, for rock slopes 1:1 (H:V) or steeper to remain (native or cut), provide additional geologic mapping and analysis that incorporates, but not limited to, the following:*

*a. Detailed mapping and description of discontinuities along the existing cut slope; such as bedding planes, lithologic contacts, joints, fractures, and faults, with characteristics such as orientation, spacing, presence of infilling or openness, continuity, etc. Provide a table with attitudes mapped and any conversions of data points used for data analysis.*

Response: The slope depicted in Section H is 1:1 or flatter. The slopes steeper than 1:1 adjacent to the driveway and McGroarty Street (see Sections K and M) have been mapped in detail, and the joint planes mapped are shown on the Revised Geologic Map.

b. *Kinematic analysis of discontinuities relative to the slope face, using stereographic methods to assess potential planar, wedge and topple type failures.*

c. *Slope stability analysis of the potential failures using appropriate methods for type of failure identified from the kinematic analysis.*

Response: In addition to checking the overall gross stability, a study of the two sections of slope steeper than 1:1 that are proposed to remain was analyzed for the potential for local failures resulting from joint planes.

Kinematic Analysis Plots #1 and #2 (enclosed) show stereonets for the kinematic feasibility of planar, topple, and wedge failures on the mapped discontinuities for the slope locations at Sections K and M, respectively. At each location, the analysis considers the relationship between the local proposed cut slope and the discontinuities mapped closest to the slope location. All discontinuities mapped are considered for each slope location. Table 1 (enclosed) lists the planar data mapped at the two slope locations, and Table 2 (enclosed) lists the slope orientations and height of the slope face and upper slope used for the analysis.

<u>Kinematic Analysis</u>

A volume of rock that is isolated from the surrounding rock mass by joints can potentially fail in one of three recognized modes: planar, wedge, or toppling. A planar failure occurs when a block slides on a single joint plane. A wedge failure occurs when a wedge-shaped block slides on two intersecting joint planes. A toppling failure occurs when a block, or a series of blocks, fail by rotation, possibly in combination with sliding. For a given joint plane or set of joint planes, a kinematic analysis indicates whether either of these modes of failure is kinematically feasible, based on the relative orientations of the joint planes(s) and the slope face, and based on friction on the joint plane(s) as the only resistance against sliding or toppling. The kinematic analyses involve, first, a stereonet projection of joint planes. Joint planes that plot outside of a sector of potential failure are ruled out from further analysis, as discussed in more detail below. Further analysis involves the calculation of the factor of safety and an assessment of the role and effect of additional resisting mechanisms. Such mechanisms may include cohesion on the joint plane, terminations of joints into areas of intact bedrock, bridges of intact bedrock between joint segments, the lack of a complete daylighting condition on the slope face for the downhill part of the joint plane, and the lack of a daylighting condition or tension crack for the uphill part of the joint plane.

Planar Failures

A planar failure, by sliding on a joint plane, is kinematically feasible when the following criteria are satisfied:

P-1 The joint plane is daylighted on the slope face.

P-2 The dip direction of the joint plane is within about 20 degrees of the dip direction of the slope.

P-3 The gravitational driving force exceeds the resisting forces.

P-4 The joint plane daylights on the upper slope.

On a stereonet, criteria P-1, P-2, and P-3 define a "Sector of Planar Failure" (SPF), which is bound by the great circle representing the slope face, by a small circle representing the so-called cone of friction, making an angle with the horizontal equal to the angle of friction, and by two great circles representing vertical planes that strike 20 degrees in either direction of the slope-dip direction. A factor of safety can be incorporated in the SPF by using a factored angle of friction to construct the small circle. For a given joint plane, a planar failure is kinematically feasible when the direction of maximum dip (represented by a point on a stereonet) plots inside the SPF. The minimum factor of safety against planar failure, $FS_p$, is given by:

$$FS_p = \frac{Tan\varphi}{Tan\alpha} \qquad \text{(Equation 1)}$$

where α is the dip of the joint plane and φ is the angle of friction. Equation 1 incorporates only (factored) friction as a resistance to sliding. Additional mechanism of resistance to sliding, including criterion P-4, the continuity of the discontinuity planes, and the effect of cohesive resistance to sliding, need to be verified for any joint plane that plots inside the sector of potential planar failure.

On Kinematic Analysis Plots #1 and #2, the SPF is plotted on the upper stereonet. Each plane is plotted as a great circle with a triangle indicating the line of true dip. Triangles that plot inside the SPF are shaded black. None of the joint planes mapped plot inside the SPF. Therefore, it is concluded that the potential for planar failures along joints and other discontinuities on the existing steep cut slopes is negligible.

Wedge Failures

A wedge failure is kinematically possible when the following criteria are satisfied:

W-1 The wedge daylights on the slope face, which requires that the dip (plunge) of the intersection line between the two joint planes is less than the dip of the slope face.

W-2 The gravitational driving force exceeds the combined frictional resistance on the two joint planes.

W-3 The wedge geometry is such that sliding occurs on both joint planes.

W-4 The intersection line daylights on the upper slope.

On a stereonet, criteria W-1 and W-2 define a "sector of wedge failure" (SWF), which is bound by the great circle representing the slope face and by the small circle representing the cone of friction. Wyllie and Mah (2004, p 161) state:

> *Many trial calculations have shown that a wedge having a factor of safety in excess of 2.0, as obtained from the friction-only stability charts, is unlikely to fail under even the most severe combination of conditions to which the slope is likely to be subjected.*

Therefore, a factor of safety FS = 2 is used to define the SWF. A wedge failure is considered kinematically unfeasible for joint intersections that plot outside the SWF. For joint intersections that plot inside the SWF, a more detailed calculation is required. For this project, the minimum factor of safety against sliding for a wedge, $FS_w$, is calculated using the methodology described by Kliche (1999), which uses friction and cohesive resistance to sliding. For joint intersections that define a kinematically feasible wedge with a minimum factor of safety $FS_w$ less than 1.5, the actual field conditions should be investigated in detail to confirm that the joint intersection does, in fact, form wedges that are capable of failure in the field. Factors that mitigate the potential for a wedge failure in this case may include the lack of continuity of individual joint planes and/or the existence of bridging structures, or the lack of physical overlap between the joint sets. For wedges that are considered potentially unstable, some form of mitigation, such as further slope trimming or structural support may be considered.

On Kinematic Analysis Plots #1 and #2, the SWF is plotted on the lower stereonet. The intersection between all planes is plotted as an arrow, pointing in the direction of plunge. Triangles that plot inside the SWF are shaded black. The results of the analysis for all intersections are summarized on Table 3, Wedge Failure Potential (enclosed). A total of 12 intersections between planar discontinuities plot inside the

SWF and indicate kinematically feasible wedge failures. These cases are further analyzed as presented on Wedge Stability Calculations #1 - #12. The factors of safety are calculated for zero cohesion on the two intersecting planes. If this condition leads to a factor of safety less than 1.5, the cohesion is increased in steps of 10 pounds-per-square-foot until the factor of safety is 1.5 or greater, and the slope gradient that eliminates the wedge is listed. In all cases, the cohesion required for a factor of safety in excess of 1.5 is 130 pounds-per-square-foot or less. All wedges with a factor of safety less than 1.5 in the absence of cohesion will be eliminated by a 1:1 trim. Since there is no information available on a minimum value for the cohesive strength of joint planes in this area, a 1:1 slope trim is recommended.

Toppling Failures

Toppling failures are of two types: direct toppling and flexural toppling. A block can fail by direct toppling when the center of gravity of a block is located outside of the base of the block. Flexural toppling requires the rotation of a series of blocks bound by a set of parallel discontinuities, with flexural slip between adjacent blocks.

For a direct toppling failure, the following criteria must be satisfied:

D-1 There must be two sets of discontinuities that dip into the slope and that intersect to form a series of prismatic blocks, or columns;

D-2 A third discontinuity must exist that forms the base of the blocks;

D-3 The width/height ratio of the block must be such that the center of gravity is located outside of the base of the block, i.e. $h/w < \tan \gamma$, where h/w is the height/width ratio and $\gamma$ is the dip of the basal discontinuity.

The conditions that favor direct toppling are not present on the existing steep cut slopes.

For a flexural toppling failure, the following three criteria must be satisfied:

F-1 There must be a set of discontinuities that dips into the slope at an angle that is sufficiently high to allow interlayer (flexural) slip.

F-2 The dip direction of the discontinuity must be within about 10 degrees of the dip direction of the slope.

F-3 Additional joint sets must be present that isolate blocks at their base and sides and allow them to move.

Condition F-1 requires that $\gamma > 90 - \alpha + \varphi$, where $\gamma$ is the dip into the slope of the discontinuity, $\alpha$ is the dip of the slope face, and $\varphi$ is the angle of friction. On a stereonet, criteria F-1 and F-2 define a "sector of flexural toppling failure" (STF), which is bound by a great circle with dip $\gamma = 90 - \alpha + \varphi$, in the opposite direction from the slope dip, and by two great circles representing vertical planes that strike 10 degrees in either direction of the slope-dip direction. For discontinuities with a direction of maximum dip that plot inside the sector of potential flexural toppling failure, it should be verified whether the discontinuity forms a sufficiently well developed set that flexural toppling may occur, and criterion F-3 should be verified.

On Kinematic Analysis Plots #1 and #2, the STF is plotted on the upper stereonet. Each plane is plotted as a great circle with a triangle indicating the line of true dip. Triangles that plot inside the SPF are shaded black. None of the joint planes mapped plot inside the flexural toppling failures on the existing steep cut slopes is negligible.

The slope adjacent to the driveway (Section M) has a factor of safety in excess of 1.5. It is proposed to trim the existing slope adjacent to McGroary Street to a 1:1 gradient, which the analysis indicates is stable with a factor of safety greater than 1.5. The slope is not on the subject property. Revised Section K shows the trim.

Item 3. *Provide additional geologic cross sections or extend existing sections illustrating existing and proposed grades and structures through the highest, steepest and/or geologically critical slopes above the proposed improvements (residences, retaining walls and driveways).*

Response: As noted in the referenced response letter (response to Item 11), dated November 13, 2017, and discussed with the reviewers in the meeting on December 13, 2017, Byer Geotechnical has previously addressed this item and the Revised Geologic Map and sections are based on the most recent grading plan dated January 30, 2018.

Item 4. *The consultants provided analysis to demonstrate that slopes 1:1 and flatter are surficially stable. As previously requested, provide surficial stability analysis using appropriate slope gradients steeper than 1:1.*

Response: Slopes steeper than 1:1 consist of bedrock and have no soil cover.

Item 5. *The figure used by the civil engineer for mudflow analysis does not appear to provide topography for the entire watershed above the subject site. Revise the map and area calculations for the entire watershed. As previously requested, provide design calculations and recommendations for construction within a potential mudflow hazard area per Section 91.7014.3. Show the tributary drainage/contributing watershed area on the regional topography map and, provide calculations for debris flow control systems within and at the base of concentrated drainage areas, using the minimum design parameters specified in section 7014.3 of the LA City Building Code. Show all proposed debris flow control systems and drainage structures on the geologic map. Note: (s) If such calculations are to be provided by a civil engineer, include the wet-signed original of the civil engineer's report, in the addendum; (b) Protective devices shall be permanent structures designed to either isolate, contain, deflect or channelize any potential debris flows.*

Response: The mudflow analysis has been revised by the civil engineer to reflect the entire watershed area. The revised mudflow analysis is enclosed.

Item 6. *An appointment for a preliminary review of the response with the report reviewers will be required prior to the Department accepting a response to this correction letter. Call (213) 482-0480 to make an appointment with the reviewers.*

Response: The project geologist, civil engineer, and property owner met with the reviewers to discuss the review letter on December 13, 2017.

Byer Geotechnical appreciates the opportunity to continue to provide our service on this project. Any questions concerning the data or interpretation of this report should be directed to the undersigned.

Respectfully submitted,
**BYER GEOTECHNICAL, INC.**

James E. Tucker
P. G. 6628

Hans Hoek
E. G. 2544

CERTIFIED ENGINEERING GEOLOGIST JOHAN (HANS) HOEK C.E.G. No. 2544 Exp. 8/31/18 STATE OF CALIFORNIA

Raffi S. Babayan
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REGISTERED PROFESSIONAL ENGINEER RAFFI S. BABAYAN No. 72168 Exp. June 30, 2018 CIVIL STATE OF CALIFORNIA

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Enc: References
LADBS, Geology and Soils Report Review Letter, dated December 5, 2017 (3 Pages)
Kinematic Analysis Plots #1 and #2 (2 Pages)
Tables 1, 2, and 3 (Page and Sheet)
Wedge Stability Calculation #1 - #12 (12 Pages)
Hayk Martirosian, Mudflow Analysis

In Pocket: Revised Geologic Map
Revised Geologic Map #2
Revised Sections A, B, and C (1 Sheet)
Revised Sections D and E (1 Sheet)
Revised Sections F and I (1 Sheet)
Revised Sections G, H, & Sections J, K, L, and M (1 Sheet)

xc: (3) Addressee (Email and Mail)

## REFERENCES

Kliche, C.A. (1999) Rock Slope Stability, Society for Mining Metallurgy & Exploration.

Wyllie, D. C. and Mah, C. W., 2004, **Rock Slope Engineering: 4th Edition,** Spon Press, London and New York, 432p.

CITY OF LOS ANGELES
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FRANK M. BUSH
GENERAL MANAGER
SUPERINTENDENT OF BUILDING

OSAMA YOUNAN, P.E.
EXECUTIVE OFFICER

# GEOLOGY AND SOILS REPORT REVIEW LETTER

December 05, 2017

LOG # 93472-01
SOILS/GEOLOGY FILE - 2
LAN

Albert Davityan
8160 McGroarty Street
Sunland, CA 91040

PROPOSED TENTATIVE TRACT: VTT-73957, Lots 1 through 13
CURRENT LEGAL: WESTERN EMPIRE TRACT (MP 18-162/163 [SHT 4]), Lot 202 1/2 (Arb. 2)
LOCATION: 8100, 8150, & 8160 W. McGroarty Street (aka 10000 N. McVine Trail)

| CURRENT REFERENCE REPORT/LETTER | REPORT No. | DATE OF DOCUMENT | PREPARED BY |
|---|---|---|---|
| Addendum/Response Report | BG 21103 | 11/13/2017 | Byer Geotechnical, Inc. |
| Oversized Documents | " | " | " |

| PREVIOUS REFERENCE REPORT/LETTER | REPORT No. | DATE OF DOCUMENT | PREPARED BY |
|---|---|---|---|
| Dept. Review Letter | 93472 | 08/18/2016 | LADBS |
| Geology/Soils Report | BG 21103 | 03/03/2016 | Byer Geotechnical, Inc. |

The Grading Division of the Department of Building and Safety has reviewed the Vesting Tentative Tract No. 73957 dated 04/04/2017 and the referenced reports that provides recommendations for the proposed 13 single family lots with 2-story residences (2 existing residences to remain on proposed lots 3 and 8), driveways, private street, retaining walls, 2:1 fill slopes, debris basins, 1.5H:1V bedrock cut slopes and 1:1 street cut slopes. The proposed subdivision is located near the toe of an approximately 430 foot high north facing slopes with steep incised drainages.

The earth materials at the subsurface exploration locations consist of up to 6 feet of uncertified fill, compacted fill and up to 2 feet of natural residual soil underlain by alluvium and Wilson diorite/granodiorite bedrock. The consultants recommend to support the proposed residences on conventional foundations bearing on a blanket of properly placed fill a minimum of 3 feet thick and the proposed retaining walls on conventional and/or drilled-pile foundations bearing on properly placed fill and/or competent bedrock.

The review of the Vesting Tentative Tract Map No. 73957 dated 04/04/2017 and the referenced reports cannot be completed because the stability or safety of the proposed development cannot be determined at this time. The review will be continued upon submittal of an addendum to the reports which includes, but need not be limited to, the following:

(Note: Numbers in parenthesis ( ) refer to applicable sections of the 2014 City of LA Building Code. P/BC numbers refer the applicable Information Bulletin. Information Bulletins can be accessed on the internet at LADBS.ORG.)

1. It is unclear how the existing site will be graded to current code conformance. Provide a geologic map that is based upon the detailed grading or site development plans in accordance to the Department of City Planning Instructions for Filing Tentative Tract Maps including the Hillside area provisions.

   As previously requested, the geologic map shall illustrate all proposed and existing contours relative to the planned grading and/or construction; show the proposed cut/fill limits (provide a cut/fill line); show and label the location of all existing cut slopes; all temporary excavations; all proposed retaining walls (label location and height); location and dimensions of all debris basins; along with all off-site slopes and conditions which could adversely affect the stability or safety of the site. In addition, the geologic map based on a revised tentative tract map shall show all erosion control and drainage devises per section 7013 of the code.

2. The consultants proposed a 1:1 street cut, offsite cut slopes adjacent to the subject lots are steeper than 1:1 (Sections H and M), and other slopes 1:1 or steeper existing on the subject lots. As previously requested, for rock slopes 1:1 (H:V) or steeper to remain (native or cut), provide additional geologic mapping and analysis that incorporates, but not limited to, the following:

   a. Detailed mapping and description of discontinuities along the existing cut slope; such as bedding planes, lithologic contacts, joints, fractures, and faults, with characteristics such as orientation, spacing, presence of infilling or openness, continuity, etc. Provide a table with attitudes mapped and any conversions of data points used for data analysis.

   b. Kinematic analysis of discontinuities relative to the slope face, using stereographic methods to assess potential planar, wedge and topple type failures.

   c. Slope stability analysis of the potential failures using appropriate methods for type of failure identified from the kinematic analysis.

3. Provide additional geological cross sections or extend existing sections illustrating existing and proposed grades and structures through the highest, steepest and/or geologically critical slopes above the proposed improvements (residences, retaining walls and driveways).

4. The consultants provided analysis to demonstrate that slopes 1:1 and flatter are surficially stable. As previously requested, provide surficial stability analysis using appropriate slope gradients steeper than 1:1.

5. The figure used by the civil engineer for mudflow analysis does not appear to provide topography for the entire watershed above the subject site. Revise the map and area calculations for the entire watershed. As previously requested, provide design calculations and **recommendations** for construction within a potential mudflow hazard area per Section 91.7014.3. Show the tributary drainage/contributing watershed area on the regional topography map and, provide calculations for debris flow control systems within and at the base of concentrated drainage areas, using the minimum design parameters specified in section 7014.3 of the LA City Building Code. Show all proposed debris flow control systems and drainage structures on the geologic map. Note: (a) If such calculations are to be provided by a civil engineer, include the wet-signed original of the civil engineer's report, in the addendum; (b) Protective devices shall be permanent structures designed to either isolate, contain, deflect or channelize any potential debris flows.

6. An appointment for a preliminary review of the response with the report reviewers will be required prior to the Department accepting a response to this correction letter. Call (213) 482-0480 to make an appointment with the reviewers.

The geologist and soils engineer shall prepare a report containing an itemized response to the review items indicated in this letter. If clarification concerning the review letter is necessary, the report review engineer and/or geologist may be contacted. Two copies of the response report, including one unbound wet-signed original for archiving purposes, a pdf-copy of the complete report in a CD or flash drive, and the appropriate fees will be required for submittal.

CASEY LEE JENSEN
Engineering Geologist Associate III

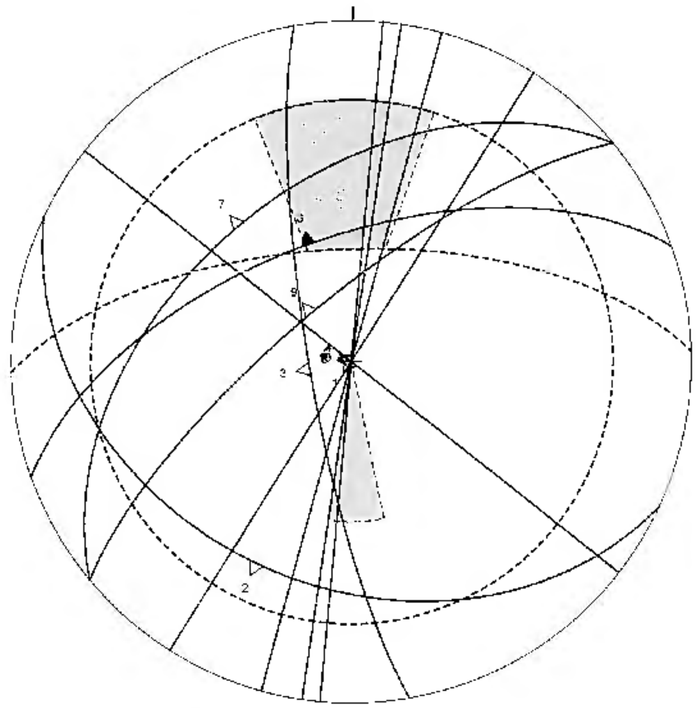
YING LIU
Geotechnical Engineer I

CLJ/YL:clj/yl
Log No. 93472-01
213-482-0480

cc: Byer Geotechnical, Inc., Project Consultant
VN District Office

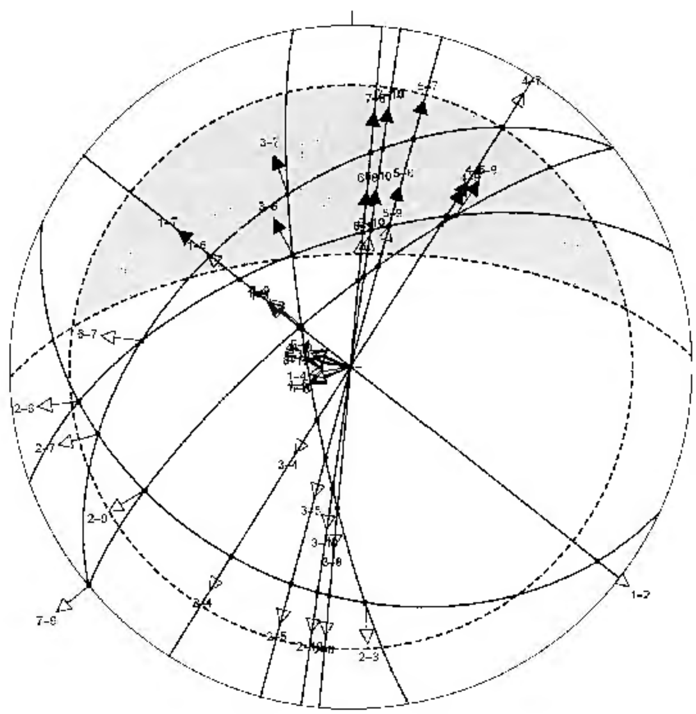
## Kinematic Feasibility for Planar and Flexural Topple Failures

The upper stereonet shows the 10 planes mapped closest to location # K.Each plane is indicated by a great circle and by a triangle that indicates the line of true dip,and is labeled with the data point number. (Refer to Table 1 for orientation and type of plane.) The slope face and friction circle are shown as dashed black lines and together define the Sector of Planar Failure (SPF), which is shaded gray. The friction circle is drawn for a phi angle of 24.2 degrees, which incorporates a factor of safety FS = 1.5. The Sector of Flexural Topple Failure (STF), also shaded gray, forms a triangle near the center of the upper stereonet. Triangles that plot outside of the SPF and STF are unshaded, indicating that planar or flexural topple failure on that plane is kinematically unfeasible. Triangles that plot inside the SPF or STF are shaded, indicating that planar or flexural topple failure is kinematically feasible based on friction alone. These cases are further analyzed as summarized on Tables 4 and 5.



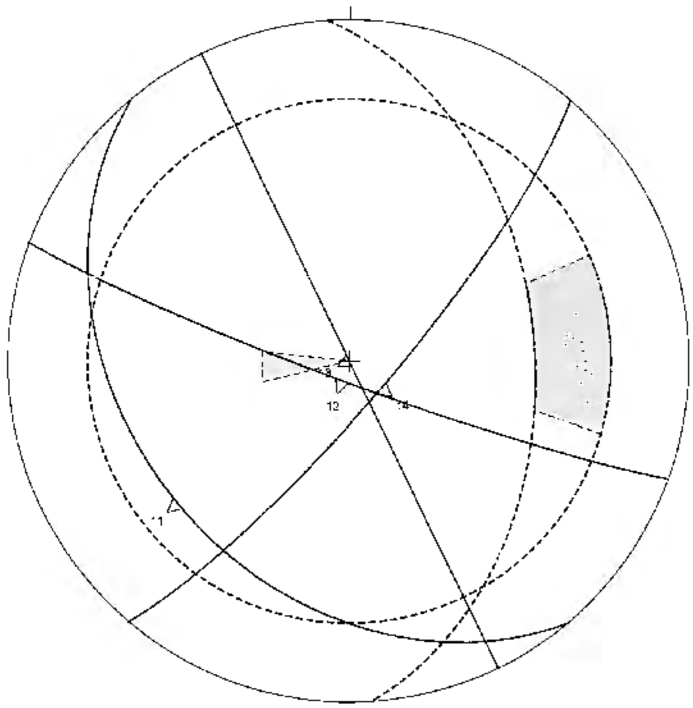
## Kinematic Feasibility for Wedge Failures

The lower stereonet shows arrows for intersections between the 10 planes mapped at location # K.The shaded area indicates the Sector of Wedge Failure (SWF), using a friction circle that is drawn for a phi angle of 18.6 degrees, which incorporates a factor of safety FS = 2. Arrows that plot outside of the SWF are unshaded, indicating that a wedge failure is kinematically unfeasible. Arrows that plot inside the SWF are black, indicating that a wedge failure is kinematically feasible. Sets of planes with a potential wedge failure are further analyzed as summarized on Table 3.



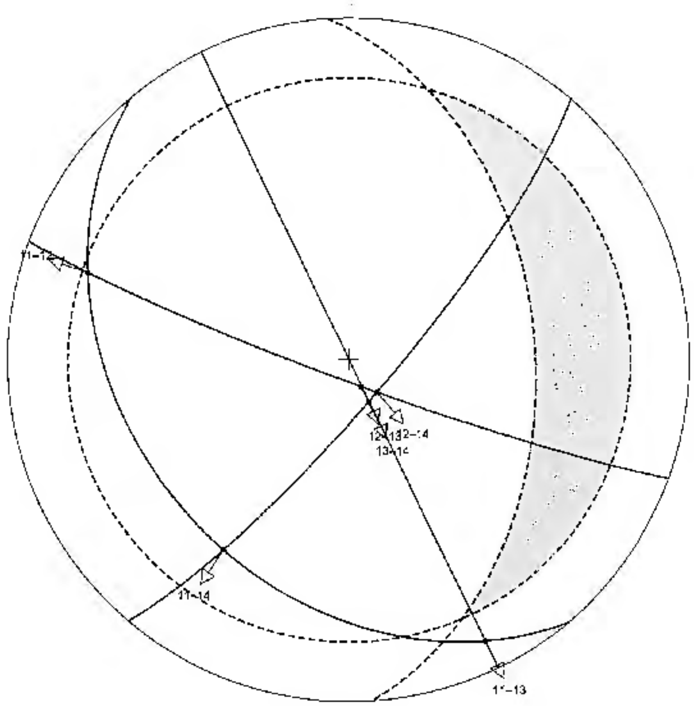
## Kinematic Feasibility for Planar and Flexural Topple Failures

The upper stereonet shows the 4 planes mapped closest to location # M.Each plane is indicated by a great circle and by a triangle that indicates the line of true dip,and is labeled with the data point number. (Refer to Table 1 for orientation and type of plane.) The slope face and friction circle are shown as dashed black lines and together define the Sector of Planar Failure (SPF), which is shaded gray. The friction circle is drawn for a phi angle of 24.2 degrees, which incorporates a factor of safety FS = 1.5. The Sector of Flexural Topple Failure (STF), also shaded gray, forms a triangle near the center of the upper stereonet. Triangles that plot outside of the SPF and STF are unshaded, indicating that planar or flexural topple failure on that plane is kinematically unfeasible. Triangles that plot inside the SPF or STF are shaded, indicating that planar or flexural topple failure is kinematically feasible based on friction alone. These cases are further analyzed as summarized on Tables 4 and 5.




## Kinematic Feasibility for Wedge Failures

The lower stereonet shows arrows for intersections between the 4 planes mapped at location # M.The shaded area indicates the Sector of Wedge Failure (SWF), using a friction circle that is drawn for a phi angle of 18.6 degrees, which incorporates a factor of safety FS = 2. Arrows that plot outside of the SWF are unshaded, indicating that a wedge failure is kinematically unfeasible. Arrows that plot inside the SWF are black, indicating that a wedge failure is kinematically feasible. Sets of planes with a potential wedge failure are further analyzed as summarized on Table 3.



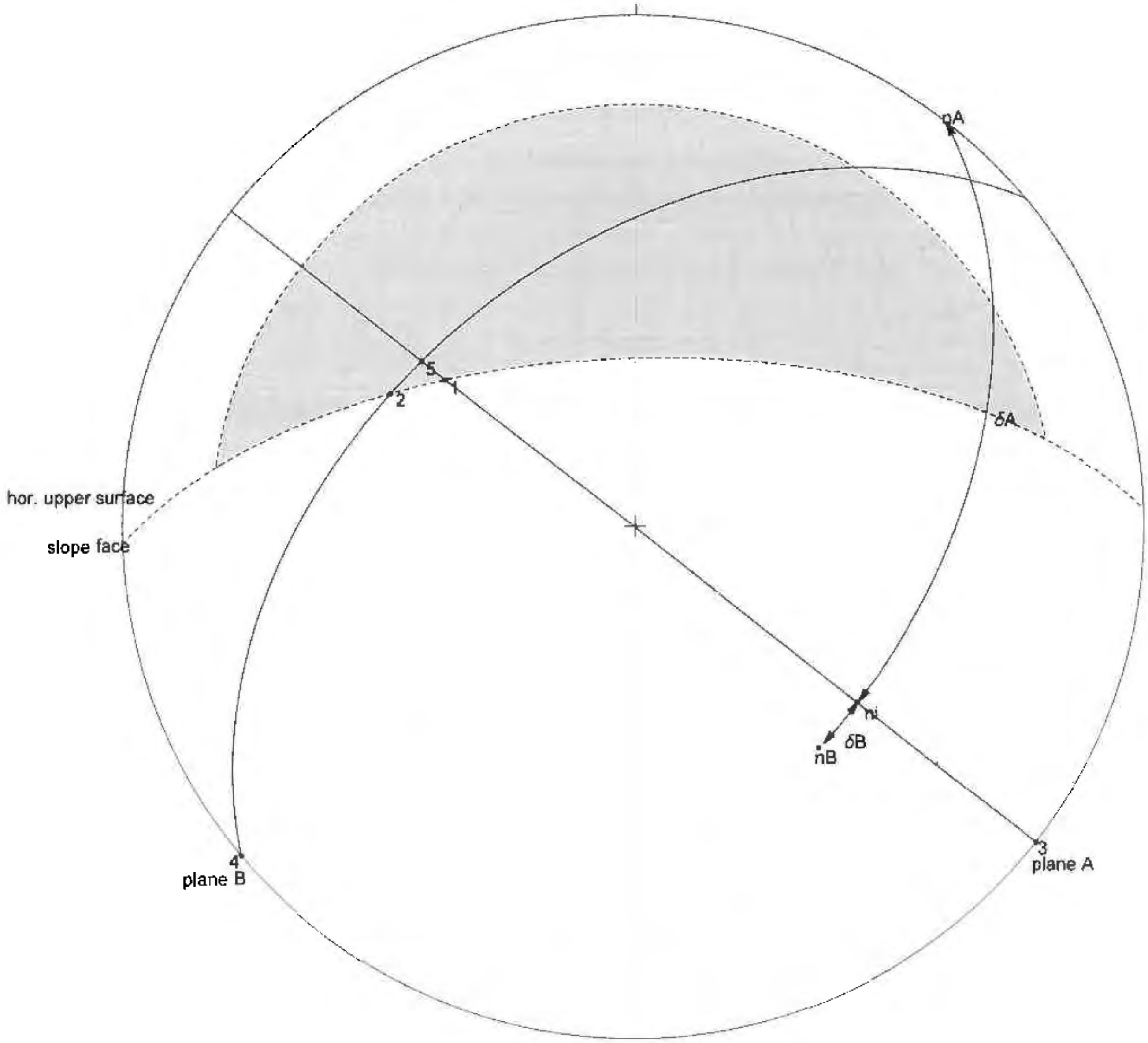
| TABLE 1 - PLANAR DATA | | | BG 21103 DAVITYAN | | |
|---|---|---|---|---|---|
| plane # | dipdir | dip | strikedip | type | Location |
| 1 | 218 | 90 | N52W, vertical | j | Section K |
| 2 | 205 | 35 | N65W, 35 SW | j | Section K |
| 3 | 260 | 80 | N10W, 80 SW | j | Section K |
| 5 | 285 | 90 | N15E, vertical | j | Section K |
| 4 | 302 | 90 | N32E, vertical | j | Section K |
| 6 | 340 | 60 | N70E, 60 NW | j | Section K |
| 7 | 320 | 47 | N50E, 47 NW | j | Section K |
| 8 | 275 | 90 | N5E, vertical | j | Section K |
| 9 | 320 | 75 | N50E, 75 NW | j | Section K |
| 10 | 278 | 90 | N8E, vertical | j | Section K |
| 11 | 230 | 35 | N40W, 35 SW | j | Section M |
| 12 | 200 | 85 | N70W, 85 SW | j | Section M |
| 13 | 244 | 90 | N26W, vertical | j | Section M |
| 14 | 130 | 80 | N40E, 80 SE | j | Section M |
| Notes/Abbreviations: planar orientations are listed as {dipdir,dip}; j = joint plane | | | | | |

| TABLE 2 - SLOPE DATA | | | | BG 21103 DAVITYAN | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| location | toe elevation | dipdir1 | dip1 | strikedip1 | top elevation | dipdir2 | dip2 | strikedip2 | slope height |
| Section K | 1528 | 358 | 63 | N88E ; 63 NW | 1550 | 358 | 0 | N88E ; 0 NW | 22 |
| Section M | 1550 | 86 | 45 | N4W ; 45 NE | 1564 | 90 | 15 | NS ; 15 N | 14 |
| Notes/Abbreviations: planar orientations are listed as {dipdir,dip} and strike and dip; 1 strikedip 1 refers to slope face; strikedip 2 refers to upper slope | | | | | | | | | |

| loc # | plane1 # | plane2 # | plane 1 | plane 2 | kinematic feasibility | height (ft) | factor of safety | required slope trim |
|---|---|---|---|---|---|---|---|---|
| K | 1 | 2 | {218, 90} | {205, 35} | wedge is not kinematically feasible | | | |
| K | 1 | 3 | {218, 90} | {260, 80} | wedge is not kinematically feasible | | | |
| K | 1 | 5 | {218, 90} | {285, 90} | wedge is not kinematically feasible | | | |
| K | 1 | 4 | {218, 90} | {302, 90} | wedge is not kinematically feasible | | | |
| K | 1 | 6 | {218, 90} | {340, 60} | wedge is not kinematically feasible | | | |
| K | 1 | 7 | {218, 90} | {320, 47} | see Wedge Stability Calculation #1 | 22 | FS = 1.68 for cohesion = 50 psf | slope trim to 58.5 degrees eliminates wedge |
| K | 1 | 8 | {218, 90} | {275, 90} | wedge is not kinematically feasible | | | |
| K | 1 | 9 | {218, 90} | {320, 75} | wedge is not kinematically feasible | | | |
| K | 1 | 10 | {218, 90} | {278, 90} | wedge is not kinematically feasible | | | |
| K | 2 | 3 | {205, 35} | {260, 80} | wedge is not kinematically feasible | | | |
| K | 2 | 5 | {205, 35} | {285, 90} | wedge is not kinematically feasible | | | |
| K | 2 | 4 | {205, 35} | {302, 90} | wedge is not kinematically feasible | | | |
| K | 2 | 6 | {205, 35} | {340, 60} | wedge is not kinematically feasible | | | |
| K | 2 | 7 | {205, 35} | {320, 47} | wedge is not kinematically feasible | | | |
| K | 2 | 8 | {205, 35} | {275, 90} | wedge is not kinematically feasible | | | |
| K | 2 | 9 | {205, 35} | {320, 75} | wedge is not kinematically feasible | | | |
| K | 2 | 10 | {205, 35} | {278, 90} | wedge is not kinematically feasible | | | |
| K | 3 | 5 | {260, 80} | {285, 90} | wedge is not kinematically feasible | | | |
| K | 3 | 4 | {260, 80} | {302, 90} | wedge is not kinematically feasible | | | |
| K | 3 | 6 | {260, 80} | {340, 60} | see Wedge Stability Calculation #2 | 22 | FS = 2.53 for cohesion = 20 psf | slope trim to 62.3 degrees eliminates wedge |
| K | 3 | 7 | {260, 80} | {320, 47} | see Wedge Stability Calculation #3 | 22 | FS = 1.52 for cohesion = 130 psf | slope trim to 46.7 degrees eliminates wedge |
| K | 3 | 8 | {260, 80} | {275, 90} | wedge is not kinematically feasible | | | |
| K | 3 | 9 | {260, 80} | {320, 75} | wedge is not kinematically feasible | | | |
| K | 3 | 10 | {260, 80} | {278, 90} | wedge is not kinematically feasible | | | |
| K | 5 | 4 | {285, 90} | {302, 90} | wedge is not kinematically feasible | | | |
| K | 5 | 6 | {285, 90} | {340, 60} | see Wedge Stability Calculation #4 | 22 | FS = 1.53 for cohesion = 70 psf | slope trim to 56. degrees eliminates wedge |
| K | 5 | 7 | {285, 90} | {320, 47} | see Wedge Stability Calculation #5 | 22 | FS = 2.19 for cohesion = 0 psf | |
| K | 5 | 8 | {285, 90} | {275, 90} | wedge is not kinematically feasible | | | |
| K | 5 | 9 | {285, 90} | {320, 75} | wedge is not kinematically feasible | | | |
| K | 5 | 10 | {285, 90} | {278, 90} | wedge is not kinematically feasible | | | |
| K | 4 | 6 | {302, 90} | {340, 60} | see Wedge Stability Calculation #6 | 22 | FS = 1.51 for cohesion = 10 psf | slope trim to 52.2 degrees eliminates wedge |
| K | 4 | 7 | {302, 90} | {320, 47} | wedge is not kinematically feasible | | | |
| K | 4 | 8 | {302, 90} | {275, 90} | wedge is not kinematically feasible | | | |
| K | 4 | 9 | {302, 90} | {320, 75} | see Wedge Stability Calculation #7 | 22 | FS = 2.83 for cohesion = 0 psf | |
| K | 4 | 10 | {302, 90} | {278, 90} | wedge is not kinematically feasible | | | |
| K | 6 | 7 | {340, 60} | {320, 47} | wedge is not kinematically feasible | | | |
| K | 6 | 8 | {340, 60} | {275, 90} | see Wedge Stability Calculation #8 | 22 | FS = 1.56 for cohesion = 70 psf | slope trim to 57.7 degrees eliminates wedge |
| K | 6 | 9 | {340, 60} | {320, 75} | see Wedge Stability Calculation #9 | 22 | FS = 2.71 for cohesion = 0 psf | |
| K | 6 | 10 | {340, 60} | {278, 90} | see Wedge Stability Calculation #10 | 22 | FS = 1.54 for cohesion = 70 psf | slope trim to 57.2 degrees eliminates wedge |
| K | 7 | 8 | {320, 47} | {275, 90} | see Wedge Stability Calculation #11 | 22 | FS = 1.58 for cohesion = 0 psf | |
| K | 7 | 9 | {320, 47} | {320, 75} | wedge is not kinematically feasible | | | |
| K | 7 | 10 | {320, 47} | {278, 90} | see Wedge Stability Calculation #12 | 22 | FS = 1.73 for cohesion = 0 psf | |
| K | 8 | 9 | {275, 90} | {320, 75} | wedge is not kinematically feasible | | | |
| K | 8 | 10 | {275, 90} | {278, 90} | wedge is not kinematically feasible | | | |
| K | 9 | 10 | {320, 75} | {278, 90} | wedge is not kinematically feasible | | | |
| M | 11 | 12 | {230, 35} | {200, 85} | wedge is not kinematically feasible | | | |
| M | 11 | 13 | {230, 35} | {244, 90} | wedge is not kinematically feasible | | | |
| M | 11 | 14 | {230, 35} | {130, 80} | wedge is not kinematically feasible | | | |
| M | 12 | 13 | {200, 85} | {244, 90} | wedge is not kinematically feasible | | | |
| M | 12 | 14 | {200, 85} | {130, 80} | wedge is not kinematically feasible | | | |
| M | 13 | 14 | {244, 90} | {130, 80} | wedge is not kinematically feasible | | | |

Notes/Abbreviations: slope ID = reference used on map and in calculations; planar orientation are listed as {dipdir,dip}; height is total height of potential wedge; Factor of Safety is first calculated for zero cohesion; if FS < 1.5, cohesion is increased in steps of 10 psf until FS > 1.5

WEDGE STABILITY CALCULATION #1 BG 21103 DAVITYAN CONSULTANT: HH/JET




INPUT PARAMETERS

Plane A ( #1, loc (joint))
- dip direction = 218.°
- dip = 89.9°
- phi ($\phi$A) = 34°
- cohesion (cohA) = 50 psf

Plane B ( #7, loc (joint))
- dip direction = 320.°
- dip= 47.°
- phi ($\phi$B) = 34°
- cohesion (cohB) = 50 psf

Slope Face
- dip direction = 358.°
- dip = 63.°

Upper Slope
- dip direction = 358.°
- dip = 0.°

Wedge
- height (h) = 22. ft
- rock denstiy ($\gamma$r) = 140 pcf

OUTPUT PARAMETERS

Plane A
- $\theta$13 = 128.5°
- $\theta$15 = 5.2°
- $\theta$35 = 133.6°
- area = 45.7 $ft^2$
- hA = 3. ft
- $\delta$A = 89.9°

Plane B
- $\theta$24 = 105.°
- $\theta$25 = 6.7°
- $\theta$45 = 81.7°
- area = 53.1 $ft^2$
- hB = 3.5 ft
- $\delta$B = 8.8°

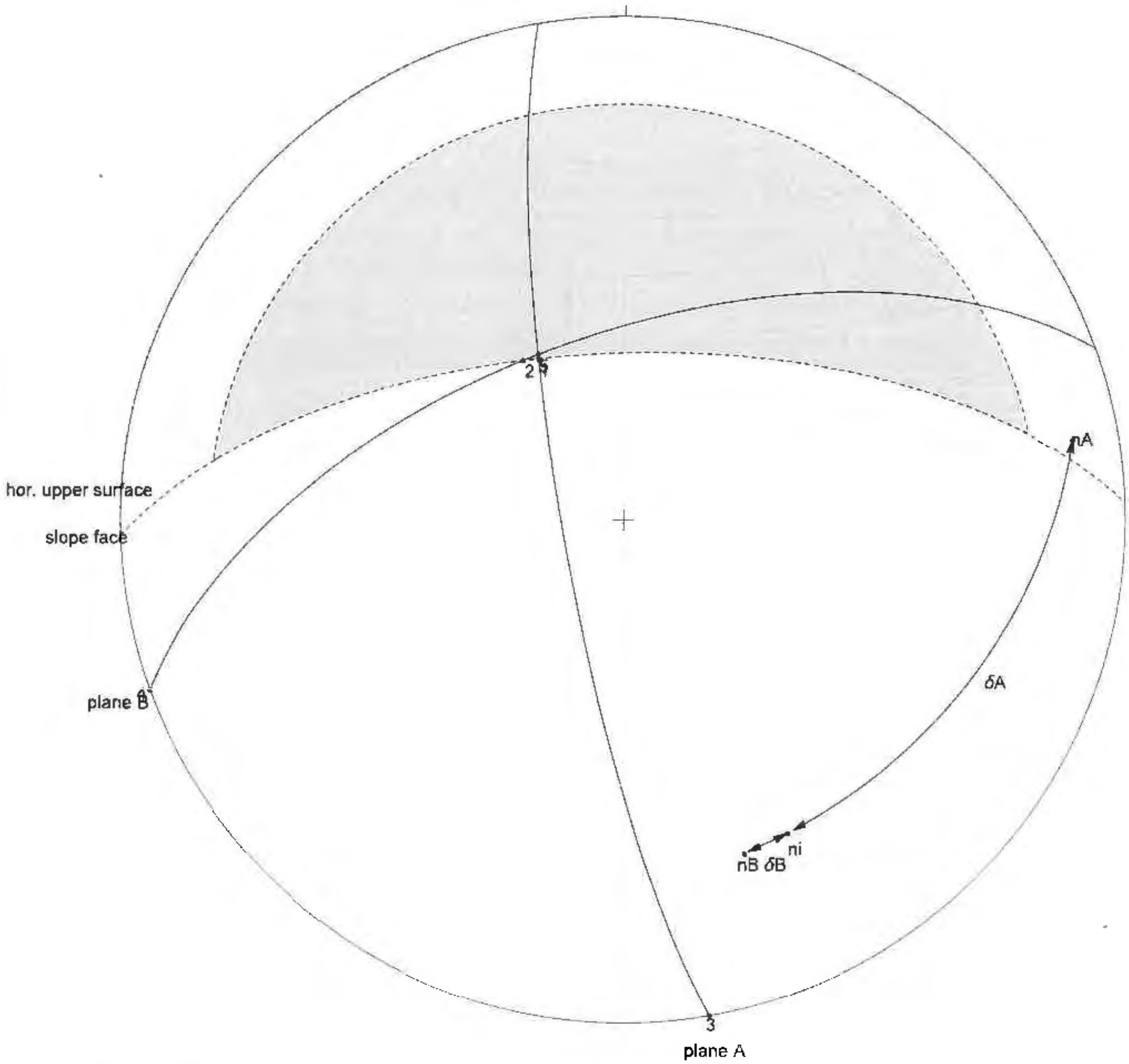
Wedge
- dihedral angle ($\theta$nA,nB) = 98.7°
- wedge angle = 81.3°
- intersection line azimuth ($\alpha$5) = 307.9°
- intersection line plunge ($\psi$5) = 46.4°
- intersection line length (L5) = 30.4 ft
- horizontal wedge length (Lh) = 21. ft
- volume = 52.6 $ft^3$
- weight = 3.7 t

Forces
- driving force = 2.7 t
- resisting forces
  - cohesion force Plane A = 1.1 t
  - friction force Plane A = 0.3 t
  - cohesion force Plane B = 1.3 t
  - friction force Plane B = 1.7 t

Factor of safety against wedge failure (FS) = 1.677

NOTES: calculation follows methodology described in Kliche (1999, p 157–169);
1, 2, 3, and 4 are intersection lines between wedge and slope;
5 is wedge intersection line (direction of sliding);
nA and nB are poles to planes A and B; ni is direction of gravitational force resolved normal to 5;
dA and db are angles used to resolve gravitational force on planes A and B.

WEDGE STABILITY CALCULATION #2 BG 21103 DAVITYAN CONSULTANT: HH/JET




INPUT PARAMETERS

Plane A ( #3, loc (joint))
dip direction = 260.°
dip = 80.°
phi (ϕA) = 34°
cohesion (cohA) = 20 psf
Plane B ( #6, loc (joint))
dip direction = 340.°
dip= 60.°
phi (ϕB) = 34°
cohesion (cohB) = 20 psf
Slope Face
dip direction = 358.°
dip = 63.°
Upper Slope
dip direction = 358.°
dip = 0.°
Wedge
height (h) = 22. ft
rock density (γr) = 140 pcf

OUTPUT PARAMETERS

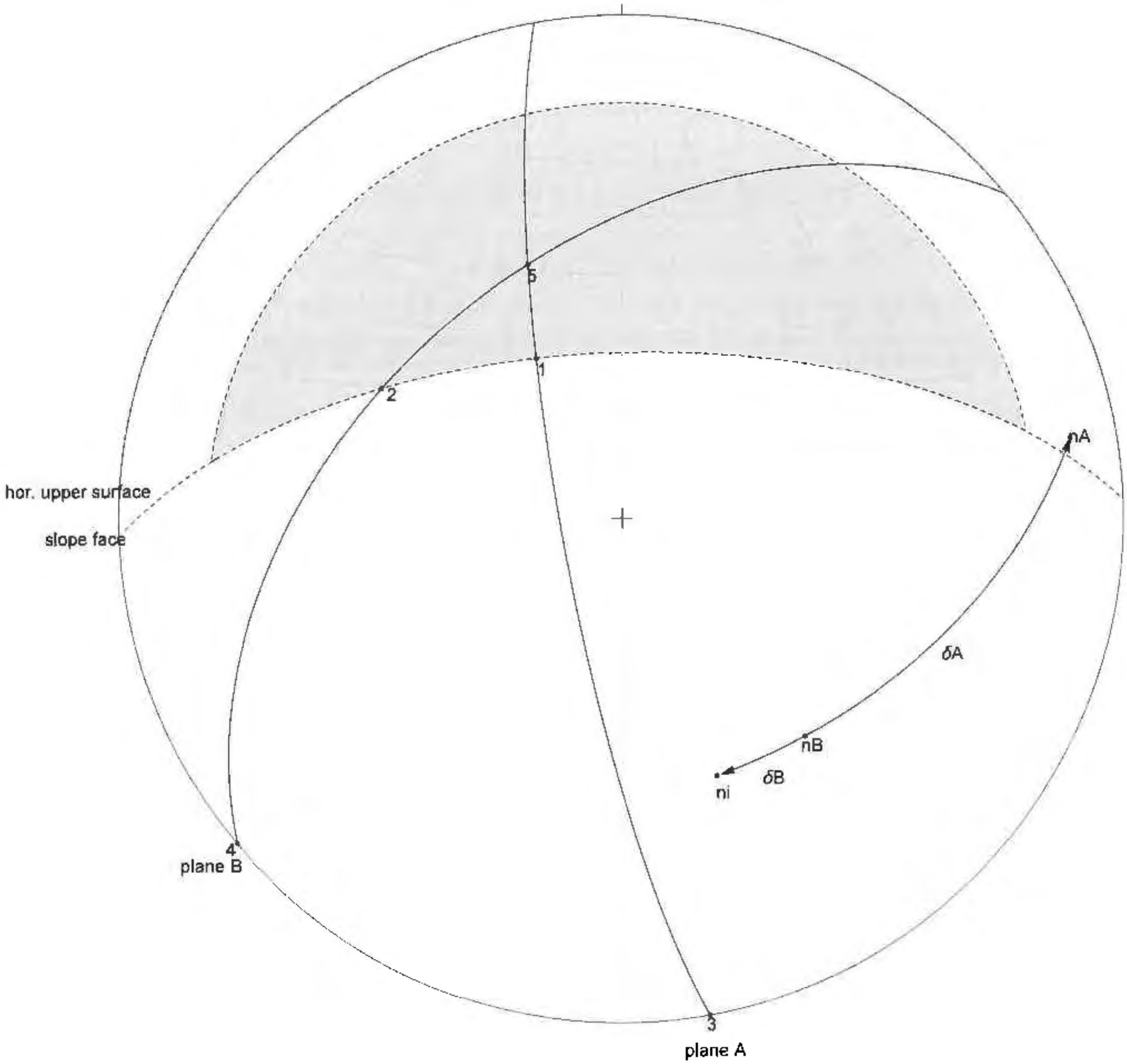
Plane A
θ13 = 118.°
θ15 = 0.7°
θ35 = 118.7°
area = 3.9 $ft^2$
hA = 0.3 ft
δA = 69.8°
Plane B
θ24 = 96.3°
θ25 = 2.5°
θ45 = 86.2°
area = 14.1 $ft^2$
hB = 1.1 ft
δB = 6.6°

Wedge
dihedral angle (θnA.nB) = 76.4°
wedge angle = 103.6°
intersection line azimuth (α5) = 332.4°
intersection line plunge (ψ5) = 59.8°
intersection line length (L5) = 25.5 ft
horizontal wedge length (Lh) = 12.8 ft
volume = 1.4 $ft^3$
weight = 0.1 t
Forces
driving force = 0.1 t
resisting forces
cohesion force Plane A = 0. t
friction force Plane A = 0. t
cohesion force Plane B = 0.1 t
friction force Plane B = 0. t

Factor of safety against wedge failure (FS) = 2.532

NOTES: calculation follows methodology described in Kliche (1999, p 157-169);
1, 2, 3, and 4 are intersection lines between wedge and slope;
5 is wedge intersection line (direction of sliding);
nA and nB are poles to planes A and B; ni is direction of gravitational force resolved normal to 5;
dA and db are angles used to resolve gravitational force on planes A and B.

WEDGE STABILITY CALCULATION #3 BG 21103 DAVITYAN CONSULTANT: HH/JET




INPUT PARAMETERS

Plane A ( #3, loc (joint))
dip direction = 260.°
dip = 80.°
phi (ϕA) = 34°
cohesion (cohA) = 130 psf
Plane B ( #7, loc (joint))
dip direction = 320.°
dip= 47.°
phi (ϕB) = 34°
cohesion (cohB) = 130 psf
Slope Face
dip direction = 358.°
dip = 63.°
Upper Slope
dip direction = 358.°
dip = 0.°
Wedge
height (h) = 22. ft
rock denstiy (γr) = 140 pcf

OUTPUT PARAMETERS

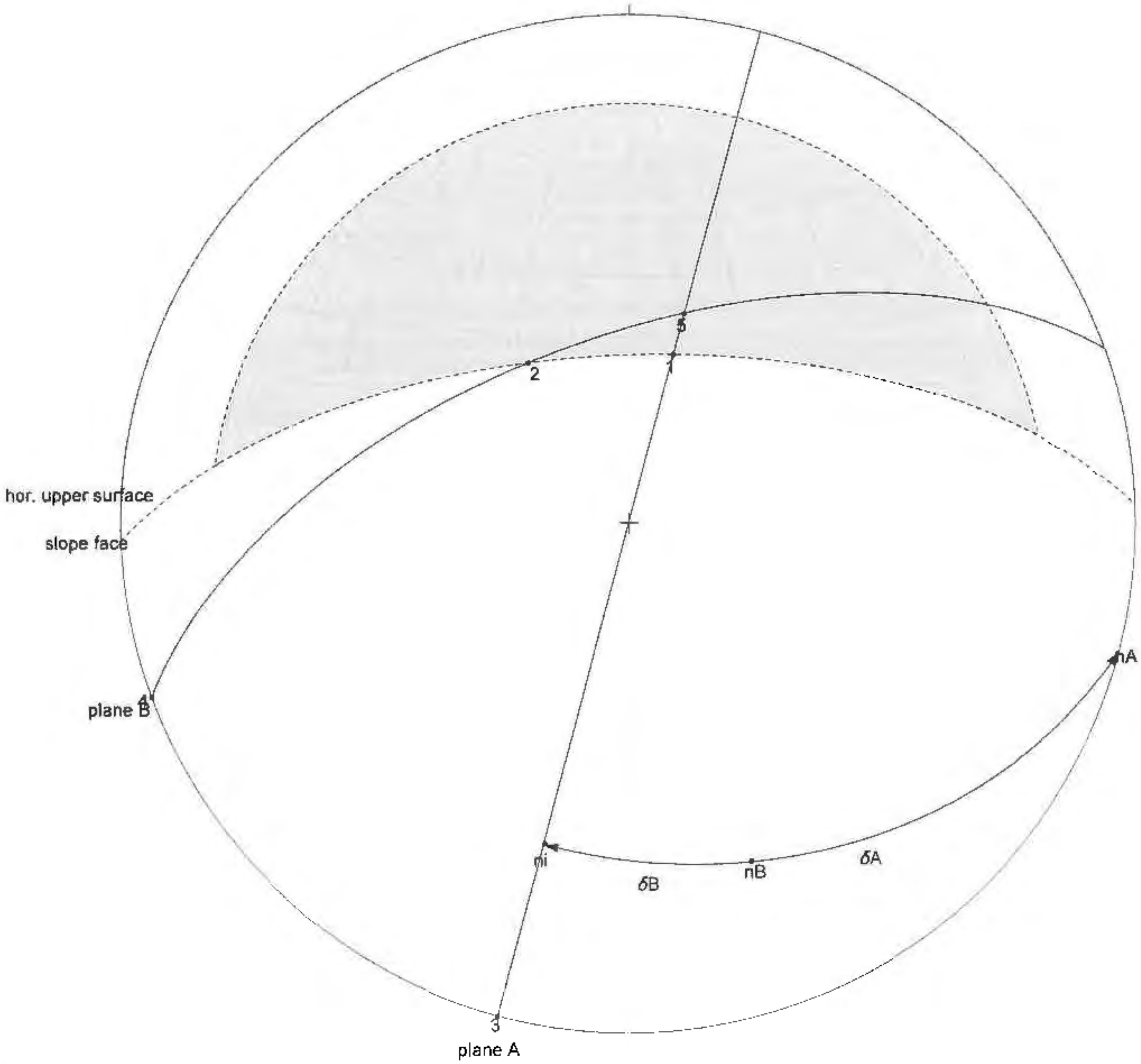
Plane A
θ13 = 118.°
θ15 = 15.9°
θ35 = 133.8°
area = 187.4 $ft^2$
hA = 12.1 ft
δA = 75.7°
Plane B
θ24 = 105.°
θ25 = 28.7°
θ45 = 103.8°
area = 303.8 $ft^2$
hB = 19.6 ft
δB = 14.3°

Wedge
dihedral angle (θnA.nB) = 61.4°
wedge angle = 118.6°
intersection line azimuth (α5) = 339.7°
intersection line plunge (ψ5) = 45.3°
intersection line length (L5) = 31. ft
horizontal wedge length (Lh) = 21.8 ft
volume = 1076. $ft^3$
weight = 75.3 t
Forces
driving force = 53.5 t
resisting forces
cohesion force Plane A = 12.2 t
friction force Plane A = 10.1 t
cohesion force Plane B = 19.7 t
friction force Plane B = 39.5 t

Factor of safety against wedge failure (FS) = 1.522

NOTES: calculation follows methodology described in Kliche (1999, p 157–169);
1, 2, 3, and 4 are intersection lines between wedge and slope;
5 is wedge intersection line (direction of sliding);
nA and nB are poles to planes A and B; ni is direction of gravitational force resolved normal to 5;
dA and db are angles used to resolve gravitational force on planes A and B.

WEDGE STABILITY CALCULATION #4 BG 21103 DAVITYAN CONSULTANT: HH/JET




INPUT PARAMETERS

Plane A ( #5, loc (joint))
dip direction = 285.°
dip = 89.9°
phi ($\phi$A) = 34°
cohesion (cohA) = 70 psf
Plane B ( #6, loc (joint))
dip direction = 340.°
dip= 60.°
phi ($\phi$B) = 34°
cohesion (cohB) = 70 psf
Slope Face
dip direction = 358.°
dip = 63.°
Upper Slope
dip direction = 358.°
dip = 0.°
Wedge
height (h) = 22. ft
rock denstiy ($\gamma$r) = 140 pcf

OUTPUT PARAMETERS

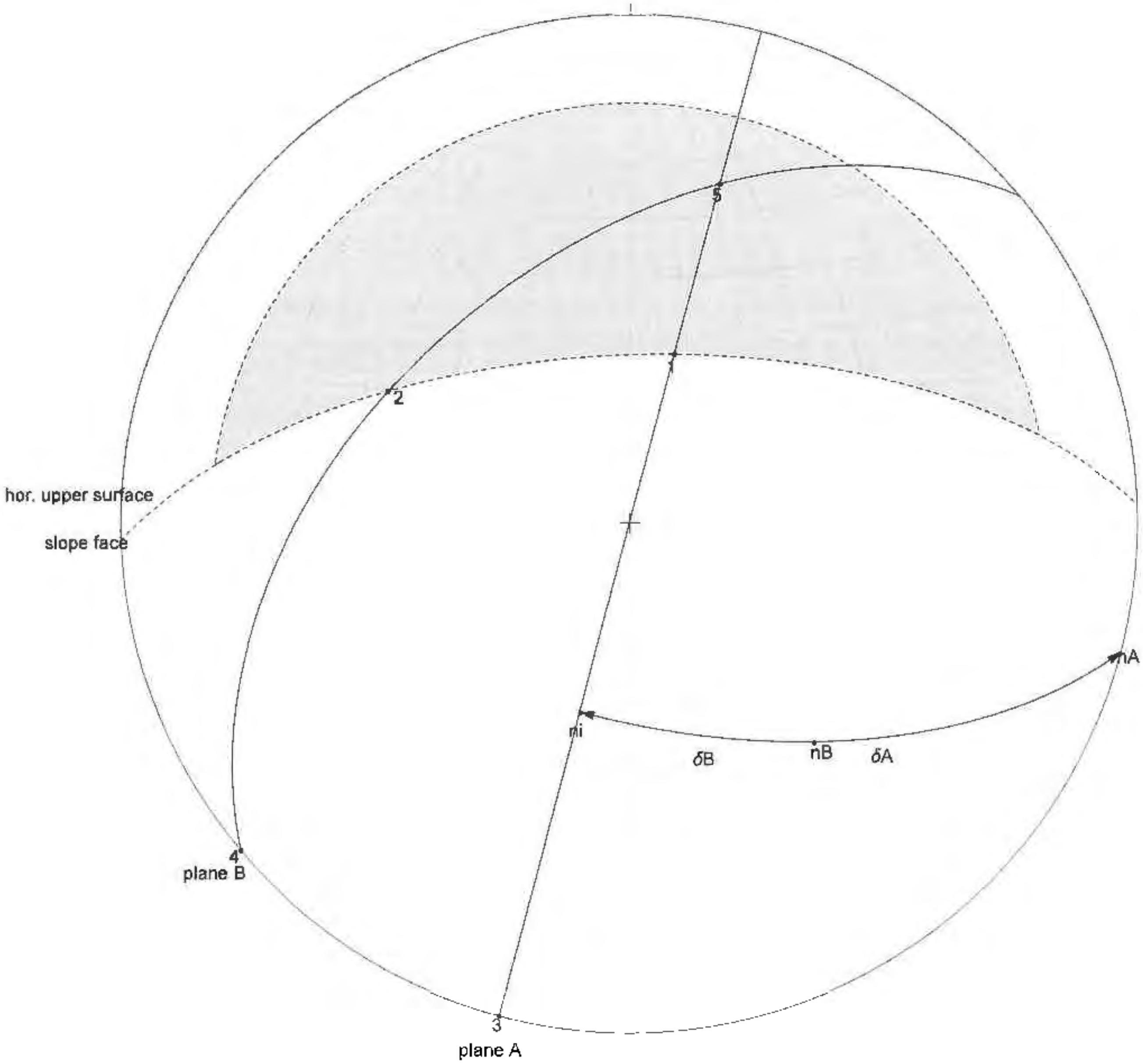
Plane A
$\theta$13 = 118.°
$\theta$15 = 7.1°
$\theta$35 = 125.1°
area = 49.4 $ft^2$
hA = 3.7 ft
$\delta$A = 89.8°
Plane B
$\theta$24 = 96.3°
$\theta$25 = 25.5°
$\theta$45 = 109.2°
area = 207.3 $ft^2$
hB = 15.4 ft
$\delta$B = 29.7°

Wedge
dihedral angle ($\theta$nA.nB) = 60.2°
wedge angle = 119.8°
intersection line azimuth ($\alpha$5) = 14.9°
intersection line plunge ($\psi$5) = 54.9°
intersection line length (L5) = 26.9 ft
horizontal wedge length (Lh) = 15.5 ft
volume = 220.2 $ft^3$
weight = 15.4 t
Forces
driving force = 12.6 t
resisting forces
cohesion force Plane A = 1.7 t
friction force Plane A = 3.4 t
cohesion force Plane B = 7.3 t
friction force Plane B = 6.9 t

Factor of safety against wedge failure (FS) = 1.53

NOTES: calculation follows methodology described in Kliche (1999, p 157–169);
1, 2, 3, and 4 are intersection lines between wedge and slope;
5 is wedge intersection line (direction of sliding);
nA and nB are poles to planes A and B; ni is direction of gravitational force resolved normal to 5;
dA and db are angles used to resolve gravitational force on planes A and B.

WEDGE STABILITY CALCULATION #5 BG 21103 DAVITYAN CONSULTANT: HH/JET




INPUT PARAMETERS

Plane A ( #5, loc (joint))
dip direction = 285.°
dip = 89.9°
phi (ϕA) = 34°
cohesion (cohA) = 0 psf
Plane B ( #7, loc (joint))
dip direction = 320.°
dip= 47.°
phi (ϕB) = 34°
cohesion (cohB) = 0 psf
Slope Face
dip direction = 358.°
dip = 63.°
Upper Slope
dip direction = 358.°
dip = 0.°
Wedge
height (h) = 22. ft
rock denstiy (γr) = 140 pcf

OUTPUT PARAMETERS

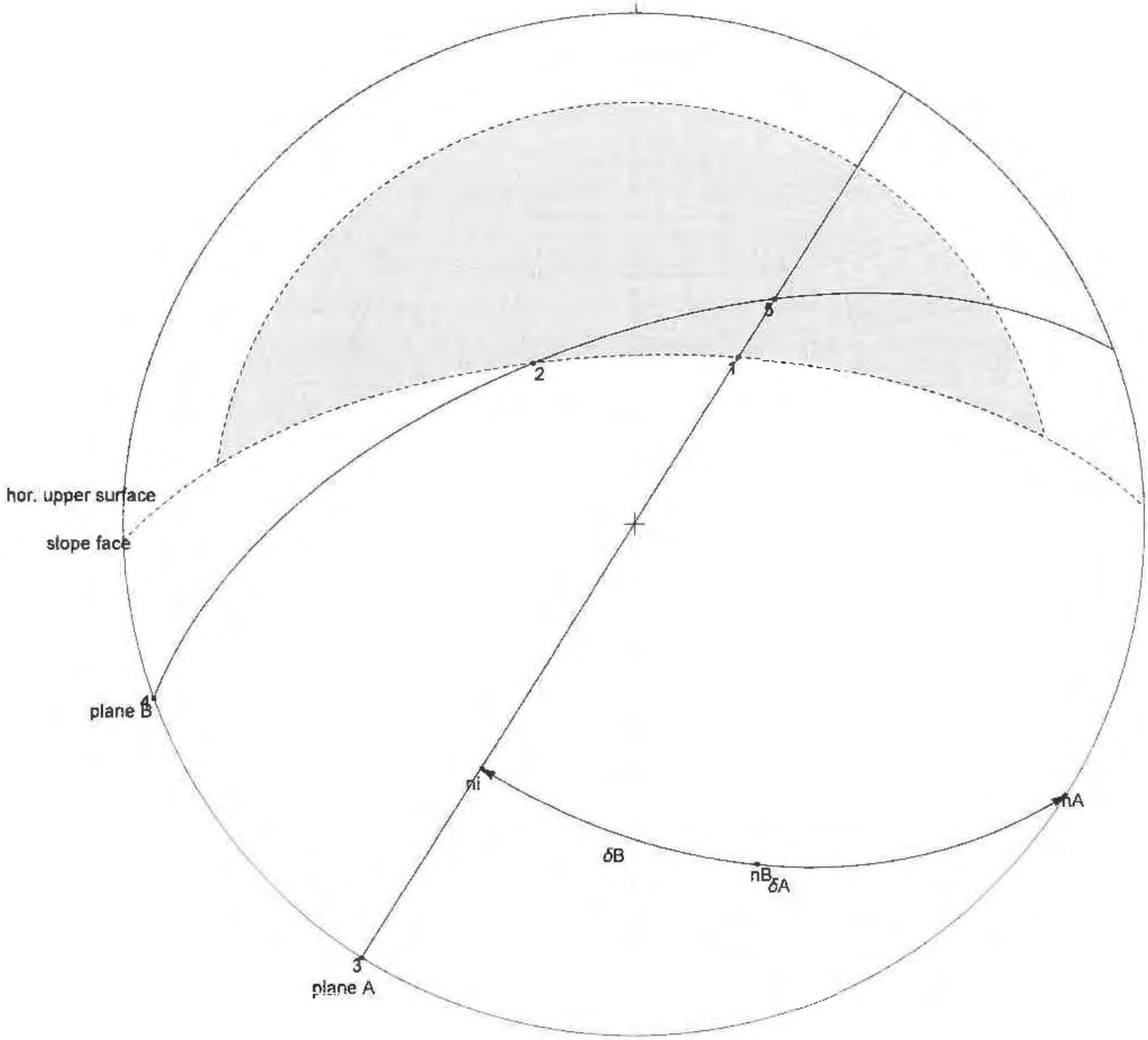
Plane A
θ13 = 118.°
θ15 = 30.3°
θ35 = 148.4°
area = 10322.1 $ft^2$
hA = 492.2 ft
δA = 89.9°
Plane B
θ24 = 105.°
θ25 = 59.2°
θ45 = 134.2°
area = −2347.2 $ft^2$
hB = −111.9 ft
δB = 36.8°

Wedge
dihedral angle (θnA.nB) = 53.1°
wedge angle = 126.9°
intersection line azimuth (α5) = 14.9°
intersection line plunge (ψ5) = 31.6°
intersection line length (L5) = 41.9 ft
horizontal wedge length (Lh) = 35.7 ft
volume = −307979. $ft^3$
weight = −21558.5 t
Forces
driving force = −11307.3 t
resisting forces
cohesion force Plane A = 0. t
friction force Plane A = −9266.9 t
cohesion force Plane B = 0. t
friction force Plane B = −15479.9 t

Factor of safety against wedge failure (FS) = 2.189

NOTES: calculation follows methodology described in Kliche (1999, p 157–169);
1, 2, 3, and 4 are intersection lines between wedge and slope;
5 is wedge intersection line (direction of sliding);
nA and nB are poles to planes A and B; ni is direction of gravitational force resolved normal to 5;
dA and db are angles used to resolve gravitational force on planes A and B.

WEDGE STABILITY CALCULATION #6 BG 21103 DAVITYAN CONSULTANT: HH/JET




INPUT PARAMETERS

Plane A ( #4, loc (joint))
dip direction = 302.°
dip = 89.9°
phi (ϕA) = 34°
cohesion (cohA) = 10 psf
Plane B ( #6, loc (joint))
dip direction = 340.°
dip= 60.°
phi (ϕB) = 34°
cohesion (cohB) = 10 psf
Slope Face
dip direction = 356.°
dip = 63.°
Upper Slope
dip direction = 356.°
dip = 0.°
Wedge
height (h) = 22. ft
rock denstiy (γr) = 140 pcf

OUTPUT PARAMETERS

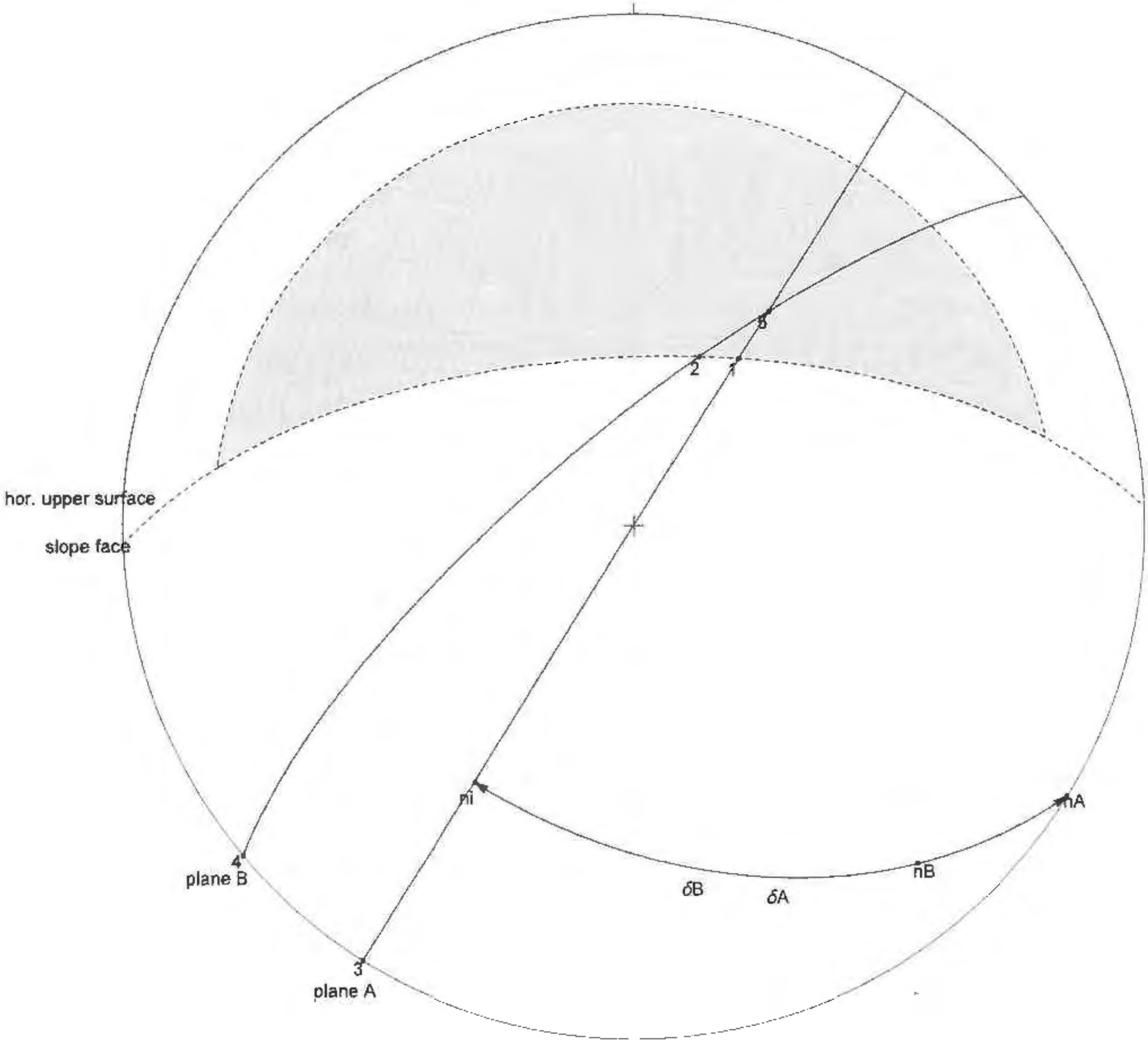
Plane A
θ13 = 121.5°
θ15 = 11.6°
θ35 = 133.1°
area = 114.9 $ft^2$
hA = 7.6 ft
δA = 89.9°
Plane B
θ24 = 96.3°
θ25 = 38.8°
θ45 = 122.5°
area = 751.1 $ft^2$
hB = 49.9 ft
δB = 43.°

Wedge
dihedral angle (θnA.nB) = 46.9°
wedge angle = 133.1°
intersection line azimuth (α5) = 31.9°
intersection line plunge (ψ5) = 46.9°
intersection line length (L5) = 30.1 ft
horizontal wedge length (Lh) = 20.6 ft
volume = 1394. $ft^3$
weight = 97.6 t
Forces
driving force = 71.3 t
resisting forces
cohesion force Plane A = 0.6 t
friction force Plane A = 42. t
cohesion force Plane B = 3.8 t
friction force Plane B = 61.6 t

Factor of safety against wedge failure (FS) = 1.514

NOTES: calculation follows methodology described in Kliche (1999, p 157–169);
1, 2, 3, and 4 are intersection lines between wedge and slope;
5 is wedge intersection line (direction of sliding);
nA and nB are poles to planes A and B; ni is direction of gravitational force resolved normal to 5;
dA and db are angles used to resolve gravitational force on planes A and B.

WEDGE STABILITY CALCULATION #7 BG 21103 DAVITYAN CONSULTANT: HH/JET




INPUT PARAMETERS

Plane A ( #4, loc (joint))
- dip direction = 302.°
- dip = 89.9°
- phi ($\phi$A) = 34°
- cohesion (cohA) = 0 psf

Plane B ( #9, loc (joint))
- dip direction = 320.°
- dip= 75.°
- phi ($\phi$B) = 34°
- cohesion (cohB) = 0 psf

Slope Face
- dip direction = 358.°
- dip = 63.°

Upper Slope
- dip direction = 358.°
- dip = 0.°

Wedge
- height (h) = 22. ft
- rock denstiy ($\gamma$r) = 140 pcf

OUTPUT PARAMETERS

Plane A
- $\theta$13 = 121.5°
- $\theta$15 = 9.2°
- $\theta$35 = 130.8°
- area = 79.7 ft$^2$
- hA = 5.5 ft
- $\delta$A = 89.8°

Plane B
- $\theta$24 = 115.1°
- $\theta$25 = 13.3°
- $\theta$45 = 128.3°
- area = 122.2 ft$^2$
- hB = 8.4 ft
- $\delta$B = 66.6°

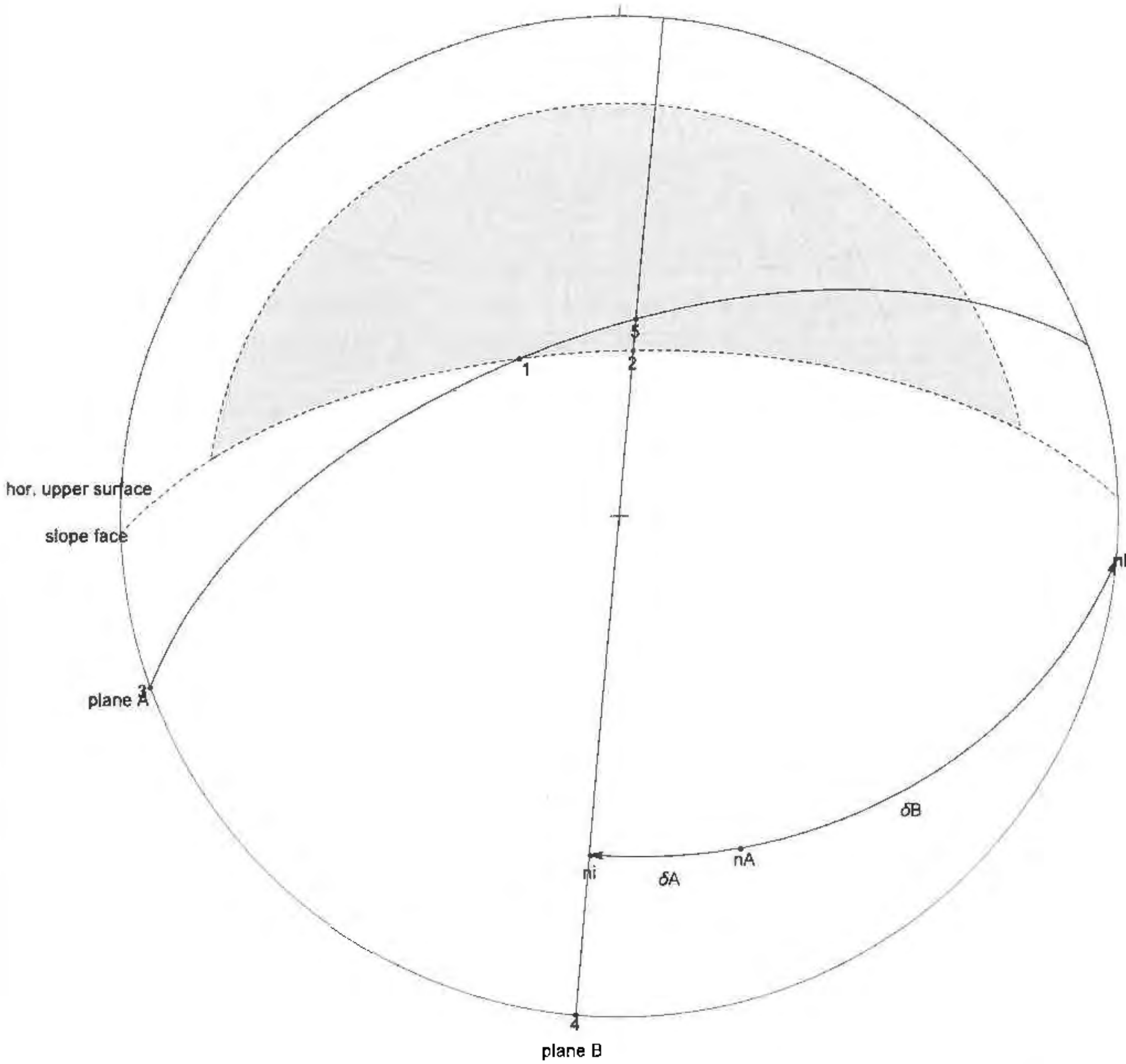
Wedge
- dihedral angle ($\theta$nA.nB) = 23.2°
- wedge angle = 156.8°
- intersection line azimuth ($\alpha$5) = 31.9°
- intersection line plunge ($\psi$5) = 49.2°
- intersection line length (L5) = 29. ft
- horizontal wedge length (Lh) = 19. ft
- volume = 88. ft$^3$
- weight = 6.2 t

Forces
- driving force = 4.7 t
- resisting forces
  - cohesion force Plane A = 0. t
  - friction force Plane A = 6.3 t
  - cohesion force Plane B = 0. t
  - friction force Plane B = 6.9 t

Factor of safety against wedge failure (FS) = 2.829

NOTES: calculation follows methodology described in Kliche (1999, p 157–169);
1, 2, 3, and 4 are intersection lines between wedge and slope;
5 is wedge intersection line (direction of sliding);
nA and nB are poles to planes A and B; ni is direction of gravitational force resolved normal to 5;
dA and db are angles used to resolve gravitational force on planes A and B.

WEDGE STABILITY CALCULATION #8    BG 21103 DAVITYAN    CONSULTANT: HH/JET




INPUT PARAMETERS

Plane A ( #6, loc (joint))
dip direction = 340.°
dip = 60.°
phi ($\phi$A) = 34°
cohesion (cohA) = 70 psf
Plane B ( #8, loc (joint))
dip direction = 275.°
dip= 89.9°
phi ($\phi$B) = 34°
cohesion (cohB) = 70 psf
Slope Face
dip direction = 358.°
dip = 63.°
Upper Slope
dip direction = 358.°
dip = 0.°
Wedge
height (h) = 22. ft
rock denstiy ($\gamma r$) = 140 pcf

OUTPUT PARAMETERS

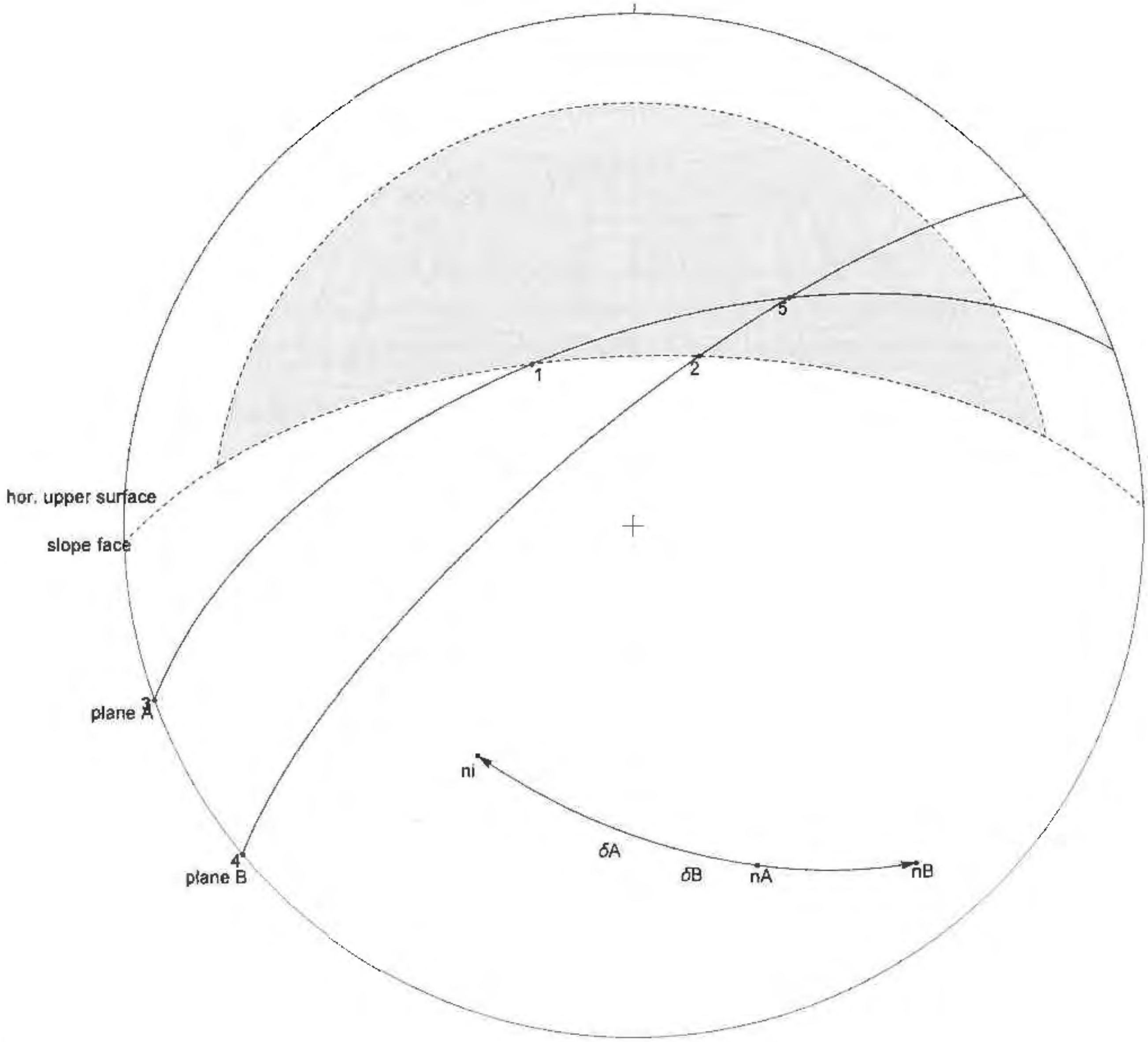
Plane A
$\theta$13 = 96.3°
$\theta$15 = 19.4°
$\theta$35 = 103.°
area = 130. ft$^2$
hA = 10. ft
$\delta$A = 21.3°
Plane B
$\theta$24 = 117.2°
$\theta$25 = 5.3°
$\theta$45 = 122.5°
area = 33.5 ft$^2$
hB = 2.6 ft
$\delta$B = 89.8°

Wedge
dihedral angle ($\theta$nA.nB) = 68.5°
wedge angle = 111.5°
intersection line azimuth ($\alpha$5) = 4.8°
intersection line plunge ($\psi$5) = 57.5°
intersection line length (L5) = 26.1 ft
horizontal wedge length (Lh) = 14. ft
volume = 103.7 ft$^3$
weight = 7.3 t
Forces
driving force = 6.1 t
resisting forces
cohesion force Plane A = 4.6 t
friction force Plane A = 2.8 t
cohesion force Plane B = 1.2 t
friction force Plane B = 1. t

Factor of safety against wedge failure (FS) = 1.564

NOTES: calculation follows methodology described in Kliche (1999, p 157–169);
1, 2, 3, and 4 are intersection lines between wedge and slope;
5 is wedge intersection line (direction of sliding);
nA and nB are poles to planes A and B; ni is direction of gravitational force resolved normal to 5;
dA and db are angles used to resolve gravitational force on planes A and B.

WEDGE STABILITY CALCULATION #9     BG 21103 DAVITYAN     CONSULTANT: HH/JET




INPUT PARAMETERS

Plane A ( #6, loc (joint))
dip direction = 340.°
dip = 60.°
phi ($\phi$A) = 34°
cohesion (cohA) = 0 psf
Plane B ( #9, loc (joint))
dip direction = 320.°
dip= 75.°
phi ($\phi$B) = 34°
cohesion (cohB) = 0 psf
Slope Face
dip direction = 358.°
dip = 63.°
Upper Slope
dip direction = 358.°
dip = 0.°
Wedge
height (h) = 22. ft
rock denstiy ($\gamma$r) = 140 pcf

OUTPUT PARAMETERS

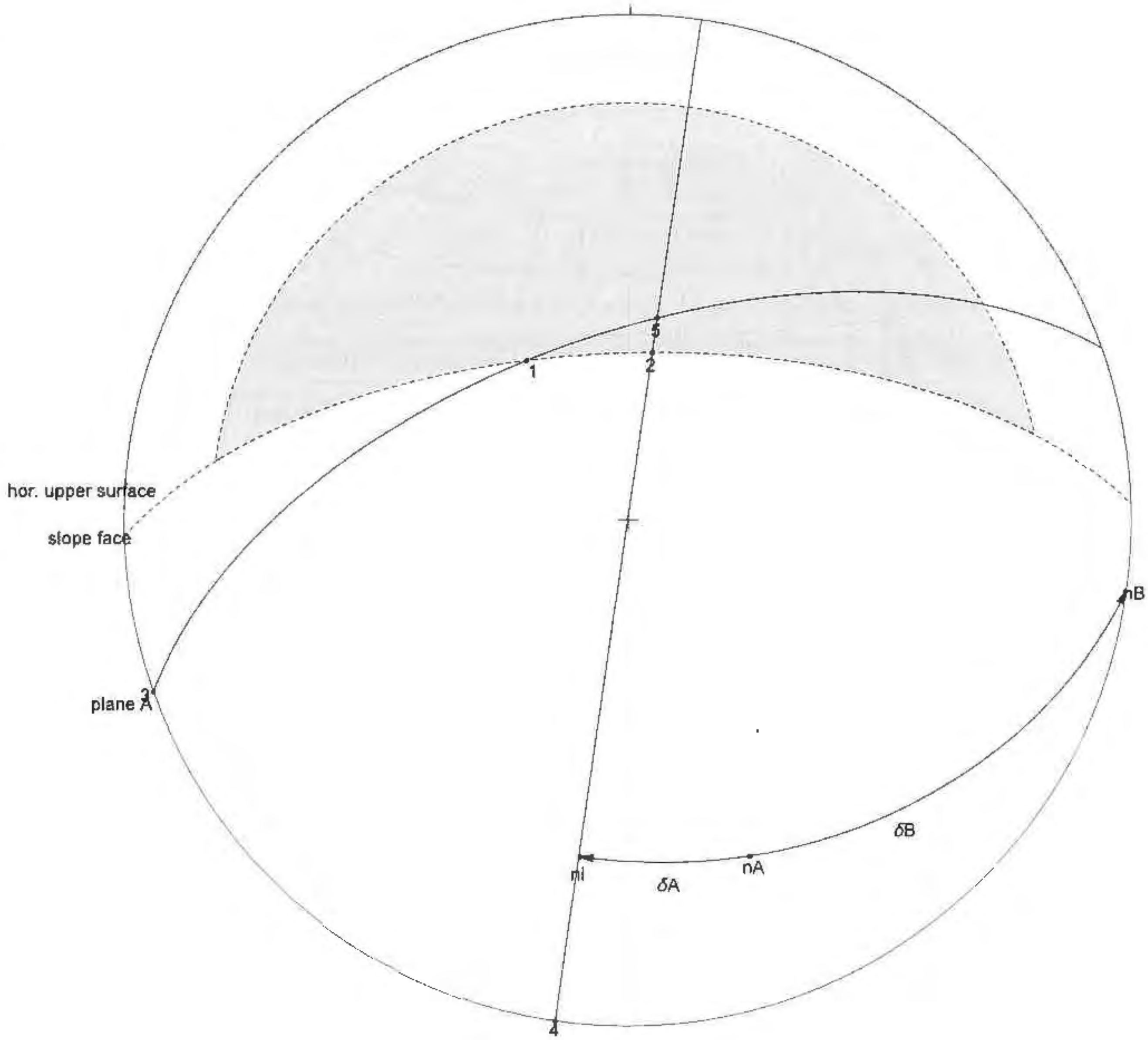
Plane A
$\theta$13 = 96.3°
$\theta$15 = 41.1°
$\theta$35 = 124.8°
area = 1064.7 $ft^2$
hA = 68.8 ft
$\delta$A = 44.7°
Plane B
$\theta$24 = 115.1°
$\theta$25 = 17.5°
$\theta$45 = 132.6°
area = 212.7 $ft^2$
hB = 13.8 ft
$\delta$B = 68.4°

Wedge
dihedral angle ($\theta$nA.nB) = 23.7°
wedge angle = 156.3°
intersection line azimuth ($\alpha$5) = 34.3°
intersection line plunge ($\psi$5) = 45.3°
intersection line length (L5) = 30.9 ft
horizontal wedge length (Lh) = 21.8 ft
volume = 1963.6 $ft^3$
weight = 137.5 t
Forces
driving force = 97.7 t
resisting forces
cohesion force Plane A = 0. t
friction force Plane A = 150.6 t
cohesion force Plane B = 0. t
friction force Plane B = 113.9 t

Factor of safety against wedge failure (FS) = 2.707

NOTES: calculation follows methodology described in Kliche (1999, p 157–169);
1, 2, 3, and 4 are intersection lines between wedge and slope;
5 is wedge intersection line (direction of sliding);
nA and nB are poles to planes A and B; ni is direction of gravitational force resolved normal to 5;
dA and db are angles used to resolve gravitational force on planes A and B.

WEDGE STABILITY CALCULATION #10 BG 21103 DAVITYAN CONSULTANT: HH/JET




INPUT PARAMETERS

Plane A ( #6, loc (joint))
- dip direction = 340.°
- dip = 60.°
- phi ($\phi$A) = 34°
- cohesion (cohA) = 70 psf

Plane B ( #10, loc (joint))
- dip direction = 278.°
- dip= 89.9°
- phi ($\phi$B) = 34°
- cohesion (cohB) = 70 psf

Slope Face
- dip direction = 358.°
- dip = 63.°

Upper Slope
- dip direction = 358.°
- dip = 0.°

Wedge
- height (h) = 22. ft
- rock denstiy ($\gamma r$) = 140 pcf

OUTPUT PARAMETERS

Plane A
- $\theta$13 = 96.3°
- $\theta$15 = 21.1°
- $\theta$35 = 104.8°
- area = 148.5 $ft^2$
- hA = 11.3 ft
- $\delta$A = 23.9°

Plane B
- $\theta$24 = 117.3°
- $\theta$25 = 5.8°
- $\theta$45 = 123.1°
- area = 37.6 $ft^2$
- hB = 2.9 ft
- $\delta$B = 89.8°

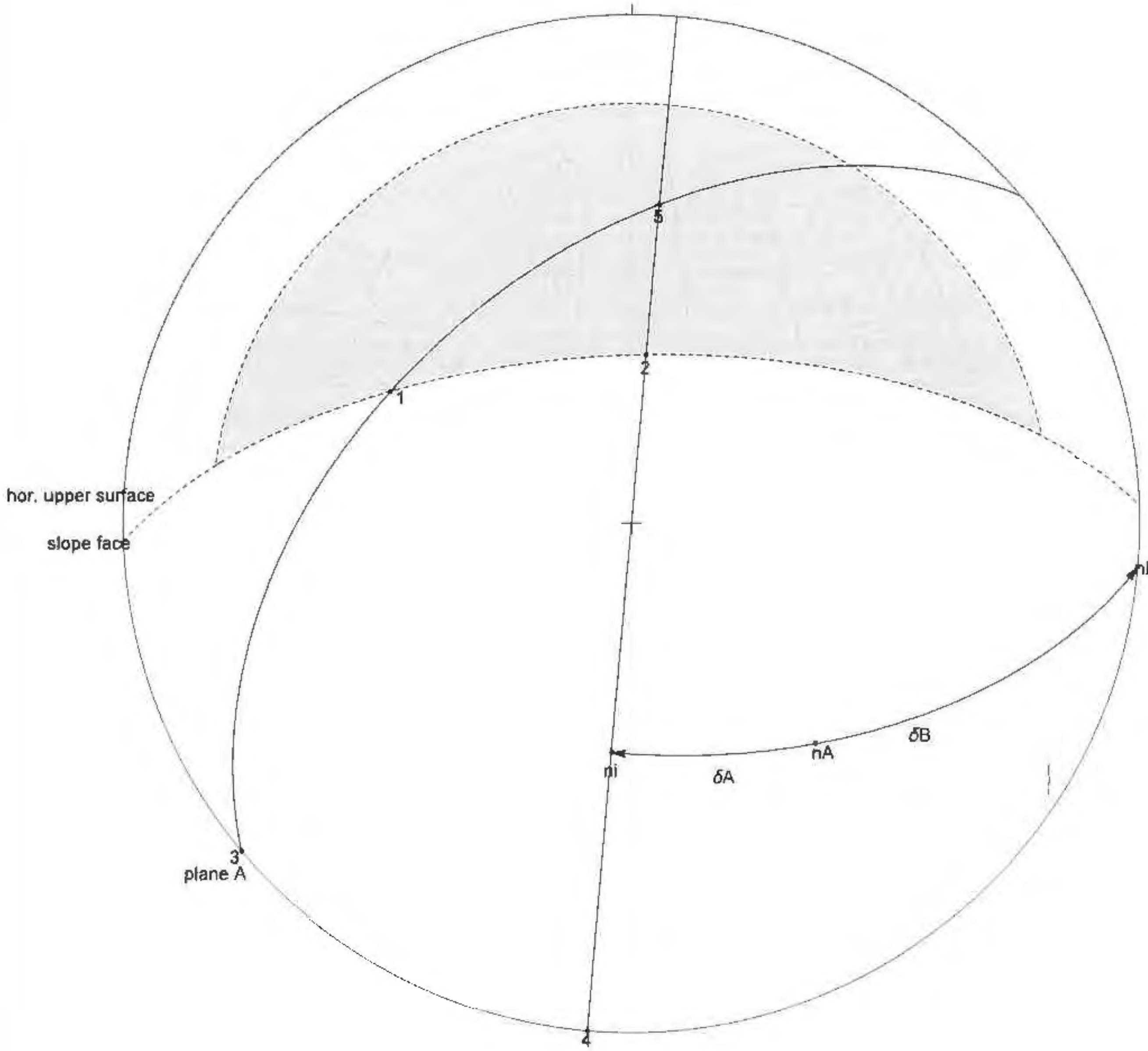
Wedge
- dihedral angle ($\theta$nA,nB) = 66.°
- wedge angle = 114.°
- intersection line azimuth ($\alpha$5) = 7.8°
- intersection line plunge ($\psi$5) = 56.9°
- intersection line length (L5) = 26.3 ft
- horizontal wedge length (Lh) = 14.4 ft
- volume = 129.2 $ft^3$
- weight = 9. t

Forces
- driving force = 7.6 t
- resisting forces
  - cohesion force Plane A = 5.2 t
  - friction force Plane A = 3.7 t
  - cohesion force Plane B = 1.3 t
  - friction force Plane B = 1.5 t

Factor of safety against wedge failure (FS) = 1.537

NOTES: calculation follows methodology described in Kliche (1999, p 157–169);
1, 2, 3, and 4 are intersection lines between wedge and slope;
5 is wedge intersection line (direction of sliding);
nA and nB are poles to planes A and B; ni is direction of gravitational force resolved normal to 5;
dA and db are angles used to resolve gravitational force on planes A and B.

WEDGE STABILITY CALCULATION #11 BG 21103 DAVITYAN CONSULTANT: HH/JET




INPUT PARAMETERS

Plane A ( #7, loc (joint))
- dip direction = 320.°
- dip = 47.°
- phi (ϕA) = 34°
- cohesion (cohA) = 0 psf

Plane B ( #8, loc (joint))
- dip direction = 275.°
- dip= 89.9°
- phi (ϕB) = 34°
- cohesion (cohB) = 0 psf

Slope Face
- dip direction = 358.°
- dip = 63.°

Upper Slope
- dip direction = 358.°
- dip = 0.°

Wedge
- height (h) = 22. ft
- rock denstiy (γr) = 140 pcf

OUTPUT PARAMETERS

Plane A
- θ13 = 105.°
- θ15 = 49.2°
- θ35 = 124.2°
- area = 3620.8 $ft^2$
- hA = 199. ft
- δA = 31.1°

Plane B
- θ24 = 117.2°
- θ25 = 25.6°
- θ45 = 142.8°
- area = 862.1 $ft^2$
- hB = 47.4 ft
- δB = 89.9°

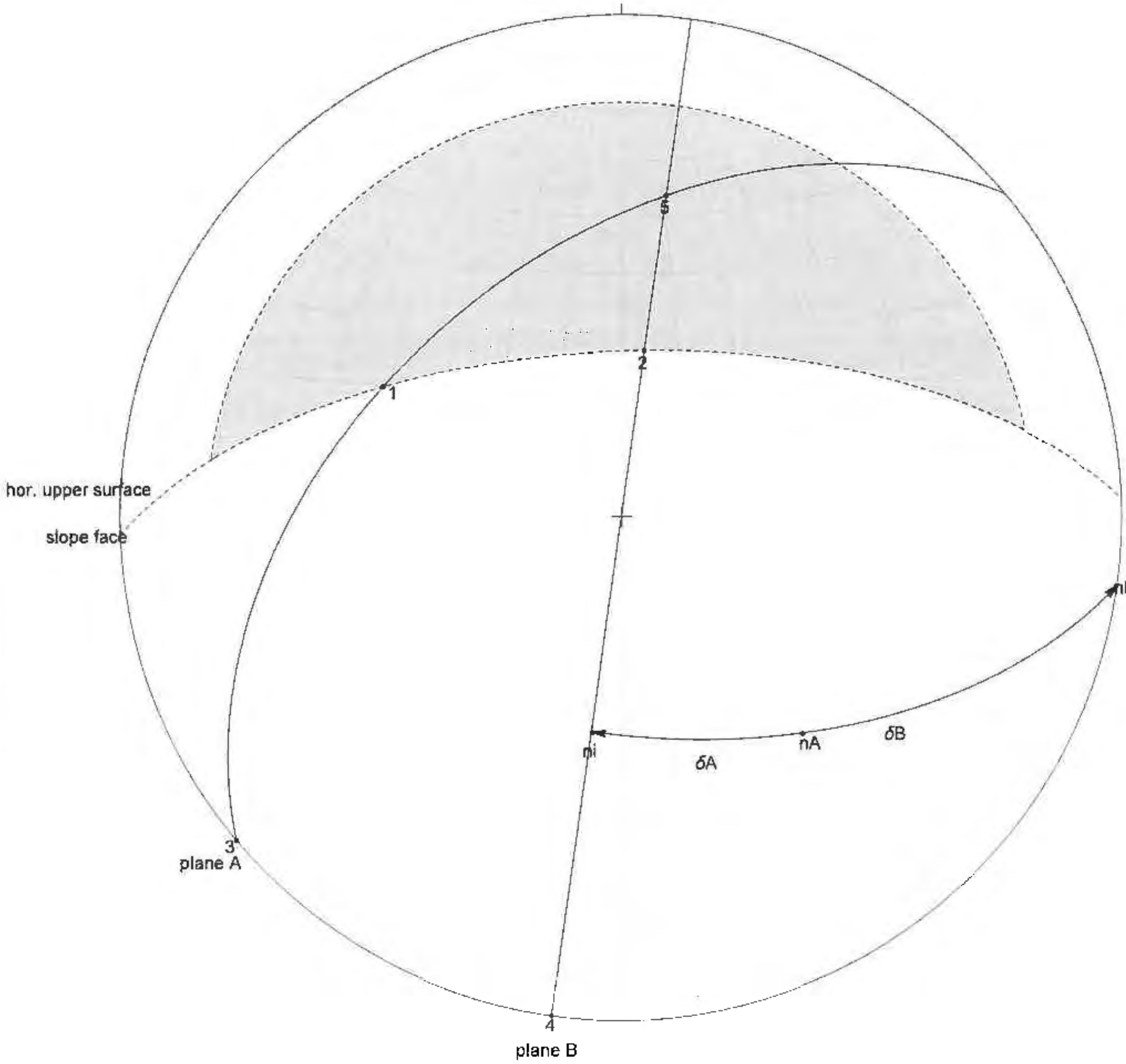
Wedge
- dihedral angle (θnA,nB) = 58.8°
- wedge angle = 121.2°
- intersection line azimuth (α5) = 4.9°
- intersection line plunge (ψ5) = 37.2°
- intersection line length (L5) = 36.4 ft
- horizontal wedge length (Lh) = 29. ft
- volume = 48917.7 $ft^3$
- weight = 3424.2 t

Forces
- driving force = 2070.7 t
- resisting forces
  - cohesion force Plane A = 0. t
  - friction force Plane A = 2151. t
  - cohesion force Plane B = 0. t
  - friction force Plane B = 1110.9 t

Factor of safety against wedge failure (FS) = 1.575

NOTES: calculation follows methodology described in Kliche (1999, p 157–169);
1, 2, 3, and 4 are intersection lines between wedge and slope;
5 is wedge intersection line (direction of sliding);
nA and nB are poles to planes A and B; ni is direction of gravitational force resolved normal to 5;
dA and db are angles used to resolve gravitational force on planes A and B.

WEDGE STABILITY CALCULATION #12 BG 21103 DAVITYAN CONSULTANT: HH/JET




INPUT PARAMETERS

Plane A ( #7, loc (joint))
dip direction = 320.°
dip = 47.°
phi (ϕA) = 34°
cohesion (cohA) = 0 psf
Plane B ( #10, loc (joint))
dip direction = 278.°
dip= 89.9°
phi (ϕB) = 34°
cohesion (cohB) = 0 psf
Slope Face
dip direction = 358.°
dip = 63.°
Upper Slope
dip direction = 358.°
dip = 0.°
Wedge
height (h) = 22. ft
rock denstiy (γr) = 140 pcf

OUTPUT PARAMETERS

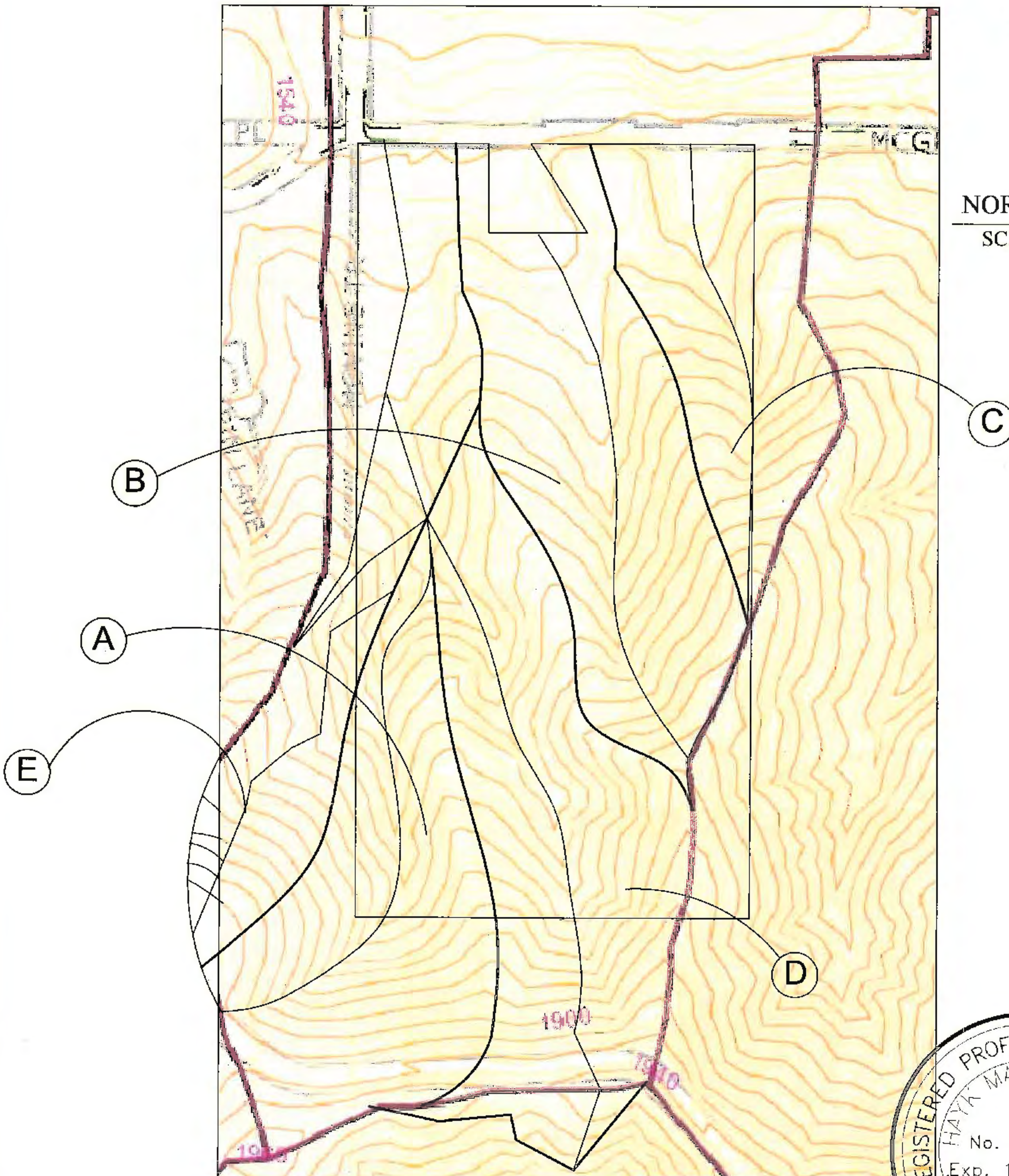
Plane A
θ13 = 105.°
θ15 = 52.1°
θ35 = 127.1°
area = 29380.3 $ft^2$
hA = 1556.6 ft
δA = 32.9°
Plane B
θ24 = 117.3°
θ25 = 27.°
θ45 = 144.3°
area = 1237.1 $ft^2$
hB = 65.6 ft
δB = 89.9°

Wedge
dihedral angle (θnA.nB) = 57.°
wedge angle = 123.°
intersection line azimuth (α5) = 7.9°
intersection line plunge (ψ5) = 35.7°
intersection line length (L5) = 37.7 ft
horizontal wedge length (Lh) = 30.6 ft
volume = 539013. $ft^3$
weight = 37730.9 t
Forces
driving force = 22017.1 t
resisting forces
cohesion force Plane A = 0. t
friction force Plane A = 24844.2 t
cohesion force Plane B = 0. t
friction force Plane B = 13379. t

Factor of safety against wedge failure (FS) = 1.727

NOTES: calculation follows methodology described in Kliche (1999, p 157–169);
1, 2, 3, and 4 are intersection lines between wedge and slope;
5 is wedge intersection line (direction of sliding);
nA and nB are poles to planes A and B; ni is direction of gravitational force resolved normal to 5;
dA and db are angles used to resolve gravitational force on planes A and B.

# 8100-8160 MC. GROARTY ST.





| | | | |
|---|---|---|---|
| (A) | TRIB. AREA=6.05 AC. | (D) | TRIB. AREA=7.03 AC. |
| (B) | TRIB. AREA=6.29 AC. | (E) | TRIB. AREA=6.19 AC. |
| (C) | TRIB. AREA=4.00 AC. | | TOT.TRIB. AREA=29.56 AC. |

REGISTERED PROFESSIONAL ENGINEER
HAYK MARTIROSIAN
No. C52563
Exp. 12-31-18
CIVIL
STATE OF CALIFORNIA
*Hayk Martirosian*

CHANNELIZED FLOW CAPACITY "Ccf"

(A) Ccf=6.05 ac. x (10) cfs=60.50 cfs

(B) Ccf= 6.29 ac. x (10) cfs=62.90 cfs

(C) Ccf= 4.00 ac. x (10) cfs=40.00 cfs

(D) Ccf= 7.03 ac. x (10) cfs=70.3 cfs

(E) Ccf= 6.19 ac. x (10) cfs=61.90 cfs

TEMPORARY STORAGE CAPACITY "Cst"

(A) Cst=6.05 ac. x (400) cy/ac.=2420 cy.

(B) Ccf= 6.29 ac. x (400) cy/ac=2516 cy

(C) Ccf= 4.00 ac. x (400) cy/ac=1600 cy

(D) Ccf= 7.03 ac. x (400) cy/ac=2812 cy

(E) Ccf= 6.19 ac. x (400) cy/ac=2476 cy


## LEGEND

| | |
|---|---|
| TP5 | LOCATION AND NUMBER OF HAND-DUG TEST PIT (THIS STUDY) |
| KBA-TP17 | LOCATION AND NUMBER OF HAND-DUG TEST PIT BY KOVACS-BYER & ASSOCIATES (REPORT DATED 03/28/1990) |
| KBA-B4 | LOCATION AND NUMBER OF BORING BY KOVACS-BYER & ASSOCIATES (REPORT DATED 03/28/1990) |
| GB3 | LOCATION AND NUMBER OF BORING BY GEOSYSTEMS, INC. (REPORT DATED 04/19/2010) |
| 80 | STRIKE AND DIP OF JOINTS |
| | STRIKE AND DIP OF VERTICAL JOINT |
| | GEOLOGIC CONTACT |
| M M | LINE OF CROSS SECTION |

REFERENCE: TENTATIVE TRACT MAP PREPARED BY TECHNA LAND COMPANY., INC. DATED 09/05/2017.

APRIL 19, 2018
NOVEMBER 13, 2017
MARCH 3, 2016

BYER GEOTECHNICAL INC.
1461 E. CHEVY CHASE DR., SUITE 200
GLENDALE, CA 91206
818.549.9959 TEL
818.543.3747 FAX

# REVISED GEOLOGIC MAP

BG: 21103 DAVITYAN

CONSULTANT : JET

DRAWN BY : AS

SCALE: 1" = 40'

CAD FILE: S:\LandProjects\21103 DAVITYAN\dwg\GEOMAP_01312018.dwg PLOT DATE:


APRIL 19, 2018
NOVEMBER 13, 2017

## LEGEND

| | |
|---|---|
| TP5 | LOCATION AND NUMBER OF HAND-DUG TEST PIT (THIS STUDY) |
| KBA-TP17 | LOCATION AND NUMBER OF HAND-DUG TEST PIT BY KOVACS-BYER & ASSOCIATES (REPORT DATED 03/28/1990) |
| KBA-B4 | LOCATION AND NUMBER OF BORING BY KOVACS-BYER & ASSOCIATES (REPORT DATED 03/28/1990) |
| GB3 | LOCATION AND NUMBER OF BORING BY GEOSYSTEMS, INC. (REPORT DATED 04/19/2010) |
| 80 | STRIKE AND DIP OF JOINTS |
| | STRIKE AND DIP OF VERTICAL JOINT |
| | GEOLOGIC CONTACT |
| M M | LINE OF CROSS SECTION |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# REVISED GEOLOGIC MAP #2

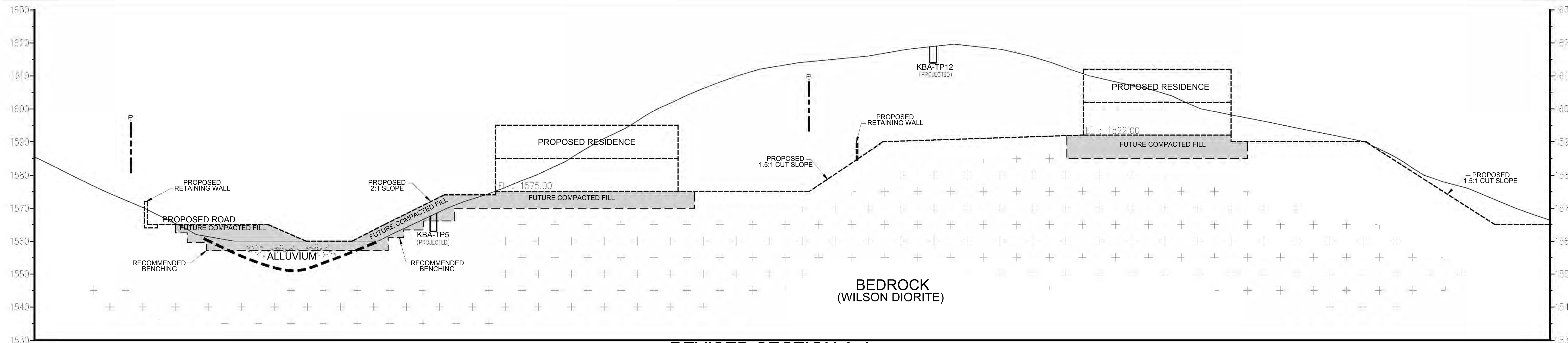
BG: 21103 DAVITYAN

CONSULTANT : JET

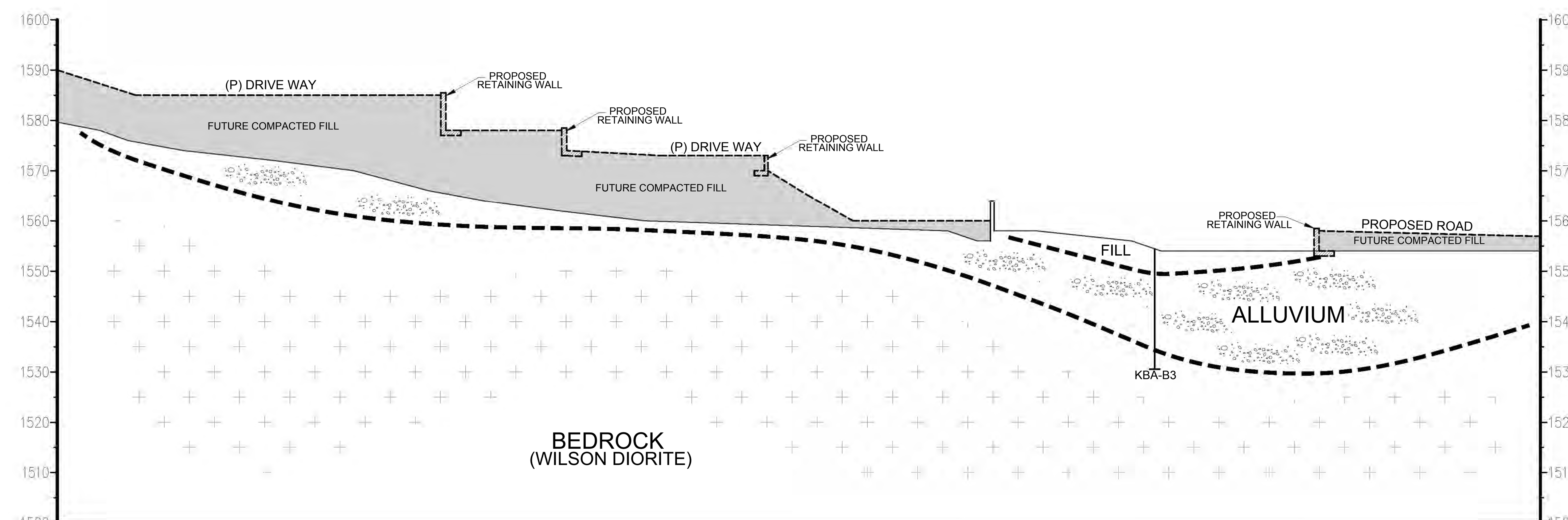
DRAWN BY : AS

SCALE: 1" = 60'

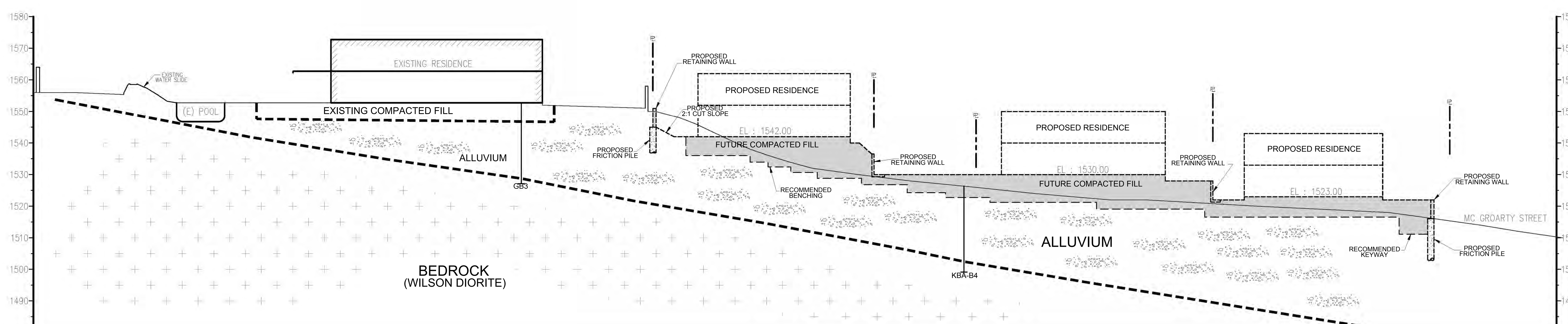
CAD FILE: S:\LandProjects\21103 DAVITYAN\dwg\GEOMAP_01312018.dwg




REVISED SECTION A-A




REVISED SECTION B-B




REVISED SECTION C-C

APRIL 19, 2018
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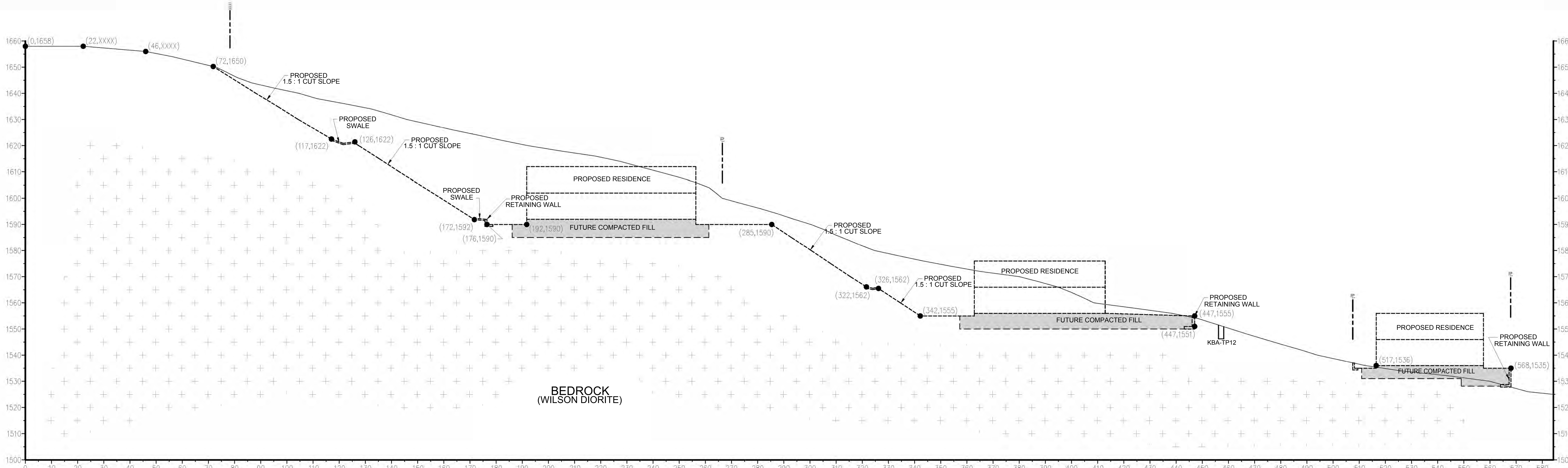
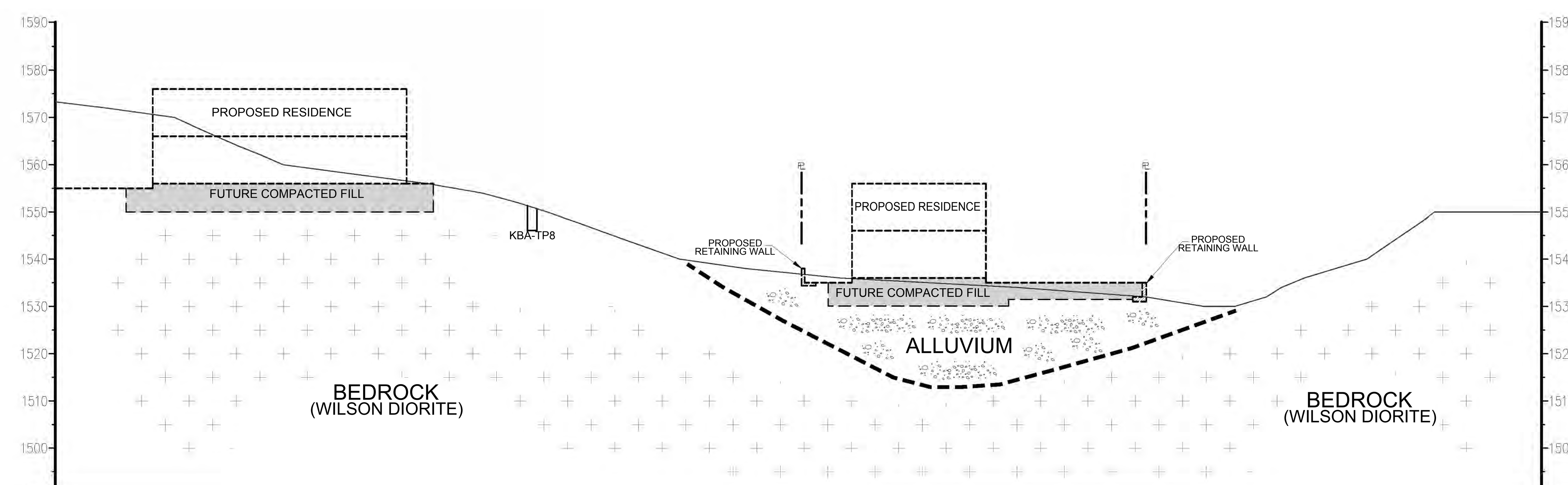
| REVISED SECTIONS A, B, & C | |
|---|---|
| BG: 21103 | DAVITYAN |
| CONSULTANT : JET | SCALE: 1" = 20' |
| DRAWN BY : AS | |




REVISED SECTION D-D




REVISED SECTION E-E

APRIL 19, 2018
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REVISED SECTIONS D & E

| | | |
|---|---|---|
| BG: 21103 | DAVITYAN | |
| CONSULTANT: JET | | SCALE: 1" = 20' |
| DRAWN BY: AS | | |

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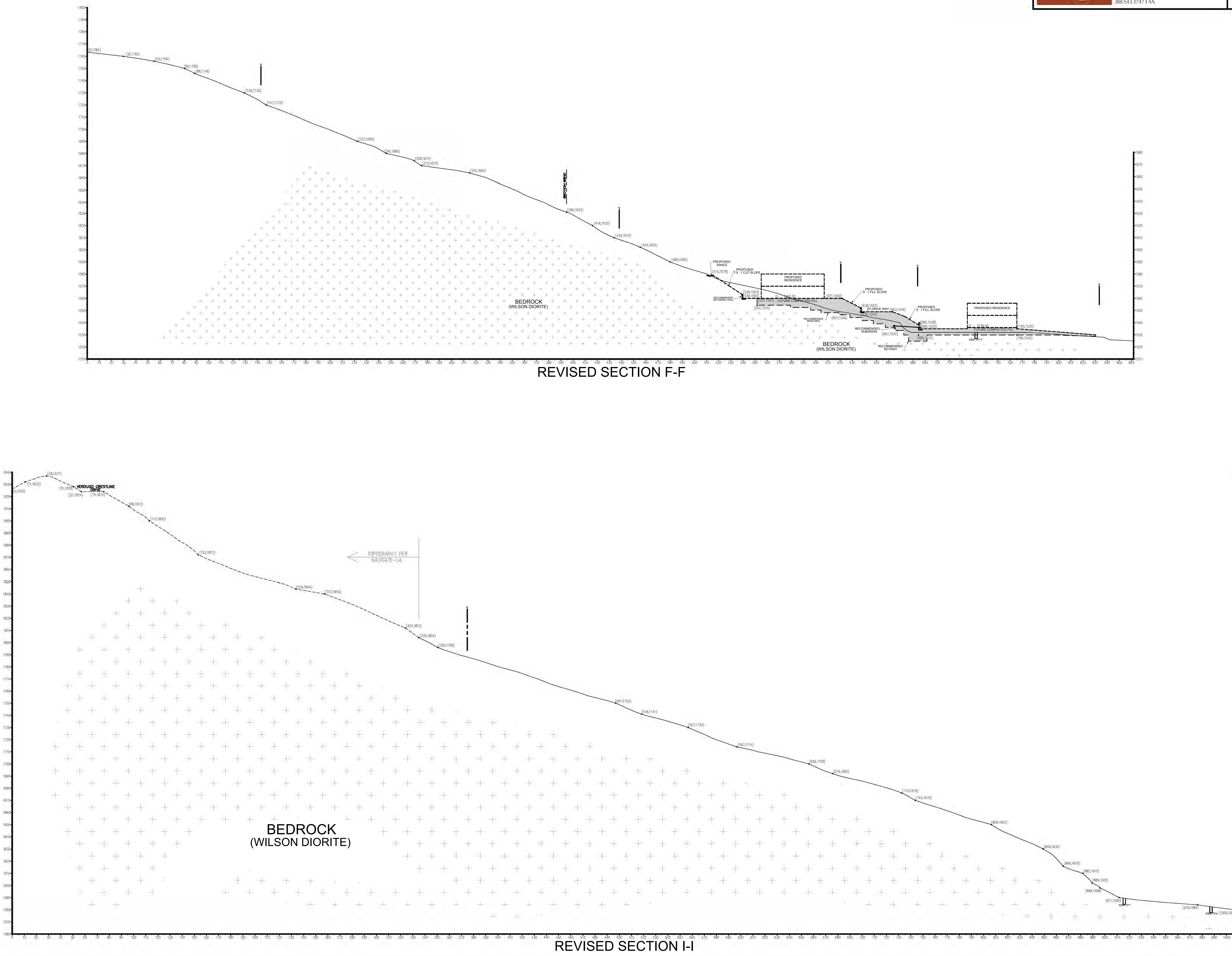
# REVISED SECTIONS F & I

| | |
|---|---|
| BG: 21103 | DAVITYAN |
| CONSULTANT : JET | SCALE: 1" = 40' |
| DRAWN BY : AS | |

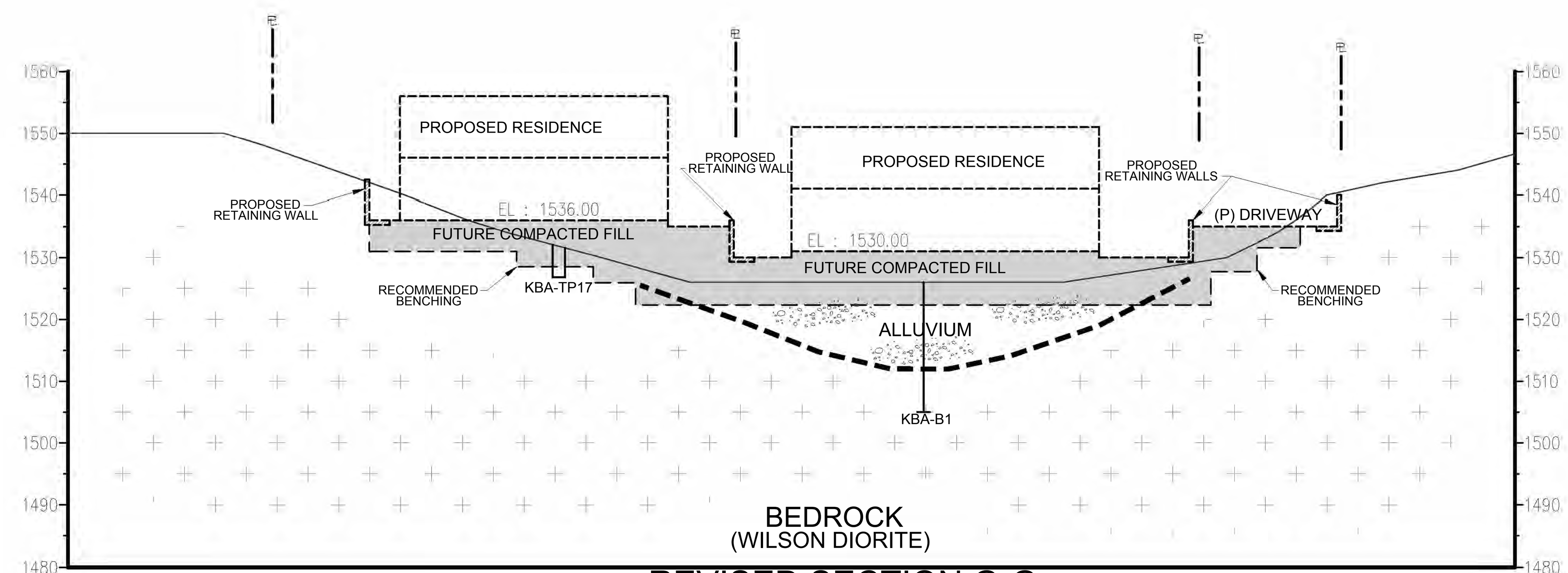
MARCH 3, 2016
NOVEMBER 13, 2017
APRIL 19, 2018



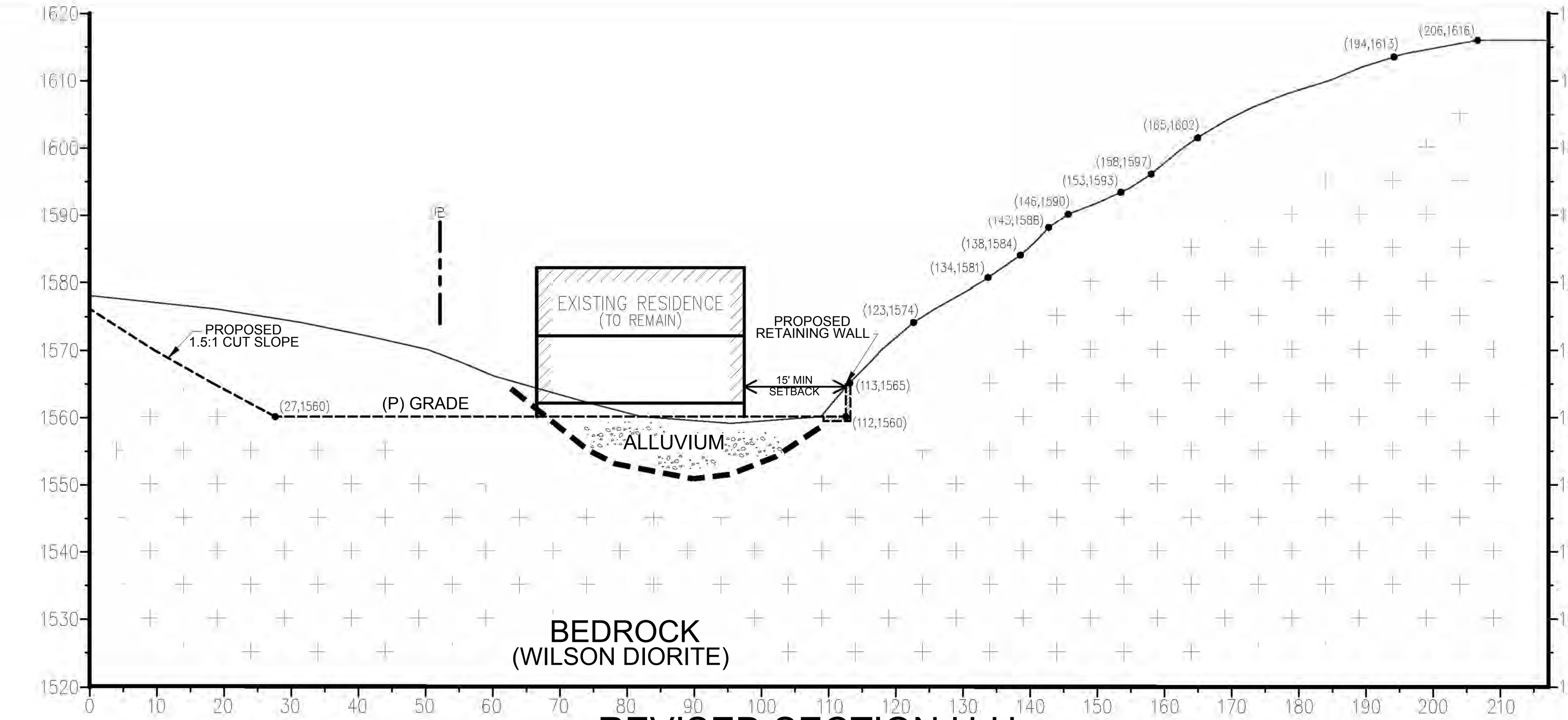

REVISED SECTION F-F



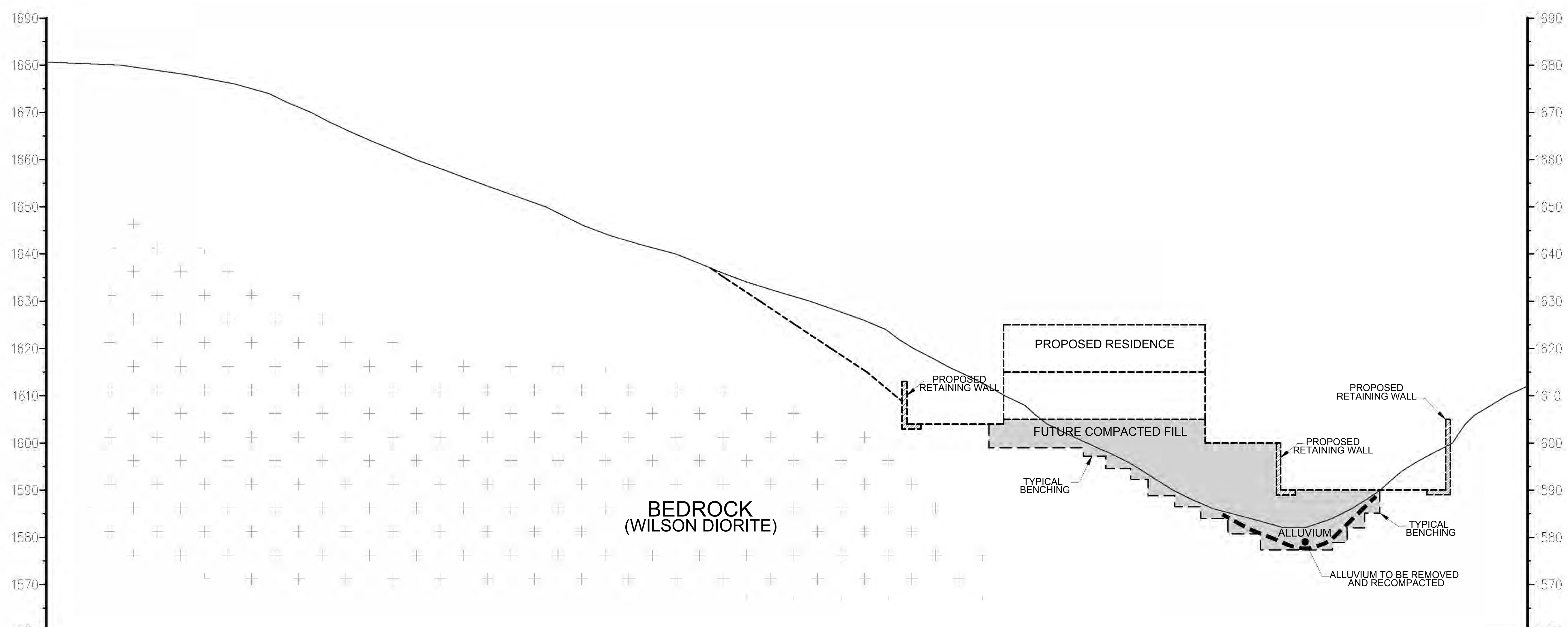
REVISED SECTION I-I



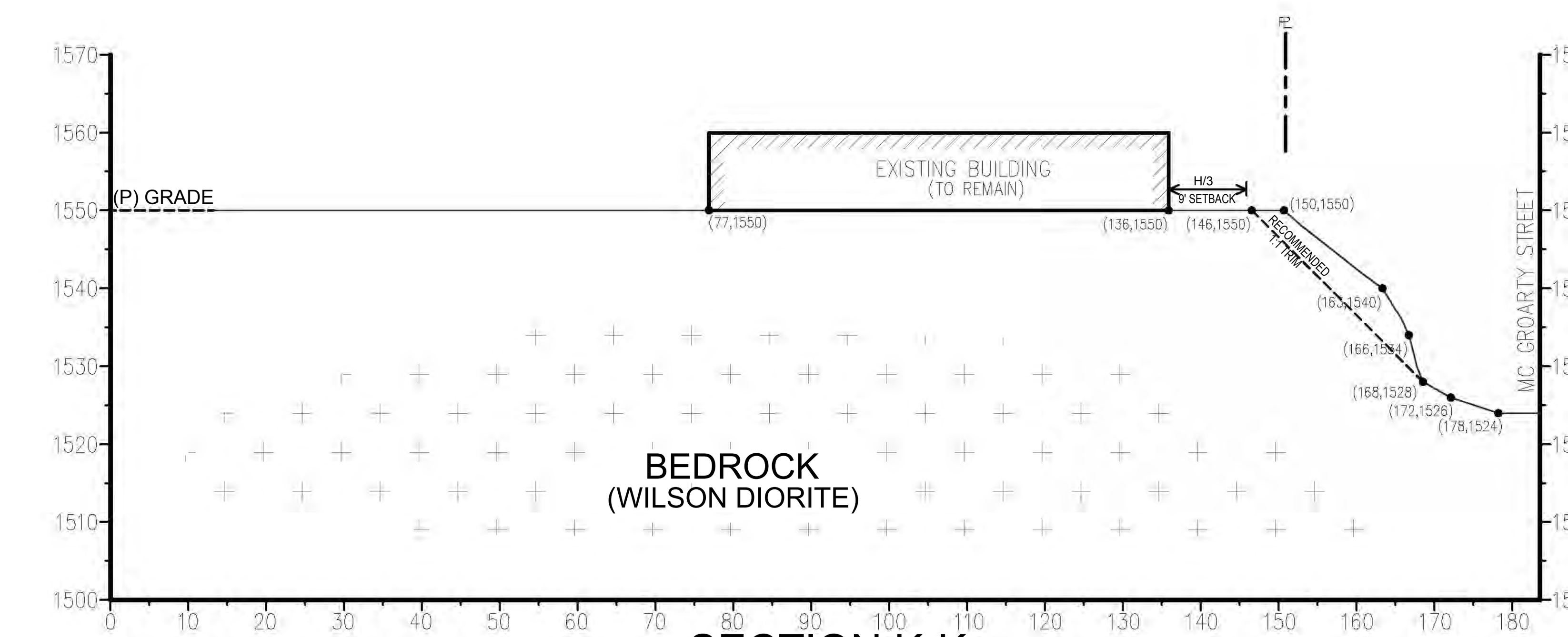

REVISED SECTION G-G



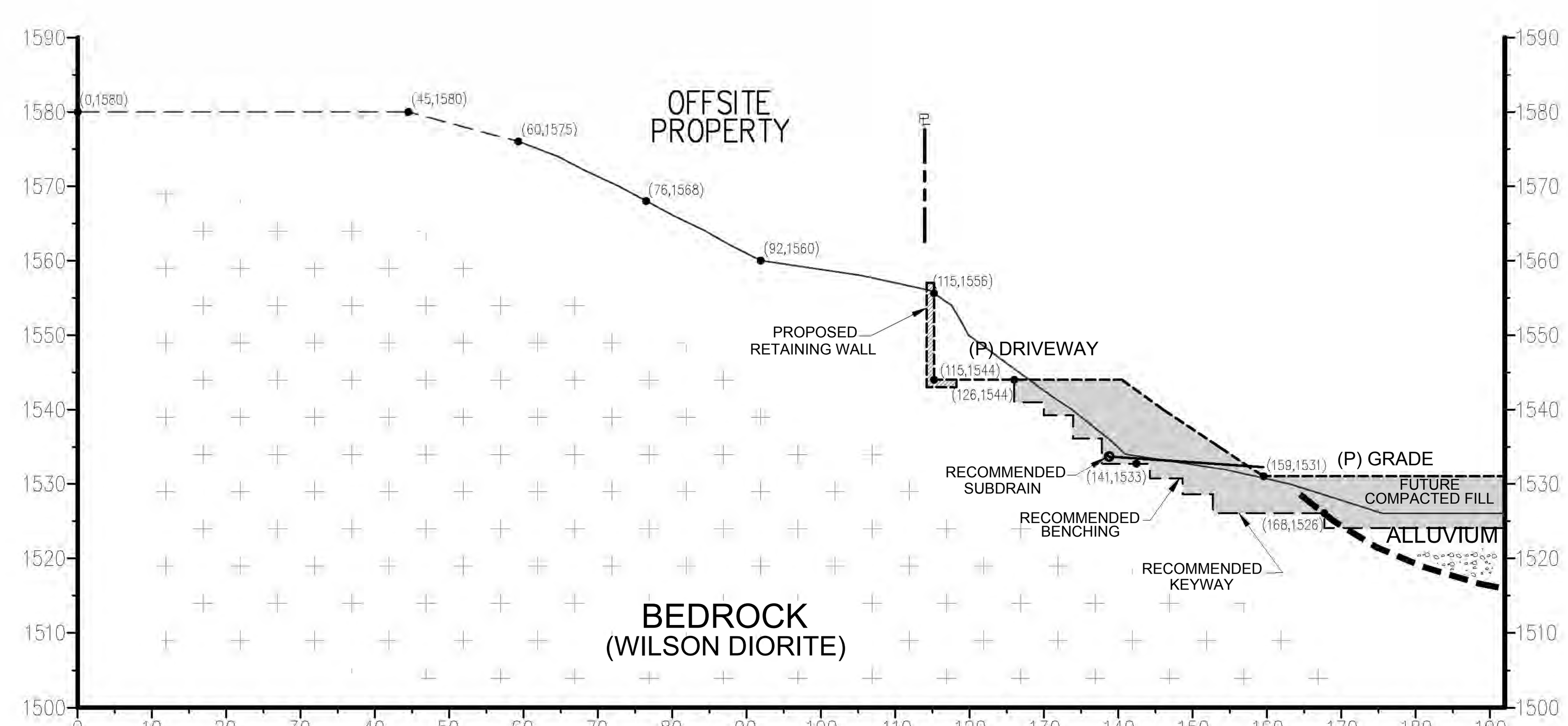

REVISED SECTION H-H



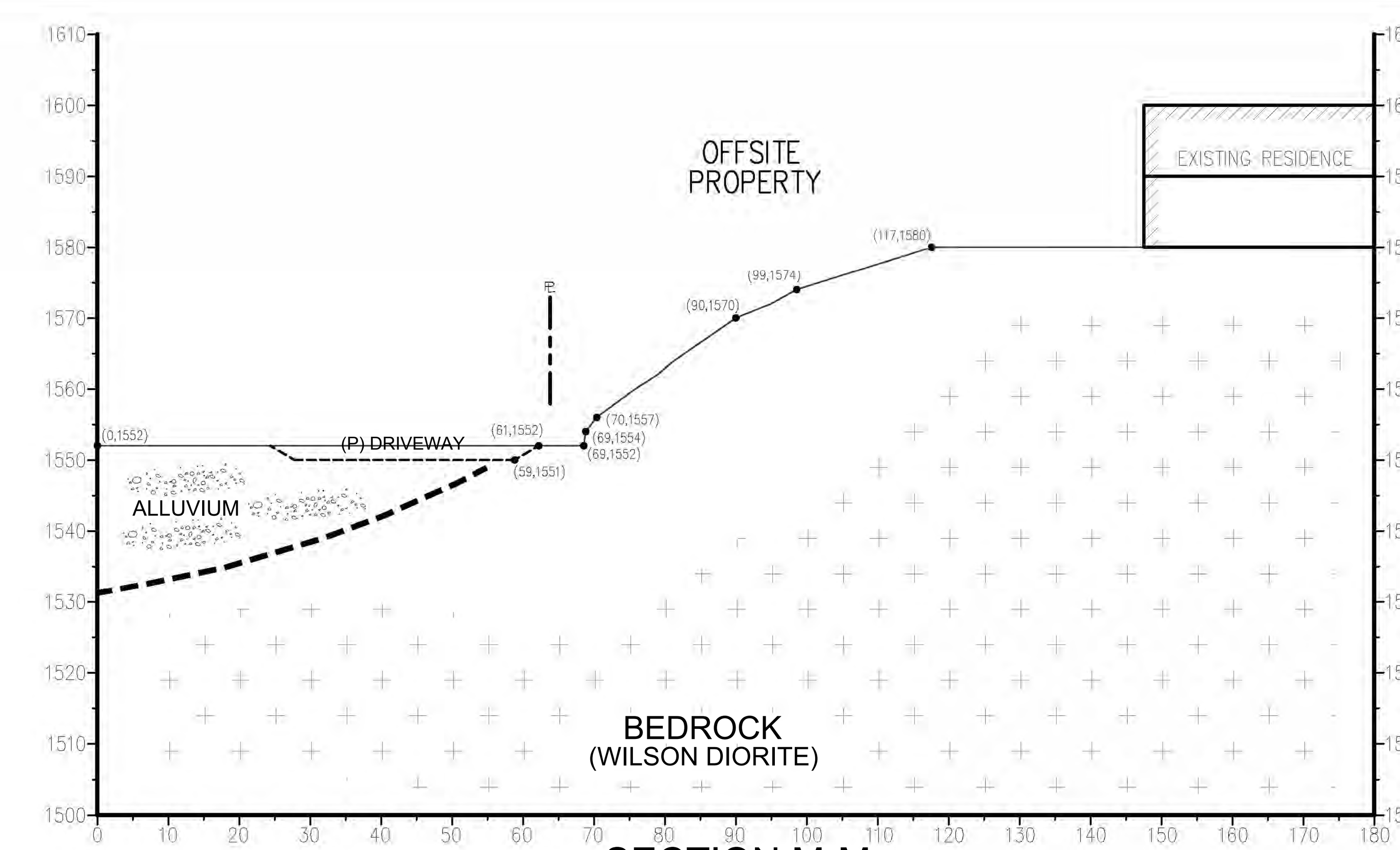

SECTION J-J




SECTION K-K




SECTION L-L




SECTION M-M

APRIL 19, 2018
NOVEMBER 13, 2017
MARCH 3, 2016

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| | | | |
|---|---|---|---|
| REVISED SECTIONS G, H, & SECTIONS J, K, L, & M | | | |
| BG: 21103 | DAVITYAN | | |
| CONSULTANT: JET | | SCALE: | 1" = 20' |
| DRAWN BY: AS | | | |