RULE 6.5 GEOTECHNICAL STABILITY EXHIBIT
FRONT RANGE AGGREGATES
PARKDALE QUARRY
FREMONT COUNTY, COLORADO

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Introduction

The Parkdale Quarry is located in Fremont County, Colorado, approximately 12 miles west of Canon City and was permitted in 1998. Aggregate reserves mined from the Parkdale Quarry site include those derived from Quaternary alluvium (alluvial deposit) and Precambrian granite (granite deposit). An approximate five-acre area of Cretaceous Dakota sandstone (sandstone deposit) is also permitted for mining on the Parkdale Quarry. However, there are no current plans to mine the sandstone deposit.

The Parkdale Quarry was initially owned and mined by Agile Stone, who operated the quarry from 1998 until 2002. The quarry was purchased by CIG (now a wholly-owned subsidiary of Martin Marietta) in 2003, and mining of the site resumed in 2004. The quarry is currently operated by Front Range Aggregates, LLC (FRA), also a wholly-owned subsidiary of Martin Marietta. The alluvial deposit was the initial deposit mined at the Parkdale Quarry, and provided the majority of the material being mined on the site until 2017. Mining transitioned to the granite deposit in 2017, and material produced from the granite deposit now accounts for the majority of the material mined at the Parkdale Quarry

Mining of the alluvial deposit was initially limited to the material above high groundwater. In 2008 the mine permit for the Parkdale Quarry was amended to allow the alluvial deposit to be excavated to bedrock, to allow for additional mining of the granite deposit, and to change the mine reclamation end use for the granite and alluvial deposits from agriculture/grazing to water storage. A geotechnical stability report was prepared by Lyman Henn, Inc. (LHI) for the 2008 Parkdale Quarry permit amendment (LHI report).

FRA submitted a 2021 application to amend the Parkdale Quarry mining permit to expand the mining area of the granite deposit north and west onto land owned by the Bureau of Land Management (BLM). As part of that amendment process, the Colorado Department of Reclamation, Mining and Safety (DRMS) requires that the geotechnical stability report for the quarry be updated to reflect the additional mining area and changes to stability requirements since the 2008 amendment. This 2021 exhibit is intended to serve as an update to the LHI report, meeting the requirements of Rule 6.5 of the Mineral Rules and Regulations of the Colorado Mined Land Reclamation Board for the Extraction of Construction Materials as amended in 2019 (Rule 6.5). This update addresses the following issues:

- Geologic hazards that have the potential to affect any proposed impoundment, slope, embankment, highwall, or waste pile within the affected area;
- Engineering stability analyses for proposed final reclaimed slopes, highwalls, waste piles and embankments;
- Operational slope configurations; and
- Information to demonstrate that off-site areas will not be adversely affected by blasting.

Site Geology

The Parkdale Quarry is located at the north end of Webster Park, approximately 12 miles west of Canon City, Colorado. Webster Park is an intermountain sedimentary basin with an area of approximately 10 square miles that is approximately seven miles long in the north-south direction, and ranges from approximately one-half to two miles wide in the east-west direction. The overall surficial geology of the Parkdale Quarry site is comprised of Mesozoic sedimentary rock units overlain by Quaternary alluvium in the southern portion of the property, bounded on the west by Precambrian intrusive igneous/metamorphosed igneous rock, and on the north and east sides by Precambrian granitic intrusive rock (granite). The Mesozoic sedimentary rocks on the site occur in a fault-bounded syncline.

The Precambrian intrusive igneous/metamorphosed igneous rock unit in the Parkdale Quarry vicinity was described by Schaefer (1969) as Parkdale Gneiss, but is shown and described as Precambrian Quartz Diorite correlating to the Boulder Creek Granodiorite by Taylor, et. al. (1975). The primary rock type making up the granite deposit is described in Schaefer (1969) as granite correlating to, or possibly a part of the Pikes Peak Granite pluton, but is shown on Map I-869 as Precambrian Granodiorite. The granitic rock is also described as granite in a 2004 report by J.A. Cesare Associates (Cesare). In 2014, R.J. Lee Group performed a petrographic analysis of the granitic rock currently mined by Front Range Aggregates. R.J. Lee Group characterized the granitic rock on the site as a pink, coarse-grained, alkali granite containing gray and black minerals. Orthoclase feldspar (K-spar) is the dominant mineral, along with quartz and biotite mica. Accessory minerals reported include plagioclase feldspar, calcite, gibbsite, muscovite, kaolinite, and unidentified opaque minerals. The granite is the primary material currently being mined and proposed for future mining. Rare chlorite and epidote were observed on fracture faces in core samples from the granite. The granite is intruded by veins of dark gray, fine-grained, mafic intrusive rock generally ranging from 6 to 24 inches thick. Examples of these mafic intrusive veins are visible in quarry faces and in road cut and cliff exposures along Highway 50 approximately one-mile east of the site. Based on visual evaluation of rock cores and mining faces in the granite deposit, the petrology of the granitic rock in the mining area is relatively homogenous across the site.

The Mesozoic sedimentary complex on the Parkdale Quarry includes the permitted sandstone deposit, and is not currently mined. The Mesozoic sedimentary rocks underlie most of the Quaternary alluvium on the site. The Mesozoic sedimentary complex is composed of Cretaceous Niobrara Formation shale, Cretaceous Graneros Formation shale and shaley limestone, Cretaceous Dakota Formation sandstone and shale, and Jurassic Morrison Formation sandstone and shale. The Mesozoic sedimentary units on the site are separated from the Precambrian intrusive igneous/metamorphosed igneous rock on the west side of the quarry site by the Ilse Fault. Though not mapped as such, drilling results demonstrated that the contact between the Mesozoic sedimentary units and the granitic rock on the east side of the site is a generally north-south trending high-angle reverse fault.

Quaternary alluvium unconformably overlies the other rock units on the property, but primarily occurs overlying the Mesozoic units in the southern portion of the property. Remnant deposits of quaternary alluvium are present overlying the Precambrian rocks on the east and west sides of the property. The Quaternary alluvium is interpreted to be a series of flood deposits resulting from the breaching of a series of glacial ice dams that formed at the west end of Sheep Canyon, west of Parkdale. The Quaternary alluvium was the initial source for materials mined at the Parkdale Quarry.

Five faults are present on or within one mile of the Parkdale Quarry and the BLM expansion area, as shown on the maps by Wobus, et. al (1979) and Taylor, et. al. (1975). The faults include the previously mentioned north-northwest trending Ilse Fault on the west side of the area that forms the western boundary of Webster

Park, the east-southeast trending Parkdale Fault that forms the north and east boundary of Cactus Mountain, the northeast trending Mikesell Fault which Highway 50 approximately follows from the Arkansas River Bridge to the Highway 50/Route 9 junction, an unnamed north trending fault which Currant Creek approximately follows, and the previously mentioned unnamed north-northeast trending fault that cuts through the southeastern part of the site and is the boundary between the Mesozoic sedimentary rocks and the granitic rock.

Geologic Hazards

Rule 6.5 requires the identification of geologic hazards that have the potential to affect any proposed impoundment, slope, embankment, highwall, or waste pile within the affected area. A geologic hazard as defined in Rule 6.5 is one of several types of adverse geologic conditions capable of causing damage or loss of property and life. Geologic hazards that may be considered include landslides and debris flows, subsidence, earthquakes and seismicity, tsunamis and seiches, and volcanic activity.

Landslides and Debris Flows

We visually evaluated landslide and debris flow hazards that have the potential to affect any proposed impoundment, slope, embankment, highwall, or waste pile within the affected area. The geologic materials present on slopes at the Parkdale Quarry and adjacent BLM area proposed for mining include Precambrian granite and Cretaceous-age sedimentary rocks. Some localized natural rockfalls occur in the area due to weathering and erosion. However, no evidence of natural landslides or debris flows were observed within or adjacent to the mining area that would be indicative of a potential hazard to proposed structures. If improperly designed, failures of mine slopes can affect proposed impoundments, embankments, highwalls, or waste piles. Mine slopes are being designed with ultimate factors of safety appropriate to minimize potential adverse impacts. Reclamation slopes are being designed with a static factor of safety of 1.5 or greater, and a seismic factor of safety of 1.3 or greater. Working slopes are being designed with a static factor of safety of 1.3 or greater, and a seismic factor of safety of 1.1 or greater. Mining activities are unlikely to decrease global stability outside of the mining area.

Earthquakes and Seismicity

There is no evidence that the five faults on or within one-mile of the Parkdale Quarry and expansion area are active (evidence of movement in the past 10,000 years) or potentially active (evidence of movement in the last 1.6-million years). The design Peak Ground Acceleration (PGA) for the site was derived from the 2021 USGS online Unified Hazard Tool and was compared to the 1997 Uniform Building Code (UBC) map. According to the UBC map, the Parkdale Quarry is located in Seismic Zone 1 defined by a PGA Range of 0.05g to 0.08g. The USGS Unified Hazard Tool predicted a PGA of 0.0801g for an earthquake with a return period of 975 years (5% chance of occurrence in 50 years). The predicted PGAs are unlikely to affect proposed impoundments, slopes, embankments, highwalls, or waste pile within the affected area.

Volcanic Activity

There are no known active volcanic features in the region with the potential to affect any proposed impoundment, slope, embankment, highwall, or waste pile within the affected area.

Tsunamis and Seiches

Tsunamis and seiches are not a potential hazard since there are no bodies of water in the vicinity of the site large enough to generate those phenomena.

Subsidence

There has not been documented underground mining under the site, and the subsurface geology is not conducive to the formation of karst features, so subsidence is unlikely.

Engineering stability analyses

The 2008 engineering stability analysis was reviewed and additional engineering stability analysis was performed to evaluate current and proposed quarry slopes based on current conditions, observed rock properties, and the proposed mining and reclamation slopes shown in Figure 1. The additional analysis was compared with and incorporated the analysis performed by LHI for the 2008 Reclamation Permit amendment. Additional measurements of discontinuities were taken in July, 2021 at 22 locations on the currently permitted granite mining area and on the proposed BLM mining area to determine whether rock properties differ significantly between the two areas.

Findings from the 2008 Slope Stability Memo

2008 Rock Slope Assessment

In 2008, LHI evaluated the Parkdale Quarry rock slopes based on the kinematic stability of rock blocks, slabs, and ledges defined by the rock joint patterns. LHI incorporated geotechnical and geological data collected at the Parkdale Quarry by Cesare in 2004 into their evaluation. Evaluation of rock mapping data by LHI and Cesare showed that the most prevalent joints are vertical to sub-vertical in two to three sets. Additionally, several sets of random joints at different strike orientations and dip angles were noted to be present. Most of the joints were determined to be fresh to slightly weathered, and moderately rough to stepped. These observations are consistent with those from the 2021 observations. Based on the joint characteristics, LHI used a friction angle of between 39 and 50 degrees. A typical friction angle for joints in granite is 40 degrees (Barton, 1974), which does not account for joint roughness. The friction angle should be modified to account for a joint roughness coefficient of 8 to 12, based on field observations. Based on the work of Williams, 1980, an appropriate modified friction angle for the rock accounting for the joint roughness is 45 degrees.

For the vertical and sub-vertical jointing, LHI stated that there is the potential for toppling and sliding of slivers, but these are expected to be limited to individual benches and highwalls. Large scale instabilities involving multiple benches and the overall quarry slopes are not expected as a result of these vertical and sub-vertical joints. For the non-vertical random jointing, LHI stated that there is the potential for sliding of blocks, slabs, and wedges in situations where the potential slide angle is steeper than the joint friction angle. Based on the then current mine plan, they concluded that this condition is not likely in the upper portion of the quarry, above elevation 5,800 feet where the quarry walls are inclined at a planned dip angle of 39 degrees; which is the lower bound of the likely joint friction angle they used. However, for the lower portion of the quarry, below elevation 5,800 feet where the quarry walls are steeper, with a planned dip angle of 51 degrees, LHI stated that rock instabilities are kinematically possible. However, LHI also stated that for a slide to occur, the joint would have to be relatively continuous and connected to other release joints to isolate a free block or wedge. Because the joints are random, it is not expected that these conditions would be persistent throughout the quarry. As such, LHI stated that there could be isolated areas of slope instability, but it is not expected that the random joints would result in slope instabilities on a large scale that would cause persistent problems. The observations of joints are consistent with those from the 2021 observations. However, as part of the 2021 amendment FRA proposes to modify reclamation slopes to generally be 45 degrees or flatter, equal or less than the calculated friction angle, except in isolated areas totaling less than 10-percent of the slope area, where near-vertical slopes up to 80 feet in height will be maintained.

LHI stated that for any rock mass there is the possibility of large-scale random joints with a low strength such as from historic sliding, weathering, or clay infilling. If such a joint or several joints exist and if these joints have a disadvantageous orientation and location, then there could be a large-scale slope instability. However, field observations by LHI and by Cesare did not reveal any such joints. Based on the information available in 2008, LHI had no reason to believe that there would be a high risk for such events. Nothing was observed during the 2021 investigation that would alter that conclusion.

LHI did not perform factor of safety analysis for granite rock slopes. As verification for the 2008 slope stability evaluations, LHI recommended that an Observational Approach to slope stability be used to develop the quarry. Using that approach, a small area of the mine in the first phase and away from the limit of mining was excavated first and used to observe actual ground conditions and rock slope behavior. The observed conditions are consistent with the assumptions used for the LHI slope stability evaluation and the rock slopes do not show unexpected behavior.

<u>2008 Soil Backfill Slope Assessment</u>

Soil is placed on benches as part of mine reclamation. LHI expected this soil to be overburden removed from above mineable rock, weathered rock, and unsaleable rock and fines as a byproduct of rock processing. They further expected that this soil would receive a low to moderate degree of compaction, and would contain waste rock containing large particles which is impractical to compact. LHI assumed that the reclamation soils are all granular with angular to sub-angular particles and no more than approximately 25 percent fines (material finer than the number 200 sieve).

LHI's soil slope stability calculations were based on a purely frictional analysis neglecting cohesion, which is a conservative assumption. Soil friction angles were estimated from correlations based on soil type and density. A safety factor of 1.1 was chosen by LHI to be the design criteria. Based on these analyses, they calculated that fill derived from overburden and unsaleable material cold be placed on slopes of 1.75 Horizontal (H) to l Vertical (V) or flatter, and that weathered rock could be placed on slopes of 1.5H to lV or flatter. With a high level of compaction and with laboratory testing to verify the soil strength, LHI expected that any of these materials could meet the design safety factor on a slope with an inclination of 1.5H to lV.

2021 Additional Stability Analysis

Additional stability analysis was performed to assess stability of proposed rock and soil slopes in the Parkdale Quarry BLM expansion area and to reassess existing quarry and fill slopes. Two slope stability conditions were investigated for rock and soil slopes: a static stability state condition and stability assuming the maximum predicted 0.08g PGA based on the seismic zonation. Condition 1 assumes the slope is in a steady state condition and that the minimum acceptable factor of safety is 1.5. Condition 2 assumes that the slope is subject to a PGA of 0.08g, and that the minimum factor of safety is 1.3.

<u>Additional Rock Slope Stability Analysis</u>

LHI evaluated the rock slopes based on the kinematic stability of rock blocks, slabs, and wedges defined by the rock joint patterns. Evaluation of rock mapping data by LHI and, also by Cesare showed that the most prevalent joints are vertical to sub-vertical. Additionally, several sets of random joints at different strike orientations and dip angles were noted to be present. As previously stated, most of the joints were determined to be fresh to slightly weathered, and moderately rough to stepped equal to a joint roughness coefficient of 8 to 12.

Exploratory mining of the granite was initiated by Agile Stone in 2001, and production-scale mining of the granite was initiated in 2017, subsequent to the observations made by LHI and by Cesare. Approximately 160,000 square feet of bench face have been exposed over the course of the mining, and large-scale random joints with a low strength such as from historic sliding, weathering, or clay infilling have not been observed.

Additional joint orientation data was collected in July, 2021 from quarry faces at eight locations in the active quarry and from 15 outcrop locations within the proposed mining area on the BLM expansion area. Information on jointing characteristics was also obtained from granite cores recovered from exploratory borings on the current mining area and BLM lands drilled by FRA in 2015 and 2018. The cores were not oriented so joint dip azimuth was not available, but the joints were generally steeply dipping. Based on observations from cores, outcrop exposures, and quarry faces in fresh rock, the joint spacing decreases with depth to an average spacing greater than 15 feet. Joints observed in quarry faces are generally discontinuous with average lengths of less than 20 feet.

No large-scale random joints with a low strength such as from historic sliding, weathering, or clay infilling were observed by during the 2021 investigation, or reported by LHI, and J. A. LHI's data on joint orientation and characteristics are consistent with the July, 2021 measurements and observations of joints in the active granite quarry area and on the BLM expansion area. The correlation between the July, 2021 data and that reported by Cesare and LHI is demonstrated by the Stereonet plots from the 2008 analysis (Figures 2A and 2B) verses Stereonet plots of data collected in July 2021 (Figures 3A, 3B, and 3C), and a Stereonet plot of the combined 2008 and 2021 date (Figure 4). Two main joint set orientations show up in each of the three (Martin Marietta, LHI, and Cesare) data sets. Three other joint sets were observed in two of the three data sets. The joint set orientations from each data set and the interpreted average orientation for each joint set are shown in Table 1.

Table 1 - Joint Set Orientations - Parkdale Quarry Area Granite

Joint Set	Dip Azimuth				Dip			
	Martin Marietta	Lyman Henn Inc.	J. A. Cesare	Average	Martin Marietta	Lyman Henn Inc.	J. A. Cesare	Average
1	322	323	315	320	69	29	Near Vertical(1)	61
2	242	242	228	237	56	81	49	62
3	57	--	40	49	74	--	69	72
4	144	141	--	143	88	86	--	87
5	--	29	35	32	--	81	Near Vertical(1)	83

(1) - A dip value of 85 degrees was assigned to Near Vertical joints for purposes of assigning the average dip for a set.
-- No joint set falling into this approximate range measured/reported.

The current and proposed mining and reclamation rock slopes were analyzed using the RockPack III computer program. RockPack III uses the stability analysis methodology developed by Hoek and Brown, 1997, as modified in 1988, and was designed to analyze the slope stability of a rock slope subjected to several critical situations that may occur during the life of the slope.

The rock properties used for the modeling are as follows:

- Density of the Granite - 163 pounds per cubic foot (Based on laboratory measurements of samples from cores and produced materials)
- Friction Angle Modified to Account for Joint Roughness - 45 degrees (from Williams, 1980, and based on an angle of friction of 40 degrees for joints in granite with a sandy loam fracture filling after Barton, 1974, and a joint roughness coefficient of 8 to 12 based on field observations).
- Joint Cohesion - 5,000 pounds per Square Foot (from Barton, 1974 and Wyllie, 1992).
- Unconfined Compressive Strength - 18, 020 psi (based on 2002 laboratory testing performed by Colorado School of Mines for Agile Stone)
- Confined Compressive Strength - 52,530 psi (based on 2002 laboratory testing performed by Colorado School of Mines for Agile Stone)
- Maximum Observed Discontinuity Length - 20 feet (Excludes two observed fault/shear zones on the site)
- Average Joint Spacing – 15 feet (Based on observations of quarry faces and from cores)

An evaluation of likely failure mechanisms for each of the mining highwall and reclamation slope orientations was performed using standard stereonet techniques (Figures 5 through 26).

As seen in stereonet plots of jointing verses reclamation slope orientations for each of the final reclamation slopes (Figures 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, and 26), only three joints intercepted the critical zone for wedge or planar failures in any orientation, therefore large-scale wedge and planar failures are unlikely to occur. Some joints did intercept the critical zone for topple failure, but if they occurred, topple failures would be localized for the reasons stated above. Based on current information there is no reason to believe that there would be a significant risk for large scale failures of rock slopes.

Potential failure mechanisms for active mining bench slopes were analyzed as shown in the stereonet plots of jointing verses mining slope orientations for each of the final mining slope orientations (Figures 5, 7, 9, 11, 13, 15, 17, 19, 21, 23, and 25). The 2021 analysis indicates that there is a low potential for toppling and sliding of slivers associated with vertical and sub-vertical jointing on mining highwalls. The analysis does indicate that there is the potential for sliding of blocks, slabs, and wedges associated with non-vertical random jointing on mining highwalls in situations where the potential slide angle is steeper than the joint friction angle, which based on joint properties is assumed to be 45 degrees. Where quarry walls are steeper, and the joint angle exceeds the joint friction angle rock instabilities are kinematically possible. However, for a slide to occur, the joint would have to be relatively continuous and connected to other release joints to isolate a free block or wedge. Because the observed joints are random and joints are generally discontinuous, it is not expected that these conditions would be persistent throughout the quarry. As such, there could be isolated and localized areas of slope instability on mining benches, but it is not expected that the random joints would result in slope instabilities on a large scale that would cause persistent problems.

Large scale instabilities involving multiple benches and the overall quarry slopes are not expected as a result of the observed joint orientations. The limited joint spacing and joint length observed during the 2021 measurements, as well as observation of quarry slopes excavated between 2001 and 2021 support the conclusion that instability is limited to sliding and toppling of localized small-scale slivers and blocks

Though the stereonet analysis indicates that mining and reclamation slopes are expected to be globally stable, slope stability factor of safety analysis were performed for mining and reclamation slopes. Slope stability factor of safety analysis was performed for the anticipated tallest mining bench and the anticipated average and maximum reclamation slope angles for each planned final reclamation slope. Factors of safety for slopes up to 80 feet tall and with an 80-degree face angle exceeded 2.53 for static conditions, and 2.35 for seismic conditions, except that the static factor of safety for wedge failure on the slope along the north pit limit on BLM property was 2.37. Since the major joint sets dip steeper than the overall 45-degree reclamation mine slope, potential failure surfaces for planar failures would not intercept the slope face so factor of safety analysis is not applicable. The observed joint sets did not exceed the proposed reclamation bench height of 35 feet so wedge failures are unlikely to affect overall reclamation slopes. Therefore, wedge failure factor of safety analysis for the final reclamation slopes was performed based on analysis for individual benches. Based on that analysis, the minimum factor of safety for the static condition was 2.37, as per the working mine bench slopes and the factor of safety for the seismic condition would exceed 2.0.

Since the observed jointing in the granite is discontinuous, an observational approach to slope stability is being used to supplement the stability modeling used to develop the quarry. Using the observational approach, a small area of the mine away from the limit of mining was excavated first and used to observe actual ground conditions and rock slope behavior. The observed conditions are consistent with the behavior predicted as part of the 2008 slope stability evaluation and as predicted by the 2021 modeling. The observations to date support the development of the mine as proposed in the 2021 mine plan and show that the rock slopes are stable using the proposed design parameters. Slope observations will continue throughout the mining process and if indications of instability are observed appropriate changes to the rock slopes will be made.

<u>Additional Soil Slope Stability Analysis</u>

Approximately 3,200 linear feet of mining benches have been reclaimed at the Parkdale Quarry since 2017. Soil is being placed on benches as part of mine reclamation. This soil is a mixture of overburden removed from above mineable rock, weathered rock, and unsaleable rock and fines as a byproduct of rock processing. During placement, this soil is tracked in with a bulldozer and receives a moderate degree of compaction. These soils are generally granular with angular to sub-angular particles and approximately 25 to 35 percent fines (material finer than the number 200 sieve) and are characterized as GC-GL (clayey gravel with many fines) using the unified soils classification system (USCS). Soil slope stability calculations performed in 2008 were based on a purely frictional analysis neglecting cohesion, which is a conservative assumption. Soil friction angles were estimated from correlations based on soil type and density. Observation of reclamation slopes indicates that cohesion is playing a significant role in stability the backfill. The following soil parameters were used for the stability analysis:

- Unified Soils Classification System GM to GC (Silty Gravels to Clayey Gravels) with cobble-size inclusions of waste rock.
- Estimated Shear Strength12 kPa
- Effective Friction Angle 35 degrees
- Poisson's Ratio 0.25
- Young's Modulus 150 MPa
- Unit Weight of soil (90% compaction) 103 pounds per cubic foot (16 kN/m3)

- Cohesion 20 psi (3,100 psf)

Soil slope stability was evaluated using the online slope stability calculator developed by the WISE Uranium Project for the evaluation of tailings dam slopes. The WISE program uses the Modified Bishop analysis method (Bishop, 1955). Two slope types were evaluated, reclamation bench fill slopes and excess overburden stockpile slopes. Each slope type was evaluated for static conditions and seismic conditions assuming a 0.08g acceleration.

Reclamation Slopes: Reclamation bench fill slopes were modeled assuming that a slope failure in a reclamation fill slope is constrained by mining benches in rock with a bench height of 35 feet, a bench face angle of 80 degrees, a horizontal bench width of approximately 30 feet, and a soil slope face angle of 45 degrees. As shown in Figure 27, the modeled failure plane assumed a worst-case scenario for a bench fill with failure initiated at the base of the fill and extending to the head of the fill. The calculated factor of safety for the seismic condition was found to be 4.930 indicating that reclamation slopes are stable. The slope was not modeled for the static condition since the seismic factor of safety exceeded 1.5. The finding that reclamation slopes are stable is consistent with four years of observation of fill slopes at the Parkdale Quarry and over 20 years of observation of similarly constructed fill slopes at the Martin Marietta Specification Aggregates Quarry in Golden, Colorado, where no stability-related failures of reclamation slopes have been observed though slopes are subject to accelerations in excess of 0.08g due to blasting on adjacent mining benches. To date, the failures observed on the existing reclamation slopes are generally caused by erosion. Rare raveling of saturated soils in areas generally less than 1,000 square feet have been observed in unvegetated or thinly vegetated areas after heavy rainfall events, but the raveling does not affect the overall stability of the slopes.

Overburden Stockpile Slopes: Overburden stockpile slopes were modeled to determine the maximum slope angle for a 35-foot tall stockpile that meets the minimum factor of safety requirements for the site. As shown in Figures 28A and 28B, the modeled failure plane assumed a worst-case scenario with failure initiated at the base of the fill and extending to the head of the fill. Based on the modeling, stockpile slopes of 1.5H to 1V or flatter will have a static factor of safety of 1.55 or greater and a seismic factor of safety of 1.34 or greater.

The soil slope factors of safety for stockpile slopes determined through the current analysis are higher than that determined by HLA. These soil parameters used for the current analysis are based on observed soil properties, and differ from those used in the LHI report which were overly conservative assumed values. The Modified Bishop method of analysis is an inherently conservative approach to stability modeling. Additionally, Irfan and Tang (1992) found that conventional strength analysis underestimates the strength of block in matrix soils (BIM soils) by 30 percent or more. Therefore, the soil parameters used for the current analysis should also be considered as conservative based on the waste rock blocks present in the materials and thus the results of the analysis should also be viewed as conservative.

Off-site Impacts from Blasting

Blasting is currently being performed at the Parkdale Quarry. All blasting is currently performed by a United States Bureau of Alcohol, Tobacco, Firearms, and Explosives (ATFE) licensed third-party blasting contractor. A blast plan prepared in accordance with Code of Federal Regulations (CFR) 30, Part 56 Subpart E - Explosives and Office of Surface Mining Reclamation and Enforcement (OSM) Blasting Performance Standards is in place for blasting operations. Only one off-site structure is located within ½-mile of the active mining area. Front Range Aggregates had performed 181 monitored blasts on the site as of November 1, 2021, with no reports of offsite damage and no recorded exceedances of allowable vibration limits.

General Blasting Procedures

Blast holes are typically loaded the day a blast is scheduled. Explosives are transported to the site by the blasting contractor on the day a blast is scheduled, any excess explosives are transported from the site after all blast holes are loaded, and no explosives are stored on the site. Personnel at the quarry prepare each area to be drilled and blasted according to the mining plan for the quarry development. The quarry manager works with the blasting contractor to design an appropriate drill pattern to ensure safe and efficient production in each area of the quarry. The drill pattern design includes burden and spacing, hole depth, number of holes, explosive densities, shot sequencing, stemming, and other factors. Drilling is performed using a rotary hammer shothole drill using either a top-hammer or down-hole-hammer. Drilling is conducted using a Martin Marietta employed driller and drill or an outside drilling contractor. Blasting is performed using conventional mining-type bulk explosives to include ammonium nitrate and fuel oil (ANFO); an emulsion of liquid ammonium nitrate and diesel fuel; or a blend of the two. Blasts are initiated using computer-controlled electronic detonators that are programable and require that a unique code be sent to them to detonate.

Blasting at the Parkdale Quarry is currently permitted from 10:00 AM to 5:00 PM, not more than five days per week. No change to the currently permitted blasting schedule is anticipated at this time. The quarry operator reached out to neighbors and other interested parties, including the local fire department, and all interested parties are notified prior to a blast. A blast notification sign is present at the quarry entrance to notify personnel entering the site as to whether a blast is scheduled for that day. On days when a blast is scheduled, onsite personnel are notified as to the scheduled blast time.

Prior to a blasting, quarry personnel, visitors, vendors, and customers are removed from the mining area and stationed at a designated assembly point. The site manager or lead blaster inspect the mining area to confirm all personnel have cleared from the blast area. Blast guards are posted at the quarry entrance to make sure that access corridors through the active mining area are secure during the blast process. Blast guards are in contact with the lead blaster via radio on a channel to be determined at the time the blasting operation begins. Blast guards have the authority to stop the blast at any time, up to the time when the blast is initiated. Audible blast signals are utilized prior to the blast according to the following schedule:

- 2 minutes before the blast
- 30 seconds before blast

Once all personnel are accounted for, all blast guards are in place, and the blast area has been confirmed to be clear, the lead blaster initiates the blast.

After the blast, the lead blaster re-enters the blast area to inspect it and verify that all holes were detonated. No one is allowed back into the mining area until the lead blaster has inspected the blast and confirmed that it is safe to resume work. At that time the 'All Clear' audible signal sounds and the blast guards release their blocks. Personnel are then be allowed back into the mining area and operations return to normal.

A misfire is the complete or partial failure of a blast hole to detonate as planned. Due to advancements in blast technology, misfires rarely happen. However, in the event of a misfire the lead blaster will not allow normal activities to resume in the blast area. The lead blaster will wait 30 minutes before completing a more thorough investigation of the cause of the misfire. Depending on the location of the blast, the lead blaster, at their discretion, can release areas not in the immediate area of the blast while waiting the required 30 minutes.

If it is found that the misfired detonator can be re-shot, the blast area will be cleared again, blast guards reestablished, the blast warning procedure will be reinitiated, and the detonator blasted. If the detonator cannot be blasted, the area will be secured, and all mining personnel warned of the hazard. The area will be carefully excavated under the supervision of the lead blaster or Quarry Manager until the blasting cap and booster is located and rendered safe.

Vibration Monitoring

Regulatory limits have been set for ground vibration, expressed as peak particle velocity (PPV) to control potential damage to offsite structures due to blasting. Blasts are monitored to verify that these limits are not exceeded. Each blast at the Parkdale Quarry is monitored through a combination of a drone equipped with a video camera and a pair of seismic monitoring stations located at the Parkdale Quarry property boundary between the mining area and the residences closest to the quarry. The two seismic monitors are monitored by VibraTech, a third-party consultant. Vibra-Tech recorded the results of 181 blasts between January 11, 2018 and November 1, 2021. To date, no blast has exceeded allowable PPV limits.

Pre-Blast Survey

Blasting is currently being conducted on the site. Prior to the start of blasting, Front Range Aggregates contacted the neighbors within one-mile of the quarry and met with those who were interested, to provide information on the blasting program and determine what their concerns were. Only one neighbor lives within one-half mile of the mining area where blasting occurs, and no pre-blast surveys were conducted. However, those neighbors wanting to be notified before blasts receive an e-mail prior to each blast notifying them of the blasting schedule. As part of the 2021 amendment, Martin Marietta will administratively alter the limit of mining further north, which will move the associated blasting north and west, further from off-site structures, thus reducing the potential for offsite damage to structures.

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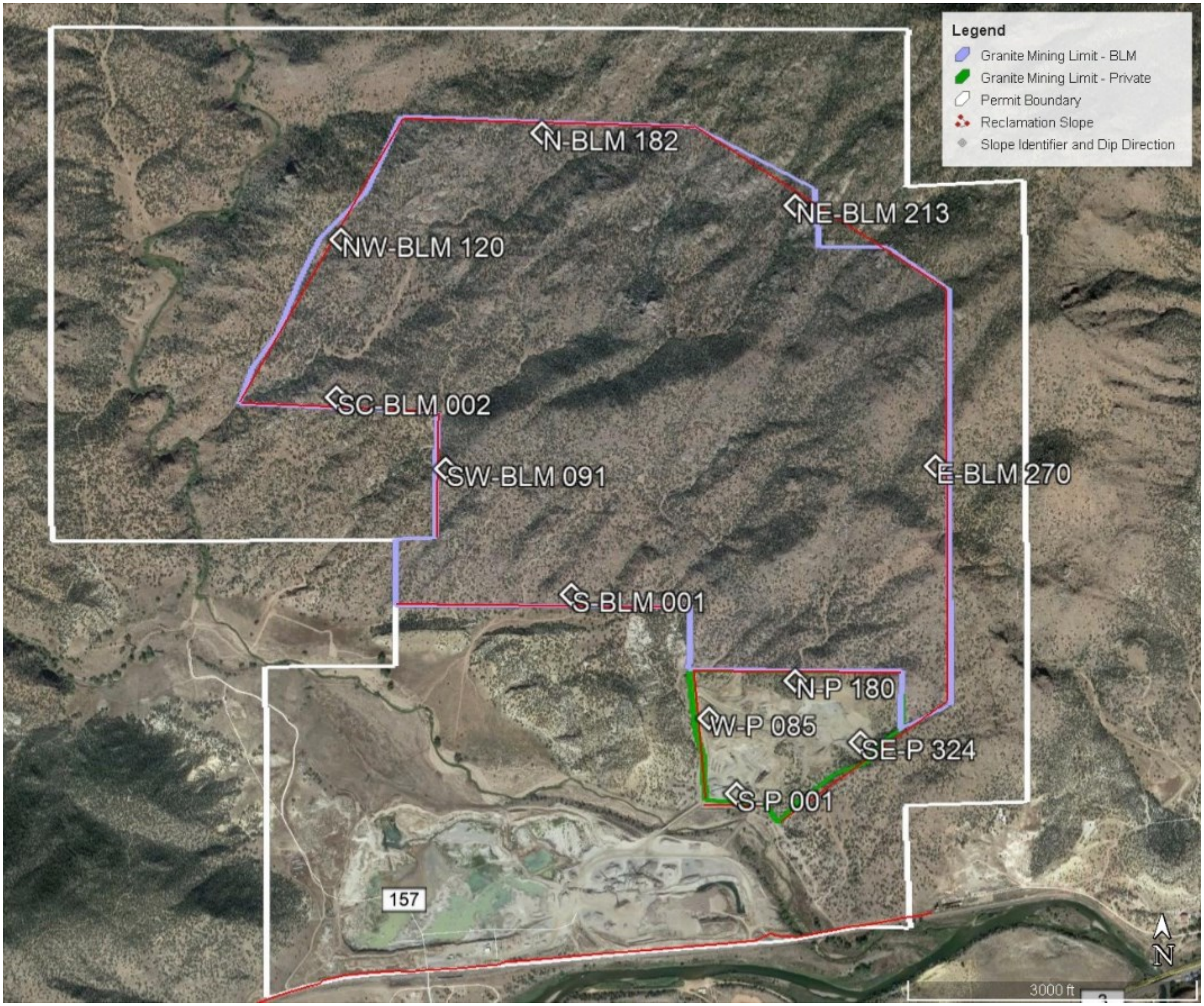
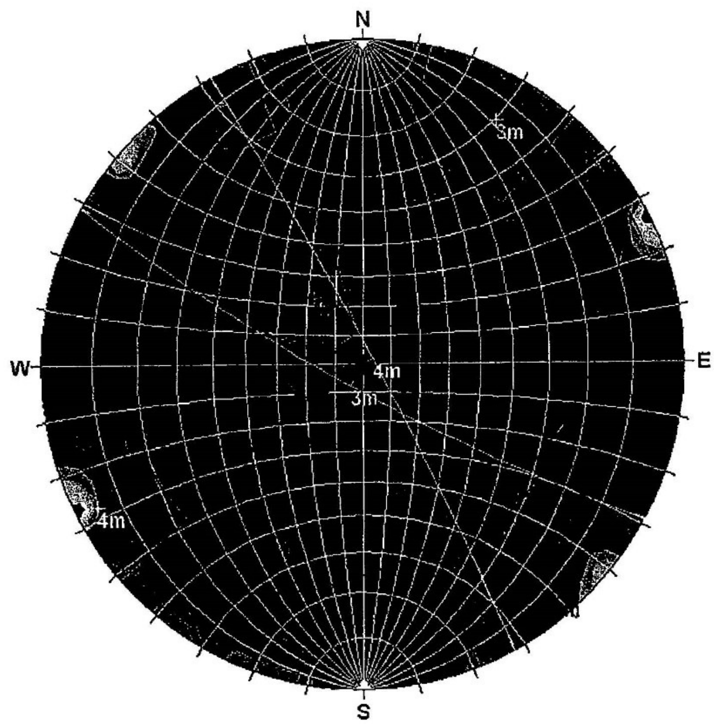


Figure 1 – Parkdale Granite Quarry Reclamation Slopes

Front Range Aggregates, LLC
Parkdale Quarry
Fremont County, Colorado
DRMS Mining Permit M1997-054

Lyman Henn Data

Vectors perpendicular to joints and joint planes



Orientations

ID		Trend / Plunge
1	m	323 / 61
2	m	141 / 04
3	m	029 / 09
4	m	242 / 04

Equal Angle
Lower Hemisphere
48 Poles
48 Entries

Figure 2A - Stereonet Plot – 2008 Stability Report
Lyman Henn, Inc. Data
Front Range Aggregates, LLC
Parkdale Quarry
Fremont County, Colorado
DRMS Mining Permit M1997-054

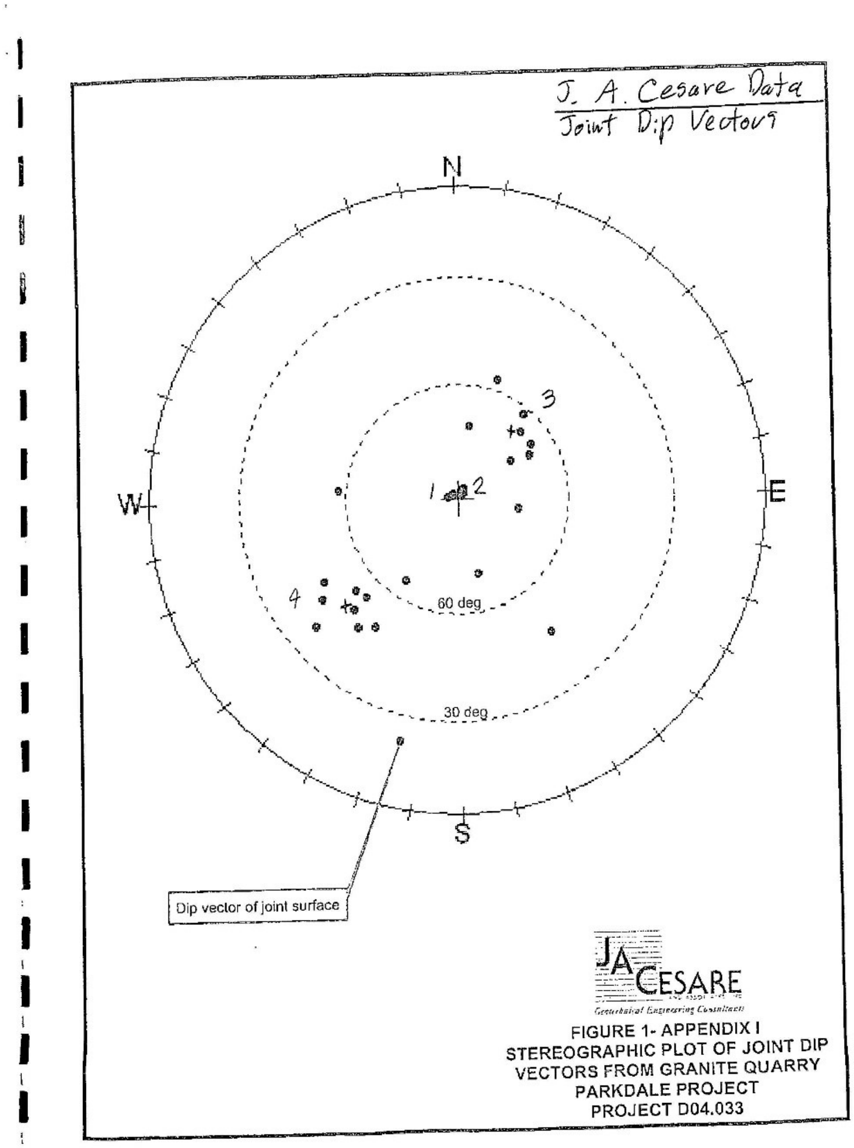


Figure 2B - Stereonet Plot – 2008 Stability Report

J. A. Cesare Data

Front Range Aggregates, LLC

Parkdale Quarry

Fremont County, Colorado

DRMS Mining Permit M1997-054

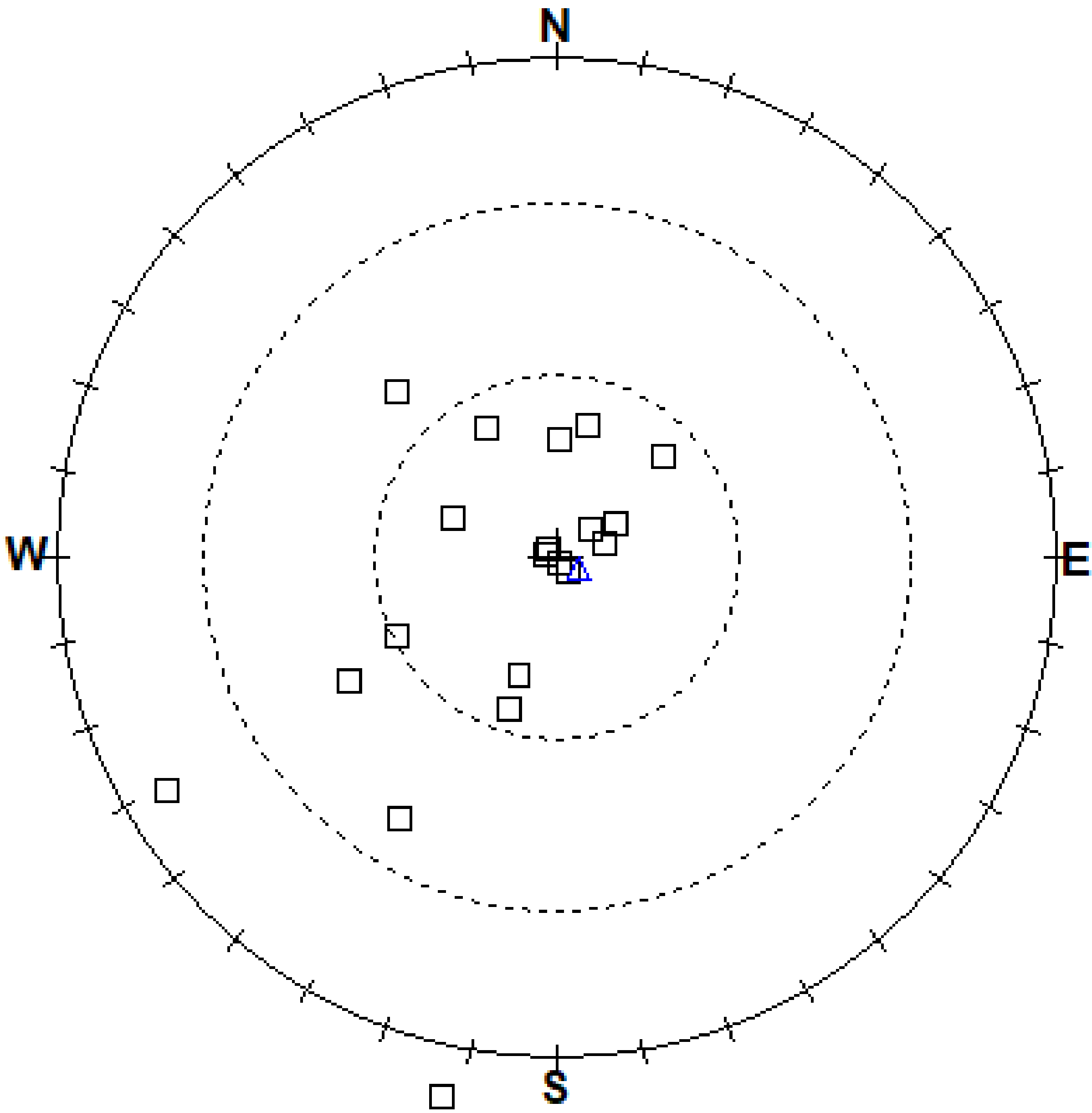


Figure 3A - Stereonet Plot – 2021 Granite Quarry Data
Combined BLM and Private

Front Range Aggregates, LLC
Parkdale Quarry
Fremont County, Colorado
DRMS Mining Permit M1997-054

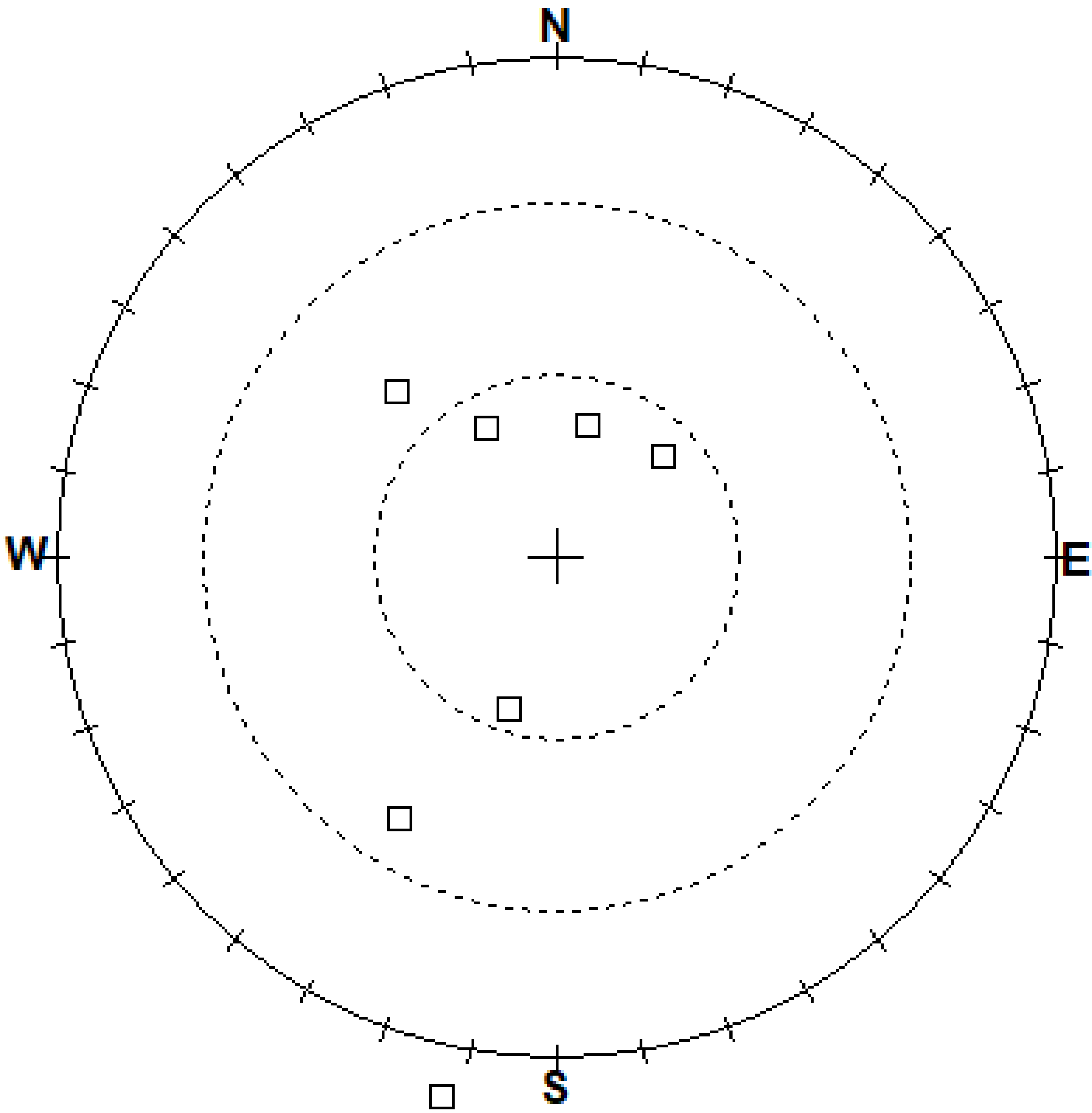


Figure 3B - Stereonet Plot – 2021 Granite Quarry Data
Private Land Granite Quarry Data
Front Range Aggregates, LLC
Parkdale Quarry
Fremont County, Colorado
DRMS Mining Permit M1997-054

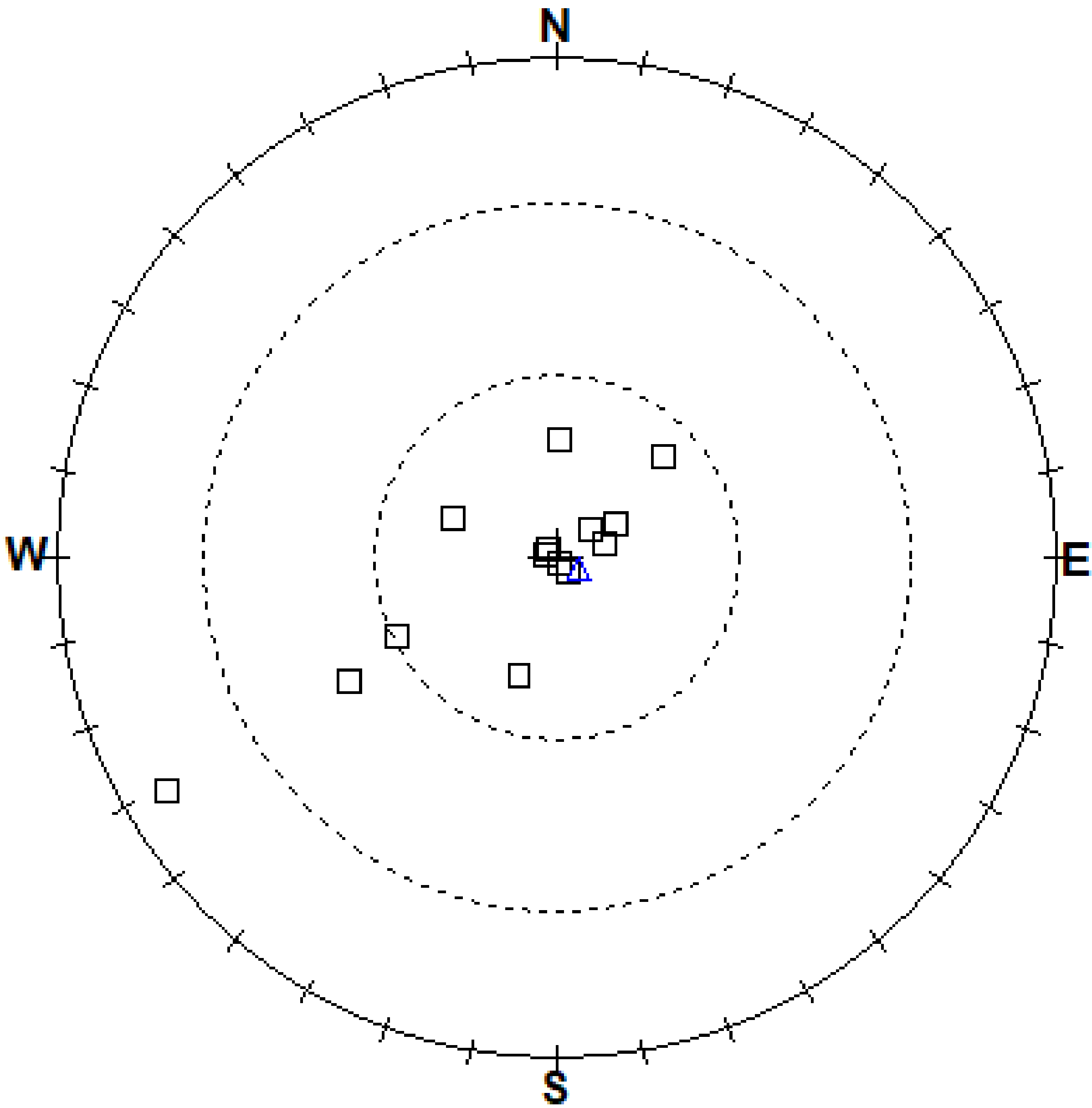


Figure 3C - Stereonet Plot – 2021 Granite Quarry Data
BLM Expansion Area Data
Front Range Aggregates, LLC
Parkdale Quarry
Fremont County, Colorado
DRMS Mining Permit M1997-054

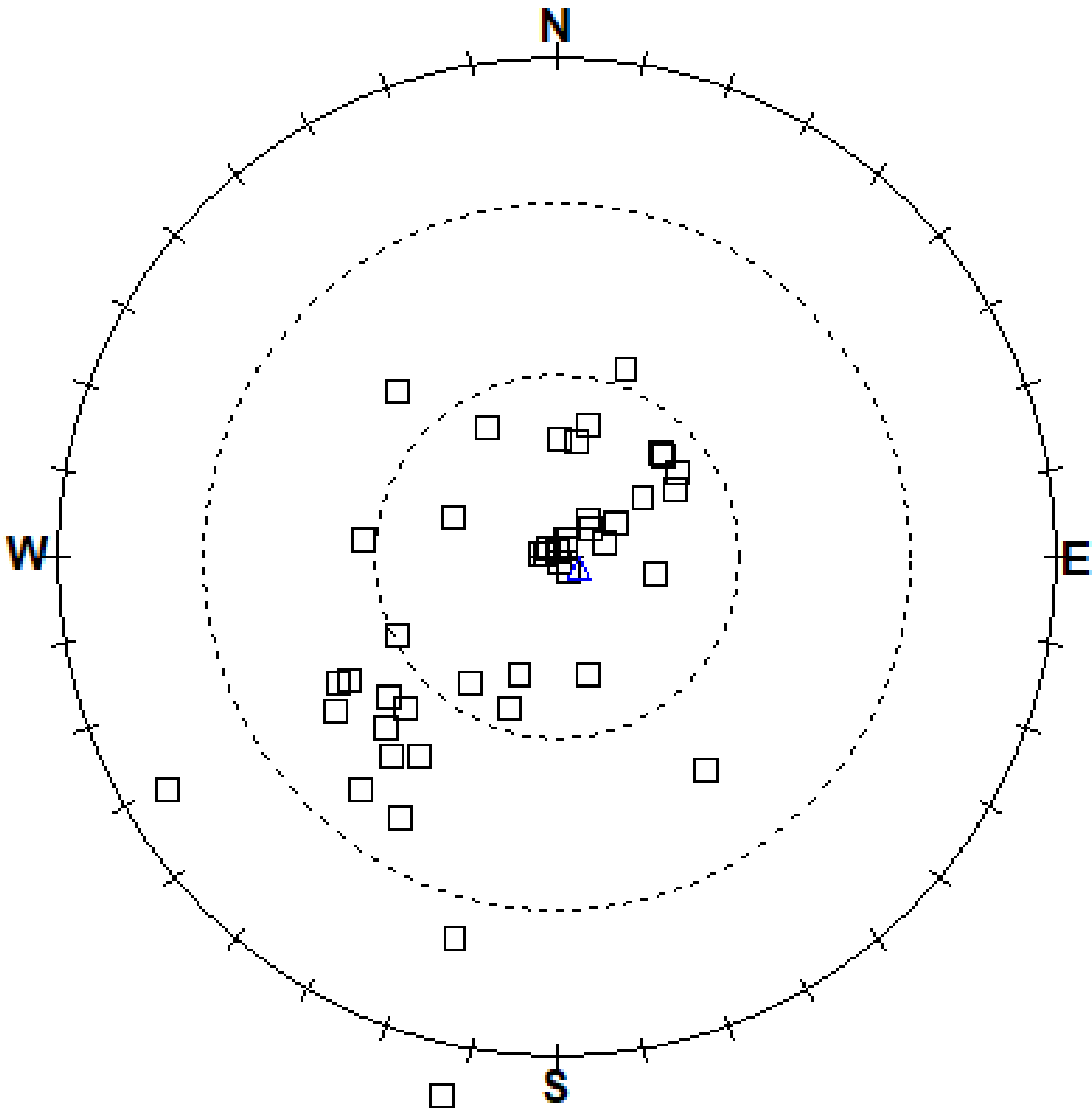


Figure 4- Stereonet Plot – 2008 and 2021 Data
Private and BLM Areas
Front Range Aggregates, LLC
Parkdale Quarry
Fremont County, Colorado
DRMS Mining Permit M1997-054

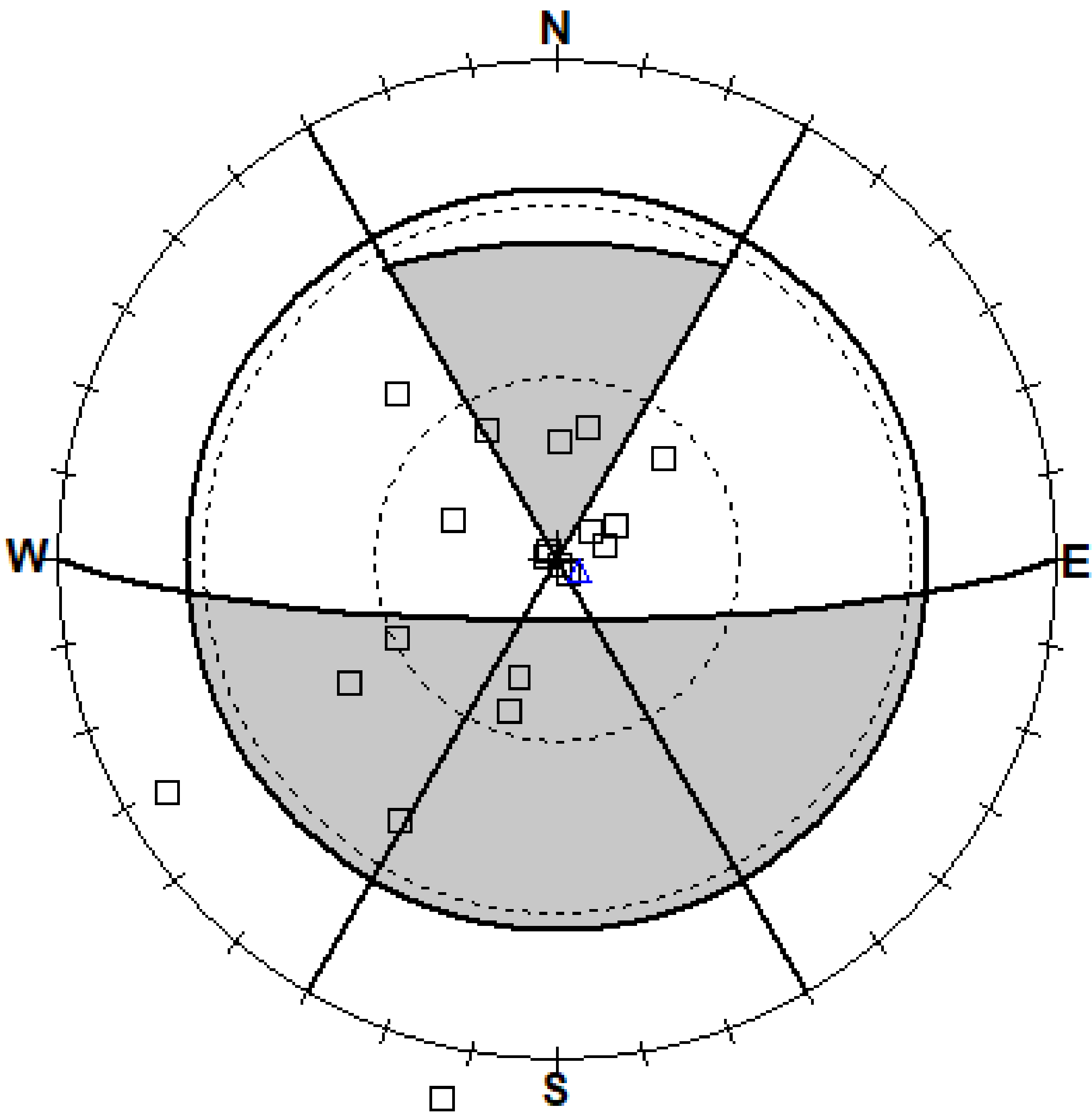


Figure 5 - Stereonet Plot – North Highwall
Granite Quarry - Private Land (N-P)
Front Range Aggregates, LLC
Parkdale Quarry
Fremont County, Colorado
DRMS Mining Permit M1997-054

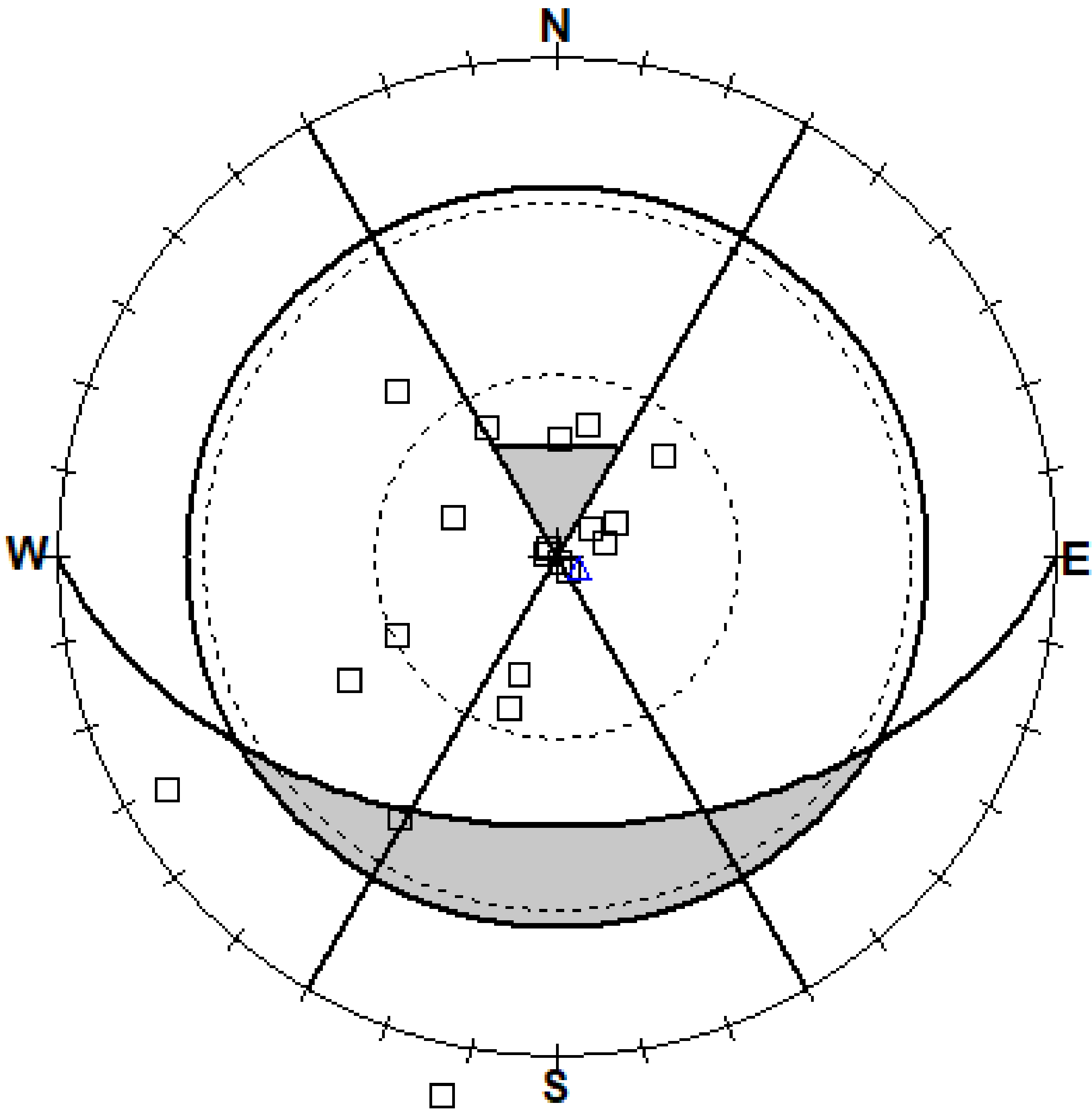


Figure 6 - Stereonet Plot – North Reclamation Slope
Granite Quarry - Private Land (N-P)
Front Range Aggregates, LLC
Parkdale Quarry
Fremont County, Colorado
DRMS Mining Permit M1997-054

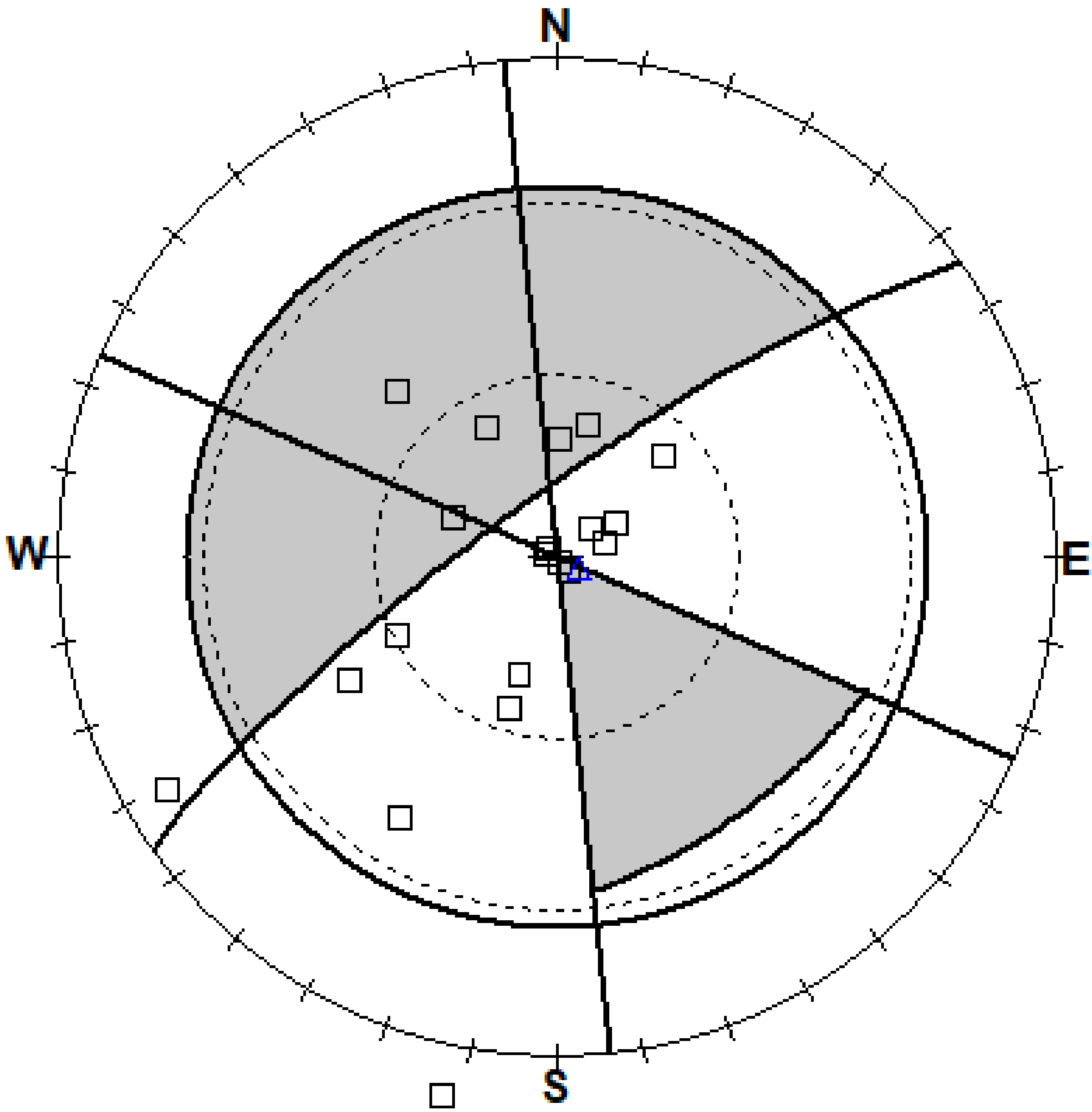


Figure 7 - Stereonet Plot – Southeast Highwall
Granite Quarry - Private Land (SE-P)
Front Range Aggregates, LLC
Parkdale Quarry
Fremont County, Colorado
DRMS Mining Permit M1997-054

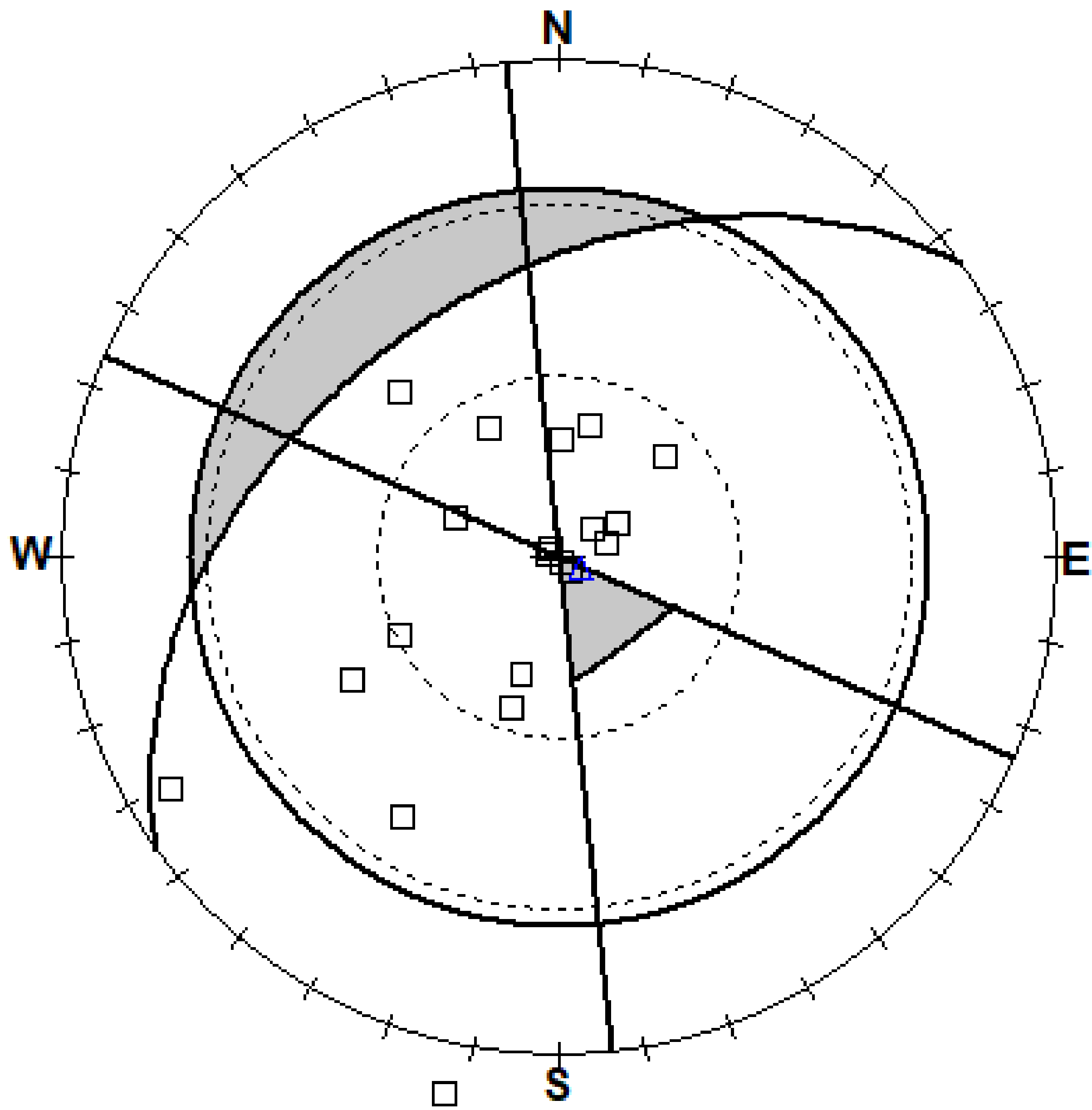


Figure 8 - Stereonet Plot – Southeast Reclamation Slope
Granite Quarry - Private Land (SE-P)
Front Range Aggregates, LLC
Parkdale Quarry
Fremont County, Colorado
DRMS Mining Permit M1997-054

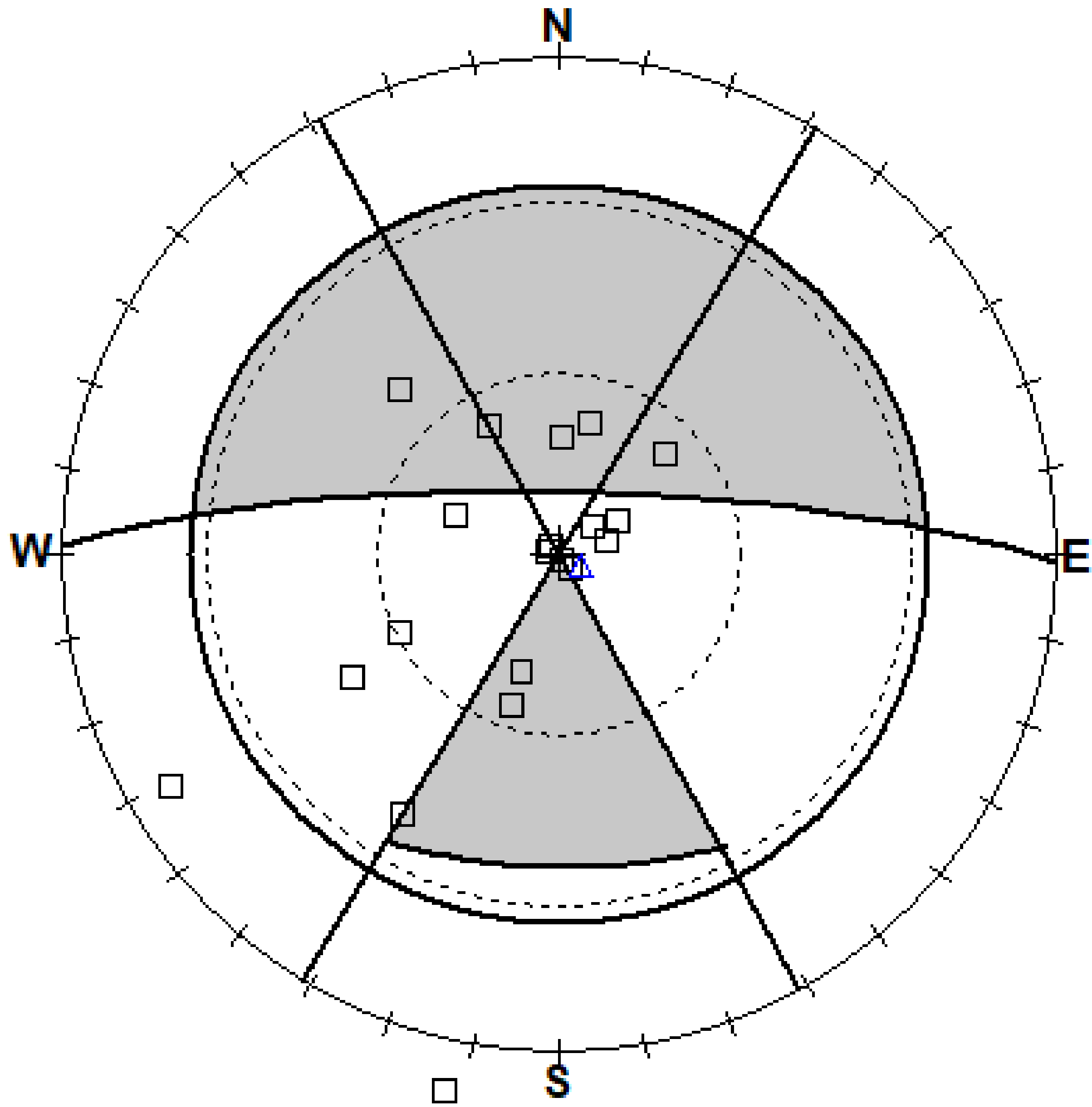


Figure 9 - Stereonet Plot – South Highwall
Granite Quarry - Private Land (S-P)
Front Range Aggregates, LLC
Parkdale Quarry
Fremont County, Colorado
DRMS Mining Permit M1997-054

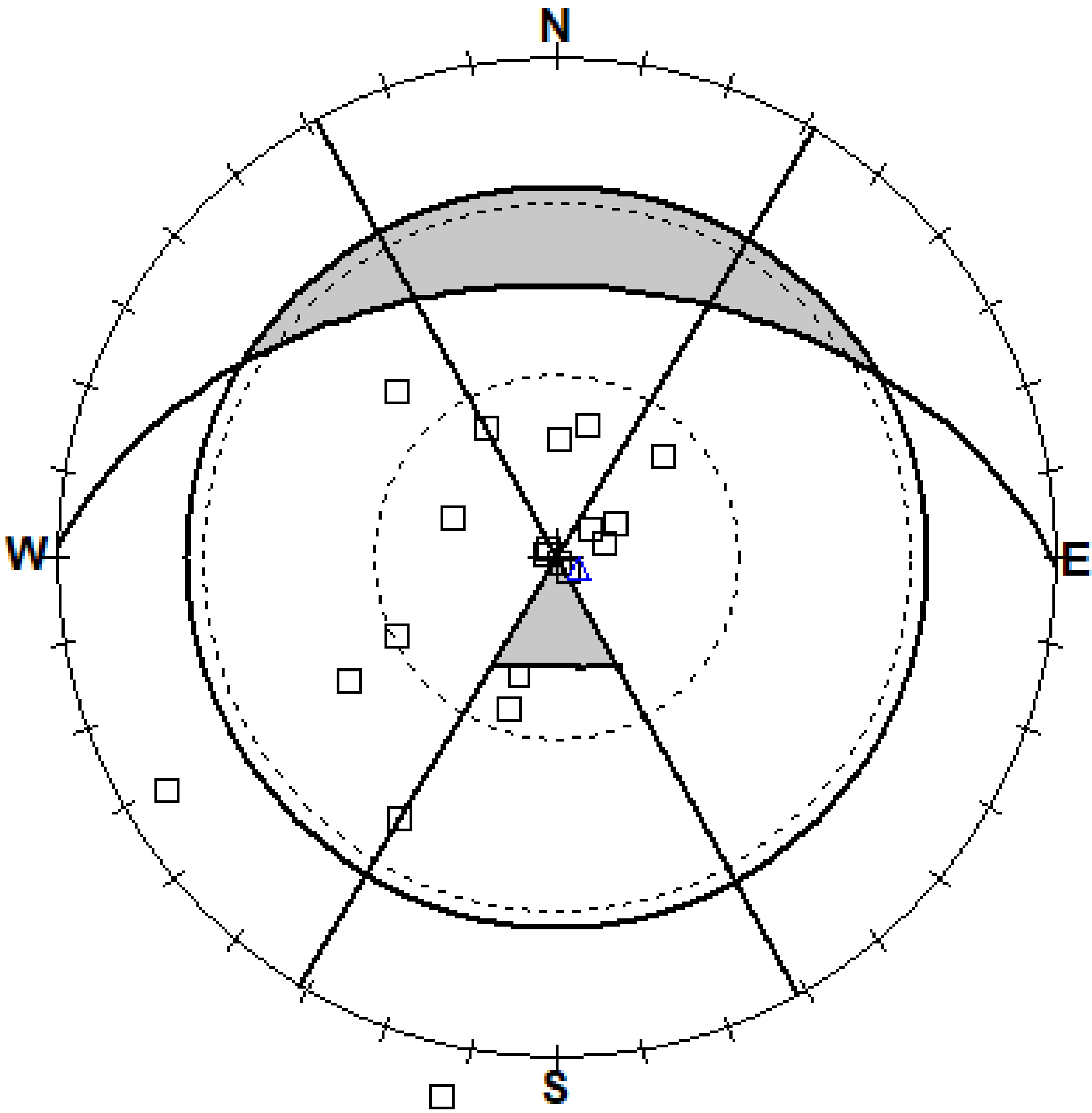


Figure 10 - Stereonet Plot – South Reclamation Slope
Granite Quarry - Private Land (S-P)
Front Range Aggregates, LLC
Parkdale Quarry
Fremont County, Colorado
DRMS Mining Permit M1997-054

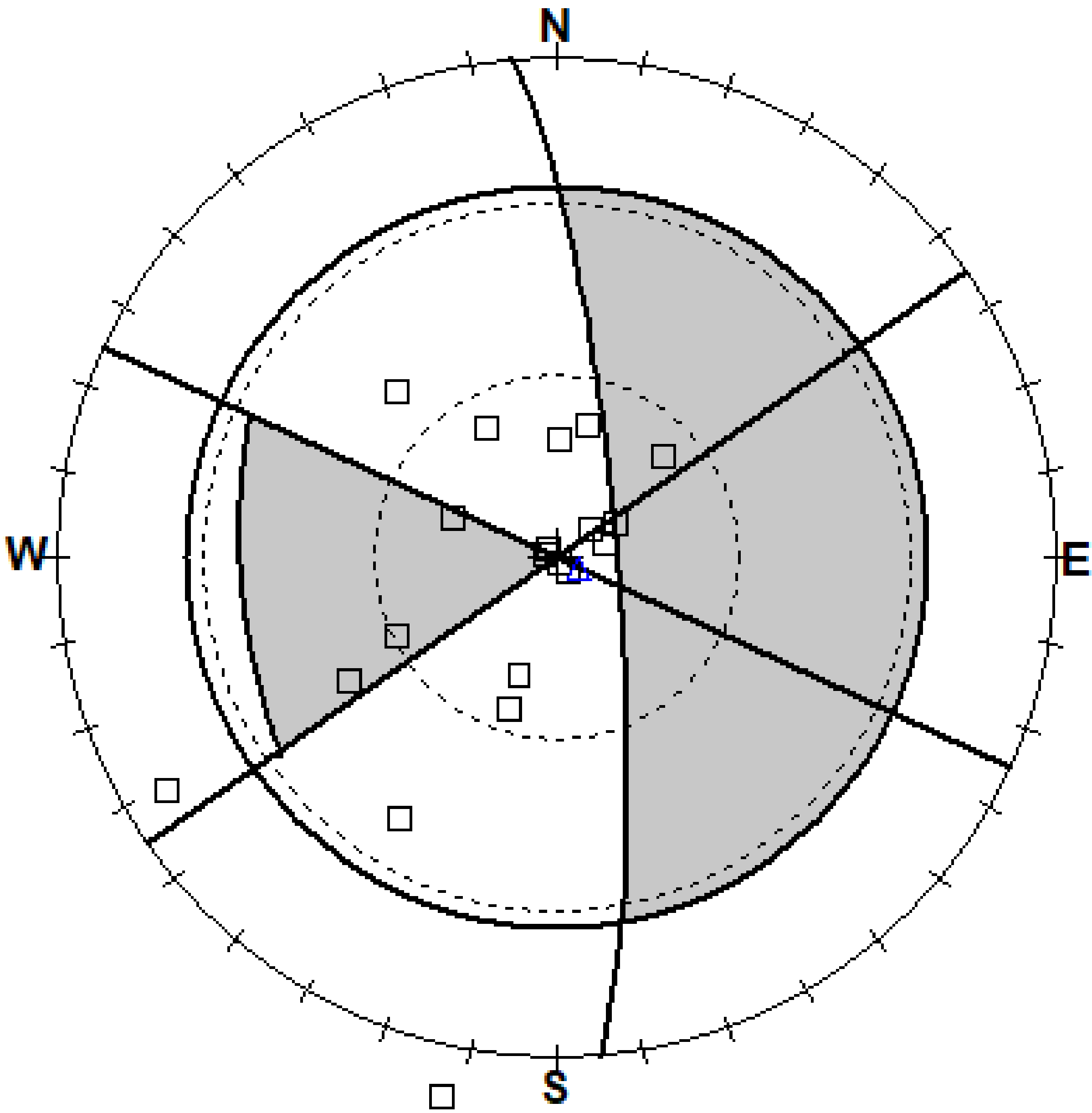


Figure 11 - Stereonet Plot – West Highwall
Granite Quarry - Private Land (W-P)
Front Range Aggregates, LLC
Parkdale Quarry
Fremont County, Colorado
DRMS Mining Permit M1997-054

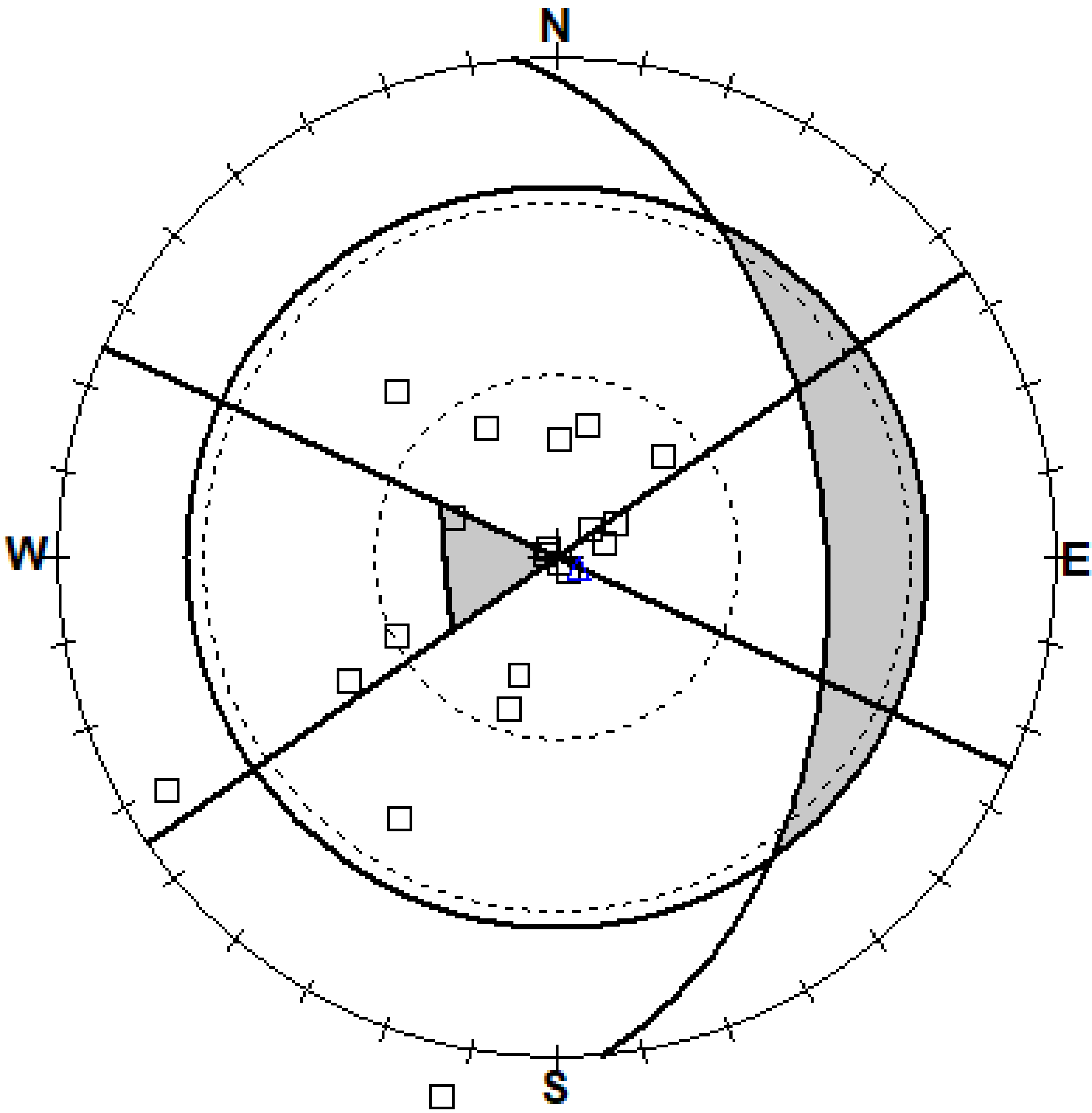


Figure 12 - Stereonet Plot – West Reclamation Slope
Granite Quarry - Private Land (W-P)
Front Range Aggregates, LLC
Parkdale Quarry
Fremont County, Colorado
DRMS Mining Permit M1997-054

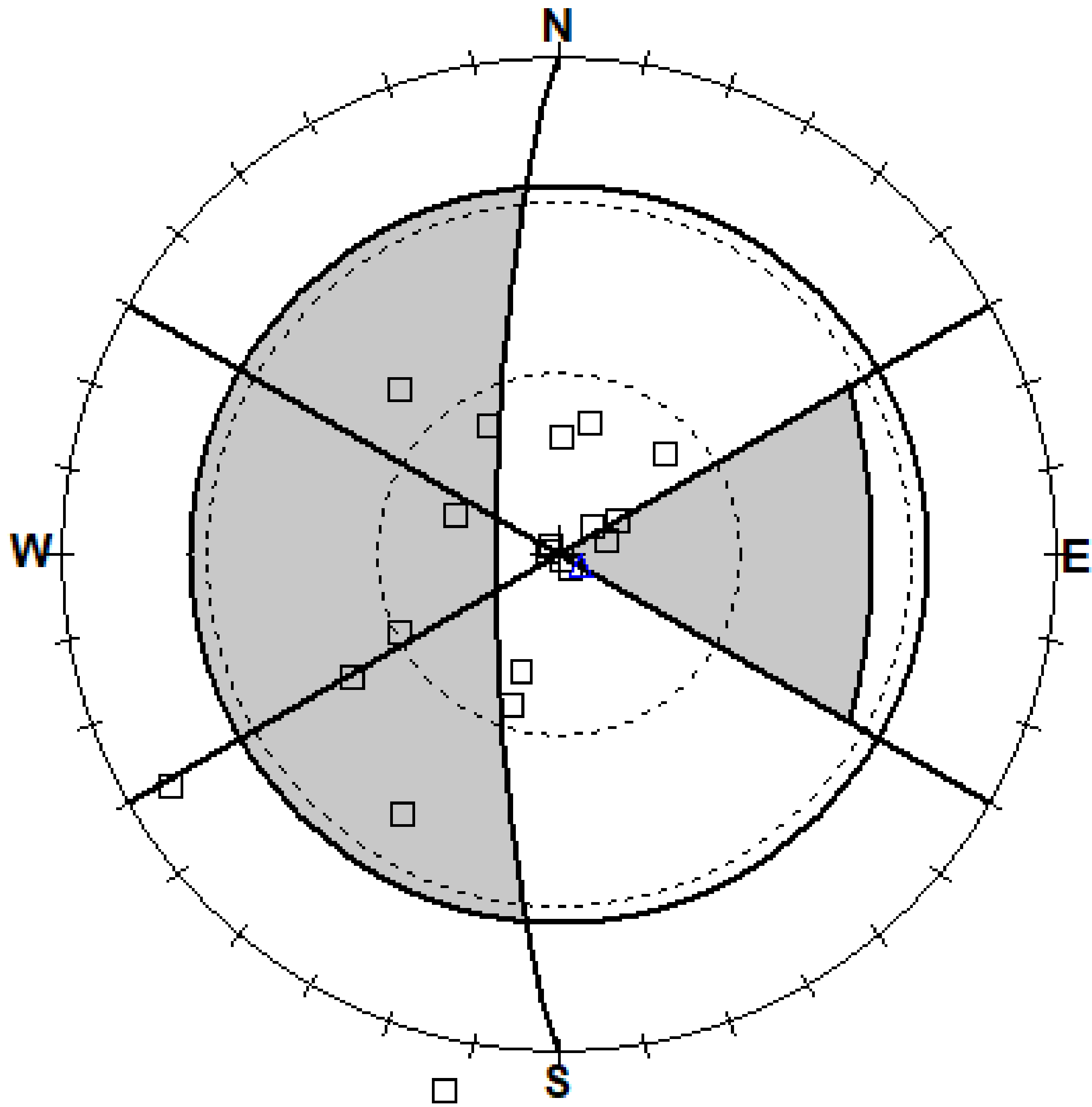


Figure 13 - Stereonet Plot – East Highwall
Granite Quarry - BLM Area (E-BLM)
Front Range Aggregates, LLC
Parkdale Quarry
Fremont County, Colorado
DRMS Mining Permit M1997-054

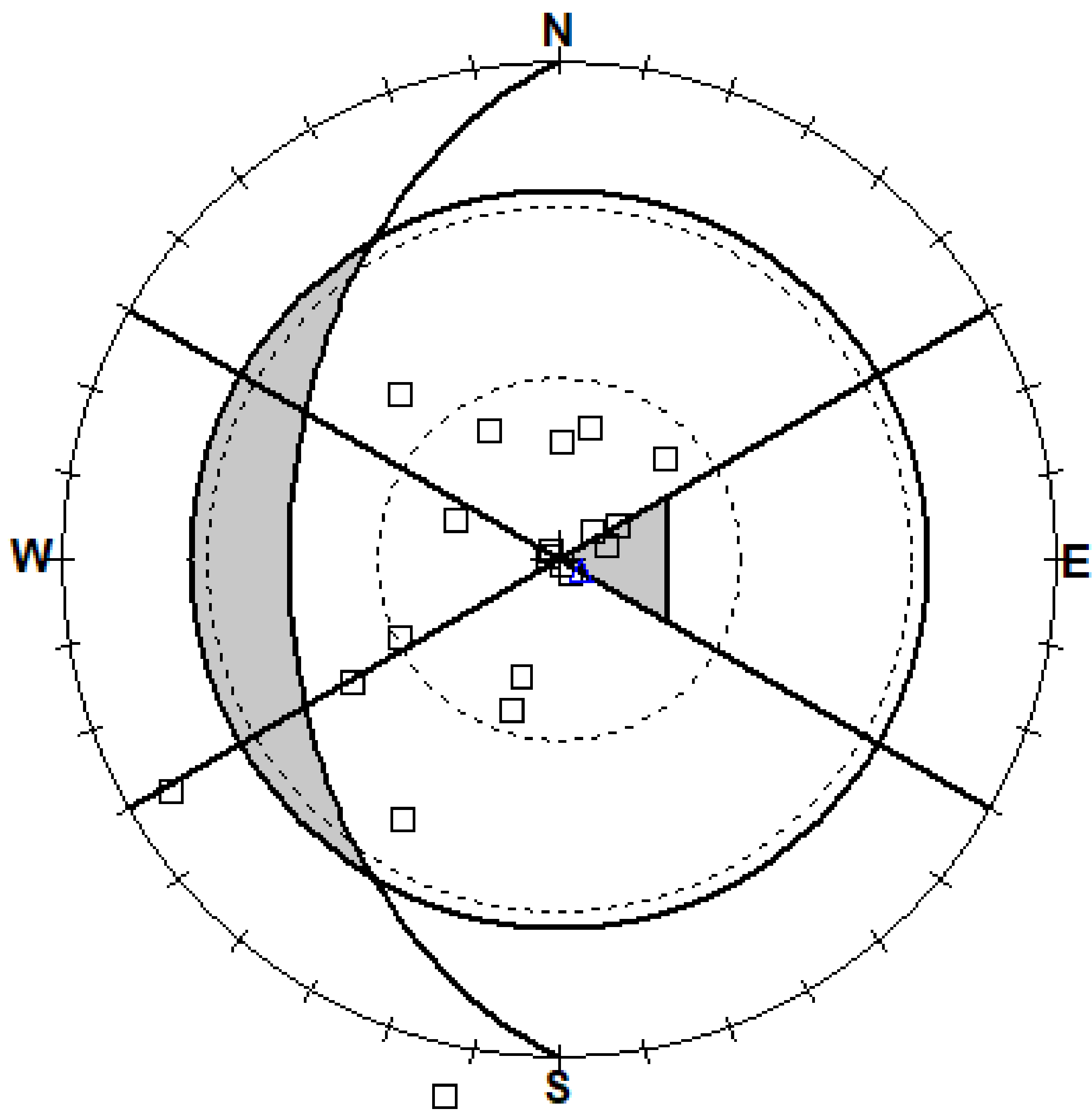


Figure 14 - Stereonet Plot – East Reclamation Slope
Granite Quarry - BLM Area (E-BLM)
Front Range Aggregates, LLC
Parkdale Quarry
Fremont County, Colorado
DRMS Mining Permit M1997-054

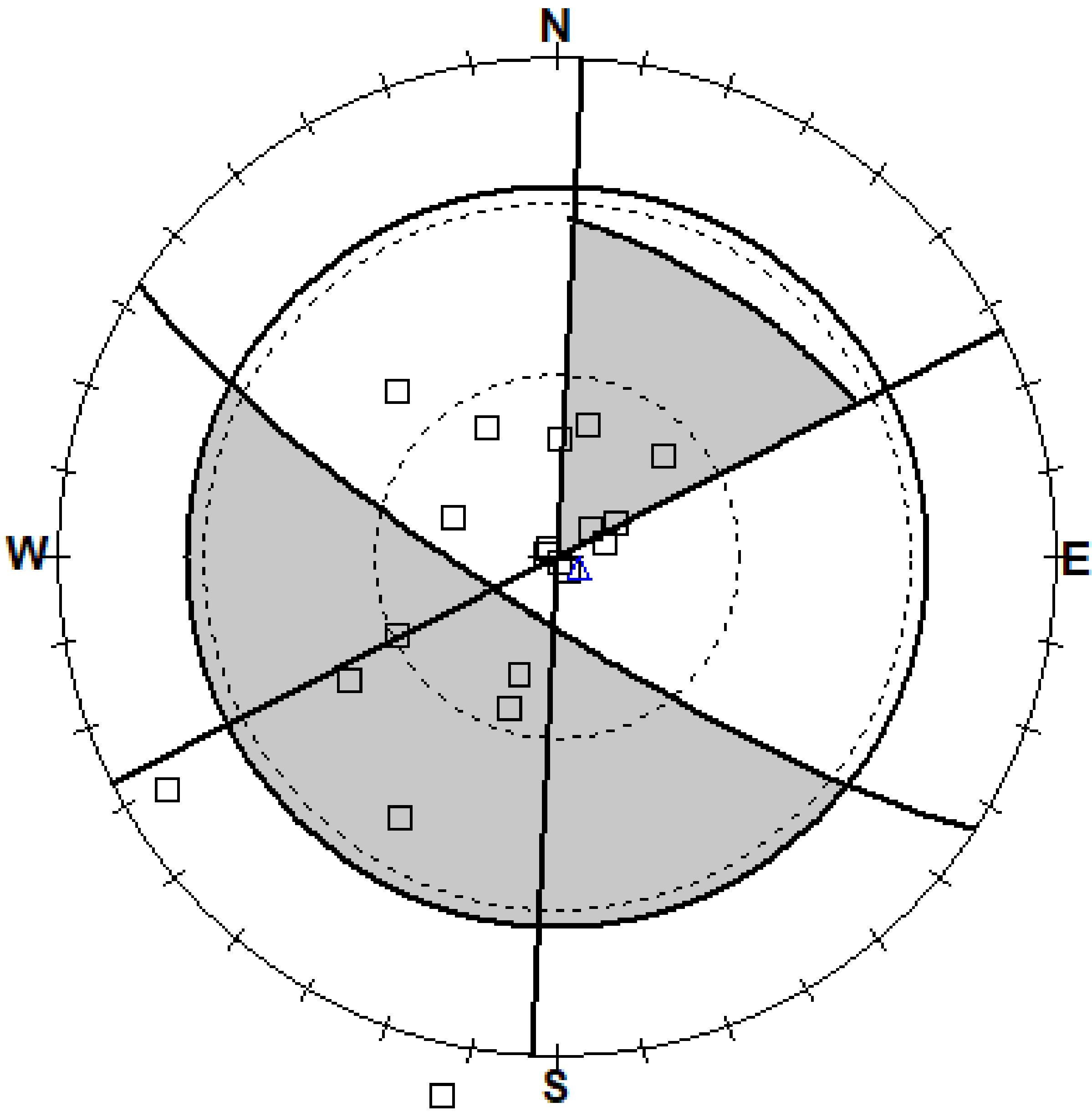


Figure 15 - Stereonet Plot – Northeast Highwall
Granite Quarry - BLM Area (NE-BLM)
Front Range Aggregates, LLC
Parkdale Quarry
Fremont County, Colorado
DRMS Mining Permit M1997-054

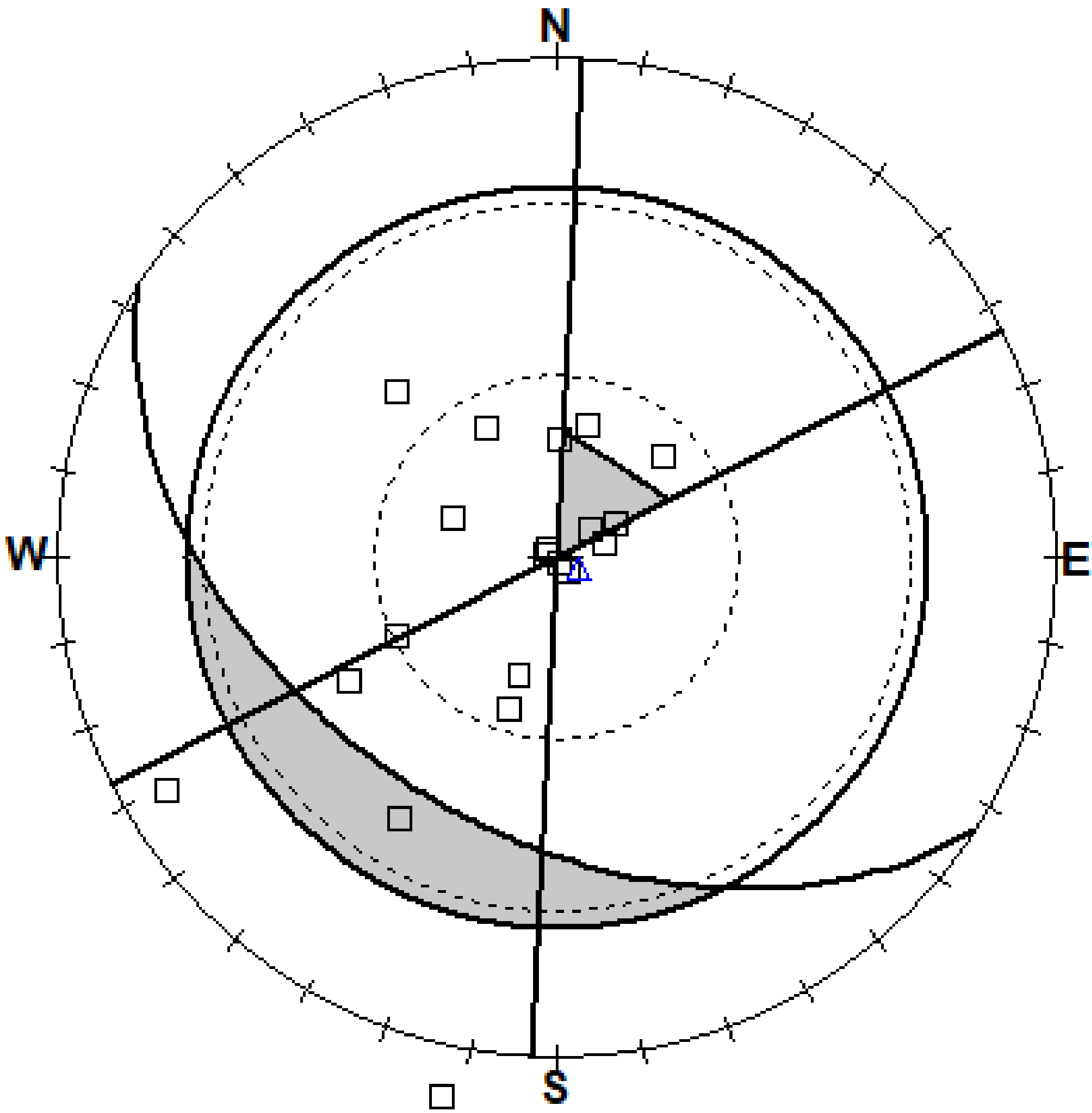


Figure 16 - Stereonet Plot – Northeast Reclamation Slope
Granite Quarry - BLM Area (NE-BLM)
Front Range Aggregates, LLC
Parkdale Quarry
Fremont County, Colorado
DRMS Mining Permit M1997-054

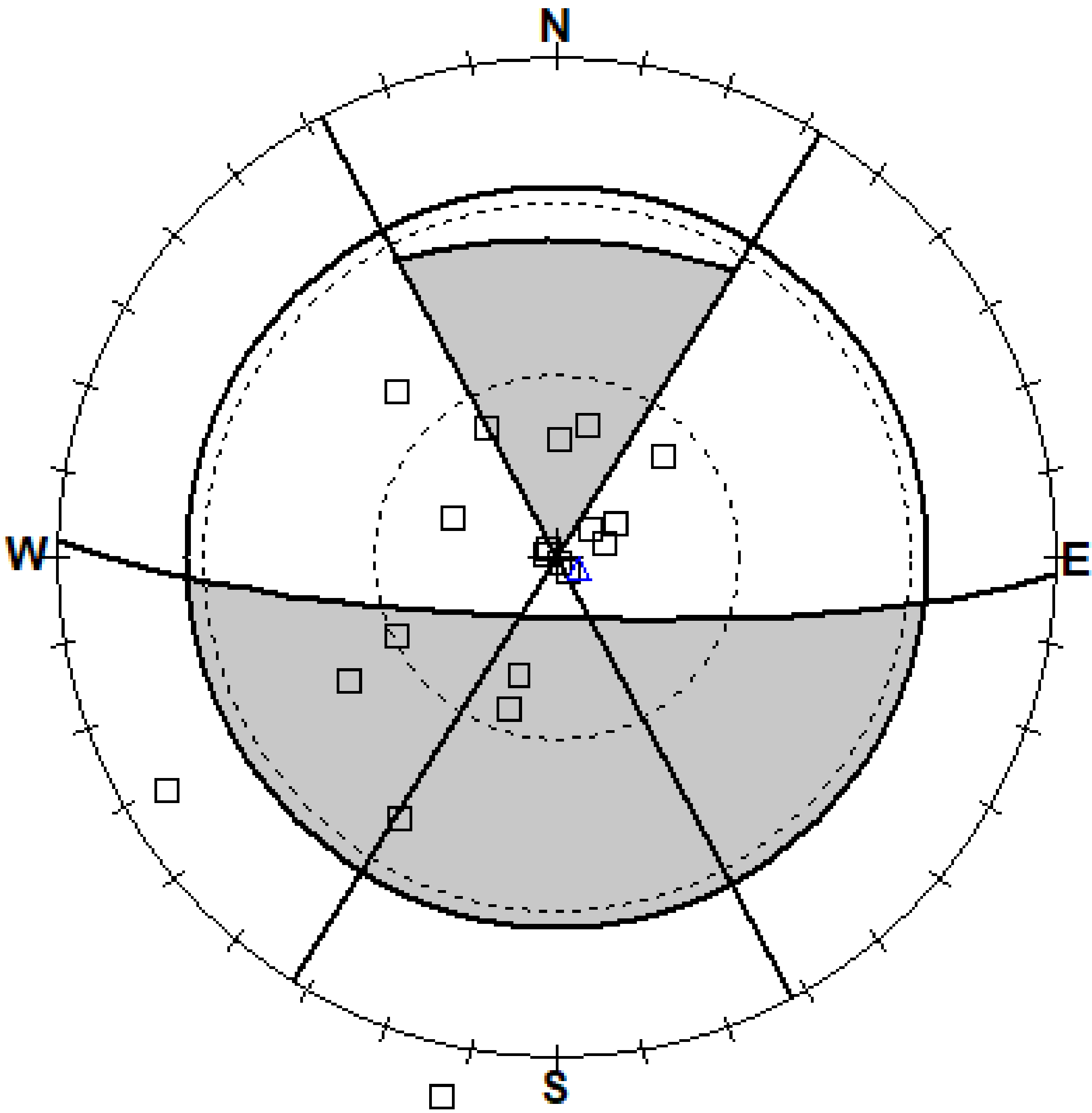


Figure 17 - Stereonet Plot – North Highwall
Granite Quarry - BLM Area (N-BLM)
Front Range Aggregates, LLC
Parkdale Quarry
Fremont County, Colorado
DRMS Mining Permit M1997-054

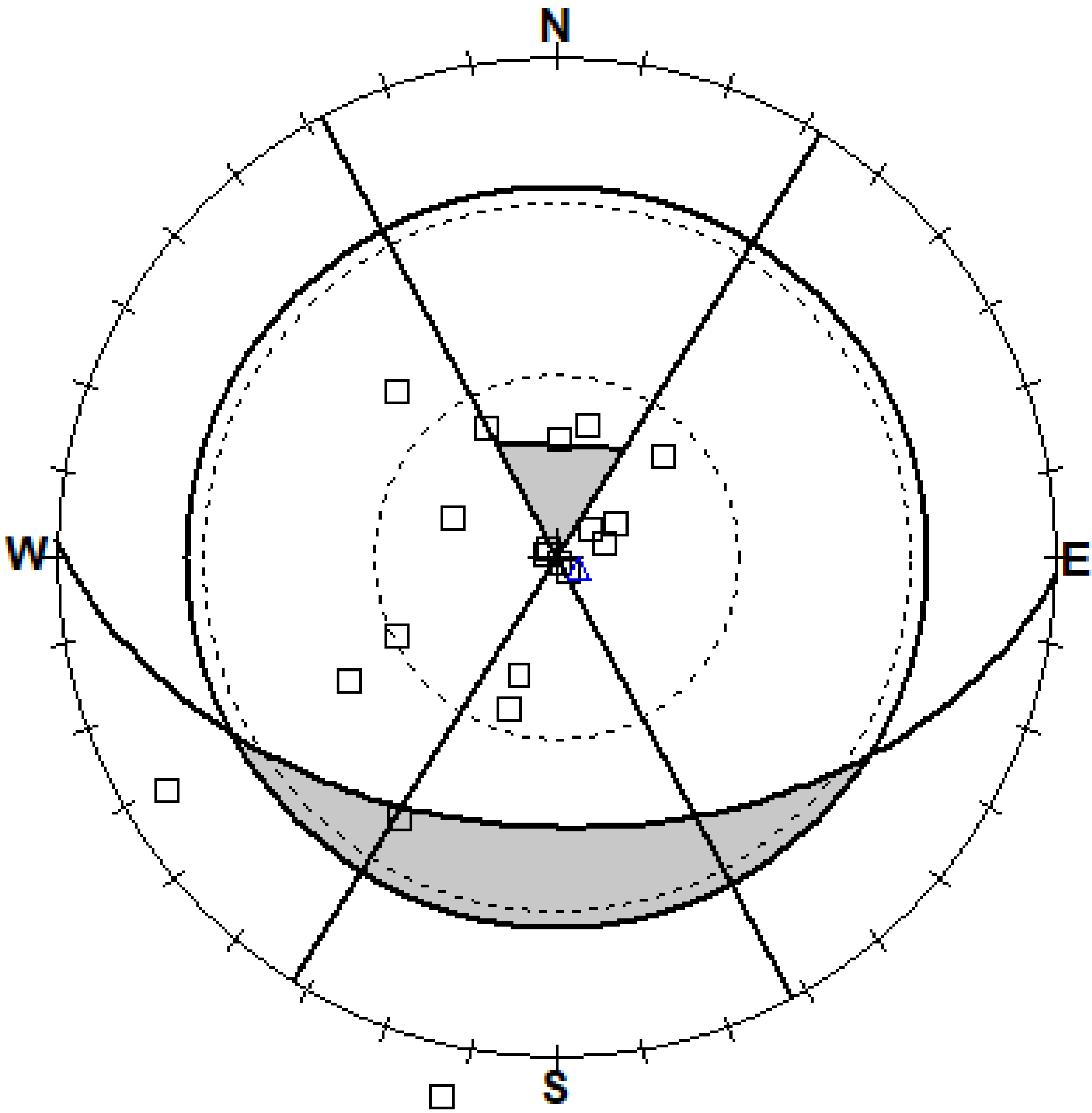


Figure 18 - Stereonet Plot – North Reclamation Slope
Granite Quarry - BLM Area (N-BLM)
Front Range Aggregates, LLC
Parkdale Quarry
Fremont County, Colorado
DRMS Mining Permit M1997-054

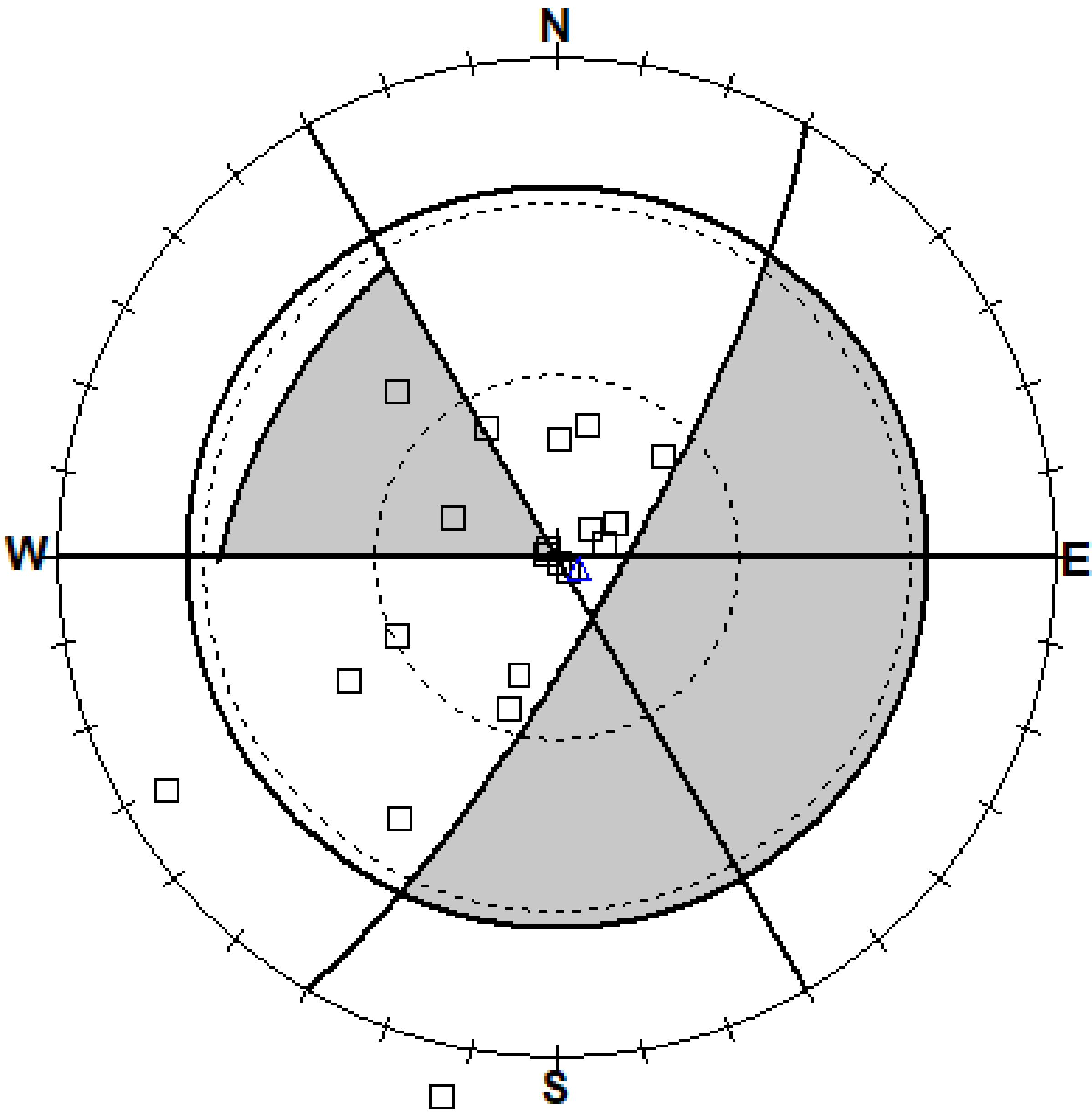


Figure 19 - Stereonet Plot – Northwest Highwall
Granite Quarry - BLM Area (NW-BLM)
Front Range Aggregates, LLC
Parkdale Quarry
Fremont County, Colorado
DRMS Mining Permit M1997-054

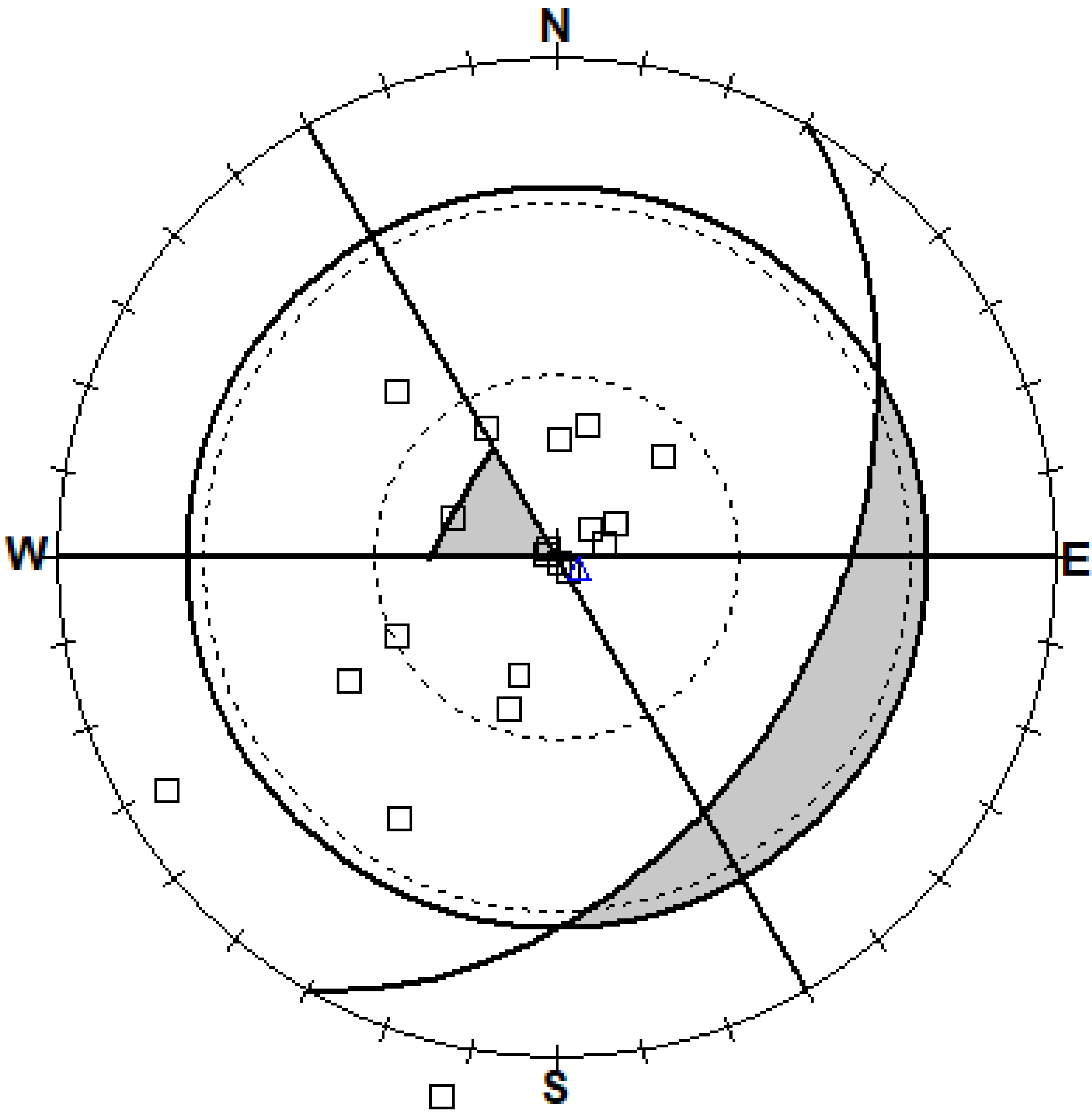


Figure 20 - Stereonet Plot – Northwest Reclamation Slope
Granite Quarry - BLM Area (NW-BLM)
Front Range Aggregates, LLC
Parkdale Quarry
Fremont County, Colorado
DRMS Mining Permit M1997-054

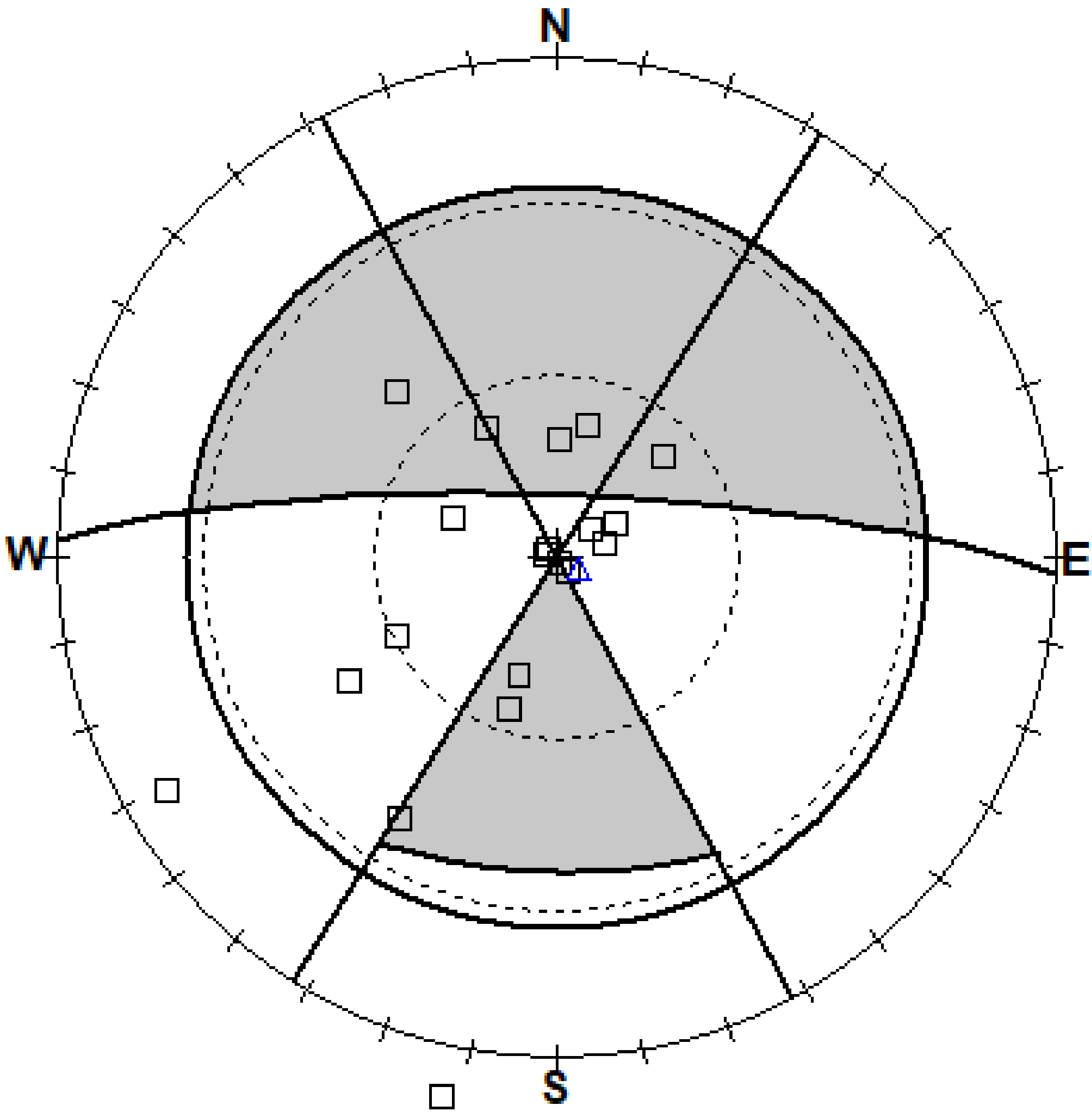


Figure 21 - Stereonet Plot – South-central Highwall
Granite Quarry - BLM Area (SC-BLM)
Front Range Aggregates, LLC
Parkdale Quarry
Fremont County, Colorado
DRMS Mining Permit M1997-054

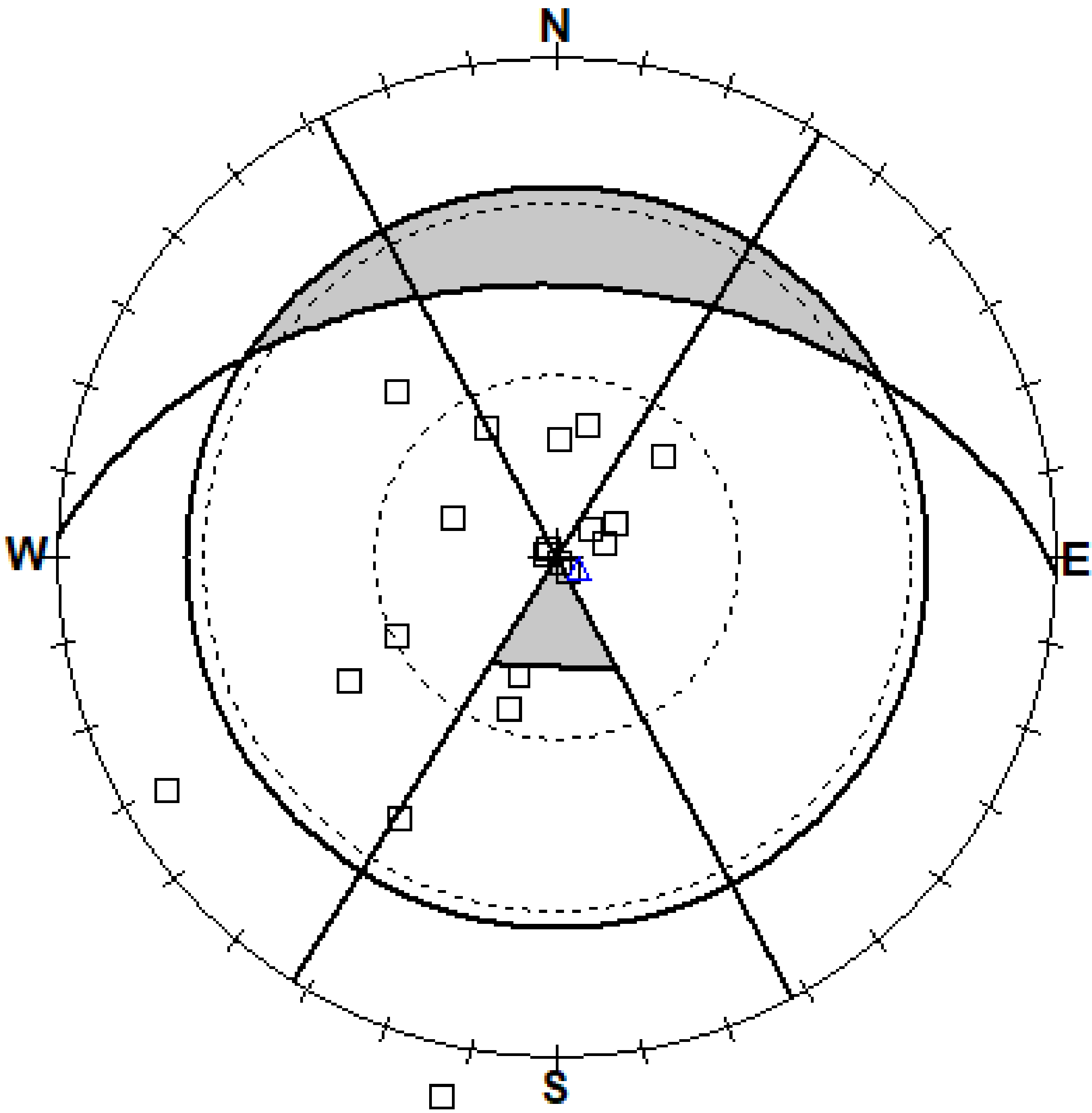


Figure 22 - Stereonet Plot – South-central Reclamation Slope
Granite Quarry - BLM Area (SC-BLM)
Front Range Aggregates, LLC
Parkdale Quarry
Fremont County, Colorado
DRMS Mining Permit M1997-054

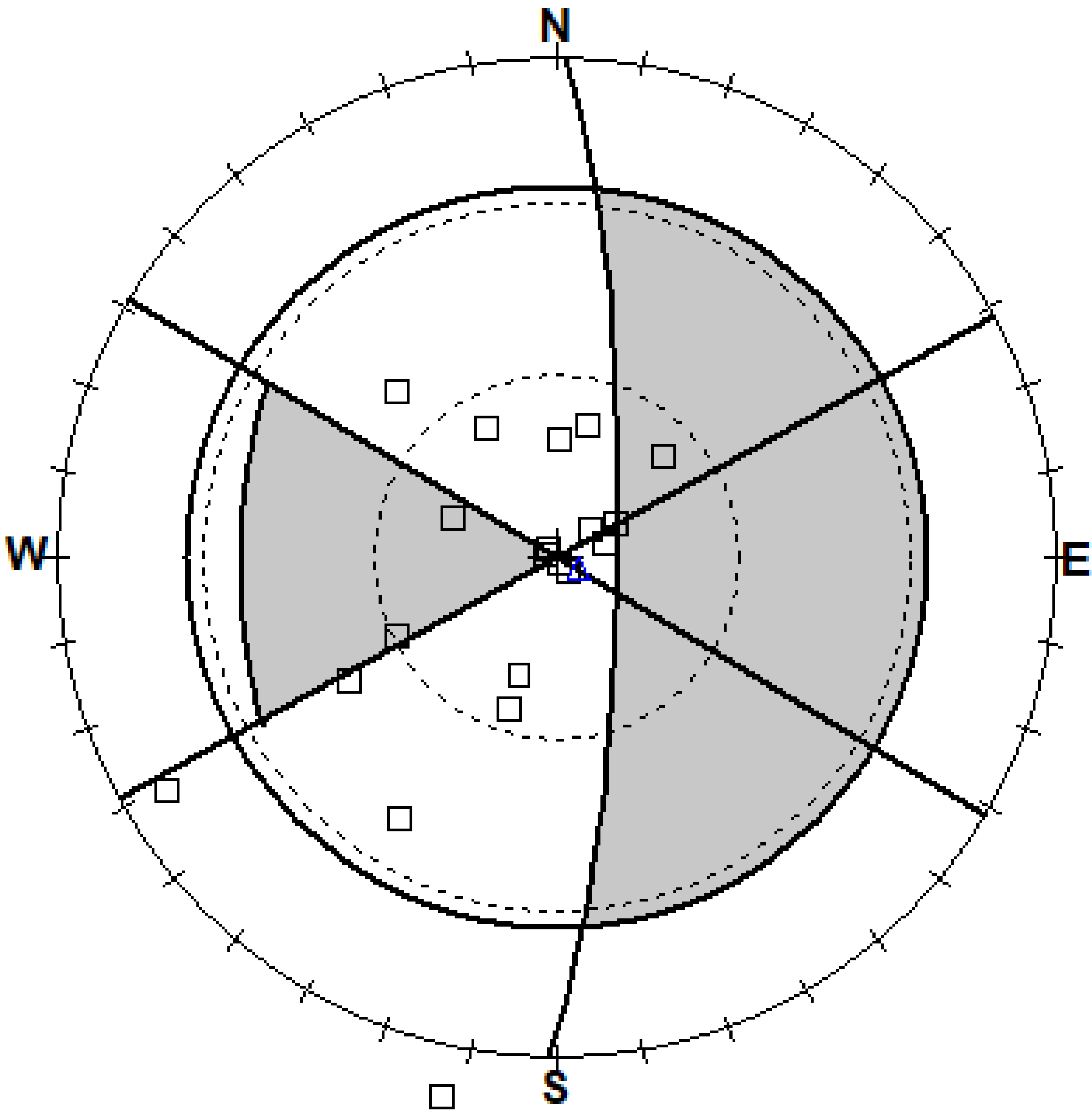


Figure 23 - Stereonet Plot – Southwest Highwall Granite Quarry - BLM Area (SW-BLM)

Front Range Aggregates, LLC

Parkdale Quarry

Fremont County, Colorado

DRMS Mining Permit M1997-054

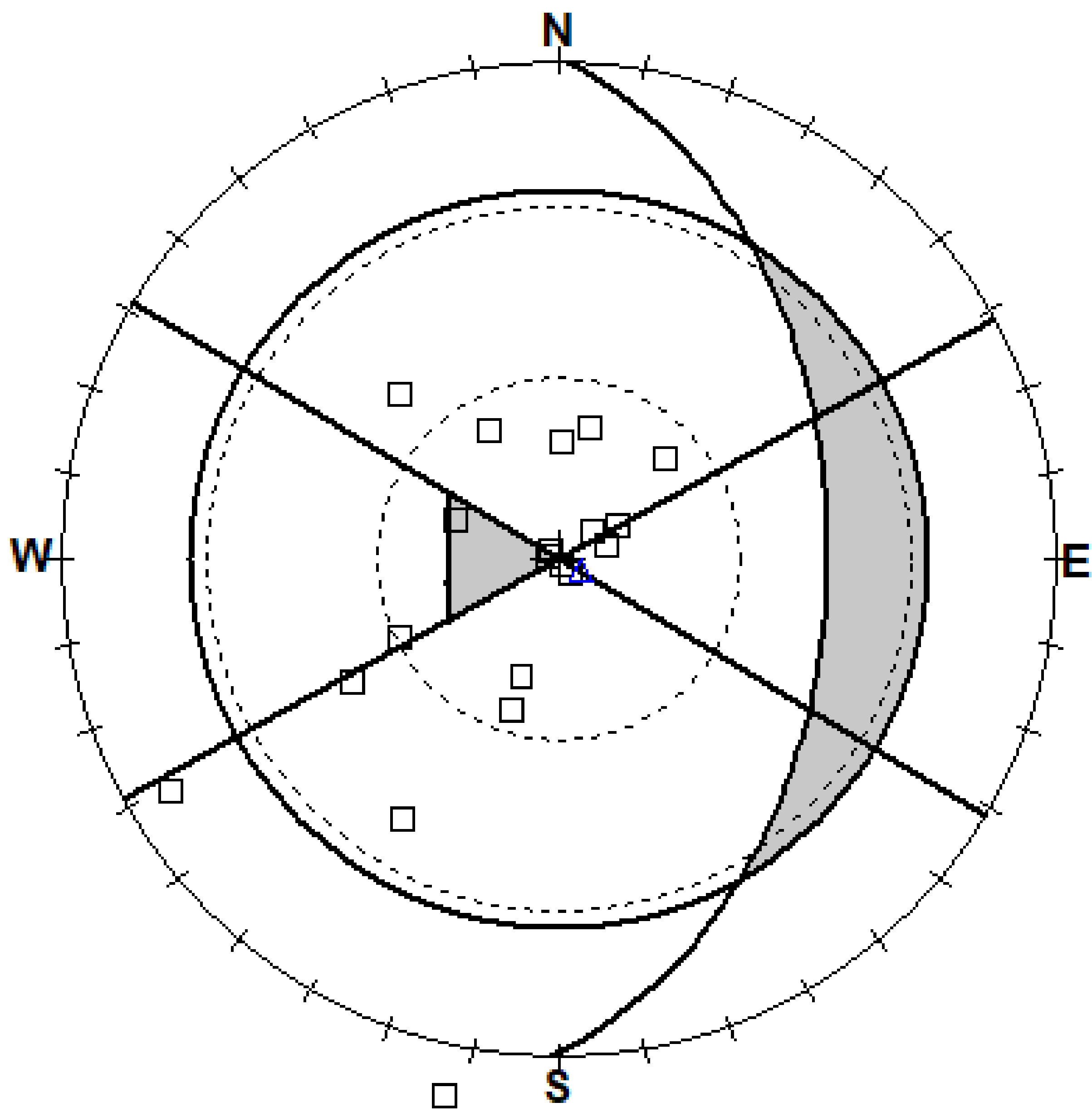


Figure 24 - Stereonet Plot – Southwest Reclamation Slope
Granite Quarry - BLM Area (SW-BLM)
Front Range Aggregates, LLC
Parkdale Quarry
Fremont County, Colorado
DRMS Mining Permit M1997-054

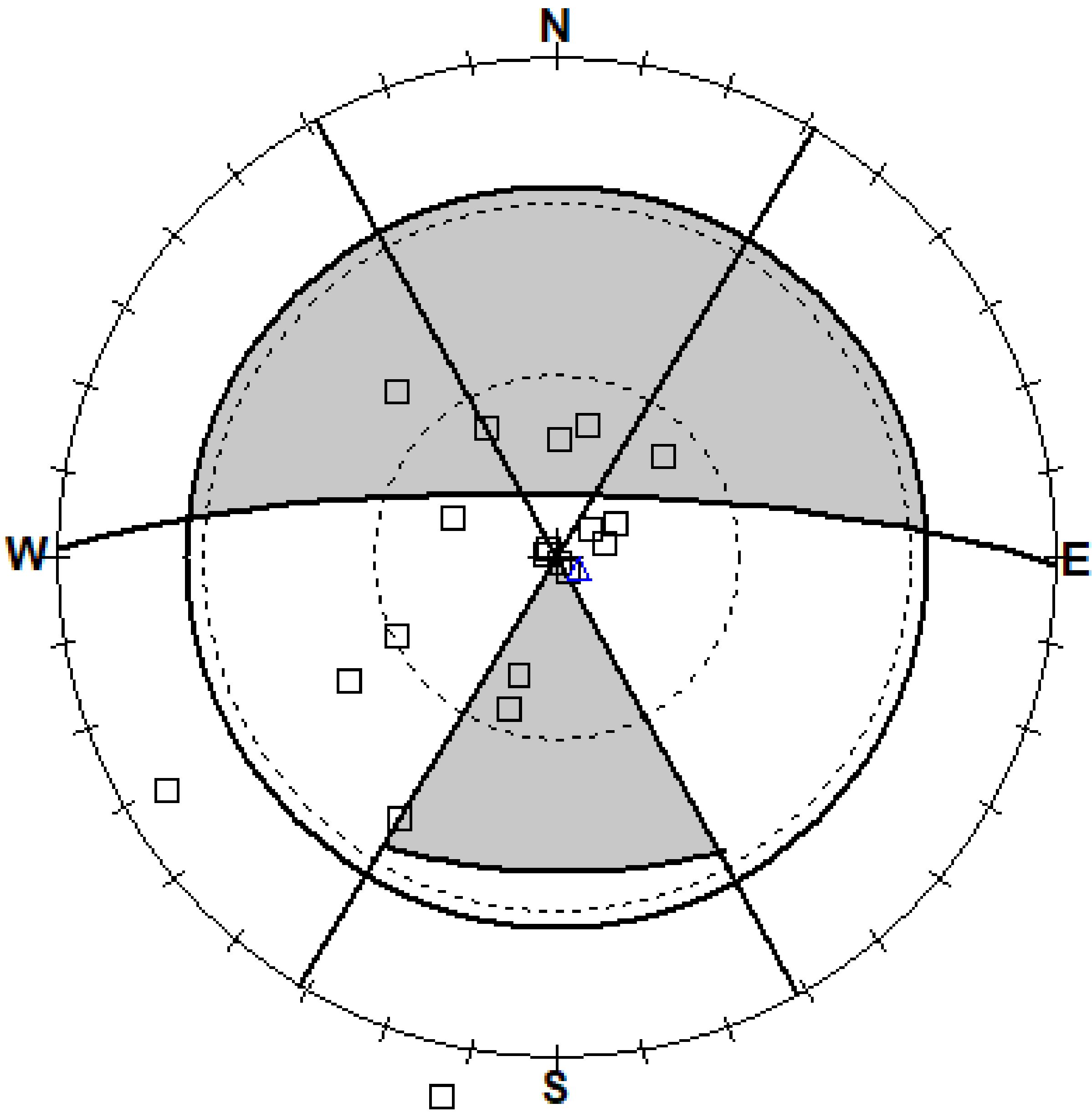


Figure 25 - Stereonet Plot – South Highwall
Granite Quarry - BLM Area (S-BLM)
Front Range Aggregates, LLC
Parkdale Quarry
Fremont County, Colorado
DRMS Mining Permit M1997-054

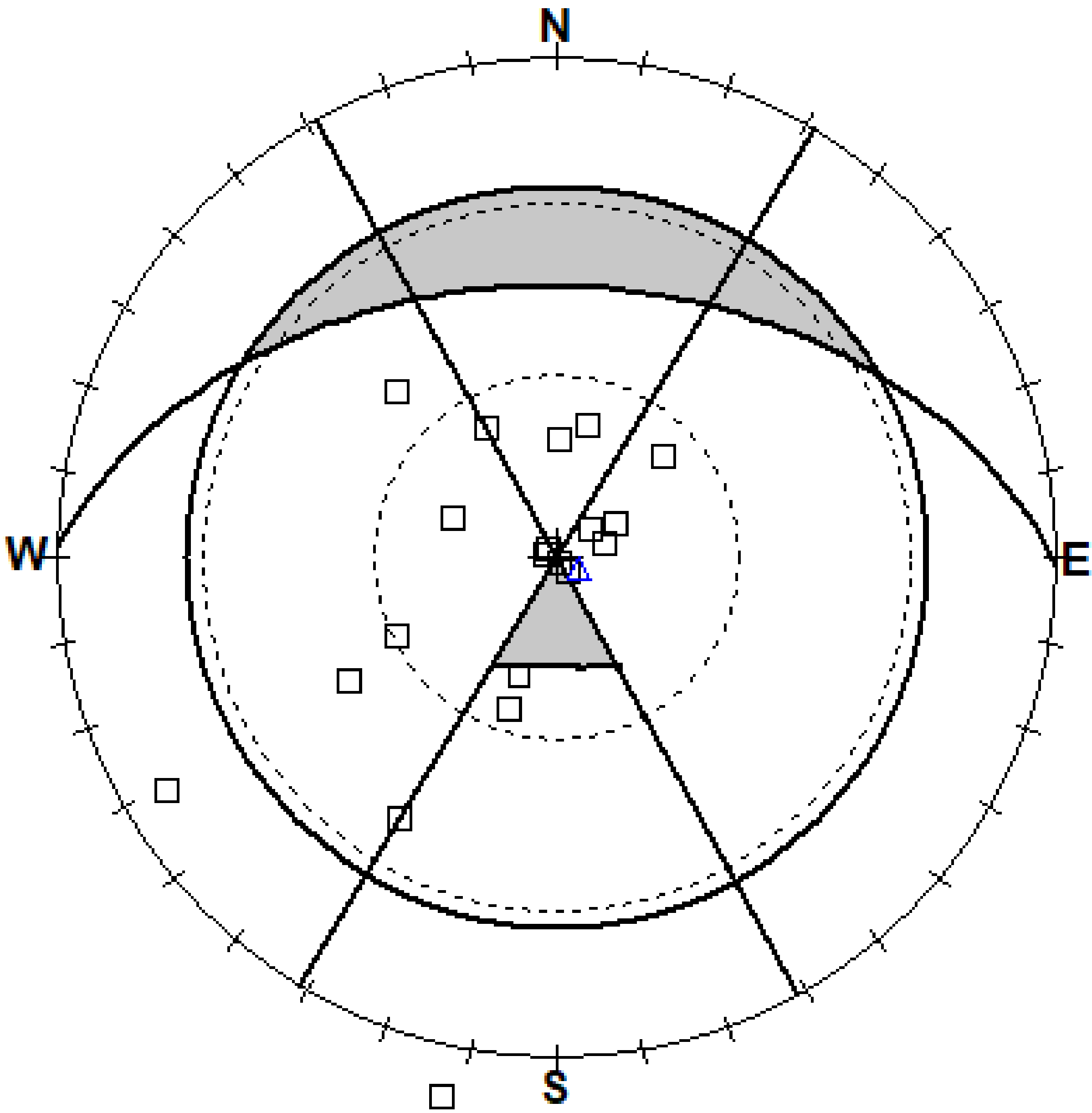


Figure 26 - Stereonet Plot – South Reclamation Slope
Granite Quarry - BLM Area (S-BLM)
Front Range Aggregates, LLC
Parkdale Quarry
Fremont County, Colorado
DRMS Mining Permit M1997-054

Method: ◉ Bishop Modified ○ Ordinary Method of Slices
Seismic Coefficient: .8 (unitless)
Seismic Option: ◉ 1 ○ 2

*) optional

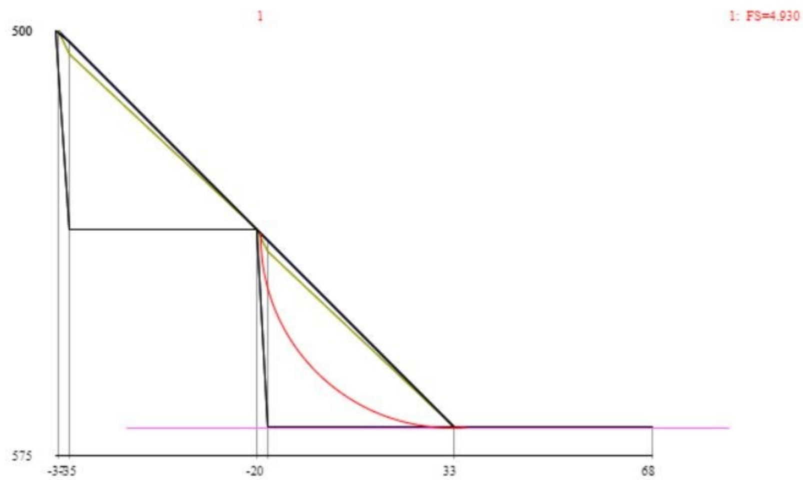


Figure 27 - Reclamation Soil Fill Slope
Seismic Stability Failure Analysis Model
Front Range Aggregates, LLC
Parkdale Quarry
Fremont County, Colorado
DRMS Mining Permit M1997-054

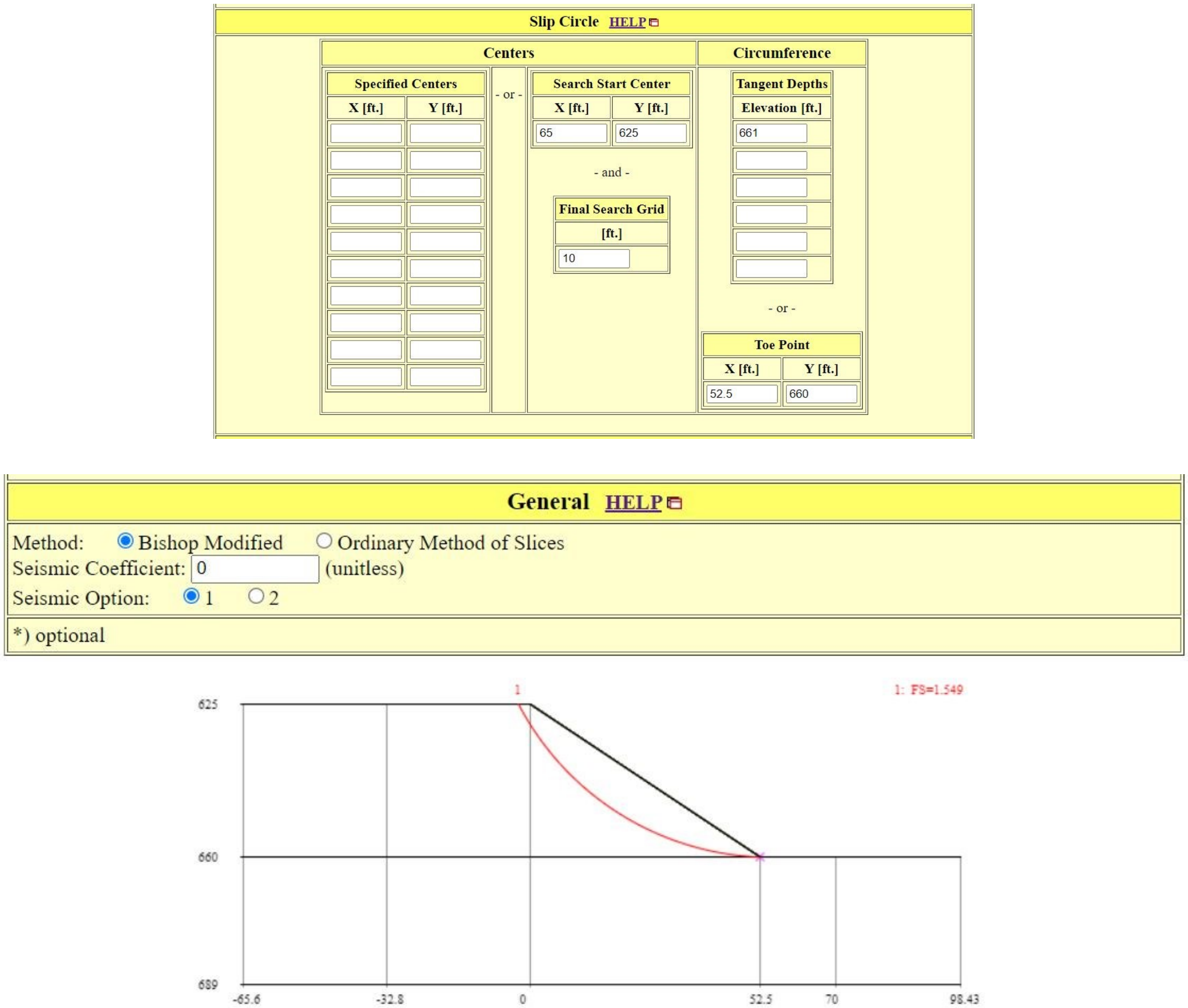


Figure 28A – Overburden Stockpile Maximum Slope Static Stability Failure Analysis Model

Front Range Aggregates, LLC

Parkdale Quarry

Fremont County, Colorado

DRMS Mining Permit M1997-054

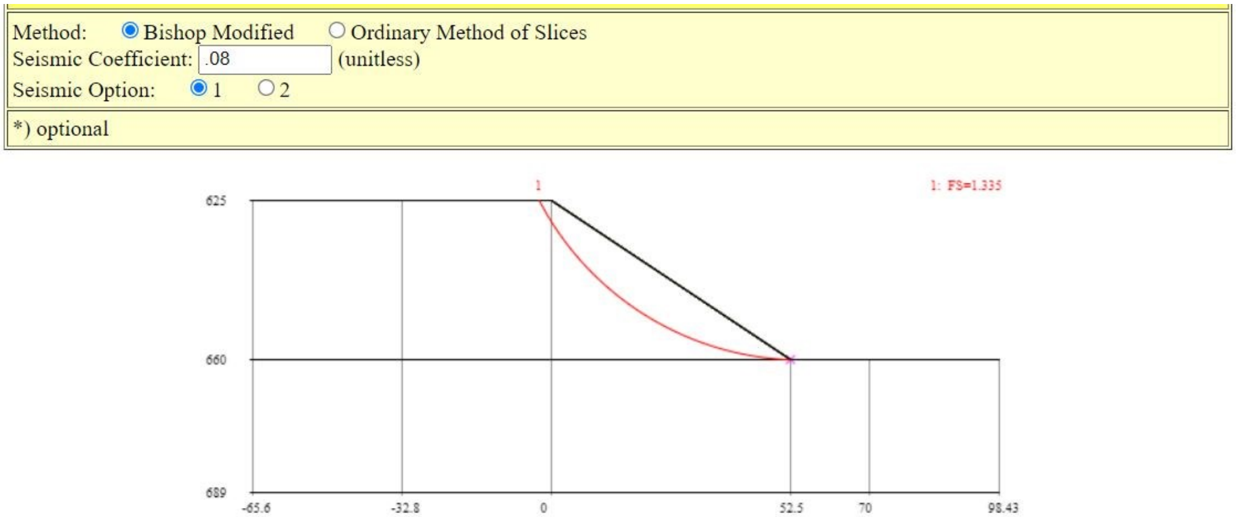


Figure 28B – Overburden Stockpile Maximum Slope Seismic Stability Failure Analysis Model

Front Range Aggregates, LLC

Parkdale Quarry

Fremont County, Colorado

DRMS Mining Permit M1997-054