BOULDER STABILITY EVALUATION

PROPOSED TONN RESIDENCE
APN 172-47-063
5429 EAST SOLANO DRIVE
PARADISE VALLEY, ARIZONA 85253

Prepared for:

Mr. Scott L. Tonn
Tonn Investments, LLC
4350 East Camelback Road, Suite A-100
Phoenix, Arizona 85018

September 27, 2018

Project 24215

September 27, 2018 Project 24215

Mr. Scott L. Tonn
Tonn Investments, LLC
4350 East Camelback Road, Suite A-100
Phoenix, Arizona 85018

**RE: BOULDER STABILITY EVALUATION
PROPOSED TONN RESIDENCE
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5429 EAST SOLANO DRIVE
PARADISE VALLEY, ARIZONA 85253**

Mr. Tonn:

Transmitted herewith is a copy of the final report of the boulder stability evaluation for the above-mentioned project. As an additional service, this firm would be pleased to review the project plans and structural notes for conformance to the intent of this report. We trust that this report will assist you in the design and construction of the proposed project. Vann Engineering, Inc. appreciates the opportunity to provide our services on this project and looks forward to working with you during construction and on future projects**.** **This firm possesses the capability of performing testing and inspection services during the course of construction**. Should any questions arise concerning the content of this report, please feel free to contact this office at your earliest convenience.

The materials encountered on the site are believed to be representative of the total area; however, soil and rock materials do vary in character between points of investigation. The recommendations contained in this report are based on the assumption that the soil conditions do not deviate appreciably from those disclosed by the investigation. Should unusual materials or conditions be encountered during construction, the soil engineer must be notified so that he may make supplemental recommendations if required.

Please note that several are present upslope from the property boundary that are believed by this firm to warrant a stability analysis. However, per the Town of Paradise Valley Hillside Code, this study is limited to only the boulders on the subject property. Our study has addressed applicable boulders within an area as defined by the Town of Paradise Valley. Other boulders exist upslope that may pose conditions of instability, thereby affecting the subject property.

Respectfully submitted,

VANN ENGINEERING, INC.

Registered Professional Engineer (Geological) CERTIFICATE NO. 15206 JEFFRY D. VANN Date Signed 09/27/18 ARIZONA, U.S.A. Expires 09/30/19

Alan J. Cuzme, BSE
Staff Geotechnical Engineer

Jeffry D. Vann, MS PE D.GE F. ASCE
Principal Engineer

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TABLE OF CONTENTS

TABLE OF CONTENTS

SECTION I

1: INTRODUCTION

This document presents the results of a boulder stability evaluation conducted by Vann Engineering, Inc. for the:

PROPOSED TONN RESIDENCE
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Figure 1: Aerial photograph of site (outlined in cyan) and immediate surroundings

1.1: Purpose

The purpose of the investigation was to deterministically and probabilistically analyze the immediate and long-term stability of boulders or boulder clusters at the subject site and provide remedial recommendations if warranted.

1.2: Scope of Services

The scope of services for this project includes the following:

- Description of the subject site
- Photographic documentation of boulders of concern
- Site Plan indicating the locations of all boulders that were analyzed
- 2012 IBC site classification

- Description of the local geology
- Probabilistic pseudo-static modeling to determine the stability of the boulders or boulder clusters
- Recommendations for mitigation, if necessary, of the boulder or boulder cluster to obtain a safe and confident factor of safety against possible boulder mobilization (sliding and rocking)
    - Two-dimensional illustration of recommended boulder stabilization protocol
    - Recommendations for aesthetic modifications to any materials used in the stabilization efforts in order to sustain the natural view of the boulder cluster.

Note: This report does not include, either specifically or by implication, any environmental assessment of the site. If the owner is concerned about the potential for such contamination, other studies should be undertaken. We are available to discuss the scope of work of such studies with you.

1.3: Authorization

The obtaining of data from the site and the preparation of this boulder stability evaluation have been carried out according to this firm's revised proposal (**Project 24215 dated 08/22/18**), authorized by **Scott L. Tonn on 08/30/18**, to proceed with the work. Our efforts and report are limited to the scope and limitations as set forth in the proposal**.**

1.4: Standard of Care

Since our investigation is based upon review of background data, observation of site materials, and engineering analysis, the conclusions and recommendations are professional opinions. Our professional services have been performed using that degree and skill ordinarily exercised, under similar circumstances, by reputable geotechnical engineers practicing in this or similar localities. These opinions have been derived in accordance with current standards of practice and no other warranty, express or implied, is made.

The limitations of this report and geotechnical issues which further explain the limitations of the information contained in this report are listed at 7.0.

2: PROJECT DESCRIPTION

2.1: Site Description

The subject site is currently occupied by an existing residential structure and an asphalt driveway. It is the understanding of this firm that all of the existing structures and hardscape are to be demolished as part of the proposed new custom residence. All boulders evaluated in this study (5 in total) were located within the parcel boundaries. Refer to the aerial site plan, GPS coordinates, and photographs in Section II of this report for the approximate locations of the studied boulders, which are denoted as B-1 through B-5. Figure 2 is an aerial photograph which shows the locations of the boulders and boulder clusters on the property.

Figure 2: Aerial photograph showing approximate locations of the boulders and the boulder clusters shaded yellow, and the parcel boundary outlined in red

Refer to the following photographs taken during the field effort of the existing boulders evaluated herein and the boulder clusters observed on site.

Figure 3: B-1 facing south

Figure 4: B-2 facing east

Figure 5: B-3 facing west

Figure 6: B-4 facing south

Figure 7: B-5 and surrounding boulder cluster facing southeast

Figure 8: Photograph showing large boulder cluster surrounding Boulder #5

Figure 9: Photograph showing large boulder cluster near Boulder #5

Figure 10: Photograph showing large boulder cluster upslope south of the property

2.2: Site Geology

The site is located on Camelback Mountain which is considered part of the Phoenix Mountains. The local geology indicates the site is comprised of Undivided Early and Middle Proterozoic granitic rocks.

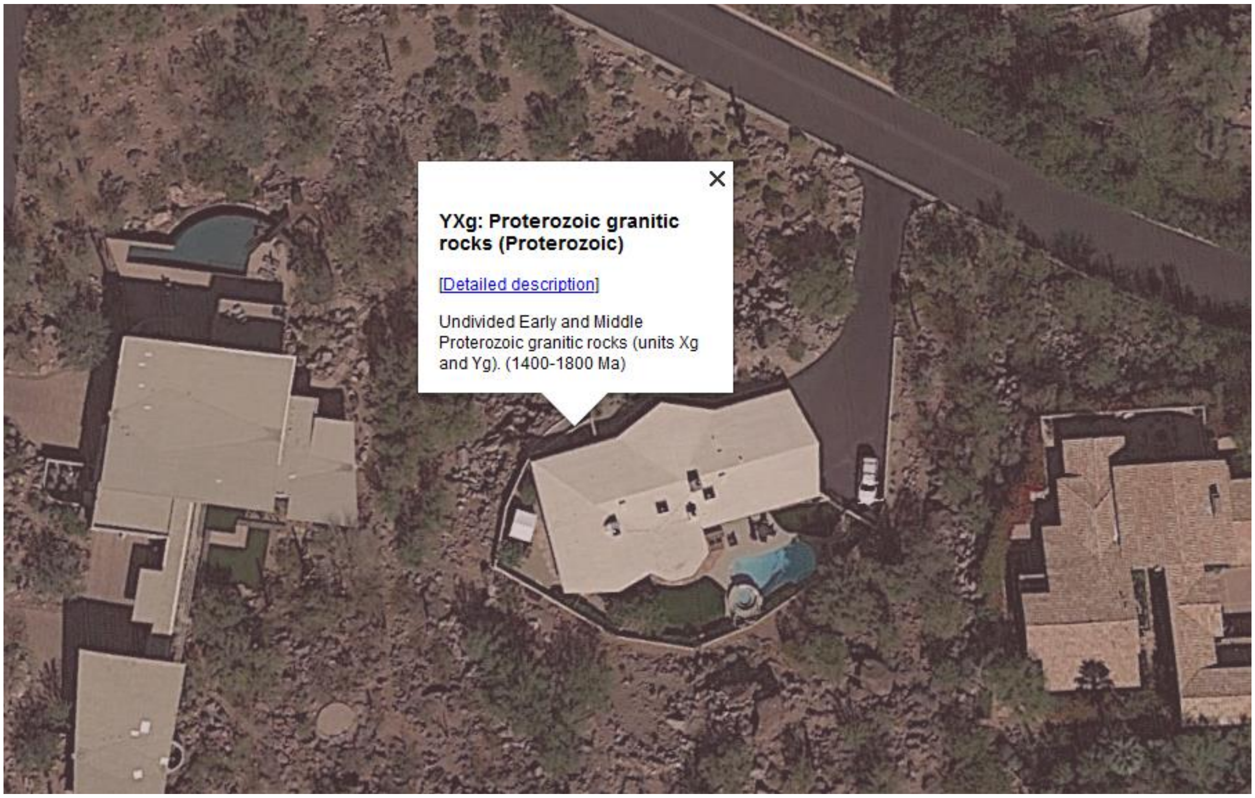


Figure 11: Geologic map of the site

Geologic Map referenced from Arizona Geological Survey, Geologic Map of Arizona, Map 26 (by Stephen J. Reynolds, 1988). Produced in cooperation with the U.S. Geological Survey.

Several of the boulders are considered by this firm to be precariously balanced rocks (PBR) due to the shape of the boulder. Boulders are defined by rock fragments with any dimension greater than 3.0 feet.

2.3: Precariously Balanced Rocks

The geomorphic process that causes precariously balanced rocks (PBR), and specifically granite boulders, to development and preserve through time generally occurs in a two-stage conceptual model. The initial stage involves subsurface chemical weathering within the joints typically from groundwater migration. The second stage involves the mechanical weathering or erosion (sediment transport) of the decomposed rock, resulting in the near-spheroidal shape of the boulders. The following figure illustrates the two-stage geomorphic process.

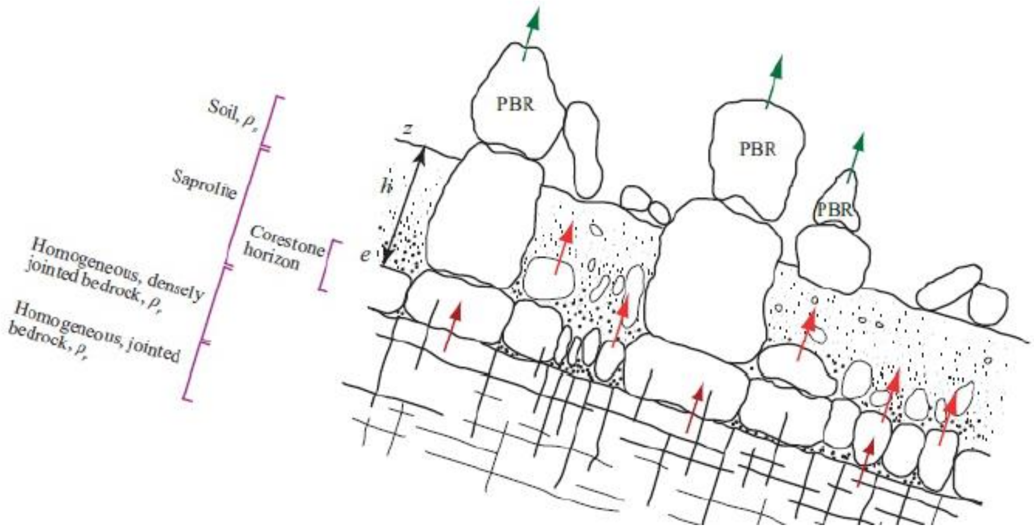


Figure 12: Conceptual geomorphic process of PBRs (originally from Haddad et al., 2012)

Granite outcrops in the arid southwest are highly subject to boulder rolling and can move at any time causing structural damage or personal injury. The most common causes that trigger boulder rolling, rock falls/slides and landslides are 1) natural processes such as ground vibrations induced from *earthquakes** or periods of *heavy rainfall***, and 2) human activities such as under cutting natural stable slopes, creating ground vibrations through blasting or heavy equipment operation or altering natural flow patterns of water during site development. These natural processes and man-made activities can cause a reduction of the friction that holds the boulder in place, and along with the force of gravity, move the boulder down-slope. Because natural erosional processes are very slow and earthquake prediction is ambiguous, only the potential for failure can be stated and not the rate or time at which a natural event or failure may occur.

**Earthquakes* are believed to be one of the main causes that trigger boulder movement. Although this region of the state is relatively earthquake free, they can still occur and have in the past. The risk of an earthquake event occurring at the site is considered low.

**Outside of human activities, *Heavy rainfall* is considered the most common natural cause of mass movement of earth materials at the site. This is most likely to be the main natural mechanism that triggers the reduction in friction of earth materials resulting in rock falls/slides, landslides or boulder rolling under the influence of gravity.

2.4: Seismic Design Parameters

This project is not located over any known active faults or fault associated disturbed zones. The 2012 IBC Site Classification **B** determined from the seismic refraction survey analysis, will be used to determine the seismic coefficient, described herein, necessary for the pseudo-static analysis of the subject boulders. The results of the seismic refraction surveys are presented in the Geotechnical Investigation Report (#24215) dated **January 15, 2016**. The following parameters obtained from the U.S. Geologic Survey Earthquake Design Maps (adopted by 2009 NEHRP and 2012 IBC) are required for the determination of the site's seismic coefficient.

Table 1: Seismic Parameters

Parameter	Value (USGS)	Definition
S_1	0.060g	Spectral Response Acceleration Parameter at 1.0-Second Period
F_V	1.0	Site Coefficient[1]
PGA	0.075g	Mapped MCE[2] Geometric Mean Peak Ground Acceleration
F_{PGA}	1.0	Site Coefficient[1]

[1]See Section 11.4.7 of ASCE 7

[2]Maximum considered earthquake

3: STATIC STABILITY MODELING

The static stability of large boulders, also known as precariously balanced rocks (PBRs), is affected by a combination of several parameters including: boulder geology, shape, weight, points of contact with slope/pedestal, slope/pedestal geology, slope/pedestal contact angle, and the potential applied loading.

The probability of potential boulder movement translationally down slope (sliding) and rotationally down slope (rocking) is modeled using a pseudo-static analysis. A pseudo-static analysis allows dynamic forces to be applied to a static scenario via an equivalent force. To account for the variability of the measured parameters in the closed form solution, a 3-point Rosenbleuth analysis was used. The Rosenbleuth 3-point method can be used to determine the reliability of the stability of the boulder (i.e. probability of movement) and the factor of safety (FS).

The magnitude of potential movement resulting from the limit equilibrium analysis cannot be determined. However, due the nature of the contact points between the subject boulders and their underlying rock mass, minimal movement of any boulder can cause an unwanted reaction from any boulder in contact.

The results of the static stability modeling aid in the determination of active mitigation of the subject boulders. Active mitigation is the reduction of driving forces and/or the increase of resisting forces associated potential boulder movement. The stabilization of boulders can be accomplished by a variety of construction methods, including pinning, netting, and grouting. The method for stabilization differs on individual site conditions.

Each boulder will be modeled under 4 separate conditions as listed below:

1. In situ Condition
2. Vibrational shaking from a seismic force
3. Erosion of the underlying slope/pedestal
4. Grouting of the void space between base of the boulder and the underlying slope (possible stabilization technique) if required by the 3 previous simulations.

The results of the models are presented as the factor of safety (FS) and the probability of movement. **A boulder is determined to be stable if the factor of safety is greater or equal to 1.5 and the probability of movement is less than or equal to 10%.** If a boulder does not meet both of the design requirements for a given simulation, stabilization of the boulder is warranted.

3.1: Field Measurements

From the field investigation, the following parameters affecting the stability of the subject boulders were determined and are tabulated below. The accuracy/range is based on the level of confidence in the measurement of described parameter.

Table 2: Measured Parameters Effecting Boulder Stability

Boulder ID	Width (ft)		Height (ft)		Base Length (ft)		Slope Angle (°)		Contact Percentage (%)		Contact Friction Angle (°)	
	w	±	h	±	b	±	β	±	C_p	±	Φ	±
B-1	16.0	0.25	9.0	0.25	16.0	0.25	15	5	70	5	40	2
B-2	7.0	0.25	4.0	0.25	7.0	0.25	15	5	30	5	42	1
B-3	16.0	0.50	8.0	0.25	8.0	0.25	10	5	50	15	40	2
B-4	8.0	0.25	3.0	0.25	4.0	0.25	25	5	90	5	40	2
B-5	12.0	0.25	8.0	0.25	7.0	0.25	10	5	95	5	40	2

Based the number of parameters affecting the boulder's stability, and the given ranges, 2187 models were simulated for each specific boulder and loading condition.

3.2: In Situ Condition

Modeling the boulder in its in-situ state, with no externally applied forces (i.e. seismic shaking), provides a maximum factor of safety and probability of movement, which can be used as a base to judge the magnitude of effects of potential earthquake shaking and loss of frictional resistance due to erosion.

The following table summarizes the results from the static condition stability analysis movement. Note that overturning potential is not presented here because a boulder will never have a potential to rock unless an external force is applied.

Table 3: Stability Results – In Situ Condition

Boulder ID	FS	Probability of Movement
B-1	2.20	≤ 10%
B-2	1.28	28%
B-3	2.38	≤ 10%
B-4	1.62	≤ 10%
B-5	4.53	≤ 10%

The analysis of the natural state of the boulder results in B-2 not meeting the design criteria the factor of safety greater or equal to 1.5 and/or the probability of movement less than or equal to 10%.

3.3: Seismic Loading Condition

Vibrational waves caused by earthquakes, excavation blasting, or heavy construction equipment are a leading cause of soil/rock movement including: slope failures, liquefaction, and boulder/rock falls. The effects of blasting and heavy equipment are able to be monitored and controlled, however seismic shaking from earthquakes cannot be predicted. As such, the stability of the subject boulders was modeled under an applied seismic load.

A pseudo-static analysis approach is used to model the boulder's response to an equivalent seismic force. The equivalent seismic force is determined from the site's seismic coefficient (k_s), which is based on the site's earthquake history, and the weight of boulder. The parameters necessary for the determination of the seismic coefficient are referenced from USGS and were previously presented in Table 1. From these parameters, the site's seismic coefficient has been determined to be 0.055g to 0.095g.

The following table summarizes the results from the pseudo-static stability analysis with the applied seismic load.

Table 4: Stability Results - Seismic Shaking

Boulder ID	Sliding		Overturning	
	FS	Probability of Movement	FS	Probability of Movement
B-1	1.68	≤ 10%	13.62	≤ 10%
B-2	0.82	70	15.96	≤ 10%
B-3	1.65	≤ 10%	9.31	≤ 10%
B-4	1.35	≤ 10%	0.34	74
B-5	3.13	≤ 10%	4.90	≤ 10%

Although the potential of the subject boulders to rock was increased by the application of the seismic force, the results of the model portray that the subject boulder's probability to rock during a seismic event is low. However, the analysis results in B-2 and B-4 not meeting the design criteria the factor of safety greater or equal to 1.5 and/or the probability of movement less than or equal to 10%.

3.4: Weathering and Erosional Effects

As previously discussed, prolonged rainfall and wind have the ability to reduce a boulder's resistance to potential movement by eroding the frictional strength and/or shrinking the contact area between the boulder and its underlying rock mass. As such, the stability of the subject boulders was modeled with a reduction of frictional resistance of 25% of the current static condition.

The following table summarizes the results from the pseudo-static stability analysis with the reduction of frictional resistance. The potential of rocking movement is not required to be analyzed for weathering effects.

Table 5: Stability Results – Erosion Effects

Boulder ID	FS	Probability of Movement
B-1	1.44	≤ 10%%
B-2	0.58	95%
B-3	1.24	34%
B-4	1.01	47%
B-5	2.23	≤ 10%

The analysis of the effects of potential erosion results in the FS and probability of downhill translation movement (sliding), for B-1, B-2, B-3, and B-4, which do not meet the design criteria.

3.5: Summary of Static Stability Modeling

The following table summarizes the results of the 3 boulder simulations. An "X" indicates that the boulder did not meet both of the design criteria. As previously stated, if a boulder does not meet both of the design requirements for a given simulation, stabilization of the boulder is warranted.

Table 6: Summary of Stability Results

Boulder ID	In Situ	Seismic Shaking		Base Erosion	Stabilization Required
	(Sliding)	(Sliding)	(Toppling)	(Sliding)	
B-1	-	-	-	X	**yes**
B-2	X	X	-	X	**yes**
B-3	-	-	-	X	**yes**
B-4	-	-	X	X	**yes**
B-5	-	-	-	-	**no**

Based on the results of the analysis, a total of 4 of the evaluated 5 boulders will require stabilization in order to meet the design stability requirements (B-1, B-2, B-3, and B-4). Since the all the potential movement is of the down hill sliding nature, grouting of the void space between the boulder base and the underlying slope/pedestal will be considered as the first stabilization technique.

3.6: Boulder Stabilization Model (Grouting)

Grouting the base of the boulder increases the contact percentage of the boulder to the underlying slope/pedestal and decreases the potential for erosion within that area. To model this scenario, the contact percentage between the base of the boulder and the underlying slope/pedestal was set to 100%. Although B-5 was determined to be stable in its natural state, it is included in this simulation in the event that an increased FS is desired at the time of construction.

The following table summarizes the results from the pseudo-static stability analysis with the 100% contact between the boulder and the underlying slope/pedestal. **The seismic force was also applied in this simulation.**

Table 7: Stability Results – Stabilization via Grouting

Boulder ID	FS	Probability of Movement
B-1	2.28	≤ 10%
B-2	2.44	≤ 10%
B-3	3.13	≤ 10%
B-4	1.42	≤ 10%
B-5	3.30	≤ 10%

Out of the 5 evaluated boulders, 4 were determined to require stabilization. For boulders B-1, B-2, B-3, and B-4 grouting of the void space between the boulder base and the underlying slope/pedestal is considered by this firm to be a feasible technique to limit potential boulder movement at the site. B-4 still does not meet the requirements, as previously stated herein, and will require bolting for stabilization.

4: RECOMMENDATIONS FOR BOULDER STABILITY

An active mitigation system is recommended in order to stabilize the subject boulders at the site that have a potential for sliding or toppling. The mitigation system utilizes a boulder stabilization technique from the Vann Engineering Boulder Mitigation Protocols (BMP).

4.1: Boulder Stability Summary

The following table is presented as a summary of the boulder management protocols recommended for this site. An “X” indicates that the BMP is recommended.

Table 8: Summary of Boulder Stability Recommendations

Boulder ID	BMP-2	BMP-7	BMP-8
B-1	X	-	-
B-2	X	-	X
B-3	X	-	-
B-4	X	X	-
B-5	-	-	-

Refer to Section II of this report for a schematic of each boulder management protocol.

4.2: Boulder Stabilization (Grouting)

It is recommended that the boulder stabilization is conducted before any blasting, demolition, earthwork, or other construction activities that may induce vibrations on site.

The voids between the boulders (B-1, B-2, B-3, and B-4) and the underlying slope/pedestal should be filled with 4000 psi non-shrink grout (ASTM C1107). Any smaller boulders wedged between the subject boulders and the underlying rock mass should be encompassed within the grout as well. Grouting the interstitial spaces is referred to as BMP-2 in Section II of this report. Prior to grouting, the areas to be grouted should be power washed, and all loose rock fragments and vegetation should be removed.

For boulders that require more sliding resistance in addition to that added by the interstitial grouting (B-2) The grout should be formed on the downhill side of the boulder to create a buttress. Refer to the BMP-8 in Section II of this report. The location of each boulder to be stabilized must be confirmed by this firm prior to grouting. Any smaller boulders wedged between the subject boulders and the underlying rock mass should be encompassed within the grout as well. The location of each boulder to be stabilized must be confirmed by this firm prior to grouting.

Furthermore, any smaller boulders or rock fragments (without a dimension greater than 3.0 feet) which sit atop other boulders should be removed, as depicted in the figure below. The stability of such boulders/rock fragments was not directly evaluated in this study; however, it is the opinion of this firm that such scenario presents a high potential for movement.

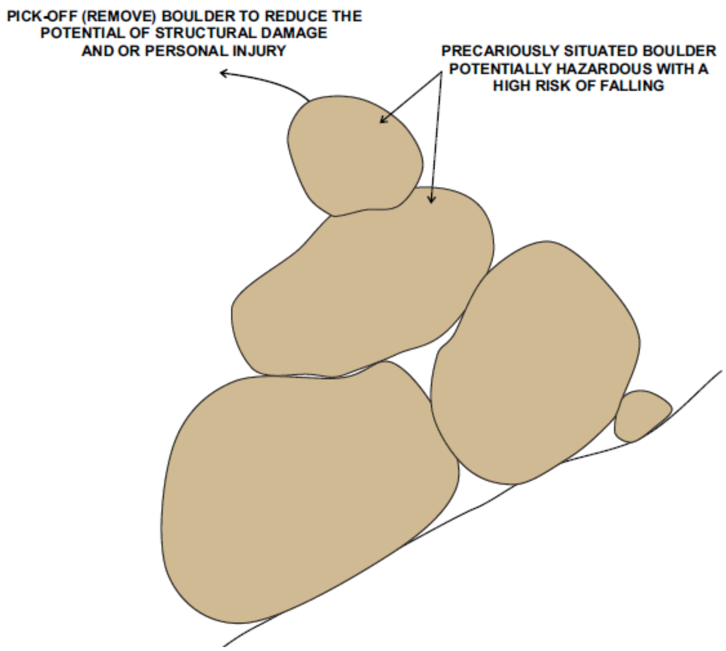


Figure 13: Boulder pick-off illustration

Although not specifically analyzed in this study, several miscellaneous boulder clusters were observed on site during the field investigation (previously shown in Figure 2). It is the opinion of this firm that these miscellaneous boulder clusters did not warrant a detailed analysis due to their size, geometry, and location as it pertains to the existing structures. However, it is recommended that all miscellaneous boulder clusters be stabilized using an interstitial grouting technique as described in BMP 2. A detailed schematic of BMP 2 is presented in Section II of this report. The following list summarizes the key details of BMP-2.

1. Use of either a coarse grout or lean non-shrink concrete mix with a minimum 28-day compressive strength of 4000 psi.
2. Remove the existing vegetation and debris as needed and place grout under and immediately adjacent to the existing boulder for a minimum lateral extent of at least one foot from the edge of the boulder.
3. The grout surface adjacent to the boulder should be built up to prevent surface water from flowing beneath the boulder and eroding the soil or rock.

4.3: Boulder Stabilization (Pinning)

A more stringent active mitigation system is recommended in order to stabilize the subject boulders at the site that have a potential for toppling (B-4). The mitigation system utilizes a boulder pinning technique modified from the Vann Engineering Boulder Mitigation Protocols (BMP).

BMP-7 is recommended for stabilization of the subject boulders, refer to Section II of this report for a detailed schematic of BMP-7. The exact location of each boulder pin must be marked and/or verified by a representative of this firm prior to coring.

The voids between the subject boulders and their underlying rock mass should be filled with 4000 psi non-shrink grout (ASTM C1107) following the pinning efforts. Any smaller boulders wedged between the subject boulders and the underlying rock mass should be encompassed within the grout as well. Coring into small boulders is not recommended as potential for fractures is high.

Table 9: Details for BMP-7

Parameter	Specification
Core hole diameter	1-1/4 inch diameter, to allow 1/4 inch on either side of the reinforcing steel
Depth of core hole	3.0 feet into both rock masses
Reinforcing steel (Pin)	#6 gauge grade 75 all-thread rebar (refer to Table 9 below which summarizes the rebar specifications per Williams Form Engineering Corp.)
Pin Spacing	Set of 1 connection. 18.0 inches, on center, along the contact of the two rock masses (both the boulder and the underlying rock)
Bonding Material	4000 psi non-shrink grout (ASTM C1107) placed in the annular space between the threaded rod and inside wall of the core hole
Encasing Material	4000 psi concrete or equivalent material with a natural appearance
Connections	All must be welded

*Core hold depth and pin spacing is subject to change upon visual inspections of the pin locations due to accessibility issues and irregularities in the two rock masses.

Table 10: Williams Form Grade 75 All-Thread Rebar (ASTM A615)

Bar Designation Nominal Diameter & Pitch	Minimum Net Area Through Threads	Minimum Ultimate Strength	Minimum Yield Strength	Nominal Weight	Approximate Thread Major Diameter
#6–¾”–5	0.44 in^2	44 kips	33 kips	1.5 lbs/ft	7/8”

4.4: Aesthetics

In order to maintain the natural aesthetics of the boulder cluster and surrounding environment the following recommendations should be met during the construction process.

- Precautions should be taken during the time of construction to avoid any disturbance or unnecessary removal of existing vegetation caused by the presence and use of construction personal, materials, and equipment such as concrete spillage, placement of drilling tools, depressions from base of scaffolding, etc.
- Forms should be utilized to minimize concrete overflow during the pouring process.
- All exposed concrete may be finished with faux rock, natural rock veneer, or equivalent textured paint. If the faux rock is mixed into the concrete design, the minimum compressive strength of the mix must still meet the requirements set forth herein. The faux rock must be treated with an aging agent.

Vann Engineering, Inc. holds no responsibility for any disturbance to the natural environment of the site, not including the recommended mitigation of the subject boulders.

5: ADDITIONAL SERVICES

As an additional service, this firm would be pleased to review the project plans for conformance to the intent of this report. Vann Engineering, Inc. should be retained to provide documentation that the recommendations set forth are met. This firm possesses the capability of performing testing and inspection services during the course of construction. Such services include, pinning inspections and concrete sampling. Please notify this firm if a proposal for these services is desired.

6: LIMITATIONS

Please note that several are present upslope from the property boundary that are believed by this firm to warrant a stability analysis. However, per the Town of Paradise Valley Hillside Code, this study is limited to only the boulders on the subject property. Our study has addressed applicable boulders within an area as defined by the Town of Paradise Valley. Other boulders exist upslope that may pose conditions of instability, thereby affecting the subject property.

This report is not intended as a bidding document, and any contractor reviewing this report must draw their own conclusions regarding specific construction techniques to be used on this project. The scope of services carried out by this firm does not include an evaluation pertaining to environmental issues. If these services are required by the lender, we would be most pleased to discuss the varying degrees of environmental site assessments.

This report is issued with the understanding that it is the responsibility of the owner to see that its provisions are carried out or brought to the attention of those concerned. In the event that any changes of the proposed project are planned, the conclusions and recommendations contained in this report shall be reviewed and the report shall be modified or supplemented as necessary. Prior to construction, we recommend the following:

1. Consultation with the design team in all areas that concern soils and rocks to ensure a clear understanding of all key elements contained within this report.
2. This firm be notified of all specific areas to be treated as special inspection items (designated by the architect, structural engineer or governmental agency).

Relative to this firm's involvement with the project during the course of construction, we offer the following recommendations:

1. The site or development owner should be directly responsible for the selection of the geotechnical consultant to provide testing and observation services during the course of construction.
2. This firm should be contracted by the owner to provide the course of construction testing and observation services for this project, as we are most familiar with the interpretation of the methodology followed herein.
3. All parties concerned should understand that there exists a priority surrounding the testing and observation services completed at the site.

SECTION II

DATE: 09/21/18
PREPARED BY: AC
SCALE: NTS

PROPOSED TONN RESIDENCE
APN 172-47-063
5429 EAST SOLANO DRIVE
PARADISE VALLEY, ARIZONA 85253
PROJECT 24215

VANN ENGINEERING INC

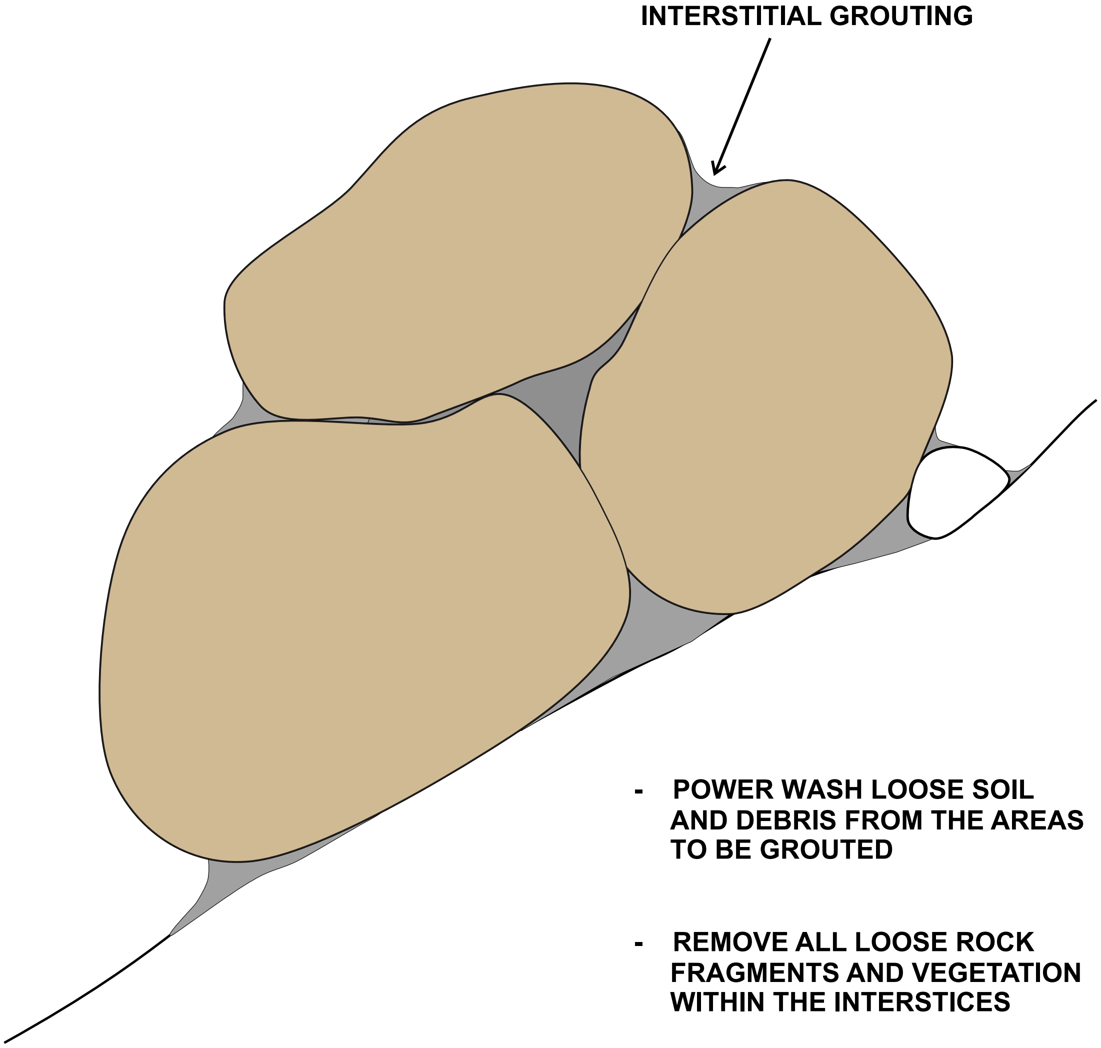
Boulder GPS Coordinates

A PROPOSED CUSTOM HILLSIDE RESIDENCE
APN 172-47-063
5429 EAST SOLANO DRIVE
PARADISE VALLEY, ARIZONA 85253

Boulder ID	North	West
B-1	33° 31’ 12.67”	111° 57’ 49.71”
B-2	33° 31’ 12.63”	111° 58’ 49.87”
B-3	33° 31’ 12.56”	111° 58’ 50.19”
B-4	33° 31’ 12.65”	111° 58’ 50.30”
B-5	33° 31’ 13.20”	111° 57’ 49.41”

BMP NO. 2

BOULDER STABILIZATION SCHEMATIC

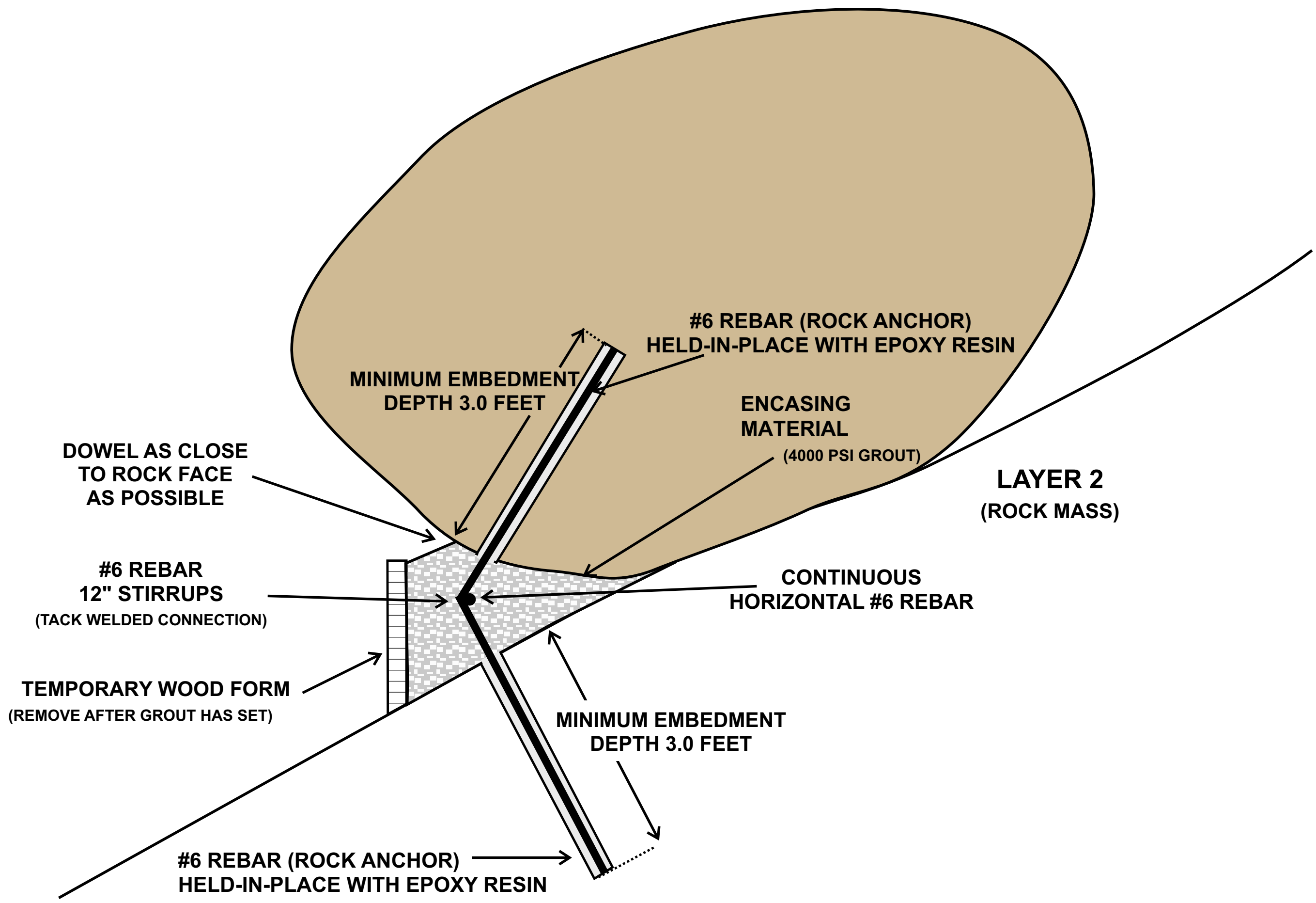


- POWER WASH LOOSE SOIL AND DEBRIS FROM THE AREAS TO BE GROUTED
- REMOVE ALL LOOSE ROCK FRAGMENTS AND VEGETATION WITHIN THE INTERSTICES
- 4000 PSI GROUT TO FILL VOIDS

VANN ENGINEERING INC

BMP NO. 7

PINNING SCHEMATIC

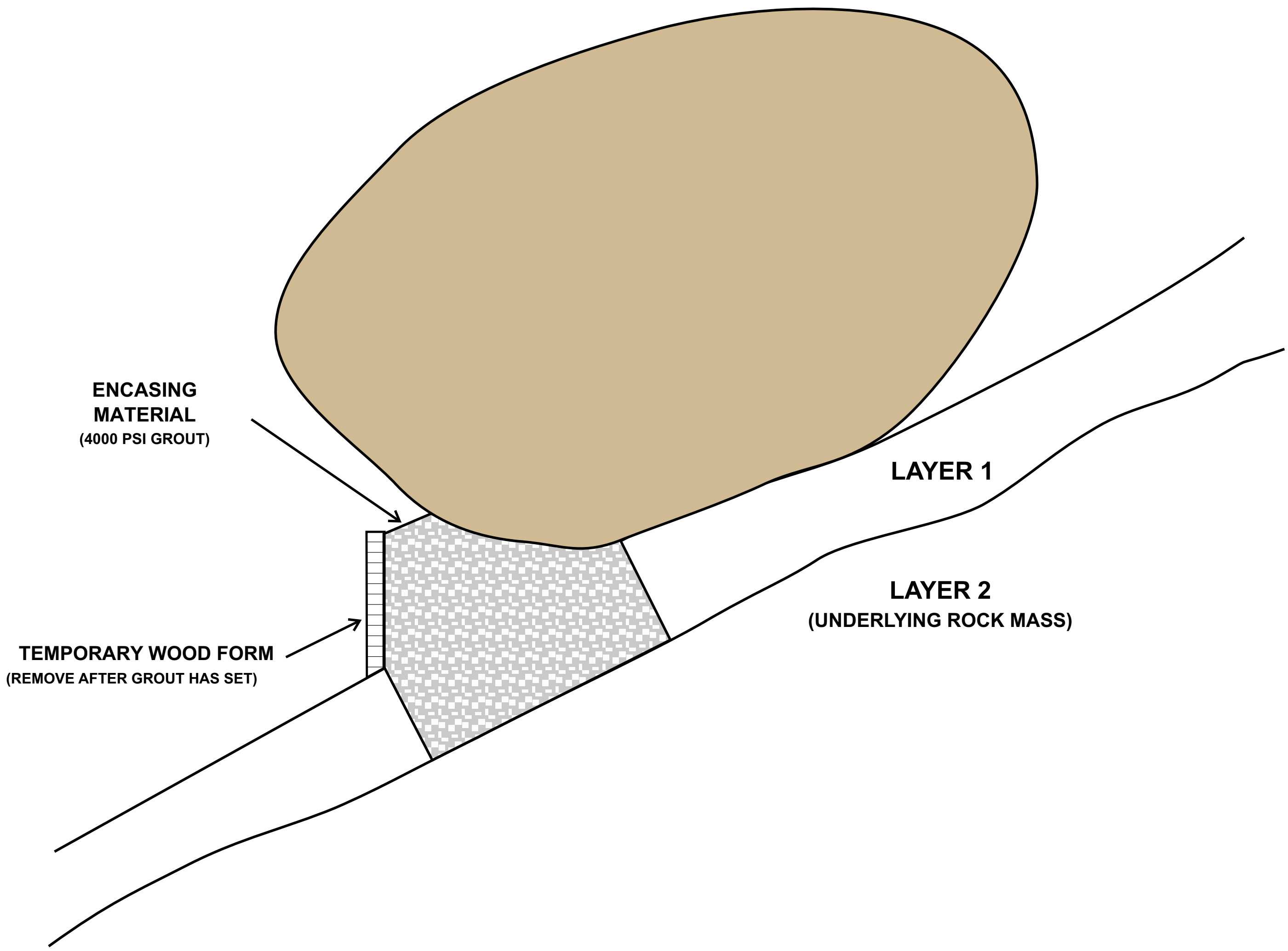


DOWELL (PIN) SPACING 4.0 FEET
ALONG THE ENTIRE FALL LINE
SIDE OF THE BOULDER

VANN ENGINEERING INC

BMP NO. 8

PINNING SCHEMATIC



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