ISO 9001:2000
FS 64925

PACIFIC BOOKER MINERALS INC.
MORRISON COPPER/GOLD PROJECT

FEASIBILITY PIT SLOPE DESIGN
(REF. NO. VA101-102/8-2)

REV. NO.	REVISION	DATE	APPROVED
0	Issued in Final	June 30, 2006	KJB
1	Kinematic Analyses Updated	October 16, 2006	KJB

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EXECUTIVE SUMMARY

Pacific Booker Minerals Inc. is in the process of completing a feasibility level study for the Morrison Copper/Gold Project located approximately 65 km northeast of Smithers in west-central British Columbia. The Morrison deposit is approximately 500 m by 900 m in plan and extends to a depth of over 330 m below ground surface. The proposed open pit for the Morrison Project is scheduled to be mined over 14 years at a production rate of 25,000 tonnes/day. Knight Piésold Ltd. was retained to conduct geotechnical investigations at the Morrison deposit and to develop recommendations for the maximum practical pit slopes that can be achieved.

A geotechnical investigation program was completed at the Morrison site during January/February 2006. Detailed geotechnical data is included in KP Report – 2006 Open Pit Geotechnical Investigations (Ref. No. VA101-102/8-1, May 8, 2006). The current geotechnical model incorporates three major geological domains: Jurassic Sediments, Intrusives and Fault Zone. The intact rock strengths were found to be generally strong except for the Fault Zone, which is of slightly lower strength. Combining the intact rock properties and characteristics of the observed discontinuities allowed the rock mass quality to be summarized as being generally FAIR to GOOD, with POOR quality rock encountered within the Fault Zone and the more altered Jurassic Sediments and Intrusives. A major, apparently vertical fault zone is known to occur in the middle of the intrusive unit. The groundwater table is near the surface and the permeability of the rock mass is low.

This geotechnical database has been utilized to evaluate rock mass characteristics and develop recommendations for pit slope design. A two-stage pit development model has been utilized for this feasibility assessment. The pit slope design was based on the nine main design sectors that were identified for each phase of pit development. These sectors accounted for the spatial distribution of the geological domains and the wall geometry/orientations. Design methods used to determine appropriate pit slope angles for the Morrison Pit included detailed kinematic stability assessment and evaluation of the overall rock mass stability in designated design sectors. The pit slope geometries for each design sector have been determined based on minimum acceptable criteria for each of these design methods.

The bench scale slope stability has been assessed using stereographic analyses. This approach attempts to identify a bench geometry that will reduce the likelihood of small-scale discontinuities interacting to form unstable wedges and blocks etc. The bench geometry is typically constrained by mining equipment available and rock structural features. Based on the assumption of 15 m high benches, a bench face angle of 60 degrees is likely appropriate for the North, lower Northeast and South Sectors, where the broken Fault Zone is encountered. A bench face angle ▲Rev 1

of 65 degrees is predicted to be achievable for the rest of the pit walls where more competent rocks are expected.

The inter-ramp slope angle is typically determined by the bench geometries and/or controlled by large-scale structural features. A 40 degree inter-ramp slope with single bench geometry is recommended for slopes in the more broken rock, and an inter-ramp slope angle of 47 degrees using a double bench configuration is appropriate for the rest of the pit walls. ▲Rev 1

The overall stability of the pit slopes has been evaluated using conventional limit equilibrium analyses. The overall slope angles have been determined to achieve a minimum factor of safety of 1.3 for the various design sectors based on the assumptions of blasting disturbance and groundwater pressure. The maximum overall pit slope angles for the current feasibility design typically range from about 39 to 45 degrees for the broken Fault Zone rocks and for the competent rock masses, respectively. These overall slopes may include flatter upper slopes in overburden and/or broken zone. Haul ramps is also incorporated on the pit walls and result in a flatter overall slope angle.

Pit water management for the open pit development will include surface water interception and diversion, slope depressurization and a pit dewatering system. A detailed pit hydrogeological study is scheduled to be conducted by others. ▲Rev 1

The design basis for the recommended pit slope angles requires the implementation of careful controlled blasting practices along with comprehensive groundwater depressurization measures. It is also essential that detailed geotechnical mapping of the rock mass be completed once bedrock is exposed during pre-production and ongoing mining. Pit face mapping should also be supplemented with continuous monitoring of the slope deformations and hydrogeological conditions in and around the pit. Data collected during pit development will be used for ongoing pit slope optimization.

The currently available data and the corresponding stability analyses confirm that the recommended pit slope design is reasonable and appropriate. However, it should be recognized that there are inherent risks in any mining development. It will be useful to update the geological model for the site and incorporate additional geological interpretations of the nature and extent of major structural features, as well as the alteration assemblages present. The existing database should be expanded to include more hydrogeological information as there is a very limited amount available for this project at the present time. An additional hydrogeological study should also be performed to provide a detailed water management plan for the pit development.

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SECTION 1.0 – INTRODUCTION

1.1 PROJECT DESCRIPTION

Pacific Booker Minerals Inc. (PBM) is in the process of completing a feasibility level study for the Morrison Copper/Gold Project located approximately 65 km northeast of Smithers in west-central British Columbia. The project location is shown on **Figure 1.1**.

The Morrison deposit is approximately 500 m by 900 m in plan and extends to a depth of over 330 m below ground surface, with the potential to be mined by open pit methods. Approximately 87 million tonnes of ore grading 0.45% copper and 0.259 grams gold per tonne has been delineated in the preliminary assessment completed by Beacon Hill Consultants (2004). The proposed mine will be an open pit with an ore production rate of 25,000 tonnes per day for approximately 14 years.

1.2 SCOPE OF WORK

Knight Piésold Ltd. (KP) has been retained to complete a feasibility level geotechnical investigation and design of the open pit slopes for the Morrison Copper/Gold Project. A total of seven geotechnical oriented core drillholes were completed at the Morrison deposit during January/February 2006. The site investigation program comprised diamond drilling, core orientation, geotechnical logging, field permeability testing, piezometer installation and groundwater level measurement. Laboratory test work completed on select samples included Point Load Testing (PLT), Unconfined Compressive Strength (UCS) testing and direct shear testing on rock joints. Detailed site investigation data is presented in KP Report – 2006 Open Pit Geotechnical Investigations (Ref. No. VA101-102/8-1, May 8, 2006).

Information collected from field and laboratory testing programs was compiled along with the geological model provided by PBM. A geotechnical database was developed to evaluate the rock mass characteristics and to develop recommendations for pit slope design. Simplified geological domains were delineated and pit design sectors were defined. Design methods used to determine appropriate pit slope angles for the Morrison Pit include: detailed kinematic assessment and the evaluation of the overall stability of the rock mass. The pit slope geometry for each design sector has been determined based on the minimum acceptable criteria for each of these design methods along with operational considerations.

SECTION 2.0 – PIT SLOPE DESIGN CONCEPTS

2.1 GENERAL

The overall objective of pit slope design is to determine the steepest practical slope angles for the open pit mine, so the operator can maximize the extraction of the identified ore resource. Balanced against this, is the increased likelihood that steep slopes will lead to the development of slope stability issues that could ultimately impact worker safety, productivity and, therefore, mine profitability. The approach is to base the pit design on achieving an acceptable level of risk and incorporating this into the stability analyses as a factor of safety (FOS). The pit slopes are over conservative if no instability occurs during operations. Hence some instability should be accommodated for and monitored during pit development.

This section briefly introduces pit slope terminology that is used throughout this report and some of the key geotechnical and mining factors that can impact slope design. In addition, a summary of the analysis techniques utilized in this study and the adopted risk management approach are discussed.

2.2 PIT SLOPE GEOMETRIES

Figure 2.1 illustrates the inter-relationships between bench geometry, inter-ramp slope angle and the overall slope angle. The primary components of a pit design are as follows:

- **Bench Geometry** – The height of benches is typically determined by the size of the shovel chosen for the mining operation. The bench face angle is usually selected in such a way as to reduce, to an acceptable level, the amount of material that will likely fall from the face or crest. The bench width is sized to prevent small wedges and blocks from the bench faces falling down the slope and potentially impacting men and equipment. The bench geometry that results from the bench face angle and bench width will ultimately dictate the inter-ramp slope angle. Double or triple benches can be used in certain circumstances to steepen inter-ramp slopes.

- **Inter-ramp Slope** – The maximum inter-ramp slope angle is typically dictated by the bench geometry. However, it is also necessary to evaluate the potential for multiple bench scale instabilities due to large-scale structural features such as faults, shear zones, bedding planes, foliation etc. In some cases, these persistent features may completely control the achievable inter-ramp angles and the slope may have to be flattened to account for their presence.

- **Overall Slope** – The overall slope angle that is achieved in a pit is typically flatter than the maximum inter-ramp angle due to the inclusion of haulage ramps. Other factors that may reduce the overall slope angles are things such as, rock mass strength, groundwater pressures, blasting vibration, stress conditions and mine equipment requirements.

2.3 KEY FACTORS FOR PIT SLOPE DESIGN

The stability of pit slopes in rock is typically controlled by the following key geotechnical and mining factors:

- **Lithology and Alteration** – The rock types intersected by the final pit walls and level of alteration are key factors that impact eventual stability of the pit. Geological domains are created by grouping rock masses with similar geomechanical characteristics.

- **Large-scale Structural Features –** The orientation and strength of major, continuous geological features such as faults, shear planes, weak bedding planes, structural fabric, and/or persistent planar joints will strongly influence the overall stability of the pit walls.

- **Small-scale Structural Features –** The orientation, strength, and persistence of smaller scale structural features such as joints will control the stability of individual benches and may ultimately restrict the inter-ramp slope angles.

- **Rock Mass Quality –** Rock mass strengths are typically estimated via intact rock strength and rock mass classification schemes such as the rock mass rating (RMR) system. Lower rock mass quality typically results in flatter overall slope angles.

- **Blasting Practice** – Production blasting can cause considerable damage to interim and final pit walls. This increased disturbance is typically accounted for with a reduction in the effective strength of the rock mass. Controlled blasting programs near the final wall can be implemented to reduce blasting induced disturbances and allow steeper slopes. Scaling of blast induced fracturing is essential.

- **Groundwater Conditions –** High groundwater pressures and water pressure in tension cracks will reduce rock mass shear strength and may adversely impact slope stability. Depressurization programs can reduce water pressure behind the pit walls and allow steeper pit slopes to be developed.

- **Stress Conditions –** Mining induces stress changes due to lateral unloading within the vicinity of the pit. Stress release can lead to effective reductions in the quality of the rock mass and increases in slope displacements. Localized stress decrease can reduce confinement and result in an increased incidence of ravelling type failures in the walls. Modifying the mining arrangement and sequence can sometimes manage these stress changes to enhance the integrity of the final pit walls.

2.4 METHODOLOGY FOR PIT SLOPE STABILITY ASSESSMENT

A series of design sectors were defined to group areas of the proposed mine with similar mine geometry, geology and rock mass characteristics in order to complete the slope stability analyses. A number of different types of stability analyses can be undertaken to determine appropriate slope angles for a given open pit slope. Slope stability analyses undertaken in this study included the following types:

- **Kinematic Stability Analyses** – Stereographic analyses were conducted on the discontinuity orientation data and the DIPS program was utilized to identify the kinematically possible failure modes. Appropriate bench face angles and/or inter-ramp slope angles are assigned in such a way as to reduce the potential for discontinuities to form unstable wedges or planes. Typically, it is not cost effective to eliminate all potentially unstable blocks and a certain percentage of bench face failure and/or multiple bench instabilities are acceptable. Most of the smaller unstable features will be removed during mining by scaling the bench faces.

- **Rock Mass Stability Analyses** – Limit equilibrium analyses of the rock slopes were performed with SLOPE/W program. This program provides an estimate for the factor of safety against large-scale, multiple-bench failures through the rock mass. In this particular analysis, as with many pit designs a minimum factor of safety of at least 1.3 was specified for this type of failure (Wyllie and Mah, 2004). Lower factors of safety (e.g. 1.2) may be utilized for shorter periods of time, such as near the end of mine life, and where good monitoring is implemented.

SECTION 3.0 – GEOTECHNICAL CONDITIONS

3.1 GENERAL

The Morrison property is located within the rolling uplands of the Nechako Plateau. This is an area of northwesterly trending ridges and valleys. The largest valleys are filled with long, narrow lakes, the largest of which is Babine Lake. Most of the area is an upland surface that stands 733 m to 1380 m above sea level (Ogryzlo, *et. al.*,1995).

The geotechnical conditions in the Morrison open pit area have been characterized based on the 2006 site investigation data and a geological model developed by PBM geologists. A simplified geological/geotechnical model has been developed for pit slope design purposes. This section provides a general overview of the geotechnical conditions for the Morrison deposit. **Table 3.1** summarizes the key parameters for the geotechnical pit slope design. A detailed site characterization process is included in the KP 2006 open pit site investigation report (Ref. No. VA101-102/8-1, May 8, 2006).

3.2 PIT GEOLOGY

3.3.1 Lithology

The Morrison deposit is a typical porphyry copper/gold deposit and is associated with a Biotite Feldspar Porphyry (BFP) intrusive. The deposit is concentrically zoned with symmetrical rings of copper sulphides and pyrite that lies in and surrounds a zone of intense hydrothermal alteration. The lithology of the Morrison deposit consists of Jurassic sedimentary rocks and Eocene intrusions. A sub-vertical fault zone has been identified at the Morrison deposit. Overburden at the Morrison deposit area is generally glacial till with a typical depth of 2 to 10 m.

3.3.2 Alteration

Three major types of alteration are present within the deposit area. These include potassic, propylitic and phyllic types of alteration. Propylitic alteration is further divided into two types, chlorite and clay carbonate.

3.3.3 Major Structures

The primary large-scale structural feature at the Morrison deposit is the north-northwesterly trending East Fault. Intense clay carbonate alteration is associated with this fault zone, which results in a 50 to 200 m wide broken zone.

3.3.4 Simplified Pit Geological Domains

For the purposes of the pit slope design, the rock units encountered in the observed rock masses were grouped based on their general lithological, alteration and structural characteristics. These three groups comprise the Jurassic Sediments, Intrusive and Fault Zone domains. **Figure 3.1** shows a preliminary sub-surficial geological domain distribution and two geological sections are shown on **Figures 3.2** and **3.3**. It is noted that the overburden is not presented on these figures. A brief description of each domain follows.

- **Domain 1 – Jurassic Sediments**
  This domain includes the Jurassic sedimentary rocks that cover most of the deposit. It generally consists of fine to medium-grained siltstones, silty argillites and minor conglomerates. The sediments are massive and strongly altered and bedding is generally not visible. The sedimentary rocks are intersected by many BFP intrusions. They mostly fall into the sericitic and clay carbonate alteration types. This domain will be encountered in both east and west pit walls.

- **Domain 2 – Intrusives**
  The Intrusive domain consists of a faulted volcanic plug and dyke network. It is characterized by two major rock units, the BFP and other minor intrusives that do not host mineralization. The BFP is speckled with abundant phenocrysts of plagioclase, biotite and hornblende in a fine-grained matrix of the same materials along with quartz and potassium feldspar and has been subjected to different levels of hydrothermal alteration, mostly clay carbonate and potassic alteration. This domain will form the lower part of all of the pit walls and is the primary mineralized unit within the ore body.

- **Domain 3 – Fault Zone**
  The Fault Zone includes broken zones and fault breccias of both of the main rock types. This domain is characterized by highly altered BFP and sedimentary units. This is the area of most intense clay carbonate alteration. The Fault Zone cuts through the deposit and will partially form the lower portion of the pit walls.

3.3 LARGE-SCALE STRUCTURAL FEATURES

The primary large-scale structural feature at the Morrison deposit is the north-northwesterly trending East Fault as shown on **Figure 3.1**. The East Fault is composed of a linear zone of parallel shears and fractures that varies in width. The fault is sub-vertical and the displacement is unknown due to erosion but is believed to be significant. Intense clay carbonate alteration is associated with this fault zone. There is another fault zone that affects the western side of the deposit, known as the West Fault, which is similar to the East Fault only smaller. The East Fault zone will affect the pit stability as the rock is much more broken and highly altered in this area. The slope design will have to take this into consideration and therefore, the maximum slope angles for the pit walls in these areas need to be flatter than elsewhere.

3.4 SMALL-SCALE STRUCTURAL FEATURES ▲Rev 1

Discontinuity data has been collected from oriented drillholes to obtain specific information on the small-scale structures that could control the stability of pit benches and inter-ramp slopes. The discontinuity data indicates a degree of scatter in the joint orientations. Disregarding the geological units, three discrete joint sets can be identified as follows:

Joint Set No.	Dip/Dip Direction (degrees)
#1	90/106
#2	87/069
#3	03/223

It is indicated that principal structures are sub-vertically striking north-south as shown in a stereographic plot on **Figure 3.4**. This feature may be associated with the predominant fault structures across the deposit. Another major structure is found to be near horizontal with a scattered pole distribution as show on **Figure 3.4**. The fabric within the rock mass of the Morrison deposit varies with both location and geological domain, and detailed stereographic analyses are provided in Section 4.0.

Comprehensive data were collected on the roughness, aperture and infilling of discontinuities throughout the 2006 drilling program. These data indicated that most discontinuity surfaces did not have any infill and were of moderate roughness. Persistence was assumed to be very high and the cohesion was conservatively excluded because it is very difficult to estimate reliably. The characteristics of the encountered discontinuities are utilized in combination with the intact properties of the rock to classify the rock mass as presented in Section 3.5.

The shear strength of the discontinuities was estimated from laboratory direct shear tests which were carried out on intact joints. Small-scale shear test results should, however, always be used with caution as they do not account for the larger scale features that will strongly influence the performance of the rock mass on a bench and inter-ramp scale. An average joint friction angle of 35 degrees has been utilized for all the rock types for the pit slope design (see **Table 3.1**) by incorporating the scaling factor and field uncertainty.

3.5 ROCK MASS QUALITY

The Rock Mass Rating (RMR) classification system (Bieniawski, 1989) was used to summarize the geomechanical characteristics of the rock masses encountered at the Morrison Project. It is based on five parameters describing the key rock mass characteristics, including: Unconfined Compressive Strength (UCS), Rock Quality Designation (RQD), joint spacing, joint conditions and groundwater conditions. Ratings are assigned to each of the five parameters and the sum of these ratings defines the rock mass quality as an RMR value. RMR values range from near zero, equating to very poor rock, to 100, equating to very good rock. This system is outlined in more detail in KP Report (Ref. No. VA101-00102/8-1, May 8, 2006).

The intact rock strengths were obtained from field estimates, laboratory UCS tests and Point Load Tests (PLTs). The estimated UCS and deformability parameters for each geological domain are summarized in **Table 3.1.** Generally the intact rock strengths for the Morrison deposit rocks are strong, with typical UCS values ranging between 60 to 100 MPa.

The typical RMR values for each geological domain are also summarized in **Table 3.1**. It indicates that the rock mass qualities in the Morrison pit area are generally FAIR to GOOD as the average RMR ranges from 45 to 60.

3.6 GROUNDWATER CONDITIONS

The groundwater table was observed to be close to the ground surface in the valleys and deeper in the hills surrounding the open pit area. The limited groundwater monitoring conducted to date indicates that groundwater levels range from 6 to 52 m below the ground surface. The groundwater is expected to form this subdued replica of the topography in upland areas. Overall the groundwater system is likely to be in a steady-state condition, with only minor fluctuations in the water table throughout the year.

The permeability of the rock mass was measured from field tests and the results are summarized on **Table 3.1**. The competent rock mass shows a low hydraulic conductivity in the order of 10^{-7} cm/sec, while the broken rock along fault zone has a higher permeability value of 10^{-5} cm/sec.

Whether the known fault zones or shears will act as conduits or barriers to groundwater flow will depend on their location relative to the open pit excavation and on the permeability contrast between these zones and the surrounding rock mass. Excavation of the open pit in zones of higher fracture density and correspondingly higher permeability will result in natural drainage and pressure relief by gravity. Additional detailed groundwater flow characteristics are currently being evaluated by Water Management Consultants.

SECTION 4.0– KINEMATIC STABILITY ANALYSES

4.1 GENERAL

Kinematic analyses were undertaken on the discontinuity orientation data within the geotechnical database. The purpose of this analysis was to identify the kinematically possible failure modes within each design sector using the stereographic technique. The bench geometry was selected to reduce, to an acceptable level, the potential of small-scale discontinuities from forming unstable wedges and planar failures. This section introduces the pit design sectors utilized throughout the stability analyses, the kinematically possible failure modes and the results of the stereographic analyses.

4.2 PIT DESIGN SECTORS

A two-stage pit development model provided by PBM (August 2005) has been utilized for this feasibility assessment. A series of pit design sectors were defined to group areas of the proposed mine with similar mine geometry, geology and rock mass characteristics. The pit design sectors have been defined in accordance with the location of the three geological domains and the orientation of the proposed pit walls. It is noted that the Morrison open pit will be developed in two stages. The Phase 1 Pit and the associated five design sectors are shown on **Figure 4.1**. The final feasibility pit geometry is that of the Phase 2 Pit. The locations of the seven main design sectors are shown on **Figure 4.2**.

In each sector, the geology and pit wall orientation are generally consistent. A review of the geomechanical data indicated that the rock mass quality does not vary substantially among rock types within each sector, and the types of discontinuities and their orientations to the proposed pit walls are generally similar throughout each sector. However, the rock mass strength of the Fault Zone is generally lower than the rock mass strength in the rest of the rock types. The overburden should also be treated as a sub-sector within each design sector. It is not generally been included on the figures because it represents such a small portion of each pit wall.

4.3 MODES OF FAILURE

Kinematically possible failure modes in rock slopes typically include planar, wedge and toppling failures. These failure modes can be identified by using stereographic analysis of peak pole concentrations of the discontinuity data. These failure modes will occur if the discontinuities are continuous over the bench scale or more, if weak infilling is present along the measured discontinuities or the geometry of the discontinuities is conducive to failure. A brief introduction on each mode of failure is provided below:

- **Planar Failure** – This failure mode is kinematically possible where a discontinuity plane is inclined less than the slope face (daylights) and at an angle steeper than the friction angle.

- **Wedge Failure –** This failure mode is kinematically possible where the plunge of the intersection of two planes (sliding vector) is inclined less than the slope face (daylights) and at an angle greater than the combined friction angle which is determined from the characteristics of each plane that forms the wedge. Where kinematics are the controlling factor, the recommended pit slope angles have been adjusted to reduce the potential for large-scale, multiple bench wedge failures.

- **Toppling Failure –** This failure mode is kinematically possible due to interlayer slip along discontinuity surfaces where sub-vertical jointing dips into the slope at a steep angle β. The condition for toppling to occur is when $\beta > (\phi_j + (90\text{-}\Psi))$, where Ψ is the slope face angle and ϕ_j is the friction angle (Goodman, 1989).

4.4 STEREOGRAPHIC ANALYSES ▲Rev 1

Stereographic analyses have been carried out for each failure mode for all the competent units using the DIPS program (Rocscience Inc, 2001). The data analyzed for each design sector includes all geotechnical drillholes in the area and all data were corrected using a 15% Terzaghi weighting to account for the effects of drillhole orientation sampling bias. The stereographic analyses of peak pole concentrations indicate that the kinematically possible failure modes at the Morrison Pit include planar, wedge and toppling failures. Detailed analyses are presented in **Figures 4.3** to **4.11** and a detailed discussion is provided below.

4.4.1 North Sector of Phase 1 Pit ▲Rev 1

The pit wall within the North Sector of the Phase 1 Pit will largely be developed in the Fault Zone domain. Stereographic analysis of this wall was completed using data from drillhole 9560-1 and is shown on **Figure 4.3**. It indicates that there is no significant adverse structural feature in this sector. However, a flatter bench face slope of 60 degrees is selected due to the presence of broken rocks.

4.4.2 Northeast Sector of Phase 1 Pit ▲Rev 1

The Northeast Sector of the Phase 1 Pit occupies the northeast wall of the pit and will be excavated in the Jurassic Sediments and Fault Zone domains. The stereographic analyses of this sector are shown on **Figure 4.4** and are based on the data collected from drillholes 9240-1 and 9240-3. The discontinuity data indicates a degree of scatter in the joint orientations and a predominant sub-vertical structure is identified. The bench face geometry in this sector will be kinematically controlled by the potential toppling features and some minor planar structures. However, most of the planes that will contribute to these failures are located near the edge of the day-lighting zone and failures are expected to be localized features. A bench face angle of 65 degrees is predicted to be achievable for the competent Jurassic Sediments and an inter-ramp slope of 47 degrees is recommended to reduce the toppling potential. A flatter bench slope of

60 degrees is more reasonable for the lower Northeast Wall where the broken Fault Zone is encountered.

4.4.3 South Sector of Phase 1 Pit ▲Rev 1

The South Sector occupies the southern wall of the proposed Phase 1 Pit and is largely comprised of the Fault Zone unit. The stereographic analyses for this sector are presented on **Figure 4.5** and are based on the data collected from drillholes 9220-1 and 9240-3. There are no significant adverse features to stability on this wall. However, a flatter bench face angle of 60 degrees has been selected due to the broken Fault Zone.

4.4.4 Southwest Sector of Phase 1 Pit ▲Rev 1

The Southwest Sector is located on the southwest side of the Phase 1 Pit and is largely comprised of rocks from the Jurassic Sediments and Intrusive domains. The kinematic analyses undertaken in this sector made use of the data collected from drillhole 9220-1 and results are shown on **Figure 4.6**. The failure mechanisms that are kinematically possible in this sector are planar structures. These features are considered minor and they will likely be removed during mining operations. A bench face angle of 65°degrees is predicted to be achievable for this sector.

4.4.5 Northwest Sector of Phase 1 Pit ▲Rev 1

The Northwest Sector of the Phase 1 Pit was evaluated using data from drillholes 9360-1 and 9560-1. The wall will be excavated in the Jurassic Sediments and Intrusive domains. The stereographic analyses for this sector are shown on **Figure 4.7**. It indicates that potential planar failure will be formed by scattered joint sets. However, most of the planes that will contribute to these failures are expected to be localized. A 65 degree bench face angle is predicted to be achievable along this sector.

4.4.6 East Sector of Phase 2 Pit ▲Rev 1

Data from drillholes 9240-1 and 9240-3 have been used in the analyses of the East Sector of the Phase 2 Pit, which will be mined in the Jurassic Sediments and Intrusive domains. Bench face angles for the East Wall are going to be controlled by some minor planar and wedge related stability issues as shown on **Figure 4.8**. A bench face angle of 65 degrees is predicated to be achievable for this sector. Some minor day-lighting of both planar and wedge structures may be expected. An inter-ramp angle of 47 degrees is recommended to offset the wedge potential.

4.4.7 Southeast Sector of Phase 2 Pit ▲Rev 1

The Southeast Sector extends along the southeast portion of the Phase 2 Pit and will be excavated in both the Jurassic Sediments and Intrusive domains. The kinematic analyses for this sector are based on data collected from drillholes 9000-1 and 9060-2 and are presented on **Figure 4.9**. Kinematic stability in this sector is likely controlled by some minor toppling and planar structural features. A bench face angle of 65 degrees is achievable for this sector. An inter-ramp slope of 47 degrees is recommended to reduce the toppling potential.

4.4.8 South Sector of Phase 2 Pit ▲Rev 1

The South Sector occupies the southern wall of the proposed Phase 2 Pit and is largely comprised of the Fault Zone unit. The stereographic analyses of the South Wall are presented on **Figure 4.10** and are based on the data collected from drillhole 9000-1. There are no significant adverse features to stability on this pit wall. However, a flatter bench face angle of 60 degrees has been selected for this design sector because of the broken Fault Zone.

4.4.9 Southwest Sector of Phase 2 Pit ▲Rev 1

The Southwest Sector is located on the southwest side of the Phase 2 Pit and is comprised of rocks from the Jurassic Sediments and Intrusive domains. The kinematic analyses undertaken in this sector made use of the data collected from drillhole 9220-1 and are shown on **Figure 4.11**. The failure mechanisms that are kinematically possible in this sector are planar structures. This feature is considered minor but localized bench loss is expected. A bench face angle of 65 degrees is predicted achievable in this sector.

4.5 SUMMARY OF KINEMATIC STABILITY ANALYSES ▲Rev 1

Pit design sectors were analyzed using stereographic plots to determine the maximum bench face angles of the pit walls without inducing major kinematic failure. A summary of the stereographic analyses is presented in **Table 4.1**. The modes of failure that are possible for each design sector are detailed. A flatter bench slope of 60 degrees is likely appropriate for the North, lower Northeast and South Sectors (for both phases) where the broken Fault Zone is encountered. A 65 degree bench face angle is predicted to be achievable for the rest of pit walls where competent rocks are expected. Localized planar daylighting and toppling potential are expected along the bench faces.

The inter-ramp slope angle is typically determined by the bench geometries and/or controlled by large-scale structural features. However, potential influences from large-scale features are not certain at this stage, particularly for the West Fault, which may have a potentially adverse impact to the Northwest and Southwest Walls. Given an assumption of 15 m high benches, a 40 degree inter-ramp slope is selected for the broken slopes with single bench geometry while a steeper inter-ramp slope angle of 47 degrees is recommended for the rest of pit walls with a double bench configuration, as indicated in **Table 4.1**.

SECTION 5.0 – ROCK MASS STABILITY ANALYSES

5.1 GENERAL

Pit walls of large open pit mines may include overburden slopes and haul ramps, which will typically result in a slightly flatter overall slope angle than the inter-ramp slope angle. The maximum overall rock slope angle of large open pit mines is usually determined by rock mass strength. Using Hoek-Brown criterion (Hoek, *et. al.,* 2002), the rock mass strengths were derived from intact rock strength, rock mass quality and blasting disturbance. Conventional limit equilibrium analyses were conducted to evaluate the maximum overall slope angle for each design sector with an acceptable factor of safety. Sensitivity analyses were carried out for the pit walls to evaluate the influence of slope angle, blasting disturbance and groundwater depressurization. This section provides a detailed discussion of overall slope stability for each design sector.

5.2 ESTIMATE OF ROCK MASS STRENGTH

The rock mass strength parameters were derived using the Hoek-Brown failure criterion (2002 edition). This criterion utilizes the characteristics of the rock mass to downgrade the measured intact rock properties to rock mass scale values. The characteristics of the rock mass are described by lithology, intact rock strength and rock mass quality. Once these strength properties have been determined, they can be adjusted to account for the expected level of disturbance. Rock mass disturbance is typically caused by blast damage and vertical unloading, as well as strains resulting from stress changes in the pit walls.

Following Hoek, et. al. (1995), the lithological factor (m_i) has been set for each domain according to what is appropriate for the rock types encountered. The m_i values for the Jurassic Sediments, Intrusive and Fault Zone domains were set at 17, 20 and 15, respectively. Intact rock strength and rock mass quality at the Morrison deposit have been discussed in Section 3.0, and the design values are summarized in **Table 3.1**.

The Geological Strength Index (GSI) is based on the RMR rating system and was introduced by Hoek et al. (1995) to overcome issues with the RMR values for very poor quality rock masses. For better quality rock masses (GSI>25), the value of GSI can be estimated from Bieniawski's RMR (1989) as GSI=RMR-5. This assumes a groundwater rating set to 15 (dry) and the adjustment for joint orientation set to 0 (very favourable). The groundwater rating in this study has been set to 15 because groundwater conditions are difficult to estimate from drill core. Therefore, as most of the RMR values are greater than 25, the GSI values are assumed to be mathematically equivalent to the equation above.

Hoek et al, 2002 recommends that the utilized rock mass strengths be downgraded to disturbed values to account for rock mass disturbance associated with heavy production blasting and vertical stress relief,. He indicates that a disturbance factor of 0.7 would be appropriate for a mechanical excavation where no blasting damage is expected. However, Knight Piésold experience has suggested that a disturbance factor approaching the value of 0.7 may be achievable for moderate height slopes with the application of EXCELLENT controlled blasting practices. A value of 1.0 is assumed for NORMAL production blasting. A GOOD controlled production blasting strategy is expected to be between these extremes and consistent with a disturbance factor of 0.85.

Table 5.1 presents a summary of the rock mass strength parameters for the main rock types encountered within the pit walls. The equivalent strength curves of each geological unit are included in **Appendix A**.

5.3 LIMIT EQUILIBRIUM ANALYSES

Limit equilibrium stability analyses were performed using the SLOPE/W computer program (Krahn, Geo-Slope International Ltd., 2004) for the seven pit design sectors. The limit equilibrium analyses were completed to evaluate the overall stability of the jointed rock mass and to demonstrate the sensitivity of the calculated Factors of Safety (FOS) to different overall slope angles, blasting disturbance and groundwater levels. A FOS of 1.3 has been targeted for all pit walls.

Table 5.2 summarizes the geometric, geotechnical parameters and the computed results of the base case stability models for each pit wall. **Figures 5.1** to **5.7** illustrate the geometry, geology, assumed groundwater conditions, and the critical slip surface for each of the highwall sections. The modelling sections usually represent the highest slope in each sector. The overburden slope was negligible due to its insignificant thickness in the deposit area. An initial groundwater level of 20 m was assumed for the open pit area prior to mining. The results of the limit equilibrium analyses are discussed below for each of the design sectors.

5.3.1 North Wall of Phase 1 Pit

A total slope height of 200 m was modelled for North Wall of the Phase 1 Pit, which will be largely excavated in the Fault Zone rocks. The sensitivity analyses evaluated the stability of the overall slope angles in the North Wall from 35 to 45 degrees. Various blasting disturbance factors (0.7 to 1.0) were tested and the results are shown on **Figure 5.1**. In this case, groundwater depressurization of 40 m has been assumed. The analyses indicate that an overall FOS of 1.31 can be achieved for a 39-degree overall slope in the North Wall with GOOD controlled production blasting (D=0.85). It also implies that increased blasting disturbance and steeper slope angles will decrease the FOS.

Further sensitivity analyses were carried out to evaluate the influence of the groundwater level behind the slope. Three groundwater drawdown levels (20, 40 and 60 m) were examined for the various slope angles and blasting disturbance factors. The analyses results are presented in matrix form in **Table 5.3**. This matrix suggests that low blasting disturbance and aggressive groundwater depressurization will allow steeper slope angles for the same FOS. The recommended design for the North Wall is for a 39-degree overall slope assuming a disturbance factor of 0.85 and groundwater depressurization to

40 m. This overall slope angle can be used for the interim South Wall of the Phase 1 Pit due to a similar slope height and geology distribution.

5.3.2 Northeast Wall of Phase 1 Pit

A total slope height of 240 m was assumed for the Northeast Wall of the Phase 1 Pit. The major portion of the slope comprises the competent Jurassic Sediments, but the lower pit wall and pit bottom will primarily be formed in the broken Fault Zone. The sensitivity analyses evaluated the stability of the overall slope angles for slopes between 41 to 51 degrees. Various disturbance factors (0.7 to 1.0) were also applied in these analyses and the results are presented graphically on **Figure 5.2**. Groundwater depressurization of 40 m has been assumed in these sensitivity analyses. The results indicate a FOS of 1.38 can be achieved for a 49-degree overall slope in the Northeast Wall with GOOD controlled production blasting (D=0.85).

Further sensitivity analyses were carried out to evaluate the influence of the groundwater level behind the slope. Three groundwater drawdown levels (20, 40 and 60 m) were examined for the various slope angles and blasting disturbance factors. The analytical results are presented in matrix form in **Table 5.4**. It suggests that high blasting disturbance and less groundwater depressurization will result in a lower FOS. A flatter overall slope angle of 45 degrees is more appropriate for the Northeast Wall.

5.3.3 Northwest Wall of Phase 1 Pit

A total slope height of 250 m was assumed for the Northwest Wall of the Phase 1 Pit, which will be developed within the competent Intrusive domain. The sensitivity analyses evaluated the stability of overall slopes ranging from 43 to 53 degrees, along with various degrees of blasting disturbance (D=0.7 to 1.0). The overall FOS for the Northwest Wall with respect to slope angle and blasting disturbance are presented on **Figure 5.3**. Under an assumed depressurization of 20 m, an overall FOS of 1.54 can be achieved for a 49-degree overall slope with GOOD controlled blasting (D=0.85). This overall slope angle can also be used for the interim Southwest Wall of the Phase 1 Pit due to a similar slope height and geology distribution.

5.3.4 East Wall of Phase 2 Pit

A total slope height of 330 m was assumed for the East Sector of the Phase 2 Pit. The proposed final East Wall will consist of the competent Jurassic Sediments and Intrusives. The sensitivity analyses were completed to evaluate the stability of overall slope angles ranging from 43 to 53 degrees. Various disturbance factors (0.7 to 1.0) and a groundwater drawdown value of 40 m were applied to the analyses. The FOS for the East wall for various slope angles and disturbance factors are shown on **Figure 5.4**. It indicates that an overall FOS of 1.38 can be achieved for a 49-degree overall slope in the East Wall with GOOD controlled production blasting (D=0.85).

5.3.5 Southeast Wall of Phase 2 Pit

A total slope height of 330 m was assumed for Southeast Sector of the Phase 2 Pit. The proposed Southeast Wall will consist of the competent Jurassic Sediments and Intrusive domains. The sensitivity analyses were completed to evaluate the stability of overall slope angles ranging from 43 to 53 degrees along with various degrees of blasting disturbance (D=0.7 to 1.0). Assuming a depressurized zone of 40 m in the slope, the FOS for the Southeast Wall for various slope angles and disturbance factors are shown on **Figure 5.5**. An overall FOS of 1.48 can be achieved for a 49-degree overall slope in the Southeast Wall with GOOD controlled production blasting (D=0.85).

5.3.6 South Wall of Phase 2 Pit

A total slope height of 250 m was assumed for the South Sector of the Phase 2 Pit. The final pit wall will consist of the Fault Zone domain. The sensitivity analyses were completed to evaluate the stability of overall slope angles ranging from 35 to 45 degrees. Various disturbance factors (0.7 to 1.0) and groundwater drawdown values (20 to 60 m) were applied to the analyses. The FOS for the South Wall for various slope angles and disturbance factors are shown on **Figure 5.6**. It indicates that an overall FOS of 1.27 can be achieved for a 39-degree overall slope in the South Wall provided that GOOD controlled production blasting (D=0.85) and ENHANCED slope depressurization of 60 m are applied.

The sensitivity analyses results are also presented in matrix form in **Table 5.3**. They suggest that low blasting disturbance and aggressive groundwater depressurization will improve the FOS for the pit wall. The FOS will fall below 1.0 (i.e. potential instability) if the rock mass is highly disturbed or the groundwater level remains high in the slope. The current design base case for the South Wall is a 39 degree overall slope assuming a disturbance factor of 0.85 and groundwater depressurization to 60 m. As the calculated overall FOS is slightly below 1.3 for this base case, this implies that EXCELLENT controlled blasting practices (D=0.7) and ENHANCED slope depressurization measures will be required for the South Wall.

5.3.7 Southwest Wall of Phase 2 Pit

A total slope height of 250 m was assumed for the Southwest Sector of the Phase 2 Pit. The slope will consist of the competent Jurassic Sediments and Intrusive domains. The sensitivity analyses were completed to evaluate the stability of overall slope angles ranging from 43 to 53 degrees along with various blasting disturbance factors (0.7 to 1.0). The FOS for the Southwest Wall for various slope angles and disturbance factors are shown on **Figure 5.7**. A depressurized zone of 20 m was assumed for these sensitivity analyses. This indicates that an overall FOS of 1.43 can be achieved for a 49-degree overall slope in the Southwest Wall with GOOD controlled production blasting (D=0.85).

5.4 SUMMARY OF ROCK MASS STABILITY ANALYSES

▲Rev 1

The design concept applied to the overall pit slope is to ensure that for the majority of the mine life the walls will have a factor of safety against large scale instability of at least 1.3. The limit equilibrium analyses demonstrate that steeper slopes can be achieved if EXCELLENT controlled blasting practices and effective groundwater depressurization measures are implemented. **Table 5.2** summarizes the computed results for these base case analyses.

The North and South Walls are in the Fault Zone and so are the areas of primary concern for potential rock mass failures. A 39-degree overall slope angle is likely appropriate for the final North and South Walls. A FOS of approximately 1.3 can be achieved provided that GOOD controlled blasting (D=0.85) practices are implemented and effective slope depressurization of 40 to 60 m is maintained. Particularly for the South Wall, the calculated FOS is slightly below 1.3 due to a higher slope in this sector. Further study will be required during operations to refine the stability analysis for the broken zone rocks in this area.

The rock mass stability analyses suggest that maximum overall slope angles of 49 degrees can be achieved for the rest of the pit slopes where the competent Jurassic Sediments and Intrusives domains are encountered. However, the maximum overall slope angles will be restricted by inter-ramp angles determined in the kinematic analyses (40 to 47 degrees). Rock mass strength may not be the controlling factor for slope design for these competent pit slopes. Furthermore, the actual overall slopes may include overburden slopes and haul ramps, which will typically result in a flatter slope angle than the inter-ramp slopes. Therefore, a maximum overall slope angle of 45 degrees is recommended for these competent pit walls. GOOD controlled production blasting (D=0.85) and an effective slope depressurization of 20 to 40 m are required.

It is noted that the overburden slope was not included in the analyses due to its insignificant thickness at the Morrison deposit. A general mine practice to stabilize the overburden slopes above the pit walls is to develop a 2H:1V slope (approximately 27 degrees) and establish safety berms at the interface between the overburden and the rock slope.

SECTION 6.0 – PIT WATER MANAGEMENT

6.1 GENERAL

Open pit development will have a significant impact on the local hydrogeologic regime as the open pit will become a groundwater discharge zone. Limited piezometer data suggests that the existing groundwater table varies between 6 and 52 m below the ground surface. Progressive development of the pit will result in a gradual lowering of the groundwater table in the vicinity of the excavation. The elevated groundwater table with respect to the pit floor influences the mine development in that groundwater inflows need to be pumped out of the pit. Groundwater depressurization measures are required to enhance pit slope stability. Surface water must be diverted to prevent overland flow into the open pit. A general concept of water management for the Morrison Pit is briefly discussed below. A detailed pit hydrogeological assessment will be provided by others.

6.2 SURFACE DIVERSION DITCH

The water ponds at the north edge of the proposed pit will need to be backfilled prior to the pit development. A diversion ditch along the pit crest is required to divert surface runoff and snowmelt away from the pit during operations. Shotcrete or a low permeability lining is often recommended for diversion ditches in order to minimize seepage losses and groundwater recharge to underlying pit slopes.

6.3 SLOPE DEPRESSURIZATION SYSTEM

As discussed earlier, slope depressurization systems are important in the overall pit slope design, and may include a combination of techniques including diversion ditches, vertical pumping wells and horizontal drains. These measures will be implemented based on a staged approach during pit development and will involve the installation of depressurization systems and associated monitoring of groundwater pressures. This will enable an assessment of the pit slope drainage capability and the requirements for additional installations.

6.4 IN-PIT DEWATERING SYSTEM

The proposed pit bottom will be approximately 180 m below the surface of Morrison Lake. The presence of continuous fracture zones which may act as conduits connecting to the lake are unknown. Pit inflows will likely be dominated by seepage from the broken Fault Zone. Inflows from good quality, low permeability rock in close proximity to the base of the Fault Zone are expected to be low. The pit dewatering system should be designed to meet the combined requirements of the anticipated groundwater pit inflow rates and runoff from precipitation. The peak operational design capacity of the system is controlled by any peak storm inflow assumptions.

SECTION 7.0 – PIT SLOPE DESIGN

7.1 GENERAL

The proposed Morrison open pit slopes will extend to a maximum depth of about 330 m. This feasibility pit slope design has considered relevant site-specific geotechnical and limited hydrogeological information collected from the 2006 pit geotechnical investigation program and the results of various stability analyses. Recommended pit slope geometries are summarized in this section, and some operational considerations related to the recommended slopes are considered, along with a discussion of the experiences encountered at other large open pit operations.

7.2 RECOMMENDED PIT SLOPE ANGLES

7.2.1 Bench Geometries

▲Rev 1

The bench design was developed based on the geology, geomechanical and geometrical characteristics of each main design sectors. The bench face angles derived from the kinematic analyses are as steep as reasonably can be expected given the characteristics of the rock masses and mine requirements. As such, the potential for planar or wedge failures still exists within most design sectors, but the majority of these are expected to be manifested as small bench-scale ravelling type failures that will be removed during initial excavation or controlled through a normal bench maintenance program.

Recommended bench geometries are summarized in **Table 7.1** based on the kinematic assessment. The analyses undertaken in this study indicate that the likelihood of adverse structure is highest along the North Sector of the proposed pit, where a bench face angle of 60 degrees is expected to be achievable for the pit wall which is largely formed within the Fault Zone. This bench face angle is also suitable for the lower Northeast Wall, the interim and final South Walls where the broken Fault Zone rocks are encountered. In all other design sectors, a bench face angle of 65 degrees is expected to be achievable.

7.2.2 Inter-ramp Slopes

▲Rev 1

The inter-ramp slope angle is typically dictated by the bench geometry and controlled by large-scale structural features. It is assumed that a 15 m high bench will be used for pit development. The recommended inter-ramp slope angles for each of the design sectors are summarized in **Table 7.1**. There is a potential for minor planar and wedge failure in most of the slopes and care will be required to ensure that the inter-ramp slopes remain stable.

An inter-ramp slope angle of 40 degrees is recommended for the broken Fault Zone rocks along the North and South Sectors. The same 40 degree inter-ramp slope is also recommended for the interim South Sector (of Phase 1 Pit) and the lower Northeast

Sector where the broken rocks are encountered. A typical bench width of 9.2 m is required for the single bench slopes to intercept the anticipated ravelling and rockfalls.

An inter-ramp slope angle of 47 degrees is recommended for the more competent rock units including the Jurassic Sediments and Intrusive domains within the east and west sides of the pit walls. A bench width of 14.0 m is recommended for the double bench configuration in these areas.

7.2.3 Overall Slopes ▲Rev 1

The overall pit slope angles for the current feasibility design typically range from about 39 to 45 degrees, for the broken Fault Zone and the competent rock mass, respectively. A summary of the maximum overall slope angles for each design sector is shown in **Table 7.1**. It indicates that rock mass strength is the controlling factor for slope design in the broken zone but not for the competent rocks. These overall slopes may include flatter upper slopes in overburden. Haul ramps will also be incorporated and will flatten the overall slopes by 2 to 5 degrees. The design basis for the maximum overall slope angles requires the implementation of careful controlled blasting practices along with comprehensive groundwater depressurization measures in order to achieve the steep overall slope angles. A 50 to 80 m “transition zone” between the flatter and the adjacent steep slopes should be incorporated into the pit design.

7.3 OPERATIONAL CONSIDERATIONS

7.3.1 Controlled Blasting

Blasting disturbance is one of the controlling factors for rock mass strength and overall slope stability. Slope instabilities are often triggered by the progressive deterioration (ravelling) of the wall face and this process often initiates with the detachment of small rock blocks (key blocks) bounded by the rock mass discontinuities. The preservation of rock mass integrity during mining is critical to prevent these progressive failures and is required to achieve the steepest bench face angles possible.

Controlled blasting methods will facilitate steeper final pit slopes by reducing face damage from blasting. Typical controlled blasting strategies utilize small diameter blast holes detonated as a pre-shear line in harder massive rock or as a post-shear (cushion) line in weak or heavily fractured rock. In all cases, it is important that blasthole lengths be staggered so the bottom of the hole does not intercept the crest of the bench below. Otherwise, highly fragmented bench crests will develop. A typical controlled blasting pattern is illustrated on **Figure 7.1** (after Brawner, 2003).

Interim pit slopes must also incorporate some “controlled blasting” to maintain safety, but the requirements in this situation are less rigorous, due to the shorter operating life of these walls. In addition, steeper walls are less critical on interim faces, since the stripping ratio is typically controlled by the final overall pit slopes. The initial pit can be developed with variable slopes and blast patterns to develop the optimal blast design for the final pit walls. Trial blasts also are recommended wherever there is a substantial change in rock mass characteristics, in order to evaluate and optimize blast performance.

7.3.2 Slope Depressurization

Groundwater is another key consideration for the overall pit slope stability. High water pressure within the pit walls is expected and the slope depressurization measures including construction of surface ditches, perimeter pumping wells and horizontal drains are recommended for slope stabilization.

An allowance for perimeter depressurization wells should be included into the feasibility study. These wells would be installed to a nominal depth, which is approximately the mid-depth of the final open pit. The wells are drilled from the floor or from a bench adjacent to the final wall of the pit in locations of higher fracture density or areas based on other geological evidence which may indicate a need for depressurization.

Sub-horizontal drains need to be installed in both interim and final pit walls. A typical installation detail for horizontal drains is illustrated on **Figure 7.2**. The drain length will be between approximately 50 and 100 m depending on the ground water depressurisation requirements. Freezing conditions may render the horizontal drains relatively ineffective during the winter months. As such, the horizontal drains should be drilled at an upslope angle of about 5 degrees to ensure more rapid drainage and to partially offset the tendency towards freezing at the outlet. The locations of the drains will be specified only on a “mine and monitor” basis to suit the actual conditions. This “observational” approach will place drain holes based on a number of different sources of information, including: geological features identified by mapping, recorded locations of wet production blastholes, geological modelling, piezometric readings, and slope monitoring observations.

7.3.3 Geotechnical Monitoring

Pro-active geotechnical monitoring is recommended for all stages of pit development. The monitoring program should be implemented as a staged approach and include detailed geotechnical and tension crack mapping, as well as a suitable combination of: surface displacement monitoring (surface prisms and wire extensometers), Time Domain Reflectometry (TDR), Multiple Point Borehole Extensometers (MPBXs) and piezometers. Sufficient staffing resources should be allocated to collect, process and interpret the geotechnical monitoring data on a weekly basis or as frequently as required. The timely identification of accelerated movements from surface displacement monitoring and tension cracks will be critical. Up-to-date reports on the status of highwall stability should be compiled and discussed regularly with operations personnel. These reports will also assist mine engineering staff with their efforts to optimize final pit slopes and improve the effectiveness of the controlled blasting program. All seeps and springs should be inspected, mapped and photographed. Large-scale structures should be characterized and monitored as they have the potential to develop into tension cracks. Detailed monitoring requirements are presented in **Appendix B**.

7.3.4 Bench Scaling

It is important that the benches be kept clear and that the bench faces be maintained regularly so that they remain functional during mining operations. Scaling will be an important part of the bench maintenance program and may be conducted after blasting in areas where access is still available. Routine scaling may allow the bench widths to be minimized, due to a reduction in the volume of material to be controlled.

7.4 PRECEDENT PRACTICE

Pit slope stability depends on a variety of site-specific factors (geological structure, alteration rock strength, groundwater conditions, discontinuity characteristics and orientation, pit geometry, blasting practices, stress conditions, climatic conditions, and time), which make it difficult to provide direct comparisons with other operations. However, it is still quite useful to review the successes and problems encountered at other open pit operations in order to recognize opportunities and potential constraints for the proposed open pit development.

A comparison of other large open pits within British Columbia is presented in **Table 7.2**. The Bell and Granisle pits are located very close to the proposed pit at Morrison. The Bell Mine was excavated to a depth of over 300 m and the Northwest Wall achieved an overall slope of 48 to 50 degrees. The rest of pit walls had overall slope angles ranging from 44 to 46 degrees except for the lower southeast wall that achieved an overall slope angle of 34 to 36 degrees. These overall slope angles are consistent with the recommendations for pit slope design for the Morrison Pit. A brief discussion of some of the slope stability considerations at some of the large open pits in British Columbia, including the Bell Mine is included in **Appendix C**. A summary plot of pit depth vs. slope angles achieved in various operations around the world is illustrated on **Figure 7.3**.

These discussions reveal that the proposed slope angles for the Morrison Pit are generally comparable to the slope angles achieved in other deep pits. This comparison highlights the importance of developing and maintaining good controlled blasting practices, effective groundwater depressurization measures and geotechnical data collection. It is also noted in these case studies, that adverse structural conditions have had a major impact on pit slope stability.

In addition, it is important to note that almost all of these large open pit operations, including porphyry copper mines, have all encountered slope stability problems in some area of the mine. The experiences at most of the large open pits suggest that there is a significant possibility that some area of the pit slope will require flattening during operations in response to slope movement. Therefore, the mine plans should remain flexible so that extra stepout/buttress can be maintained in critical areas of the pit until the end of the mine life when lower factors of safety can be tolerated.

SECTION 8.0 – CONCLUSIONS AND RECOMMENDATIONS

The fundamental considerations for design of the Morrison Pit slopes at the feasibility stage are related to allowable inter-ramp and overall slope angles, as these will affect the stripping ratio and the amount of ore that can be economically removed from the mineralized zone. The feasibility pit slope design for the Morrison Project is based on the currently available geotechnical data and geological model. The corresponding stability analyses suggest the recommended pit slope angles are reasonable and appropriate. However, this design has a number of operational constraints including careful controlled blasting and effective slope depressurization. It also requires extensive monitoring and ongoing commitments to data collection throughout the operational life of the mine.

Additional studies are recommended to increase confidence in the feasibility pit slope design as follows:

- **Additional Data Collection** – Geotechnical and hydrogeological data should be collected in any further drillholes at the Morrison site in the future. The geotechnical logging should be consistent with the existing guidelines, and hydrogeological data including static groundwater level and rock mass permeability should be collected.

- **Geological Model Update –** It will be helpful for PBM geologists to update the geological model for the deposit. This study will incorporate additional geological interpretations on lithology and alteration, nature and extent of major structural features (i.e. faults, shears, geological contacts, etc.), as well as the alteration assemblages present. These data will be used to optimize the current pit slope design.

- **Further Hydrogeological Study** – Current hydrogeological data is not adequate enough to develop a comprehensive interpretation to the groundwater condition in the pit area. A meaningful hydrogeological model should be established once additional hydrogeological area is available. Further hydrogeological study should be carried out to estimate pit inflow and develop a detailed water management plan for the pit area.

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SECTION 10.0 – CERTIFICATION

This report was prepared and approved by the undersigned.

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TABLE 3.1

PACIFIC BOOKER MINERALS INC.
MORRISON COPPER/GOLD PROJECT

FEASIBILITY PIT SLOPE DESIGN
GEOTECHNICAL DESIGN PARAMETERS OF ROCK MASS

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Rev'd Apr/25/06

Geological Domain	Unconfined Compressive Strength (UCS)	Specific Gravity	Young's Modulus	Poisson's Ratio	Rock Mass Rating (RMR)	Friction Angle of Joint	Hydraulic Conductivity
	MPa	-	GPa	-	-	degrees	cm/s
Jurassic Sediments	80	2.57	70	0.22	55	35	1E-07
Intrusives	90	2.71	60	0.28	60	35	1E-07
Fault Zone	60	2.55	N/A	N/A	40	N/A	1E-05

Notes:
(1) Geotechnical data based on the 2006 geotechnical drillholes.
(2) Slightly conservative UCS and RMR design values were applied to offset the uncertainty of rock mass qualities.
(3) Specific gravity data from previous study (Beacon Hill, 2004).

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TABLE 4.1

PACIFIC BOOKER MINERALS INC.
MORRISON COPPER/GOLD PROJECT

FEASIBILITY PIT SLOPE DESIGN
SUMMARY OF STEREOGRAPHIC ANALYSES

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Pit Stage	Pit Design Sector	Nominal Pit Wall Dip Direction (1)	Pit Wall Geology	Data Source	Maximum Bench Face Angle (2) (3)	Maximum Inter-ramp Slope Angle of Single Bench Slope (4)	Maximum Inter-ramp Slope Angle of Double Bench Slope (5)	**Predicted Achievable Bench Face Angle**	**Recommended Inter-ramp Slope Angle (6),(7)**	Failure Mechanism	Figure No. of Stereographic Plots
		degrees			degrees	degrees	degrees	**degrees**	**degrees**		
Phase 1	North	180	Jurassic Sediments, Intrusives and Fault Zone	9560-1	60	42	46	**60**	**40**	Insignificant	4.3
Phase 1	Northeast	260	Jurassic Sediments and Fault Zone	9240-1, 9240-3	65	45	49	**65**	**47**	Toppling/Planar	4.4
Phase 1	South	315	Jurassic Sediments, Intrusives and Fault Zone	9220-1, 9240-3	60	42	46	**60**	**40**	Insignificant	4.5
Phase 1	Southwest	40	Jurassic Sediments and Intrusives	9220-1	65	45	49	**65**	**47**	Planar	4.6
Phase 1	Northwest	120	Intrusives	9360-1, 9560-1	65	45	49	**65**	**47**	Planar	4.7
Phase 2	East	230	Jurassic Sediments, Intrusives and Fault Zone	9240-1, 9240-3	65	45	49	**65**	**47**	Planar/Wedge	4.8
Phase 2	Southeast	300	Jurassic Sediments and Intrusives	9000-1, 9060-2	65	45	49	**65**	**47**	Toppling/Planar	4.9
Phase 2	South	10	Jurassic Sediments, Intrusives and Fault Zone	9000-1	60	42	46	**60**	**40**	Insignificant	4.10
Phase 2	Southwest	45	Jurassic Sediments and Intrusives	9220-1	65	45	49	**65**	**47**	Planar	4.11

Notes:
(1) Nominal pit wall dip directions based on pit model provided by Pacific Booker Minerals Inc. (February 2006).
(2) Bench face angles determined by small-scale structural features and localized wedge/planar failures on bench faces are allowed.
(3) A friction angle of 35 deg is used for all types of discontinuities.
(4) Assuming a single bench height of 15m, the inter-ramp slope angles were determined by a minimum bench width of 8m.
(5) Assuming a double bench height of 30m, the inter-ramp slope angles were determined by a minimum bench width of 12m.
(6) A slightly flat inter-ramp slope angle is recommended by implementing a wider bench width in order to enhance bench reliability during pit development.
(7) Single bench configuration is recommended for the North and South (Phase 1 and Phase 2) Sectors where the broken fault zone is encountered. Double bench configuration is recommended for the rest of pit sectors.

Rev. 1 - Analyses Updated

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TABLE 5.1

PACIFIC BOOKER MINERALS INC.
MORRISON COPPER/GOLD PROJECT

FEASIBILITY PIT SLOPE DESIGN
SUMMARY OF ROCK MASS STRENGTH AND DEFORMABILITY PARAMETERS

M:\1\01\00102\08\A\Data\Pit Slope Design\[Tab 5.1r0_Summary of Rock Mass Strength.xls]Metric

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Rev'd Apr/25/06

Geological Domain			Jurassic Sediments	Intrusives	Fault Zone
Location			East, Upper SE & SW Walls	NW, Lower SW & SE Walls	North, South & Lower NE Walls
Basic Parameters					
Unit Weight	γ	kN/m^3	27	28	25
Intact Rock Unconfined Compressive Strength (UCS)	σ_{ci}	MPa	80	90	60
Basic Rock Mass Rating (1989)	RMR	-	55	60	40
Geological Strength Index	GSI	-	50	55	35
Petrographic Constant for Intact Rock	m_i	-	17	20	15
Young's Modulus	E	GPa	60	55	20
Poisson's Ratio	υ	-	0.22	0.28	0.25
Shear Modulus	G	GPa	24.6	21.5	8.0
Undisturbed Rock Mass (Disturbance Factor D=0)					
Hoek-Brown Constant for Rock Mass	m_b	-	2.85	4.01	1.47
Hoek-Brown Constant	s	-	0.0039	0.0067	0.0007
Friction Angle of Rock Mass	ϕ'	deg	45	49	37
Cohesion of Rock Mass	c'	MPa	2.1	2.5	1.4
Compressive Strength of Rock Mass	s_{cm}	MPa	18.0	24.2	9.1
Deformation Modulus	E_m	GPa	8.9	12.6	3.3
Partially Disturbed Rock Mass (Disturbance Factor D=0.7)					
Hoek-Brown Constant for Rock Mass	m_b	-	2.85	4.01	1.47
Hoek-Brown Constant	s	-	0.0039	0.0067	0.0001
Friction Angle of Rock Mass	ϕ'	deg	37	42	27
Cohesion of Rock Mass	c'	MPa	1.5	1.8	0.8
Compressive Strength of Rock Mass	s_{cm}	MPa	11.0	15.5	4.8
Deformation Modulus	E_m	GPa	5.8	8.2	2.1
Partially Disturbed Rock Mass (Disturbance Factor D=0.85)					
Hoek-Brown Constant for Rock Mass	m_b	-	0.76	1.22	0.26
Hoek-Brown Constant	s	-	0.00043	0.00093	0.00004
Friction Angle of Rock Mass	ϕ'	deg	24	30	23
Cohesion of Rock Mass	c'	MPa	3.0	1.6	0.7
Compressive Strength of Rock Mass	s_{cm}	MPa	9.1	13.1	3.8
Deformation Modulus	E_m	GPa	5.1	7.3	1.9
Disturbed Rock Mass (Disturbance Factor D=1.0)					
Hoek-Brown Constant for Rock Mass	m_b	-	0.48	0.80	0.14
Hoek-Brown Constant	s	-	0.00024	0.00055	0.00002
Friction Angle of Rock Mass	ϕ'	deg	30	35	19
Cohesion of Rock Mass	c'	MPa	1.1	1.4	0.5
Compressive Strength of Rock Mass	s_{cm}	MPa	7.2	10.6	2.7
Deformation Modulus	E_m	GPa	4.4	6.3	1.6

Notes:
(1) Design parameters derived using Hoek-Brown strength criterion for fractured rock masses (Hoek, et. al., 2002).

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TABLE 5.2

PACIFIC BOOKER MINERALS INC.
MORRISON COPPER/GOLD PROJECT

FEASIBILITY PIT SLOPE DESIGN
SUMMARY OF LIMIT EQUILIBRIUM ANALYSES

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M:\1\01\00102\08\A\Data\Pit Slope Design\[Tab 5.2r0_Summary of L-E Analyses.xls]Base Case Rev'd Jun/06/06

Final Pit Wall (1)	Geometric Parameters					Geological Parameters							Factor of Safety of Overall Slope	Comments
	Segment of Pit Wall	Upper Elevation	Lower Elevation	Overall Slope Height	Overall Slope Angle	Geology	UCS (1)	m_i (2)	RMR (3)	GSI (4)	Disturbance Factor, D (5)	Groundwater Depressurization		
		m	m	m	degrees		MPa	-	-	-	-	m	-	
North (Phase 1 Pit)	N/A	800	600			Fault Zone	60	15	40	35	0.85	40		Effective groundwater depressurization of 40m, and GOOD controlled production blasting (D=0.85) are required to achieve an overall FOS of 1.3.
				200	**39**								**1.31**	
Northeast (Phase 1 Pit)	Upper	840	670			Jurassic Sediments	80	17	55	50	0.85	40		Effective groundwater depressurization of 40m and GOOD controlled production blasting (D=0.85) are required to achieve a FOS of 1.3.
	Lower	670	600			Fault Zone	60	15	40	35	0.85	40		
				240	**49**								**1.38**	
Northwest (Phase 1 Pit)	N/A	850	600			Intrusives	90	20	60	55	0.85	20		Effective groundwater depressurization of 20m and GOOD controlled production blasting (D=0.85) are required to achieve a FOS of 1.3.
				250	**49**								**1.54**	
East (Phase 2 Pit)	Upper	880	670			Jurassic Sediments	80	17	55	50	0.85	40		Effective groundwater depressurization of 40m and GOOD controlled production blasting (D=0.85) are required to achieve a FOS of 1.3.
	Lower	670	550			Intrusives	90	20	60	55	0.85	40		
				330	**49**								**1.38**	
Southeast (Phase 2 Pit)	Upper	880	775			Jurassic Sediments	80	17	55	50	0.85	40		Effective groundwater depressurization of 40m and GOOD controlled production blasting (D=0.85) are required to achieve a FOS of 1.3.
	Lower	775	550			Intrusives	90	20	60	55	0.85	40		
				330	**49**								**1.48**	
South (Phase 2 Pit)	N/A	880	550			Fault Zone	60	15	40	35	0.85	60		ENHANCED groundwater depressurization of 60m and GOOD controlled production blasting (D=0.85) are required to achieve a FOS near 1.3.
				250	**39**								**1.27**	
Southwest (Phase 2 Pit)	Upper	800	725			Jurassic Sediments	80	17	55	50	0.85	20		Effective groundwater depressurization of 20m, and GOOD controlled production blasting (D=0.85) are required to achieve a FOS of 1.3.
	Lower	725	550			Intrusives	90	20	60	55	0.85	20		
				250	**49**								**1.43**	

Notes:
(1) Interim pit walls of the Phase 1 Pit not included.
(2) UCS refers to intact rock Unconfined Compressive Strength measured with point load tests and UCS tests.
(3) m_i - Hoek-Brown petrographic constant for intact rock.
(4) RMR refers to Rock Mass Rating (Bieniawski, 1989).
(5) GSI refers to Geolgical Strength Index (Hoek, et. al., 1995)
(6) Disturbance factor D, D=0 refers undisturbed rock mass, while D=1 refers disturbed rock mass (Hoek, et. al., 2002).

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TABLE 5.3

PACIFIC BOOKER MINERALS INC.
MORRISON COPPER/GOLD PROJECT

FEASIBILITY PIT SLOPE DESIGN
FACTOR OF SAFETY MATRIX - NORTH AND SOUTH WALLS

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Rev'd Jun/0618/06

Slope Height of Fault Zone (m)	Disturbance Factor, D	Depth of Groundwater Depressurization (m)	Overall Slope Angle (degrees)					
			35	37	39	41	43	45
200 (North Wall of Phase 1 Pit)	0.7	60	1.82	1.74	1.68	1.61	1.55	1.49
		40	1.67	1.58	1.53	1.46	1.39	1.33
		20	1.47	1.39	1.31	1.23	1.16	1.09
	0.85	60	1.55	1.49	1.44	1.38	1.33	1.27
		40	1.43	1.35	**1.31**	1.25	1.20	1.14
		20	1.26	1.19	1.13	1.06	1.00	0.94
	1	60	1.25	1.21	1.16	1.12	1.08	1.03
		40	1.16	1.10	1.06	1.02	0.97	0.93
		20	1.03	0.97	0.92	0.87	0.82	0.77
250 (South Wall of Phase 2 Pit)	0.7	60	1.61	1.55	1.49	1.43	1.37	1.31
		40	1.49	1.42	1.36	1.30	1.24	1.17
		20	1.33	1.25	1.19	1.12	1.05	0.97
	0.85	60	1.38	1.32	**1.27**	1.22	1.17	1.12
		40	1.28	1.22	1.17	1.12	1.06	1.00
		20	1.14	1.08	1.02	0.96	0.90	0.84
	1	60	1.11	1.06	1.03	0.99	0.95	0.91
		40	1.03	0.98	0.95	0.90	0.86	0.81
		20	0.93	0.88	0.83	0.79	0.73	0.68

Notes:
(1) Rock mass strength derived from UCS, GSI/RMR, mi and D values (Hoek et.al., 2002).
(2) D=0.7 refers to "EXCELLENT controlled blasting", D=0.85 refers to "GOOD controlled production blasting", and D=1 refers to "NORMAL production blasting".
(3) Groundwater depressurization may incorporate vertical pumping and horizontal drains.
(4) The design base FOS is **BOLDED**.

Legend

- FOS >= 1.4
- 1.3<= FOS < 1.4
- 1.2<= FOS < 1.3
- 1.1<= FOS < 1.2
- 1.0<= FOS < 1.1
- FOS < 1.0

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TABLE 5.4

PACIFIC BOOKER MINERALS INC.
MORRISON COPPER/GOLD PROJECT

FEASIBILITY PIT SLOPE DESIGN
FACTOR OF SAFETY MATRIX - NORTHEAST WALL

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Rev'd Jun/06/06

Total Slope Height (m)	Disturbance Factor, D	Depth of Groundwater Depressurization (m)	Overall Slope Angle (degrees)				
			43	45	47	49	51
240	0.7	60	2.00	1.95	1.88	1.79	1.74
		40	1.80	1.72	1.66	1.56	1.48
		20	1.50	1.41	1.31	1.24	1.18
	0.85	60	1.79	1.73	1.68	1.59	1.55
		40	1.61	1.53	1.47	**1.38**	1.31
		20	1.34	1.25	1.16	1.09	1.04
	1	60	1.54	1.49	1.44	1.37	1.33
		40	1.38	1.31	1.26	1.19	1.12
		20	1.15	1.07	0.99	0.94	0.91

Notes:

(1) Rock mass strength derived from UCS, GSI/RMR, mi and D values (Hoek et.al., 2002).

(2) D=0.7 refers to "EXCELLENT controlled blasting", D=0.85 refers to "GOOD controlled production blasting", and D=1 refers to "NORMAL production blasting".

(3) Groundwater depressurization may incorporate vertical pumping and horizontal drains.

(4) The design base FOS is **BOLDED**.

Legend

- **FOS >= 1.4**
- **1.3<= FOS < 1.4**
- **1.2<= FOS < 1.3**
- **1.1<= FOS < 1.2**
- **1.0<= FOS < 1.1**
- **FOS < 1.0**

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TABLE 7.1

PACIFIC BOOKER MINERALS INC.
MORRISON COPPER/GOLD PROJECT

FEASIBILITY PIT SLOPE DESIGN
RECOMMENDED PIT SLOPE ANGLES

M:\1\01\00102\08\A\Data\Pit Slope Design\[Tab 7.1r1_Pit Slope Angles.xls]Slope Angles

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Rev'd Oct/12/06

Pit Stage	Pit Design Sector	Major Geology	Total Slope Height(1)	Kinematic Stability Analyses (2)			Rock Mass Stability Analyses (3)			**Recommended Pit Slope Design (5)**					Comments
				Max. Bench Face Angle	Max. Inter-ramp Slope Angle	Potential Instability Mechanism	Max. Overall Slope Angle	Disturbance Factor, D(4)	Groundwater Depressurization	**Overall Slope Angle (6)**	**Inter-ramp Angle**	**Bench Face Angle**	**Bench Height**	**Bench Width**	
			m	degrees	degrees	-	degrees	-	m	**degrees**	**degrees**	**degrees**	**m**	**m**	
Phase 1	North	Fault Zone	200	60	40	Insignificant	39	0.85	40	**39**	**40**	**60**	**15**	**9.2**	Rock mass strength is likely the controlling factor for pit slope design. Effective groundwater depressurization of 40m, and GOOD controlled production blasting (D=0.85) are required to achieve an overall FOS of 1.3. Single bench configuration is recommended for the broken Fault Zone.
	Northeast	Jurassic Sediments	240	65	47	Toppling/Planar	49	0.85	40	**45**	**47**	**65**	**30**	**14.0**	Rock mass structure is likely the controlling factor for pit slope design. Effective groundwater depressurization of 40m, and GOOD controlled production blasting (D=0.85) are required to achieve an overall FOS of 1.3. Single bench configuration is recommended for the lower slope where the broken Fault Zone is encountered.
		Fault Zone		60	40			0.85	40		**40**	**60**	**15**	**9.2**	
	South	Fault Zone	200	60	40	Insignificant	Same as North Wall of Phase 1 Pit			**39**	**40**	**60**	**15**	**9.2**	Rock mass strength is likely the controlling factor for pit slope design. Effective groundwater depressurization of 40m, and GOOD controlled production blasting (D=0.85) are required to achieve an overall FOS of 1.3. Single bench configuration is recommended for the broken Fault Zone.
	Southwest	Intrusives	240	65	47	Planar	Same as Northwest Wall of Phase 1 Pit			**45**	**47**	**65**	**30**	**14.0**	Rock mass structure is likely the controlling factor for pit slope design. Effective groundwater depressurization of 40m, and GOOD controlled production blasting (D=0.85) are required to achieve an overall FOS of 1.3.
	Northwest	Intrusives	250	65	47	Planar	49	0.85	20	**45**	**47**	**65**	**30**	**14.0**	Rock mass structure is likely the controlling factor for pit slope design.Effective groundwater depressurization of 40m, and GOOD controlled production blasting (D=0.85) are required to achieve an overall FOS of 1.3.
Phase 2	East	Jurassic Sediments	330	65	47	Planar/Wedge	49	0.85	40	**45**	**47**	**65**	**30**	**14.0**	Rock mass structure is likely the controlling factor for pit slope design.Effective groundwater depressurization of 40m, and GOOD controlled production blasting (D=0.85) are required to achieve an overall FOS of 1.3.
		Intrusives		65	47			0.85	40		**47**	**65**	**30**	**14.0**	
	Southeast	Jurassic Sediments	330	65	47	Toppling/Planar	49	0.85	40	**45**	**47**	**65**	**30**	**14.0**	Rock mass structure is likely the controlling factor for pit slope design. Effective groundwater depressurization of 40m, and GOOD controlled production blasting (D=0.85) are required to achieve an overall FOS of 1.3.
		Intrusives		65	47			0.85	40		**47**	**65**	**30**	**14.0**	
	South	Fault Zone	250	60	40	Insignificant	39	0.85	60	**39**	**40**	**60**	**15**	**9.2**	Rock mass strength is likely the controlling factor for pit slope design. EHANCED groundwater depressurization of 60m, and GOOD controlled production blasting (D=0.85) are required to achieve an overall FOS of near 1.3. Single bench configuration is recommended for the broken Fault Zone.
	Southwest	Jurassic Sediments	250	65	47	Planar	49	0.85	20	**45**	**47**	**65**	**30**	**14.0**	Rock mass structure is likely the controlling factor for pit slope design. Effective groundwater depressurization of 20m, and GOOD controlled production blasting (D=0.85) are required to achieve an overall FOS of 1.3.
		Intrusives		65	47			0.85	20		**47**	**65**	**30**	**14.0**	

Notes:
(1) Represent the highest wall in design each sector.
(2) Single bench configuration applied for the broken fault zone and double benches used for the rest of pit walls.
(3) A minimum Factor of Safety (FOS) of 1.3 is targeted.
(4) A disturbance factor of 0 is assigned for undisturbed ground and 1 for a disturbed rock mass (Hoek, et. al., 2002), D=0.85 refers to GOOD controlled production blasting, and 0.7 refers to EXCELLENT controlled blasting practice.
(5) The recommended slope angles were determined by the lesser value from the kinematic and rock mass stability analyses.
(6) Overall slope angle may include overburden slopes and haul ramps.

Rev. 1 - Kinematic Analyses Updated

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TABLE 7.2

PACIFIC BOOKER MINERALS INC.
MORRISON COPPER/GOLD PROJECT

FEASIBILITY PIT SLOPE DESIGN
COMPARISON TO LARGE OPEN PITS IN BRITISH COLUMBIA

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Rev'd Sep/29/06

Mine	Slope Height (m)	Slope Angle (degrees)	UCS (MPa)	Failure Type and Comments
Afton Mine	170/300	45 (O)	20~110	Unstable failure
Bell Mine, Most Pit Walls	300	44-50 (O)	50~175	No failures
Bell Mine, Southeast Wall	300	34-36 (O)	Low	No failures
Brenda Mine	335	45 (O)	150	Unstable failure
Cassiar Mine	180/370	42 (O)	80	Slow and stable failure
Highland Valley - Lornex Pit see Note 4	380	35(I); 30(O)	(3)~140	Slow and stable failure
Highland Valley - Valley Pit see Note 4	350	38(I); 35(O)	(3)~140	Slow and stable failure
Highmont Mine	60-110	40 (O)	1~140	Slow and stable failure
Island Copper, South Wall	365	40 (O)	Medium	Slow failure; stepout
Island Copper, North Wall	500	50 (O)	Medium	No failures
Nickel Plate Mine	225	63 (I)	250~450	No failures
Proposed Morrison Pit Slopes				
North & South Wall	200/250	39 (O)	60	
East & Southeast Walls	330	45 (O)	80~90	

Notes:

(1) O = Overall Slope Angle

(2) I = Inter-ramp Slope Angle

(3) The slope height is the height of the slope at failure or the currently highest stable slope in the pit.

(4) UCS ‘(3)’ refers to sporadic argillaceous alteration that reduces the intact rock strength to 3 MPa.

Rev. 1 - Slope Angle Updated

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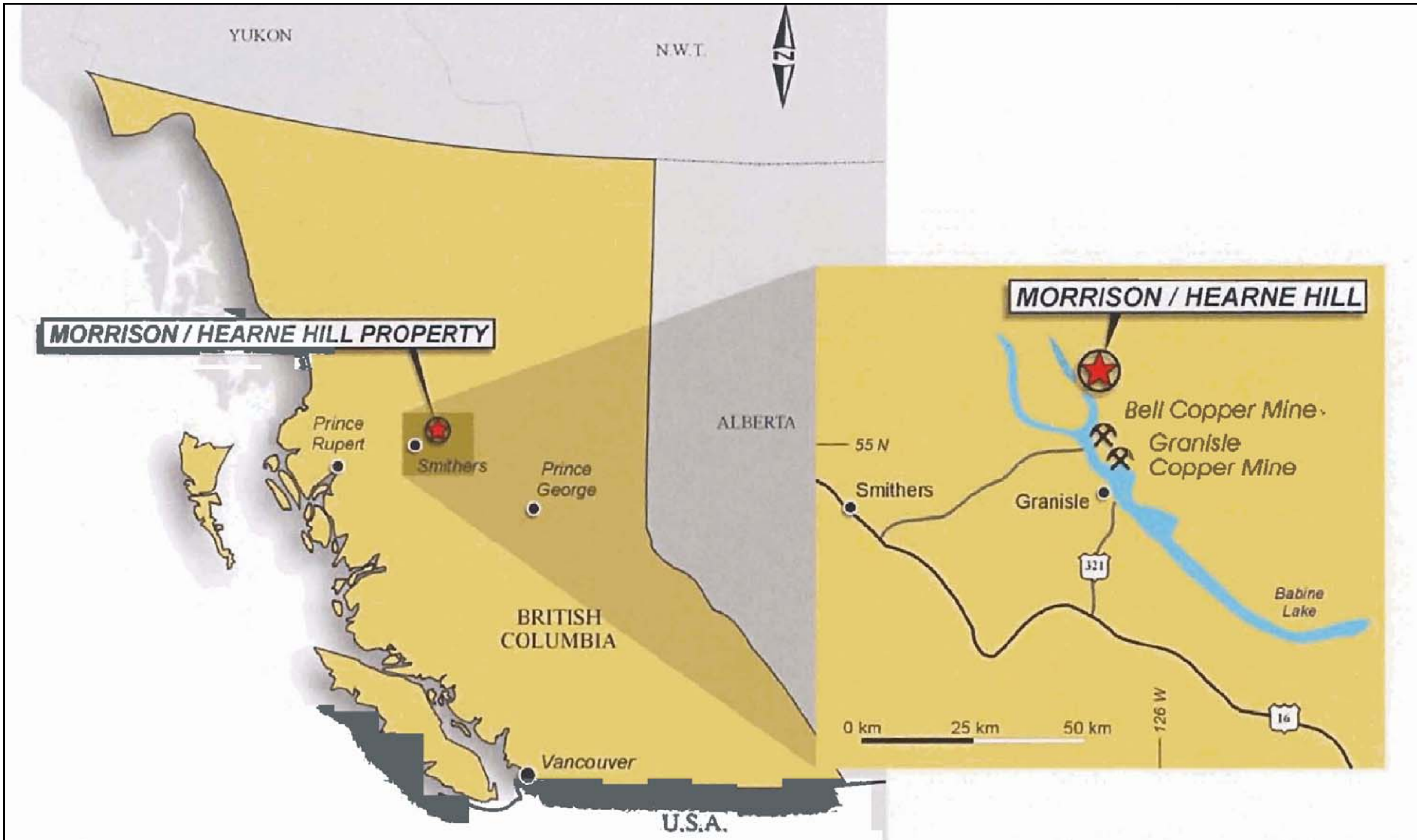

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PACIFIC BOOKER MINERALS INC.

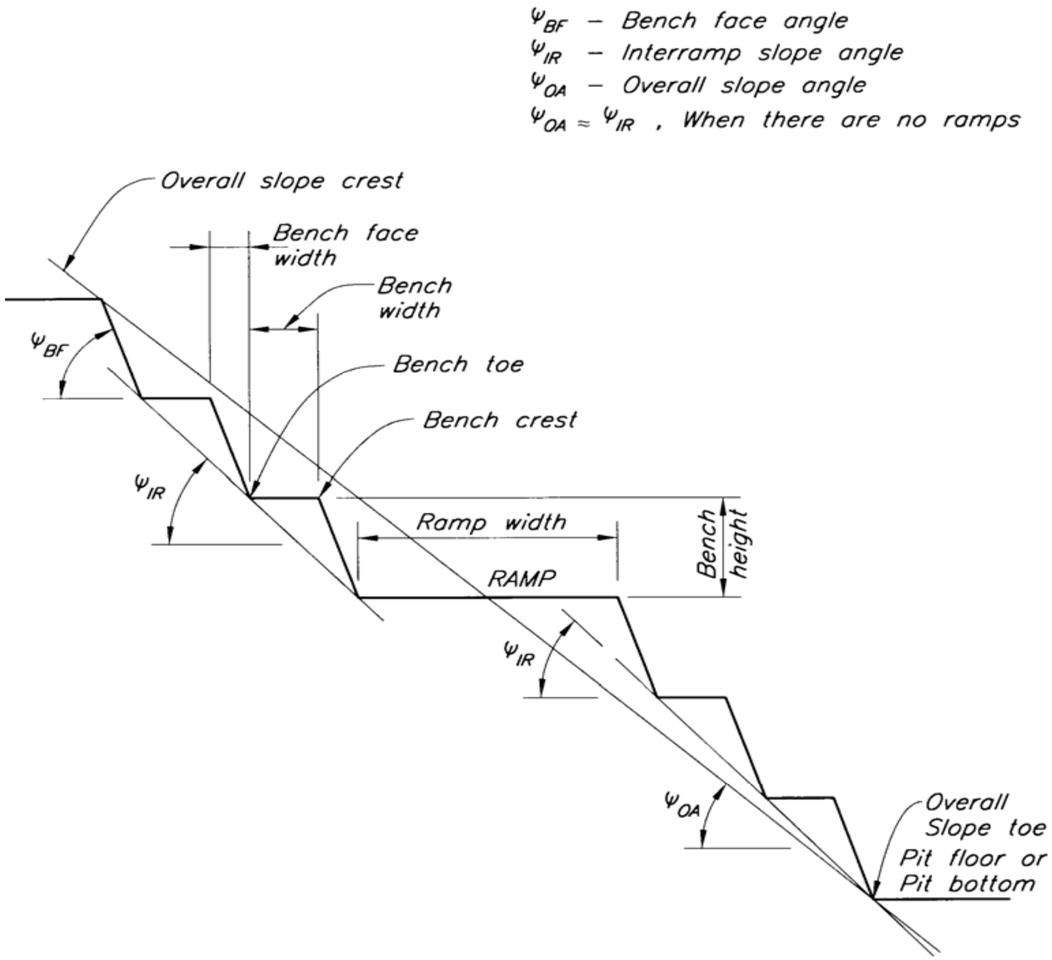
MORRISON COPPER/GOLD PROJECT

FEASIBILITY PIT SLOPE DESIGN
PROJECT LOCATION

Knight Piésold CONSULTING

PROJECT/ASSIGNMENT NO.	REF. NO.
VA101-102/8	2

FIGURE 1.1 REV. 0



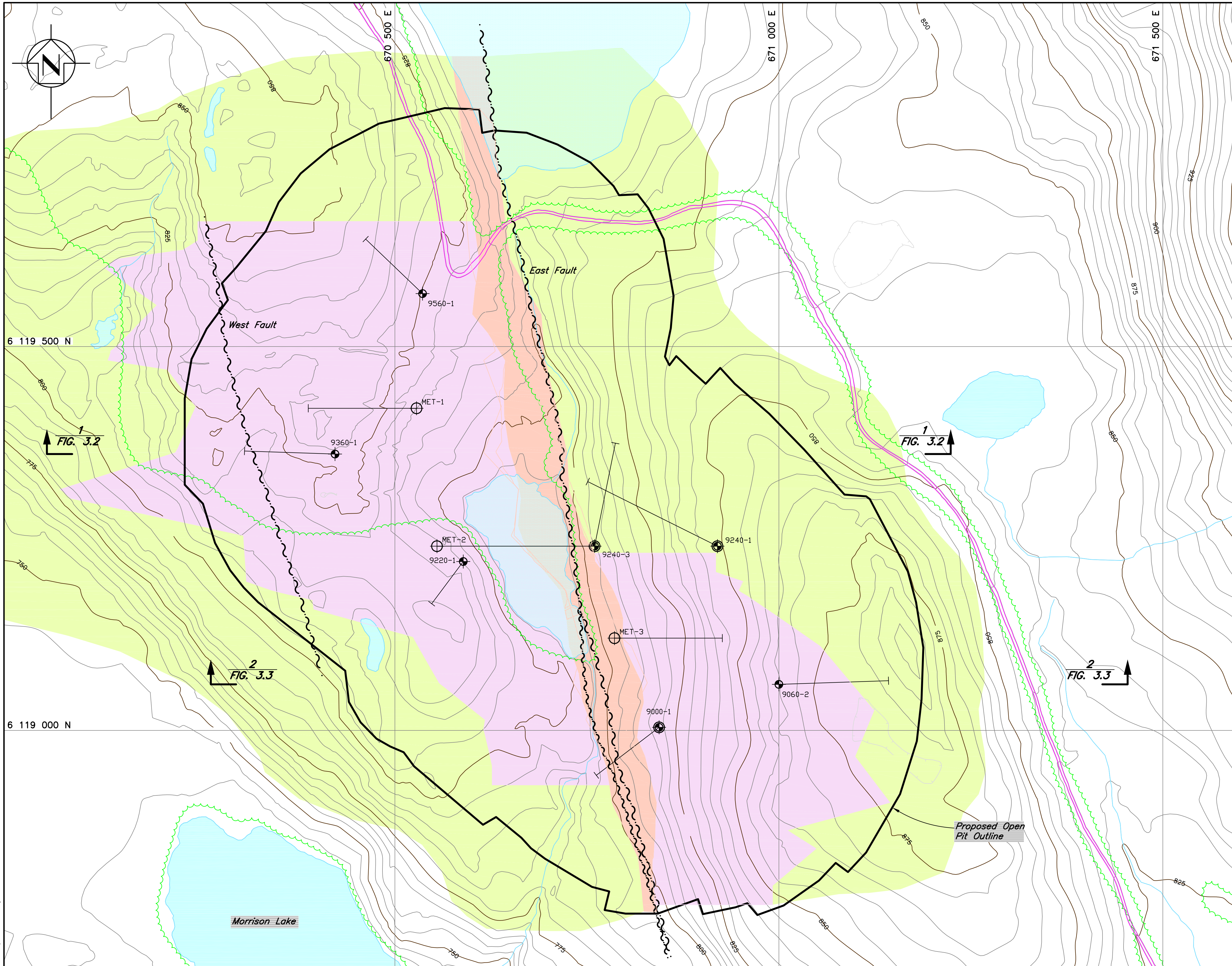
PACIFIC BOOKER MINERALS INC.

MORRISON COPPER/GOLD PROJECT

FEASIBILITY PIT SLOPE DESIGN
TYPICAL OPEN PIT SLOPE GEOMETRY

Knight Piésold CONSULTING	PROJECT / ASSIGNMENT NO. VA101-00102/8	REF NO. 2	REV. 0
	FIGURE 2.1		

Rev. 0 - Issued for Report



LEGEND

- 9060-2 Geotechnical Drillhole (with inclination)
- 9000-1 Geotechnical Drillhole with Piezometer (with inclination)
- MET-1 Metallurgical Drillhole with Vibrating Wire Piezometer (March 2005)
- Existing Access Roads
- Fault

GEOLOGY

- Fault Zone
- Intrusives
- Jurassic Sediments

NOTES

1. Topography produced from Aerial photography (Eagle Mapping 2001), UTM NAD83 Zone 9.
2. Pit outline provided by Pacific Booker Minerals Inc., August 2005.
3. Geological model provided by Pacific Booker Minerals Inc. February, 2006.

Scale 50 0 50 100 150 200 250 m

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PACIFIC BOOKER MINERALS INC.	
MORRISON COPPER/GOLD PROJECT	
FEASIBILITY PIT SLOPE DESIGN SIMPLIFIED GEOLOGICAL DOMAINS	
Knight Piésold CONSULTING	PROJECT/ASSIGNMENT NO. VA101-102/8 — REF. NO. 2
	FIGURE 3.1 — REV. 0

XREF FILE : Topo, Features, Hydro

REV. 0	08MAY'06	ISSUED FOR REPORT

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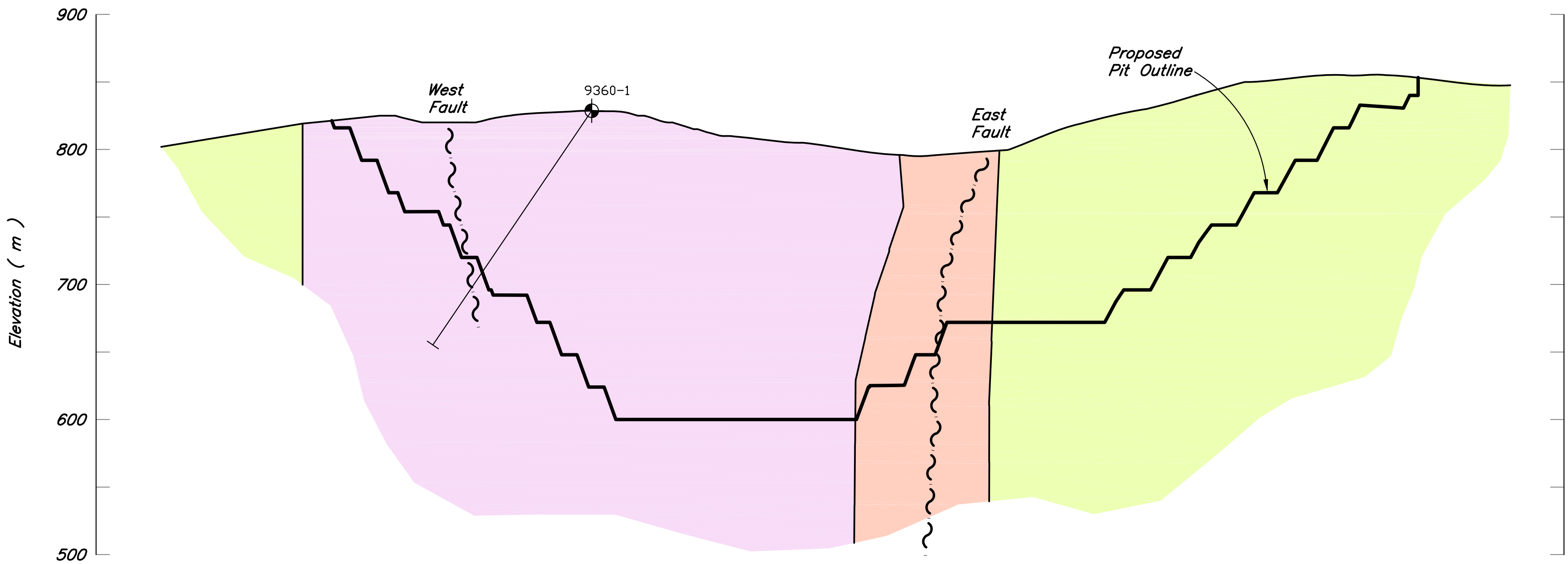

SECTION 1/FIG. 3.1

LEGEND

9060-2 Geotechnical Drillhole

9000-1 Geotechnical Drillhole with Piezometer

Fault

GEOLOGY

Fault Zone

Intrusives

Jurassic Sediments

Scale 50 0 50 100 150 200 250 m

REV. 0	08MAY'06	ISSUED FOR REPORT

PACIFIC BOOKER MINERALS INC.

MORRISON COPPER/GOLD PROJECT

FEASIBILITY PIT SLOPE DESIGN
GEOLOGICAL SECTION 1
(6 119 360 N)

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PROJECT/ASSIGNMENT NO.	REF. NO.	REV.
VA101-102/8	2	0

FIGURE 3.2

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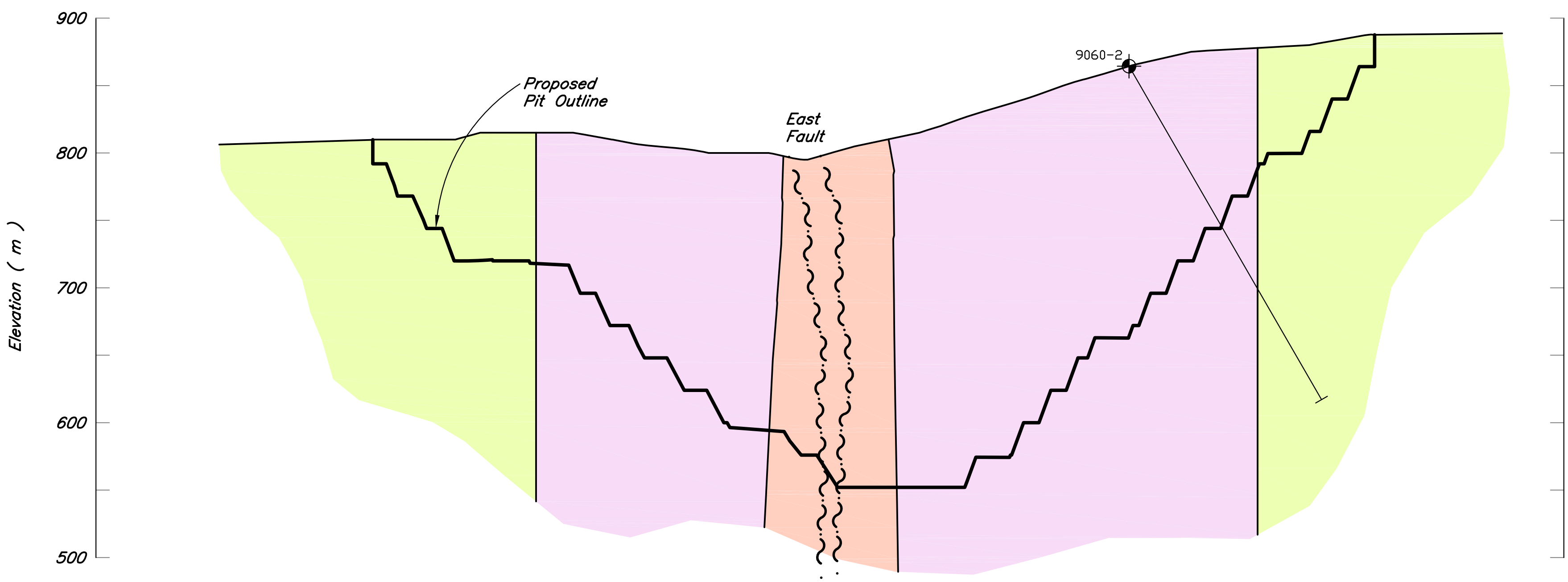


SECTION 2/FIG. 3.1

LEGEND

9060-2 Geotechnical Drillhole

9000-1 Geotechnical Drillhole with Piezometer

Fault

GEOLOGY

Fault Zone

Intrusives

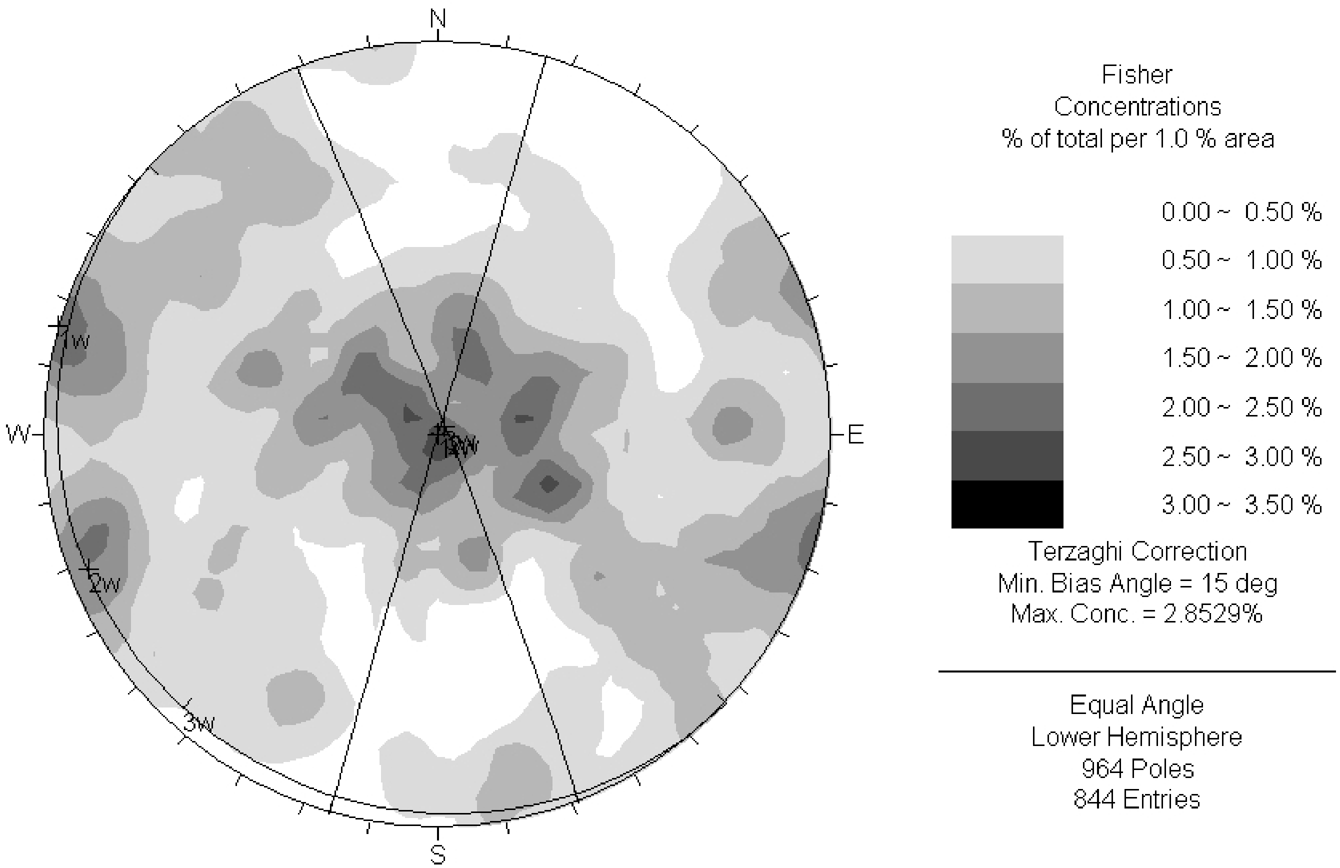
Jurassic Sediments

Scale 50 0 50 100 150 200 250 m

PACIFIC BOOKER MINERALS INC.				
MORRISON COPPER/GOLD PROJECT				
FEASIBILITY PIT SLOPE DESIGN GEOLOGICAL SECTION 2 (6 119 060 N)				
Knight Piésold CONSULTING	PROJECT/ASSIGNMENT NO. VA101-102/8		REF. NO. 2	
	FIGURE 3.3			REV. 0

REV. 0	08MAY'06	ISSUED FOR REPORT

VANCOUVER B.C. CAD FILE: M:\1\01\00102\08\A\Acad\Figs\A09.dwg 1=5000 PLOT 1=1(PS) May 08 2006 by:jyang Time @ 14:25



PREDOMINANT STRUCTURAL ORIENTATIONS:

Discontinuity Set No.	Dip/Dip Direction (deg)
#1	90/106
#2	87/069
#3	03/223

PACIFIC BOOKER MINERALS INC.

MORRISON COPPER/GOLD PROJECT

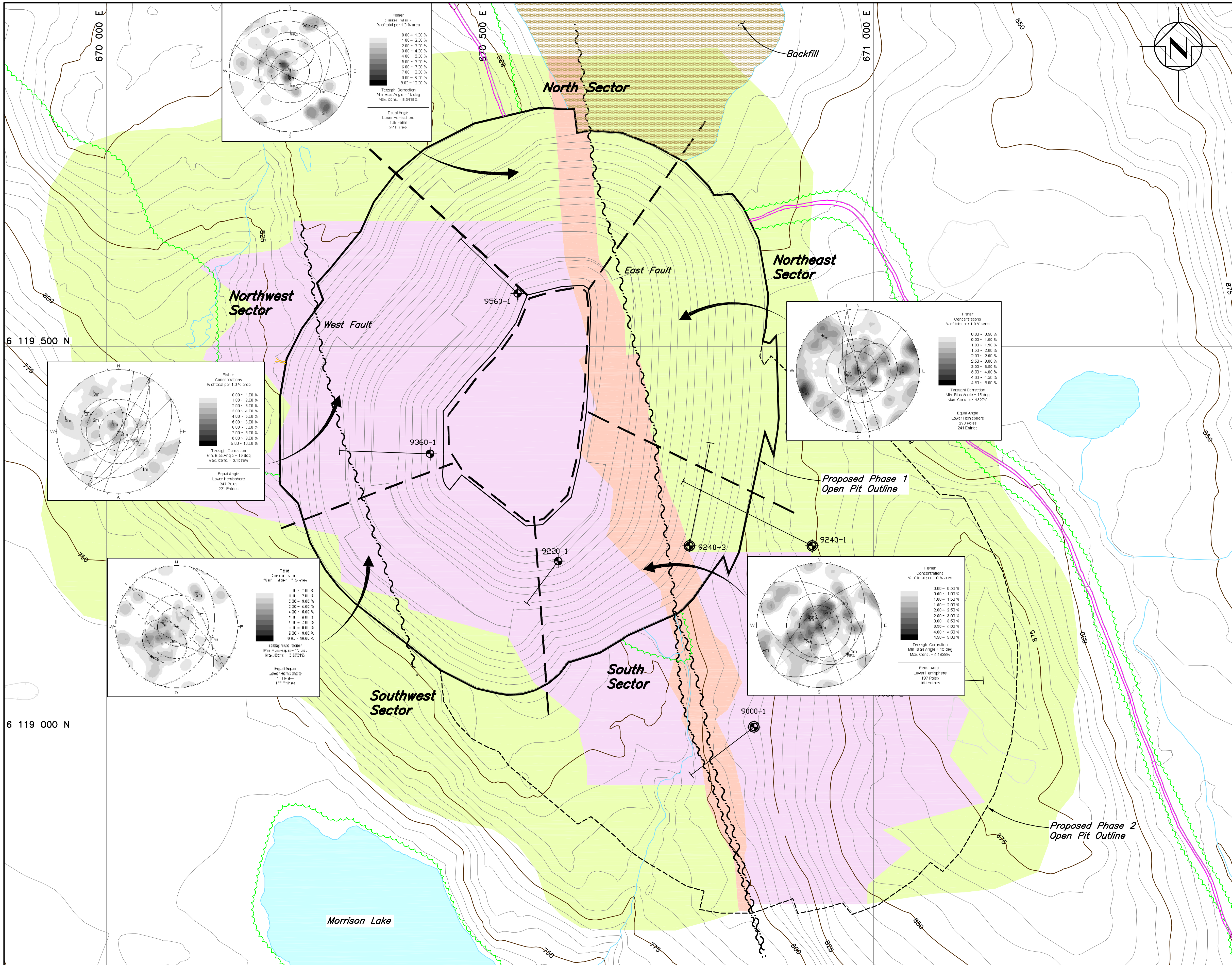
FEASIBILITY PIT SLOPE DESIGN
PRINCIPAL STRUCTURE ORIENTATIONS

Knight Piésold
CONSULTING

PROJECT / ASSIGNMENT NO.	REF NO.	REV.
VA101-00102/8	2	0

FIGURE 3.4

Rev. 0 - New Figure Issued for Rev 1 Report



NOTES

1. Topography produced from Aerial photography (Eagle Mapping 2001), UTM NAD83 Zone 9.
2. Pit outline provided by Pacific Booker Minerals Inc., August 2005.
3. Geological model provided by Pacific Booker Minerals Inc. February, 2006.

LEGEND

- 9060-2 Geotechnical Drillhole
- 9000-1 Geotechnical Drillhole with Piezometer
- Existing Access Roads
- Fault
- Approx. Boundary of Pit Design Sectors

GEOLOGY

- Fault Zone
- Intrusives
- Jurassic Sediments

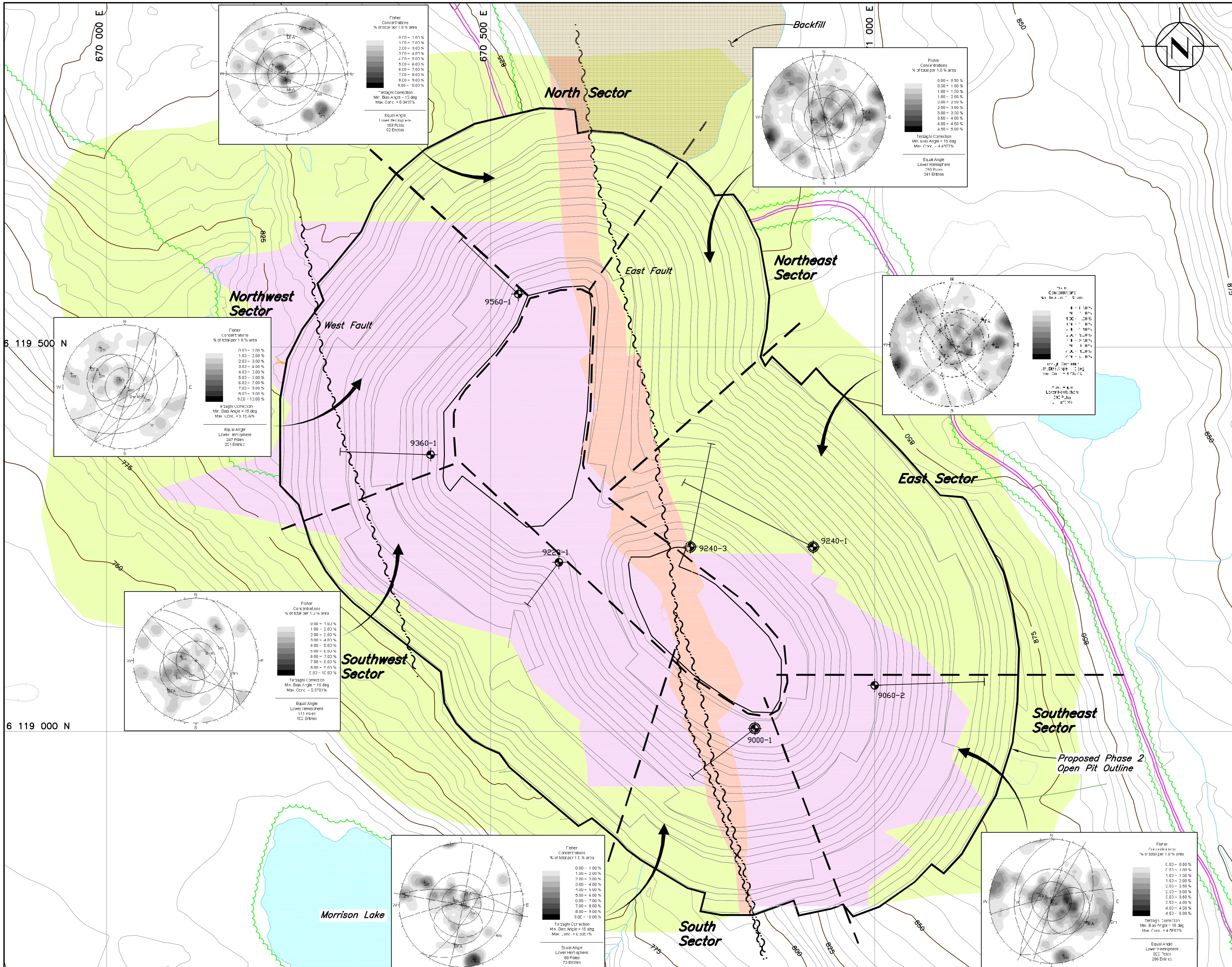
Scale 50 0 50 100 150 200 250 m

PACIFIC BOOKER MINERALS INC.		
MORRISON COPPER/GOLD PROJECT		
FEASIBILITY PIT SLOPE DESIGN PIT WALL GEOLOGY AND DESIGN SECTORS PHASE 1 PIT		
Knight Piésold CONSULTING	PROJECT/ASSIGNMENT NO. VA101-102/8	REF. NO. 2
	FIGURE 4.1	REV. 1

REV.	DATE	DESCRIPTION
1	26SEP'06	STEREOGRAPHIC PLOTS UPDATED

XREF FILE :

VANCOUVER B.C. CAD FILE: M:\1\01\00102\08\A\Acad\Figs\B03.dwg 1=5000 PLOT 1=1(PS) Sept. 26 2006 by:WAL



NOTES

1. Topography produced from Aerial photography (Eagle Mapping 2001), UTM NAD83 Zone 9.
2. Pit outline provided by Pacific Booker Minerals Inc., August 2005.
3. Geological model provided by Pacific Booker Minerals Inc. February, 2006.

LEGEND

- 9060-2 Geotechnical Drillhole (with inclination)
- 9000-1 Geotechnical Drillhole with Piezometer (with inclination)
- Existing Access Roads
- Fault
- Approx. Boundary of Pit Design Sectors

GEOLOGY

- Fault Zone
- Intrusives
- Jurassic Sediments

Scale 50 0 50 100 150 200 250 m

PACIFIC BOOKER MINERALS INC.

MORRISON COPPER/GOLD PROJECT

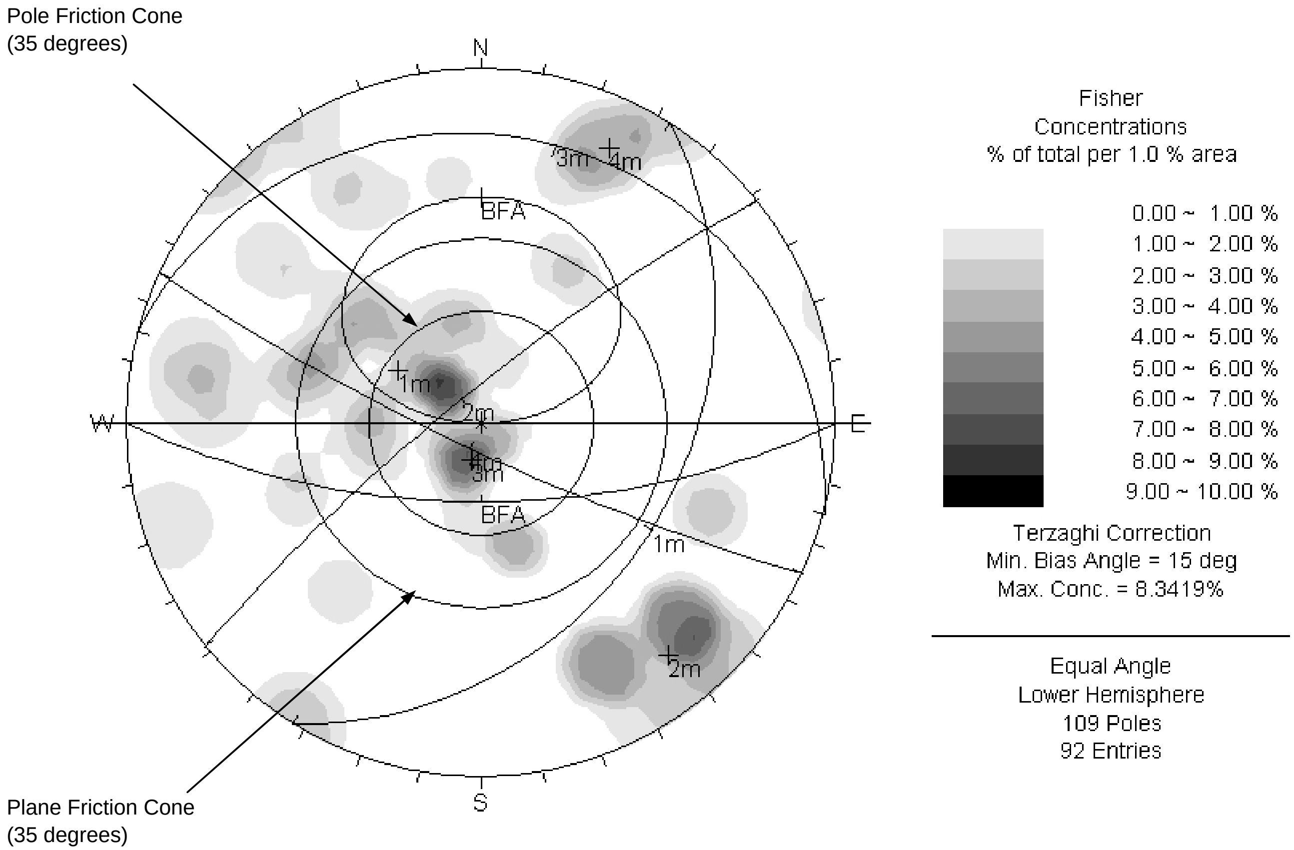
FEASIBILITY PIT SLOPE DESIGN
PIT WALL GEOLOGY AND DESIGN SECTORS
PHASE 2 PIT

PROJECT/ASSIGNMENT NO.	REF. NO.
VA101-102/8	2

Knight Piésold CONSULTING

FIGURE 4.2 REV. 1

REV. 1	26SEP'06	STEREOGRAPHIC PLOTS UPDATED



Rock Types: Jurassic Sediments and Intrusives
Discontinuity Types: Joints, Veins

Discontinuity Sets:	No.	Dip/Dip Direction (deg)
	#1	31/121
	#2	79/322
	#3	12/015
	#4	82/206

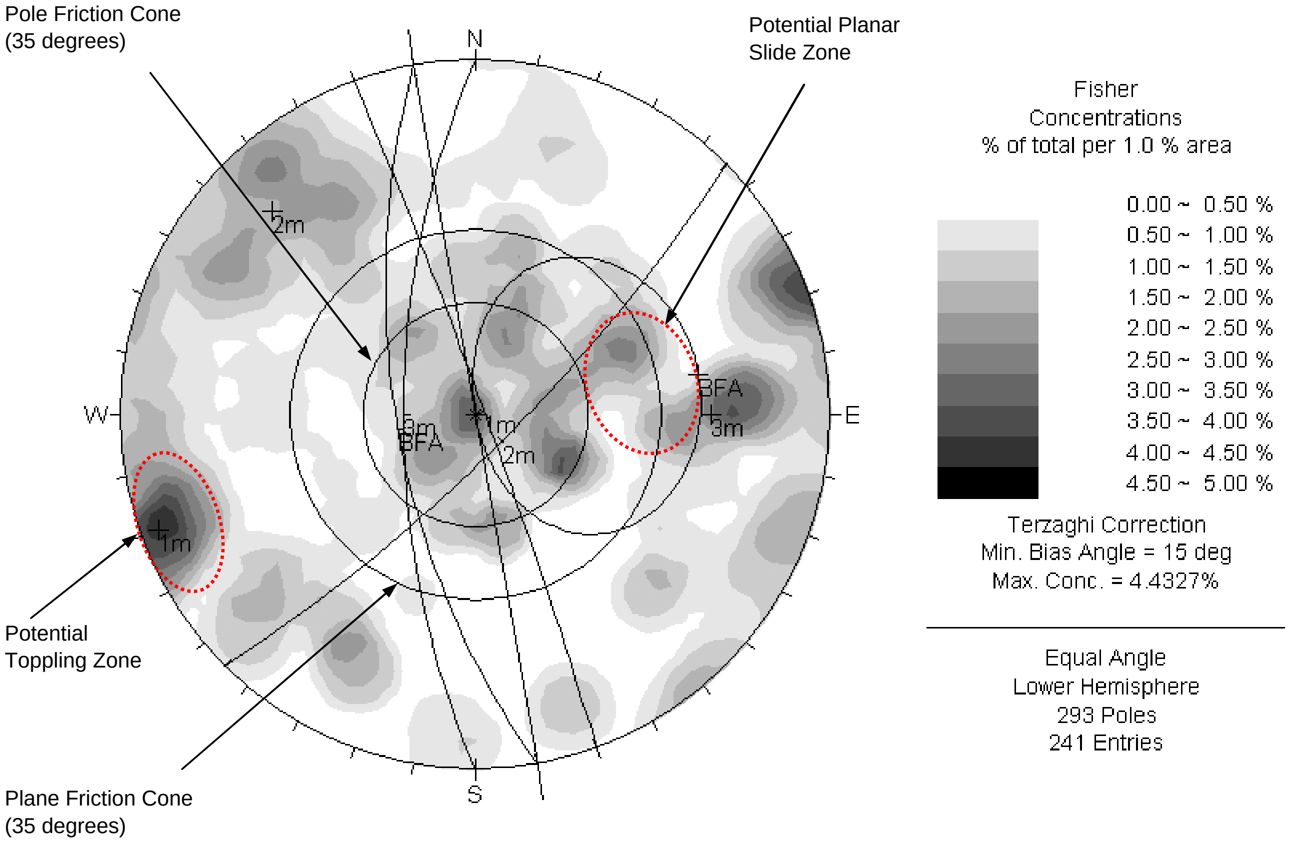
Bench Face Angle (BFA): 65 deg
Potential Instability Mode: No significant adverse structural features.

General Assumptions and Slope Stability Considerations:

1) Nominal pit wall dip direction of the North Sector (Phase 1 Pit) is 180 deg.
2) A friction angle of 35 deg is used for all types of discontinuities.
3) No significant adverse structural features. However, a flatter bench face angle of 60 deg is more realistic as the broken fault zone is encountered.

PACIFIC BOOKER MINERALS INC.			
MORRISON COPPER/GOLD PROJECT			
FEASIBILITY PIT SLOPE DESIGN **STEREOGRAPHIC ANALYSIS RESULT** **NORTH SECTOR - PHASE 1 PIT**			
Knight Piésold CONSULTING	PROJECT / ASSIGNMENT NO. VA101-00102/8	REF NO. 2	REV. 1
	FIGURE 4.3		

Rev. 1 - Traverse Data Updated



Rock Types: Jurassic Sediments
Discontinuity Types: Joints & Veins

Discontinuity Sets:	No.	Dip/Dip Direction (deg)
	#1	88/069
	#2	78/135
	#3	67/270

Bench Face Angle (BFA): 65 deg
Potential Failure Mode: Toppling (Set #1) and Planar Slide (Set #3)

General Assumptions and Slope Stability Considerations:

1) Nominal pit wall dip direction of the Northeast Sector (Phase 1 Pit) is 260 deg.
2) A friction angle of 35 deg is used for all types of discontinuities.
3) A 65 deg bench face angle is predicted to be achievable, however, localized planar slide is expected. Potential toppling failure will be formed by predominant discontinuity sets. An inter-ramp slope of 47 degrees is recommended to reduce the toppling potential.

Rev. 1 - Traverse Data Updated

PACIFIC BOOKER MINERALS INC.

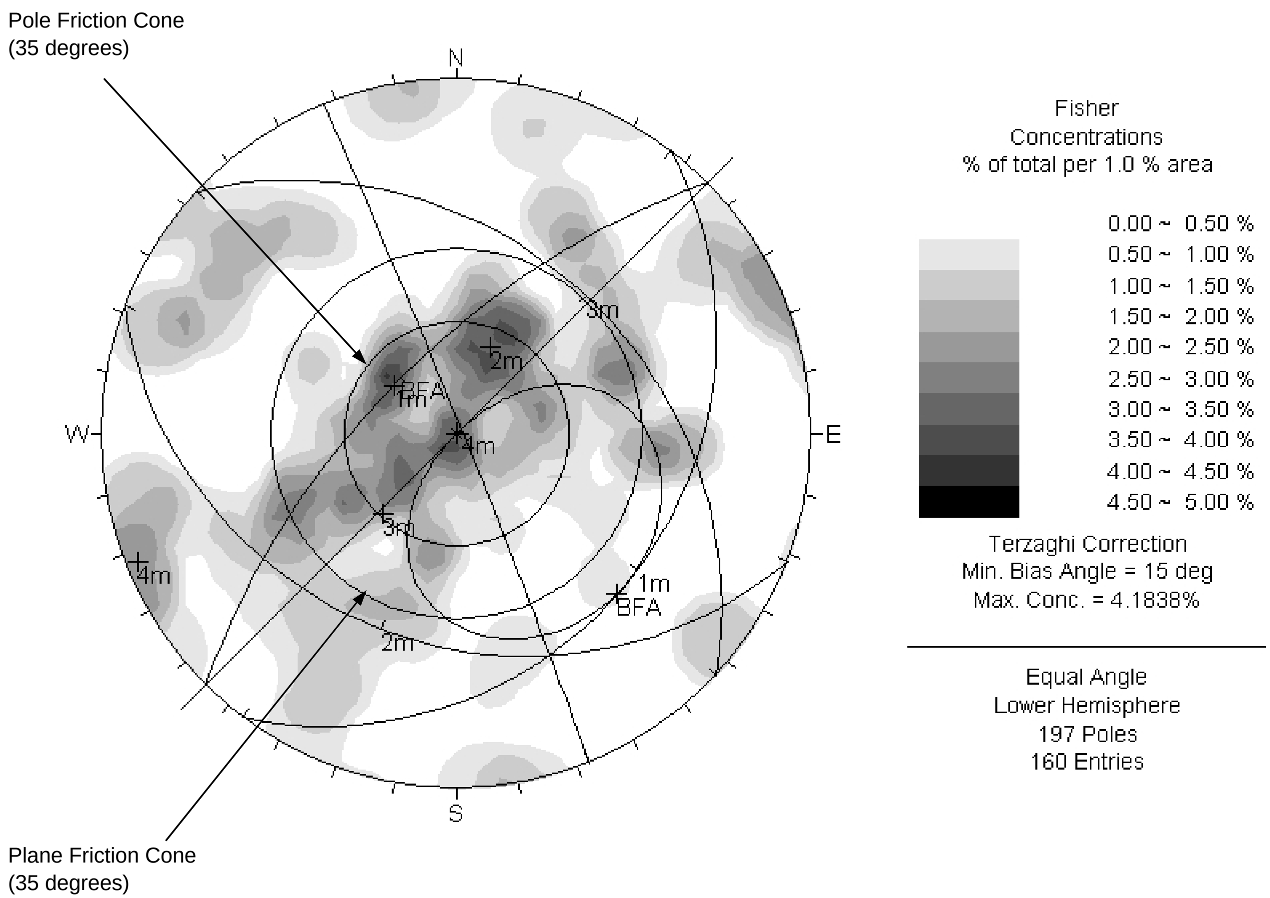
MORRISON COPPER/GOLD PROJECT

FEASIBILITY PIT SLOPE DESIGN
STEREOGRAPHIC ANALYSIS RESULT
NORTHEAST SECTOR - PHASE 1 PIT

Knight Piésold
CONSULTING

PROJECT / ASSIGNMENT NO.	REF NO.	REV.
VA101-00102/8	2	1

FIGURE 4.4



Rock Types: Jurassic Sediments & Intrusives
Discontinuity Types: Joints & Veins

Discontinuity Sets:	No.	Dip/Dip Direction (deg)
	#1	25/127
	#2	29/201
	#3	34/042
	#4	88/068

Bench Face Angle (BFA): 65 deg
Potential Instability Mode: No significant adverse structural features.

General Assumptions and Slope Stability Considerations:
1) Nominal pit wall dip direction of the South Sector (Phase 1 Pit) is 315 deg.
2) A friction angle of 35 deg is used for all types of discontinuities.
3) No significant adverse structural features. However, a flatter bench face angle of 60 deg is more realistic as the broken fault zone is encountered.

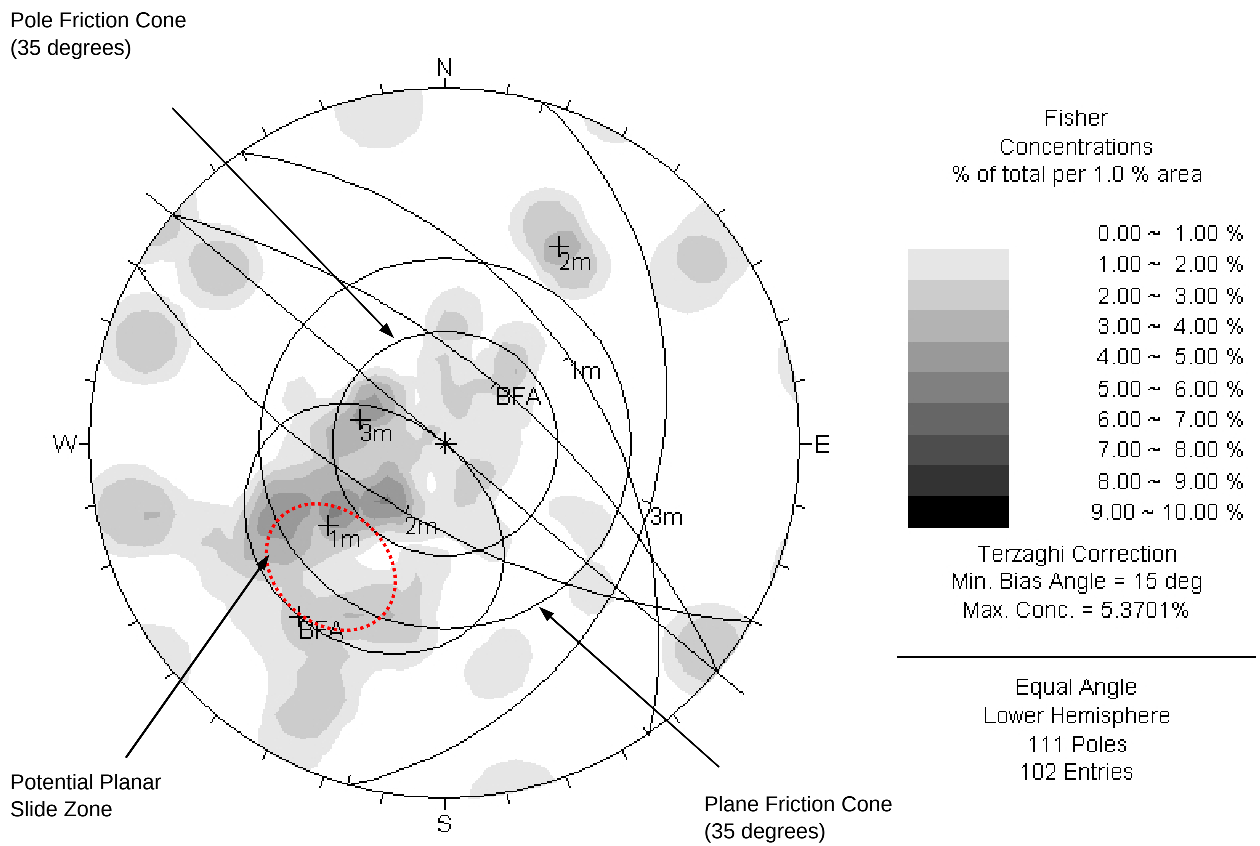
Rev. 1 - Traverse Data Updated

PACIFIC BOOKER MINERALS INC.
MORRISON COPPER/GOLD PROJECT
FEASIBILITY PIT SLOPE DESIGN
STEREOGRAPHIC ANALYSIS RESULT
SOUTH SECTOR - PHASE 1 PIT

Knight Piésold CONSULTING

PROJECT / ASSIGNMENT NO.	REF NO.	REV.
VA101-00102/8	2	1

FIGURE 4.5



Rock Types: Jurassic Sediments & Intrusives
Discontinuity Types: Joints & Veins

Discontinuity Sets: No.	Dip/Dip Direction (deg)
#1	44/055
#2	65/210
#3	28/109

Bench Face Angle (BFA): 65 deg
Potential Failure Mode: Planar Slide (Set #1).

General Assumptions and Slope Stability Considerations:
1) Nominal pit wall dip direction of the Southwest Sector (Phase 1 Pit) is 40 deg.
2) A friction angle of 35 deg is used for all types of discontinuities.
3) Potential planar failure will be formed by some scattered discontinuity sets. A bench face angle of 65 deg is predicted to be achievable, however, localized bench loss is expected.

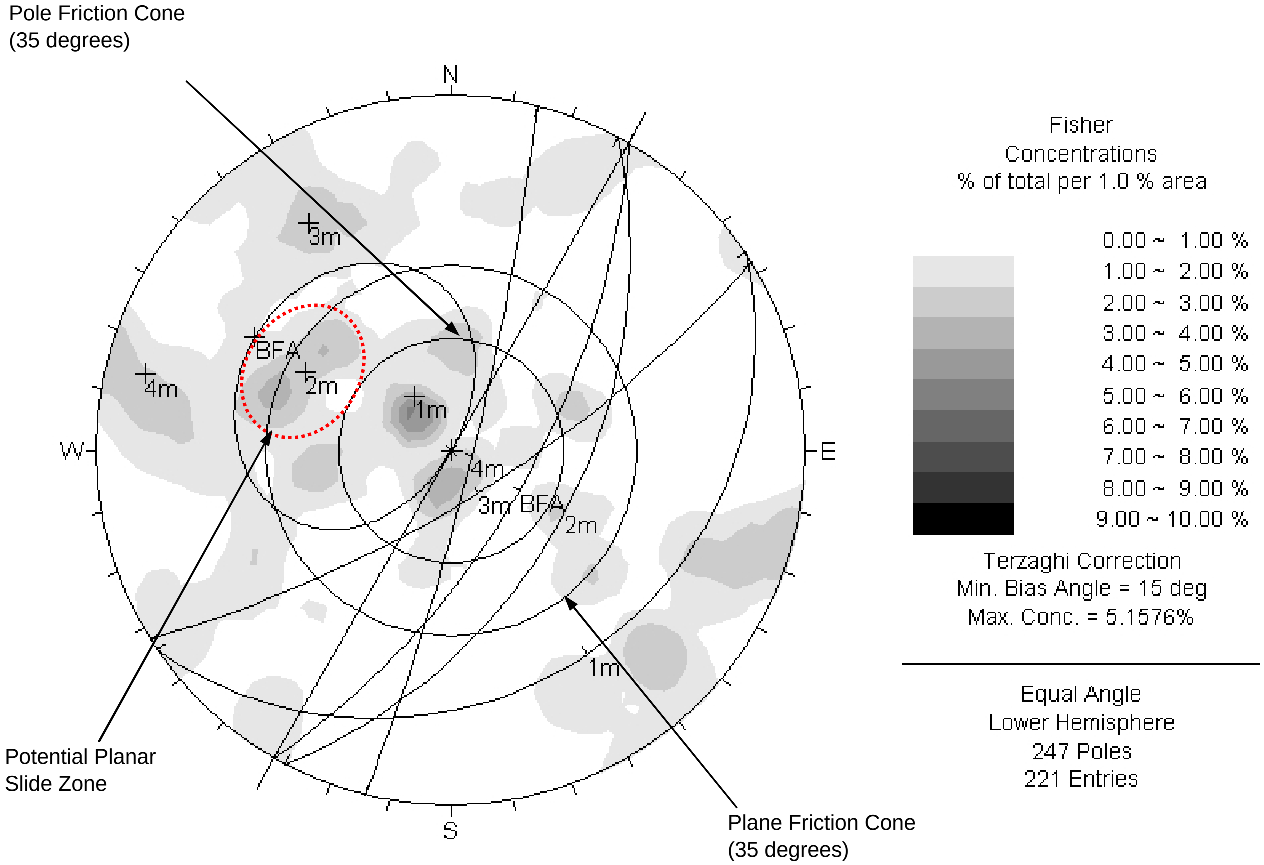
Rev. 1 - Traverse Data Updated

PACIFIC BOOKER MINERALS INC.
MORRISON COPPER/GOLD PROJECT
FEASIBILITY PIT SLOPE DESIGN
STEREOGRAPHIC ANALYSIS RESULT
SOUTHWEST SECTOR - PHASE 1 PIT

Knight Piésold CONSULTING

PROJECT / ASSIGNMENT NO.	REF NO.	REV.
VA101-00102/8	2	1

FIGURE 4.6



Rock Types: Jurassic Sediments & Intrusives
Discontinuity Types: Joints & Veins

Discontinuity Sets:	No.	Dip/Dip Direction (deg)
	#1	22/149
	#2	50/118
	#3	75/148
	#4	88/105

Bench Slope Angle (BFA): 65 deg
Potential Failure Mode: Planar Slide (Set #2)

General Assumptions and Slope Stability Considerations:

1) Nominal pit wall dip direction of the Northwest Sector (Phase 1 Pit) is 120 deg.
2) A friction angle of 35 deg is used for all types of discontinuities.
3) Potential planar failure will be formed by scattered discontinuity sets. A bench face angle of 65 deg is predicted to be achievable, however, localized planar slide is expected.

Rev. 1 - Traverse Data Updated

PACIFIC BOOKER MINERALS INC.

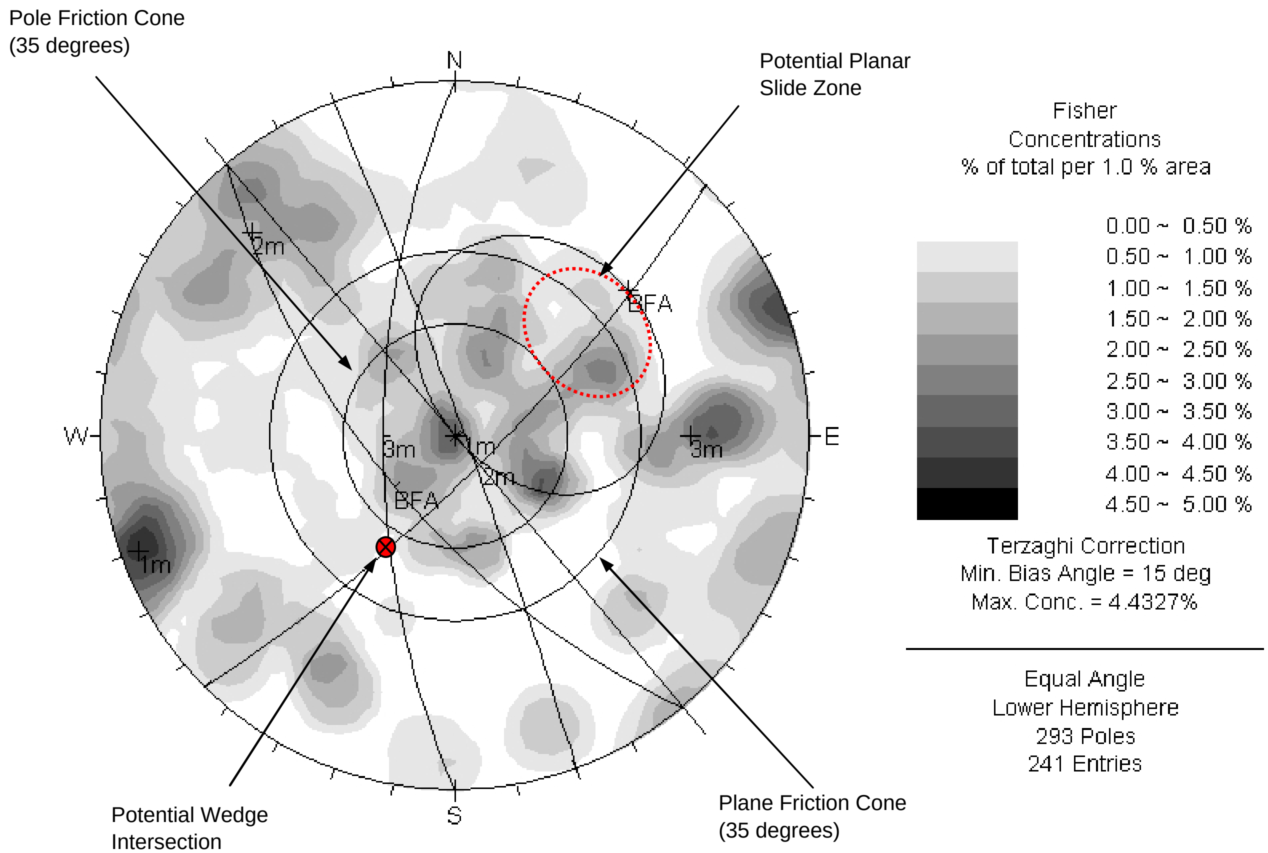
MORRISON COPPER/GOLD PROJECT

FEASIBILITY PIT SLOPE DESIGN
STEREOGRAPHIC ANALYSIS RESULT
NORTHWEST SECTOR - PHASE 1 PIT

Knight Piésold
CONSULTING

PROJECT / ASSIGNMENT NO.	REF NO.	REV.
VA201-00102/8	2	1

FIGURE 4.7



Rock Types: Jurassic Sediments & Intrusives
Discontinuity Types: Joints & Veins

Discontinuity Sets:	No.	Strike/Dip Right (deg)
	#1	88/069
	#2	78/135
	#3	67/270

Bench Face Angle (BFA): 65 deg
Potential Instability Mode: Planar Slide (Set #4), Wedge (Set #2 & Set #3)

General Assumptions and Slope Stability Considerations:

1) Nominal pit wall dip direction of the East Sector (Phase 2 Pit) is 230 deg.
2) A friction angle of 35 deg is used for all types of discontinuities.
3) A 65 deg bench face angle is predicted to be achievable, however, minor planar/wedge failures is expected. An inter-ramp angle of 47 degrees is recommended to offset the potential wedge potential.

Rev. 1 - Traverse Data Updated

PACIFIC BOOKER MINERALS INC.

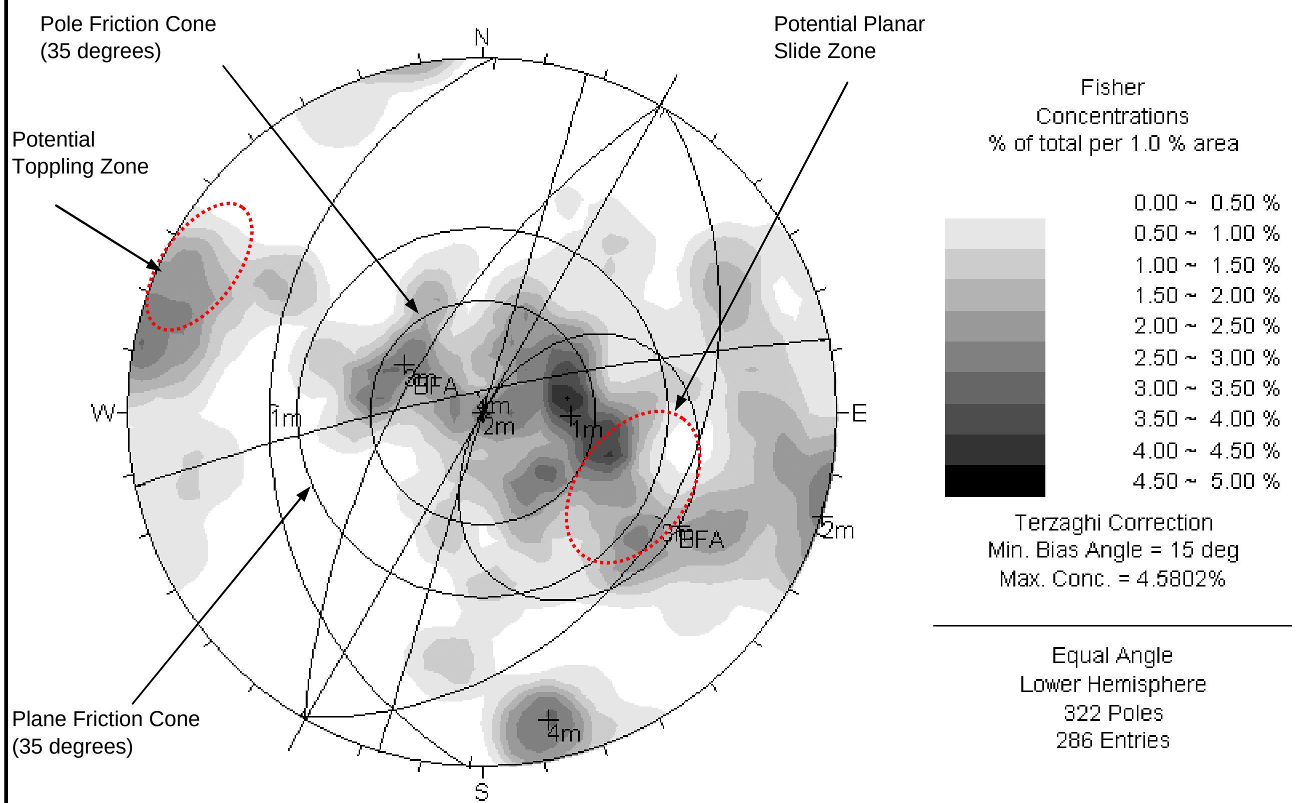
MORRISON COOPER/GOLD PROJECT

FEASIBILITY PIT SLOPE DESIGN
STEREOGRAPHIC ANALYSIS RESULT
EAST SECTOR - PHASE 2 PIT

Knight Piésold
CONSULTING

PROJECT / ASSIGNMENT NO.	REF NO.	REV.
VA101-00102/8	2	1

FIGURE 4.8



Rock Types: Jurassic Sediments & Intrusives
Discontinuity Types: Joints and Veins
Discontinuity Sets:

No.	Dip/Dip Direction (deg)
#1	27/270
#2	89/107
#3	30/122
#4	83/348

Bench Face Angle (BFA): 65 deg
Potential Failure Mode: Toppling (Set #2), Planar Slide (Set #3)

General Assumptions and Slope Stability Considerations:

1) Nominal pit wall dip direction of the Southeast Sector (Phase 2 Pit) is 300 deg.
2) A friction angle of 35 deg is used for all types of discontinuities.
3) A 65 deg bench face angle is predicted to be achievable, however, localized planar slide is expected. Potential toppling failure will be formed by predominant discontinuity sets. An inter-ramp slope of 47 degrees is recommended to reduce the toppling potential.

Rev. 1 - Traverse Data Updated

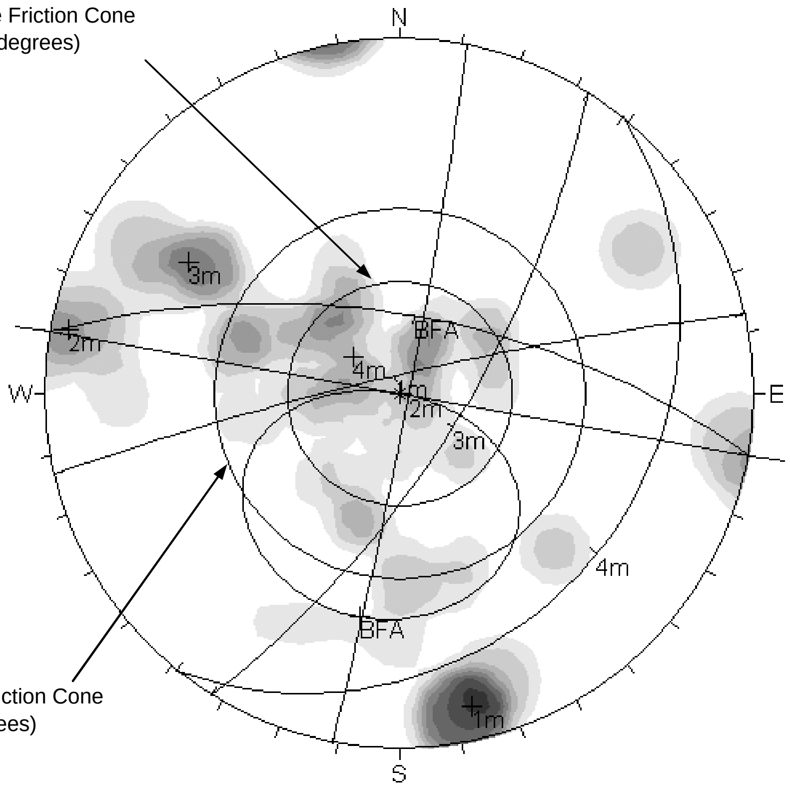
PACIFIC BOOKER MINERALS INC.
MORRISON COPPER/GOLD PROJECT
FEASIBILITY PIT SLOPE DESIGN
STEREOGRAPHIC ANALYSIS RESULT
SOUTHEAST SECTOR - PHASE 2 PIT

Knight Piésold
CONSULTING

PROJECT / ASSIGNMENT NO.	REF NO.	REV.
VA101-00102/8	2	1

FIGURE 4.9

Pole Friction Cone
(35 degrees)



Plane Friction Cone
(35 degrees)

Fisher
Concentrations
% of total per 1.0 % area

0.00 ~ 1.00 %
1.00 ~ 2.00 %
2.00 ~ 3.00 %
3.00 ~ 4.00 %
4.00 ~ 5.00 %
5.00 ~ 6.00 %
6.00 ~ 7.00 %
7.00 ~ 8.00 %
8.00 ~ 9.00 %
9.00 ~ 10.00 %

Terzaghi Correction
Min. Bias Angle = 15 deg
Max. Conc. = 8.5357%

Equal Angle
Lower Hemisphere
80 Poles
70 Entries

Rock Types: Jurassic Sediments & Intrusives
Discontinuity Types: Joints & Veins
Discontinuity Sets:

No.	Dip/Dip Direction (deg)
#1	84/347
#2	87/100
#3	71/121
#4	18/143

Bench Face Angle (BFA): 65 deg
Potential Instability Mode: No significant adverse structural features.

General Assumptions and Slope Stability Considerations:

1) Nominal pit wall dip direction of the South Sector (Phase 2 Pit) is 10 deg.
2) A friction angle of 35 deg is used for all types of discontinuities.
3) No significant adverse structural features. However, a flatter bench face angle of 60 deg is more realistic as the broken fault zone is encountered.

Rev. 1 - Traverse Data Updated

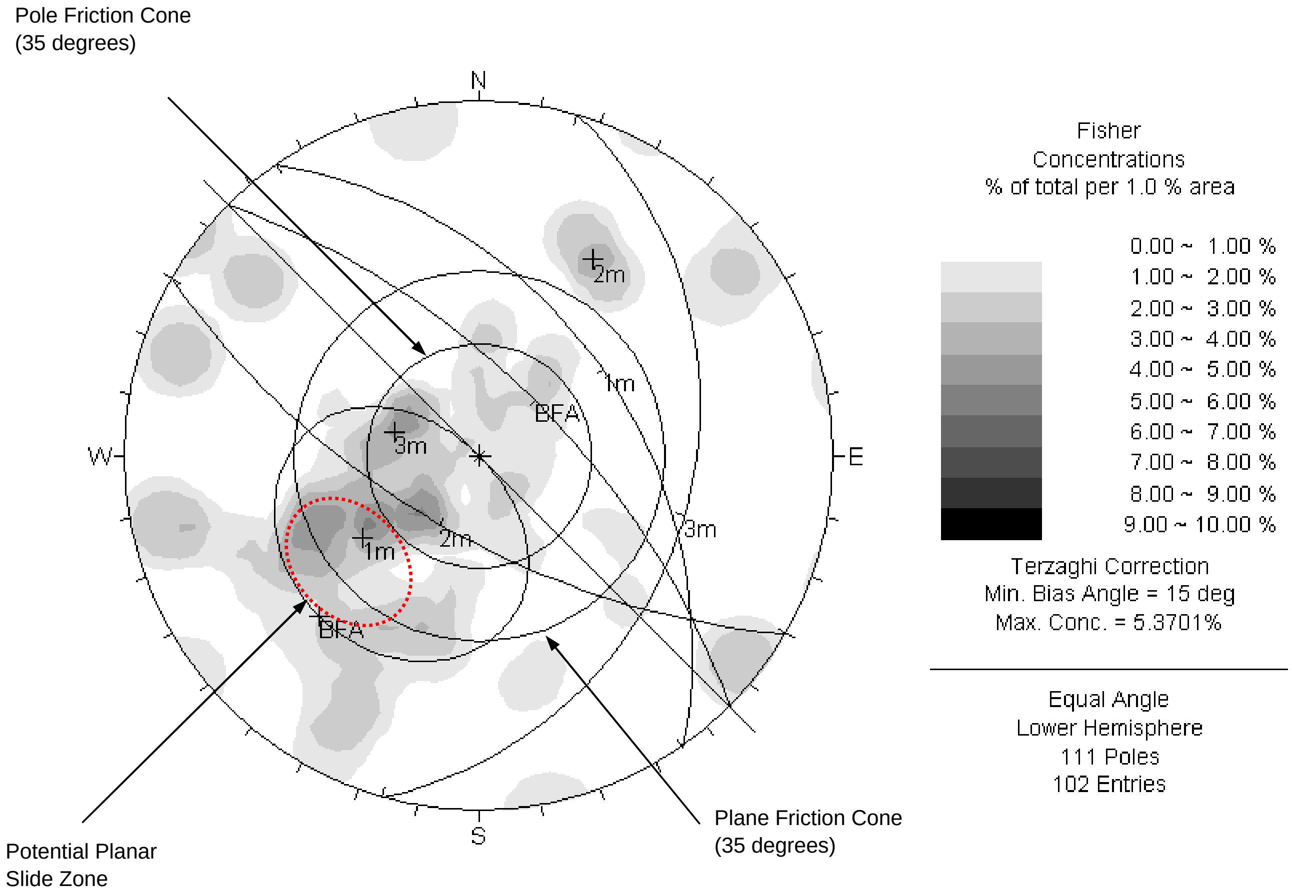
PACIFIC BOOKER MINERALS INC.
MORRISON COPPER/GOLD PROJECT

FEASIBILITY PIT SLOPE DESIGN
STEREOGRAPHIC ANALYSIS RESULT
SOUTH SECTOR - PHASE 2 PIT

Knight Piésold CONSULTING

PROJECT / ASSIGNMENT NO.	REF NO.	REV.
VA101-00102/8	2	1

FIGURE 4.10



Rock Types: Jurassic Sediments & Intrusives
Discontinuity Types: Joints and Veins

Discontinuity Sets: No.	Dip/Dip Direction (deg)
#1	44/055
#2	65/210
#3	28/109

Bench Face Angle (BFA): 65 deg
Potential Failure Mode: Planar Slide (Set #1).

General Assumptions and Slope Stability Considerations:

1) Nominal pit wall dip direction of the Southwest Sector (Phase 2 Pit) is 45 deg.
2) A friction angle of 35 deg is used for all types of discontinuities.
3) Potential planar failure formed by some scattered discontinuity sets. A bench face angle of 65 deg is likely achievable, however, localized bench loss is expected.

Rev. 1 - Traverse Data Updated

PACIFIC BOOKER MINERALS INC.

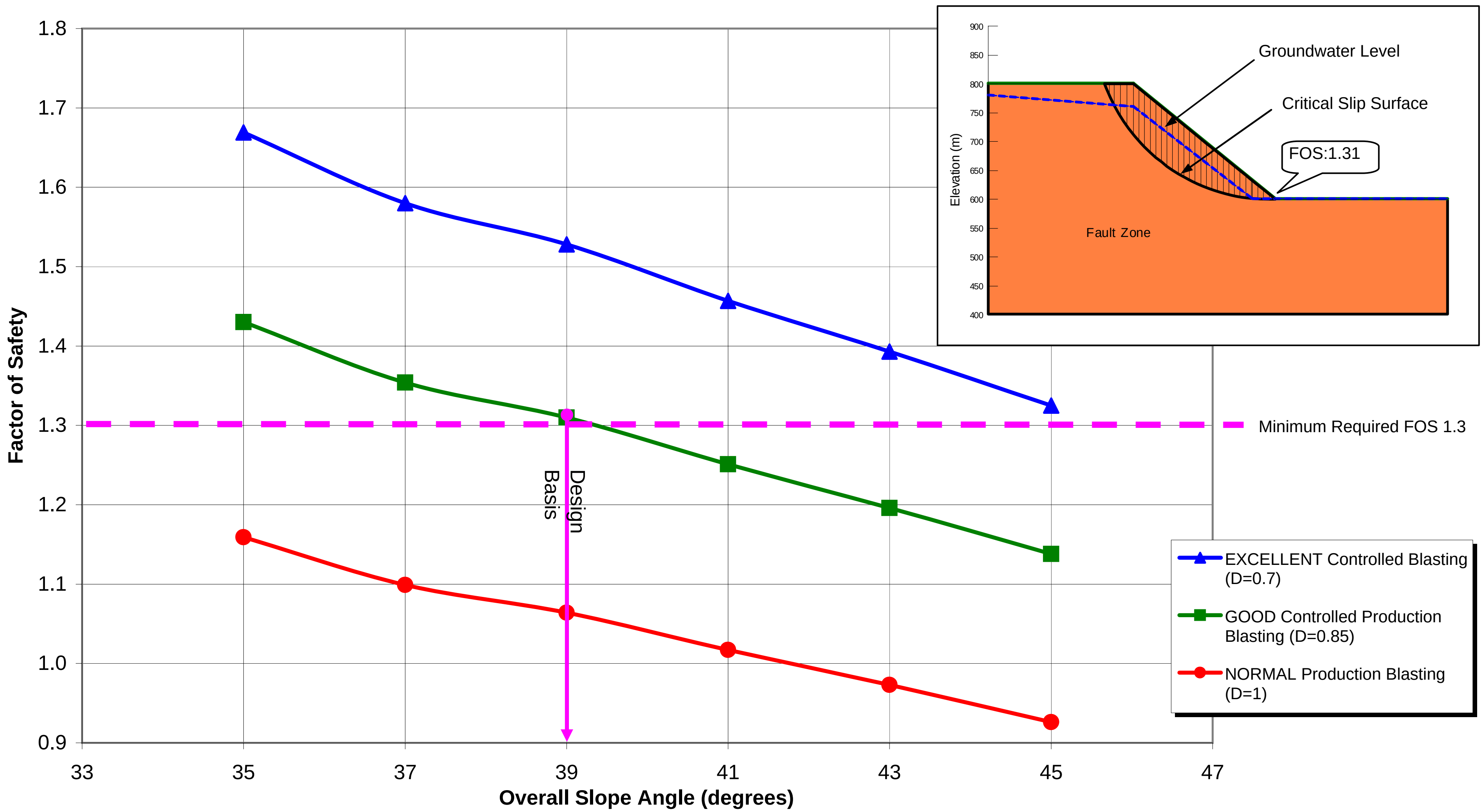
MORRISON COPPER/GOLD PROJECT

FEASIBILITY PIT SLOPE DESIGN
STEREOGRAPHIC ANALYSIS RESULT
SOUTHWEST SECTOR - PHASE 2 PIT

Knight Piésold
CONSULTING

PROJECT / ASSIGNMENT NO.	REF NO.	REV.
VA101-00102/8	2	1

FIGURE 4.11



Assumptions:
(1) Rock mass strength derived from UCS, GSI/RMR, mi and D values using Hoek-Brown Criterion (Hoek, et. al., 2002).
(2) A total slope height of 200 m is assumed. Initial groundwater level at 20 m.
(3) Enhanced slope depressurization of 40 m is assumed. Groundwater depressurization may incorporate vertical pumping and horizontal drainage.
(4) D refers to disturbance factor.

Rev. 0 - Issued for Report

PACIFIC BOOKER MINERALS INC.

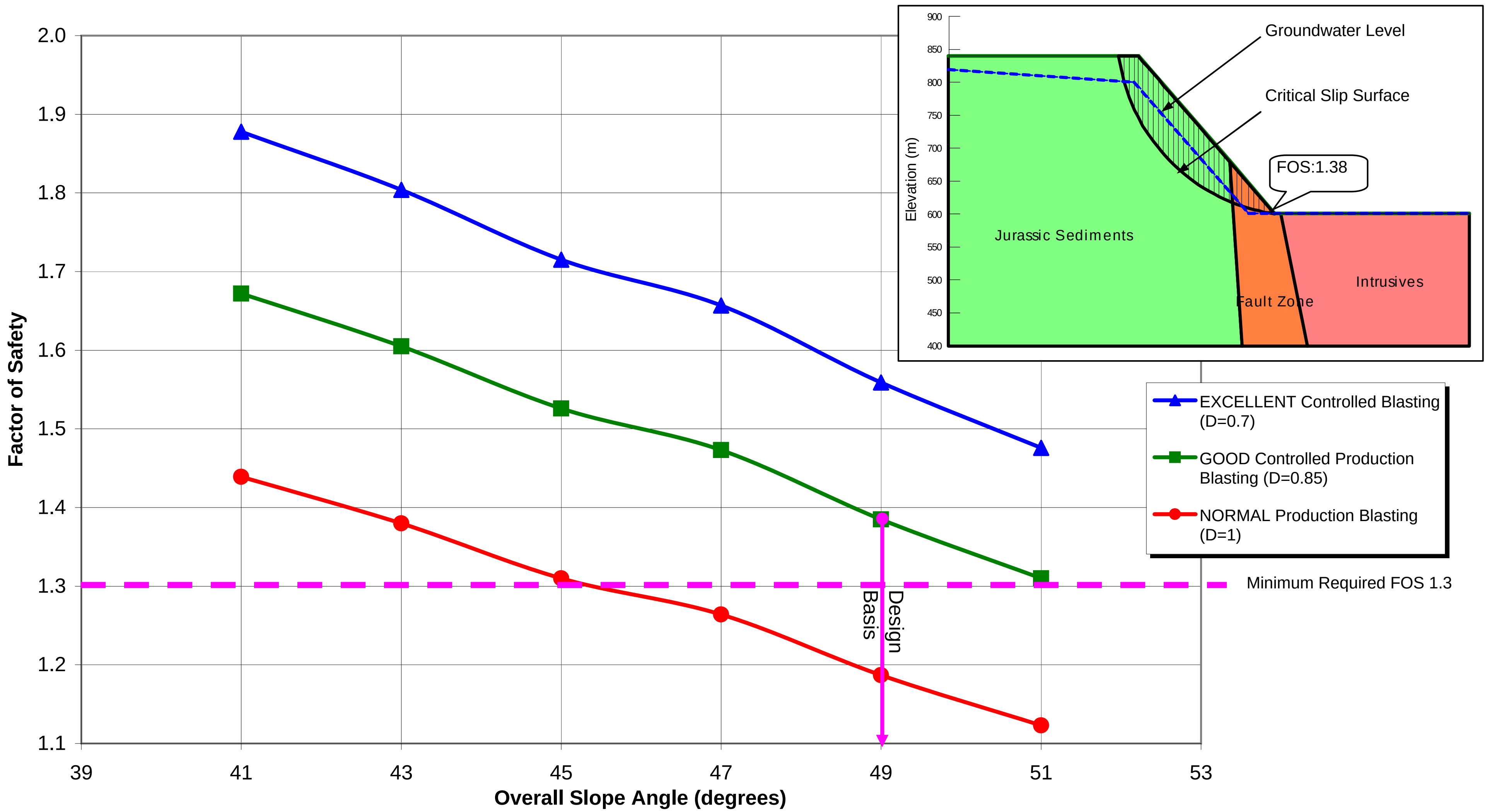
MORRISON COPPER/GOLD PROJECT

FEASIBILITY PIT SLOPE DESIGN
LIMIT EQUILIBRIUM ANALYSIS RESULT
NORTH WALL - PHASE 1 PIT

Knight Piésold CONSULTING

PROJECT / ASSIGNMENT NO.	REF NO.	REV.
VA101-00102/8	2	0

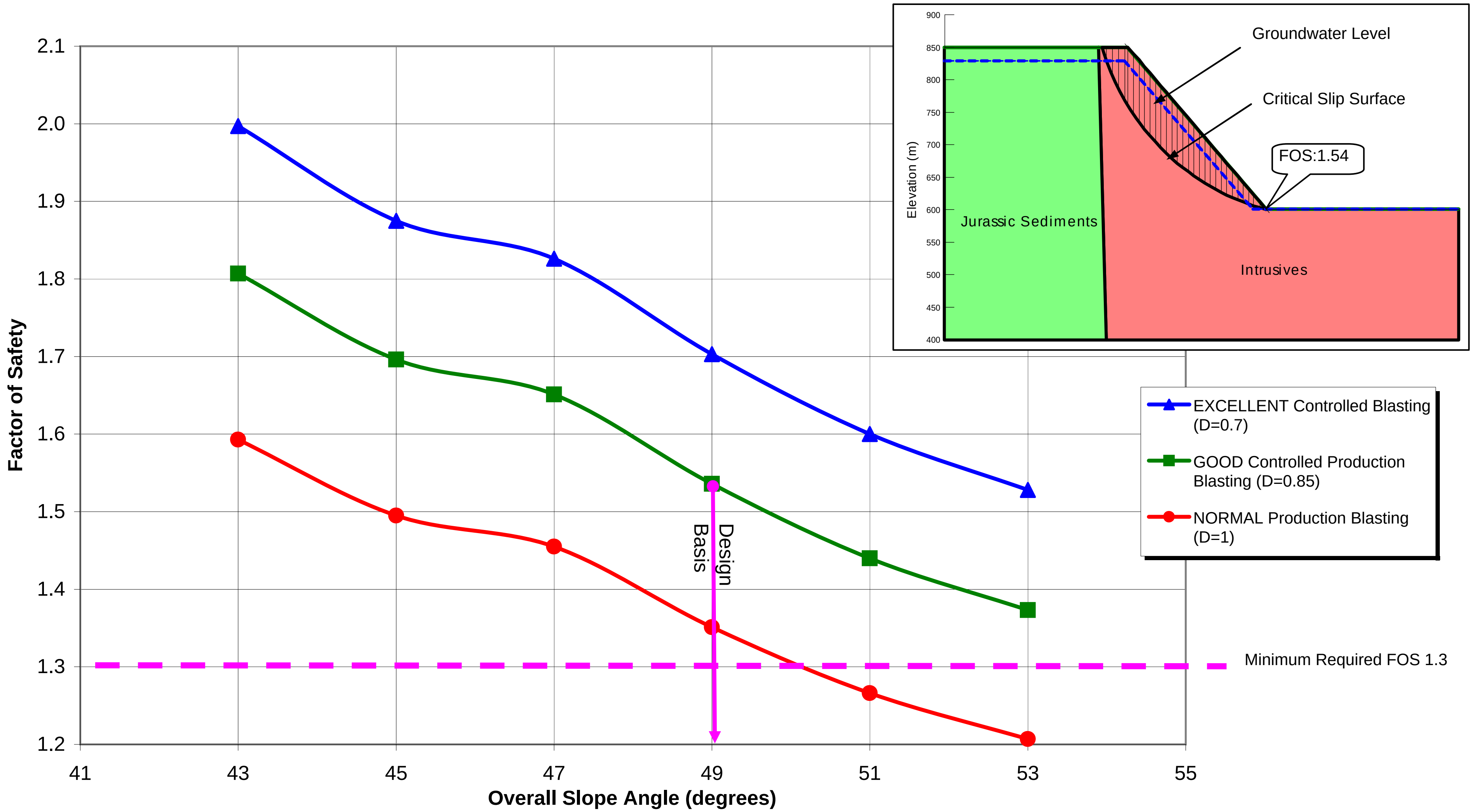
FIGURE 5.1



Assumptions:
(1) Rock mass strength derived from UCS, GSI/RMR, mi and D values using Hoek-Brown Criterion (Hoek, et. al., 2002).
(2) A total slope height of 240 m is assumed. Initial groundwater level at 20 m.
(3) Enhanced slope depressurization of 40 m is assumed. Groundwater depressurization may incorporate vertical pumping and horizontal drainage.
(4) D refers to disturbance factor.

Rev. 0 - Issued for Report

PACIFIC BOOKER MINERALS INC.			
MORRISON COPPER/GOLD PROJECT			
FEASIBILITY PIT SLOPE DESIGN **LIMIT EQUILIBRIUM ANALYSIS RESULT** **NORTHEAST WALL - PHASE 1 PIT**			
Knight Piésold CONSULTING	PROJECT / ASSIGNMENT NO. VA101-00102/8	REF NO. 2	REV. 0
	FIGURE 5.2		



Assumptions:
(1) Rock mass strength derived from UCS, GSI/RMR, mi and D values using Hoek-Brown Criterion (Hoek, et. al., 2002).
(2) A total slope height of 250 m is assumed. Initial groundwater level at 20 m.
(3) D refers to disturbance factor.

Rev. 0 - Issued for Report

PACIFIC BOOKER MINERALS INC.

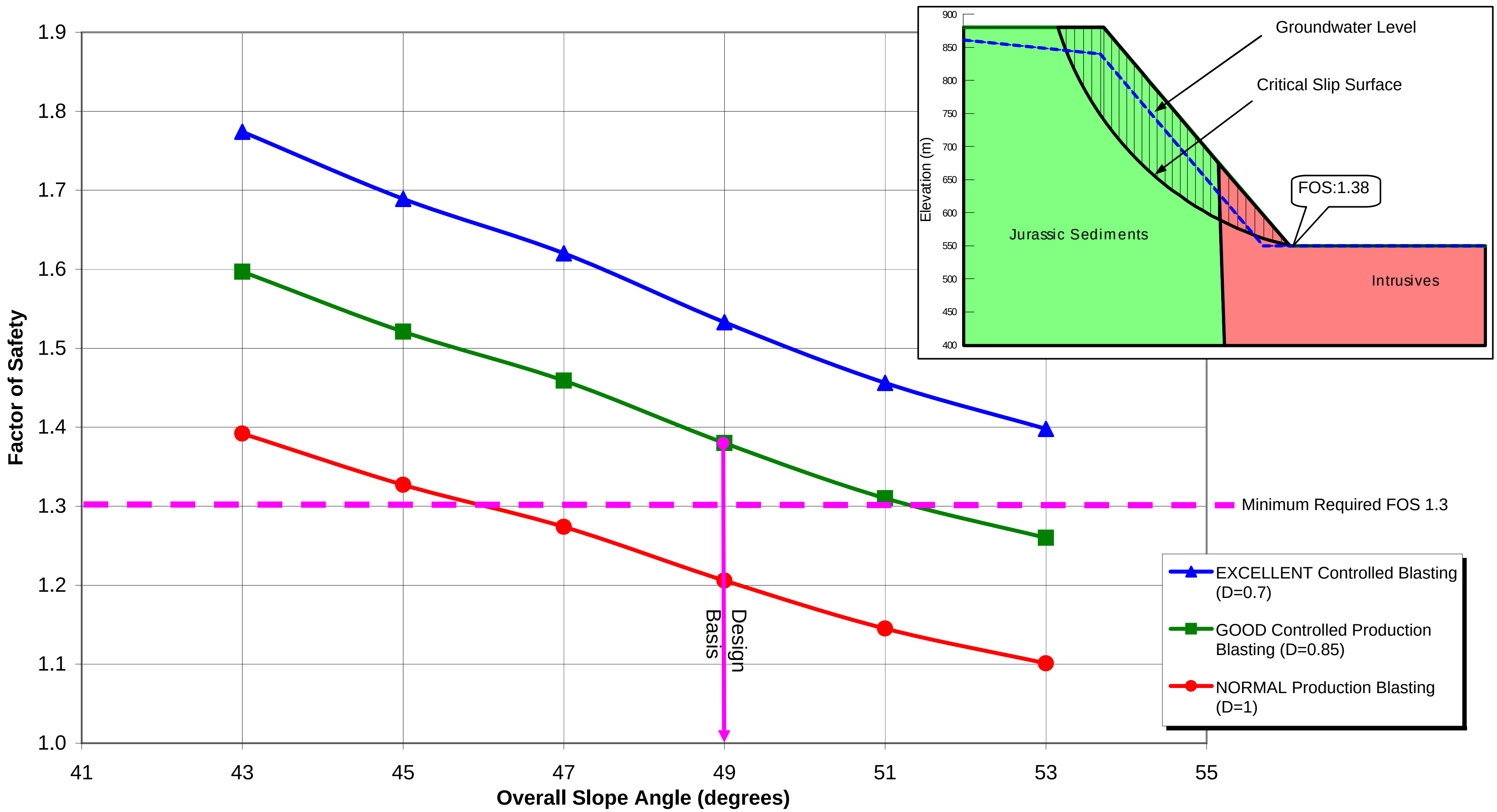
MORRISON COPPER/GOLD PROJECT

FEASIBILITY PIT SLOPE DESIGN
LIMIT EQUILIBRIUM ANALYSIS RESULT
NORTHWEST WALL - PHASE 1 PIT

Knight Piésold
CONSULTING

PROJECT / ASSIGNMENT NO.	REF NO.	REV.
VA101-00102/8	2	0

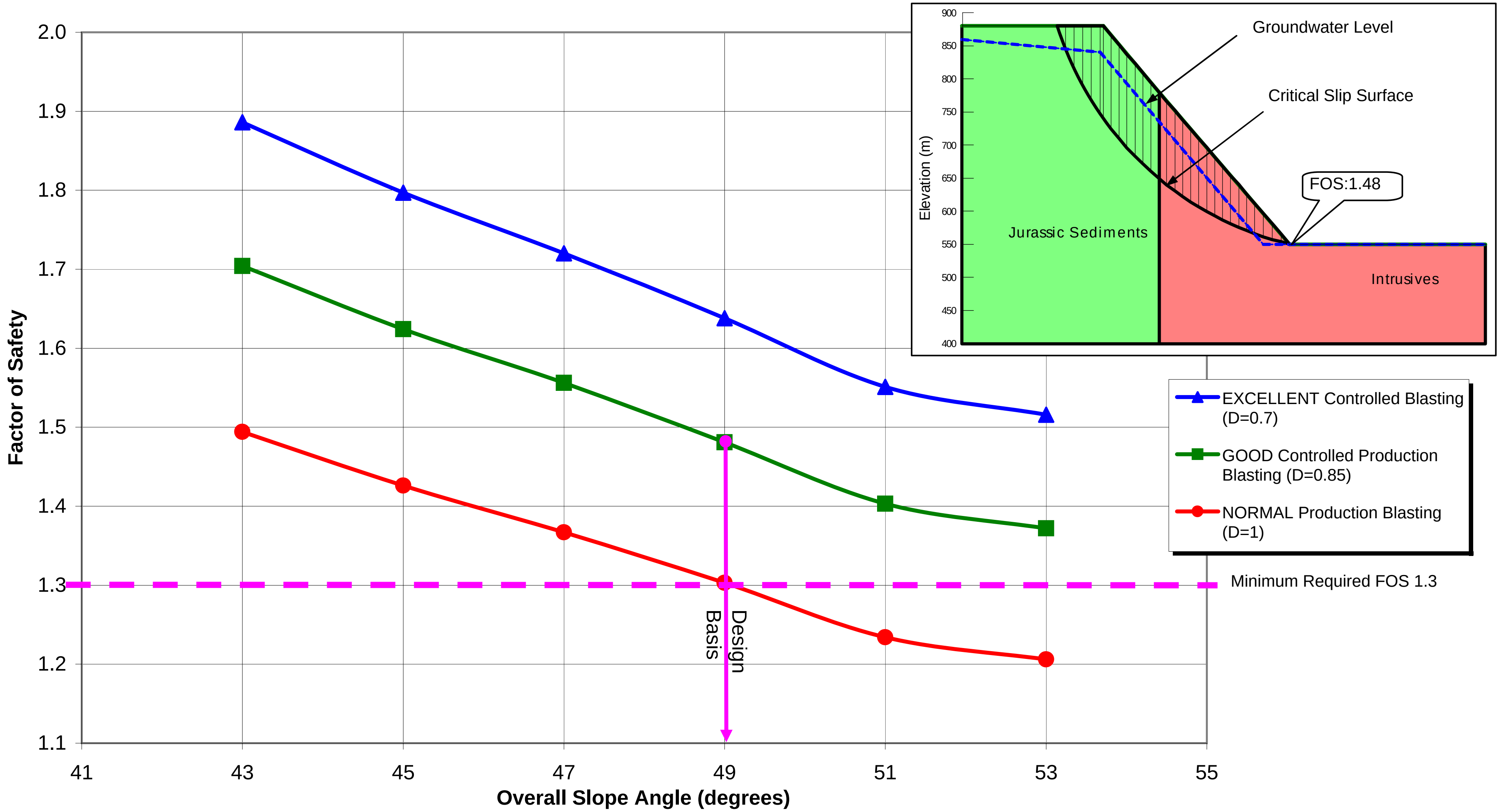
FIGURE 5.3



Assumptions:
(1) Rock mass strength derived from UCS, GSI/RMR, mi and D values using Hoek-Brown Criterion (Hoek, et. al., 2002).
(2) A total slope height of 330 m is assumed. Initial groundwater level at 40 m.
(3) D refers to disturbance factor.

Rev. 0 - Issued for Report

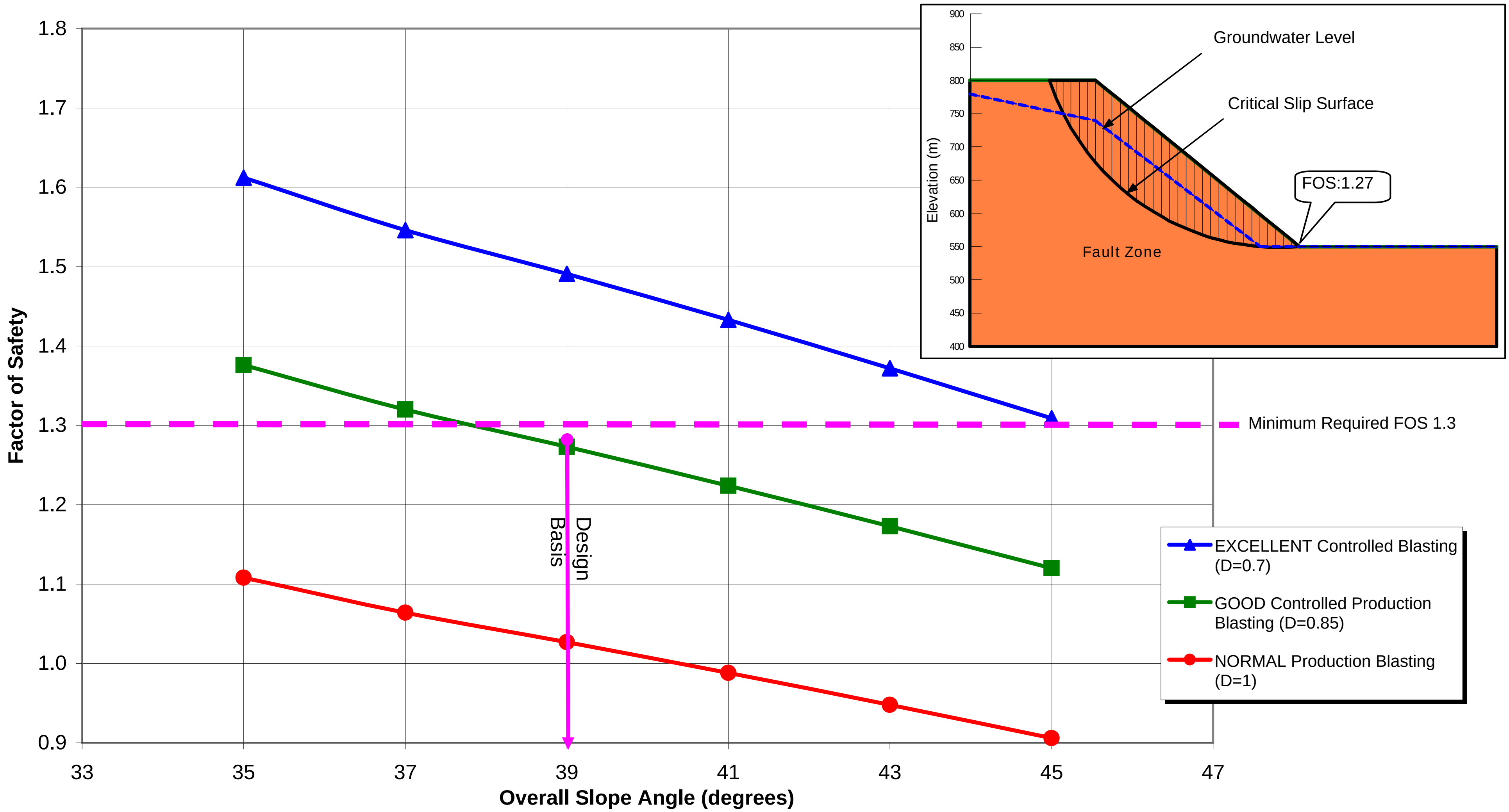
PACIFIC BOOKER MINERALS INC.		
MORRISON COPPER/GOLD PROJECT		
FEASIBILITY PIT SLOPE DESIGN **LIMIT EQUILIBRIUM ANALYSIS RESULT** **EAST WALL - PHASE 2 PIT**		
Knight Piésold CONSULTING	PROJECT / ASSIGNMENT NO. VA101-00102/8	REF NO. 2 / REV. 0
	FIGURE 5.4	



Assumptions:
(1) Rock mass strength derived from UCS, GSI/RMR, mi and D values using Hoek-Brown Criterion (Hoek, et. al., 2002).
(2) A total slope height of 330 m is assumed. Initial groundwater level at 40 m.
(3) D refers to disturbance factor.

Rev. 0 - Issued for Report

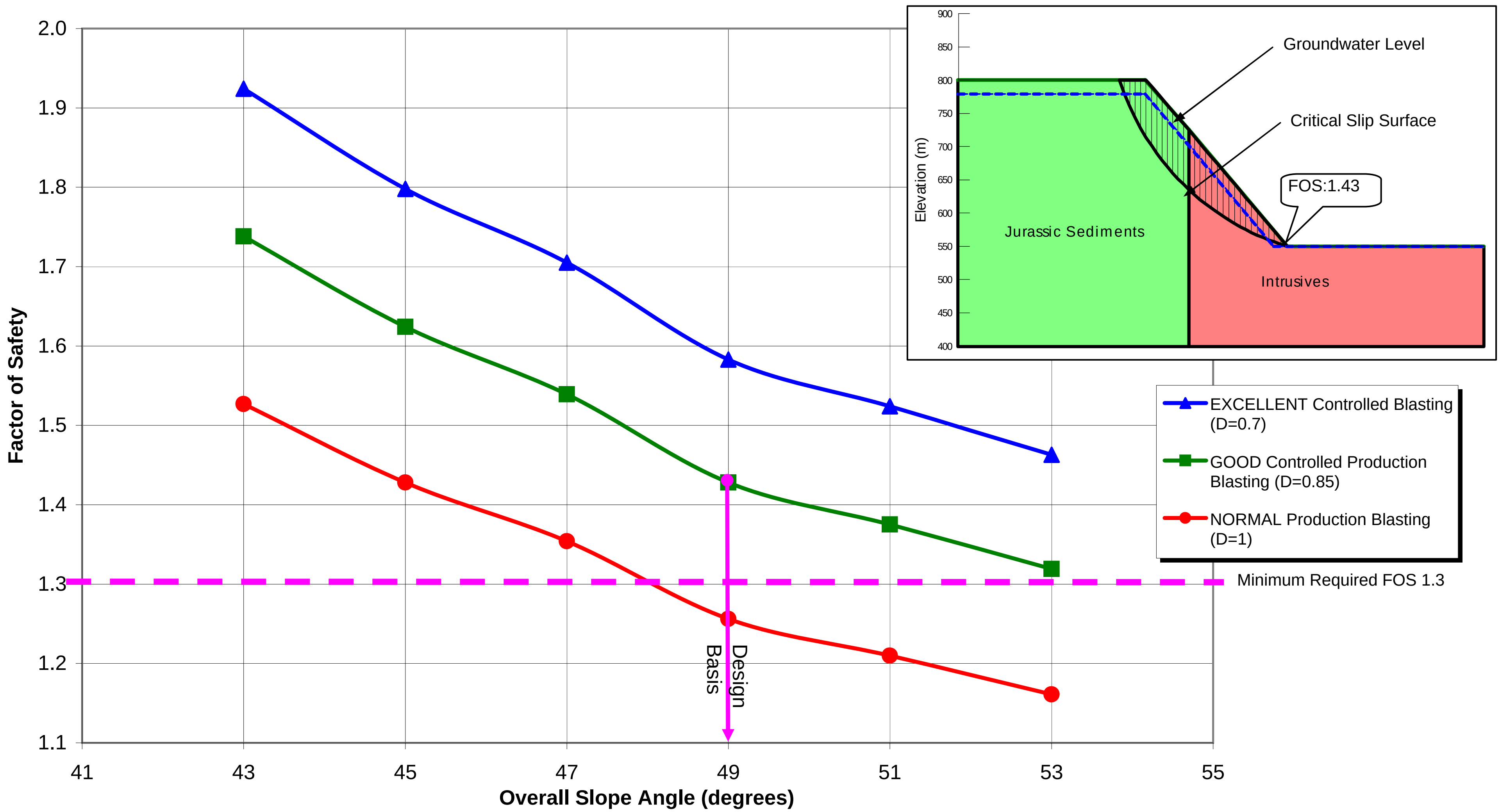
PACIFIC BOOKER MINERALS INC.			
MORRISON COPPER/GOLD PROJECT			
FEASIBILITY PIT SLOPE DESIGN LIMIT EQUILIBRIUM ANALYSIS RESULT SOUTHEAST WALL - PHASE 2 PIT			
Knight Piésold CONSULTING	PROJECT / ASSIGNMENT NO. VA101-00102/8	REF NO. 2	REV. 0
	FIGURE 5.5		



Assumptions:
(1) Rock mass strength derived from UCS, GSI/RMR, mi and D values using Hoek-Brown Criterion (Hoek, et. al., 2002).
(2) A total slope height of 250 m is assumed. Initial groundwater level at 20 m.
(3) Enhanced slope depressurization of 60 m is assumed. Groundwater depressurization may incorporate vertical pumping and horizontal drainage.
(4) D refers to disturbance factor.

Rev. 0 - Issued for Report

PACIFIC BOOKER MINERALS INC.			
MORRISON COPPER/GOLD PROJECT			
FEASIBILITY PIT SLOPE DESIGN **LIMIT EQUILIBRIUM ANALYSIS RESULT** **SOUTH WALL - PHASE 2 PIT**			
Knight Piésold CONSULTING	PROJECT / ASSIGNMENT NO. VA101-00102/8	REF NO. 2	REV. 0
	FIGURE 5.6		



Assumptions:
(1) Rock mass strength derived from UCS, GSI/RMR, mi and D values using Hoek-Brown Criterion (Hoek, et. al., 2002).
(2) A total slope height of 250 m is assumed. Initial groundwater level at 20 m.
(3) D refers to disturbance factor.

Rev. 0 - Issued for Report

PACIFIC BOOKER MINERALS INC.

MORRISON COPPER/GOLD PROJECT

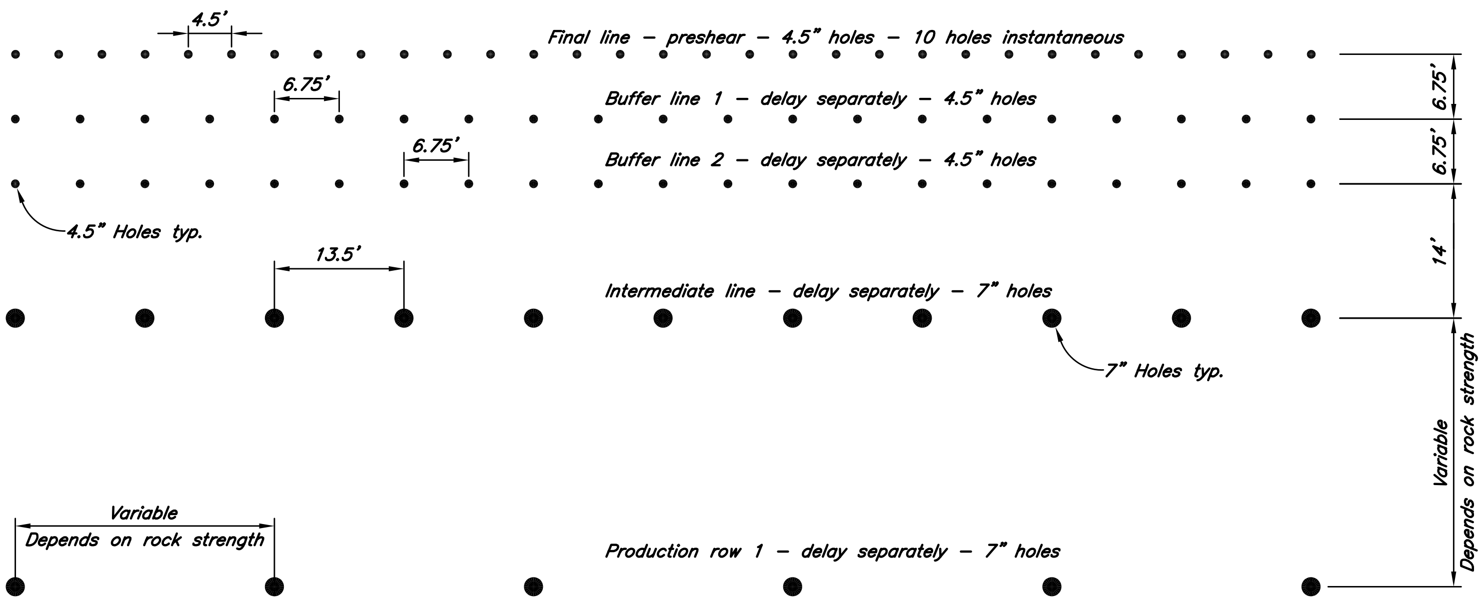
FEASIBILITY PIT SLOPE DESIGN
LIMIT EQUILIBRIUM ANALYSIS RESULT
SOUTHWEST WALL - PHASE 2 PIT

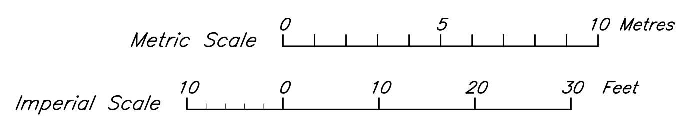
Knight Piésold
CONSULTING

PROJECT / ASSIGNMENT NO.	REF NO.	REV.
VA101-00102/8	2	0

FIGURE 5.7

XREF FILE : –





VANCOUVER B.C. CAD FILE: M:\1\01\00102\08\A\Acad\Figs\A10.dwg 1"=100' PLOT 1=1(PS) May 08 2006 by:jyang Time @ 16:20

NOTES

1. The "Controlled Blasting" pattern for the final pit wall recommended by C.O. Brawner.
2. For "Controlled Blasting", production holes within 100 feet of the final wall to be delayed separately. Blast preshear line first then outer production row and progressively toward preshear line.

REV. 0	08MAY'06	ISSUED FOR REPORT

PACIFIC BOOKER MINERALS INC.

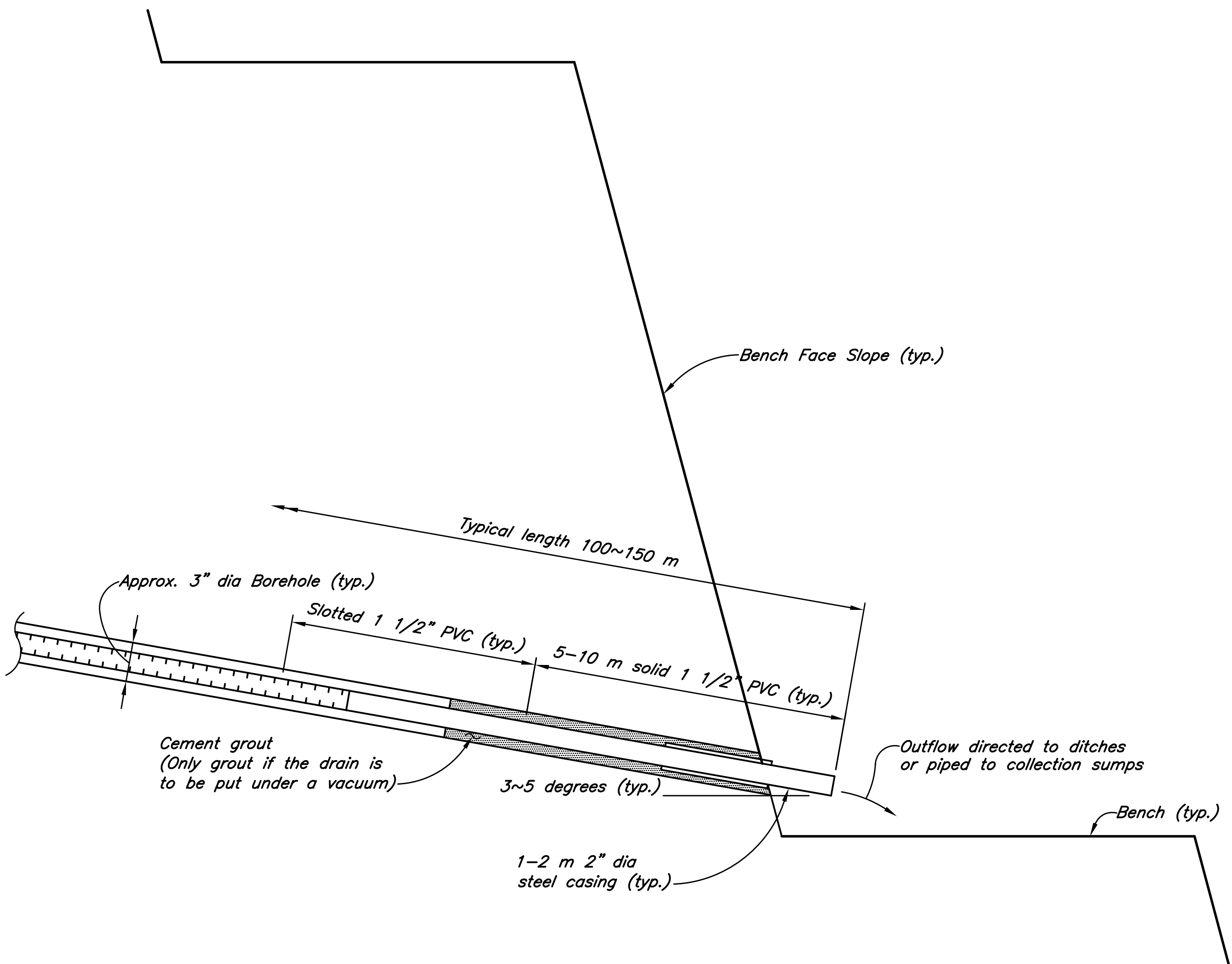
MORRISON COPPER/GOLD PROJECT

FEASIBILITY PIT SLOPE DESIGN
TYPICAL CONTROLLED BLASTING PATTERN
FOR FINAL PIT WALL

Knight Piésold CONSULTING

PROJECT/ASSIGNMENT NO.	REF. NO.
VA101-102/8	2

FIGURE 7.1 REV. 0



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XREF FILE : –

REV. 0	08MAY'06	ISSUED FOR REPORT

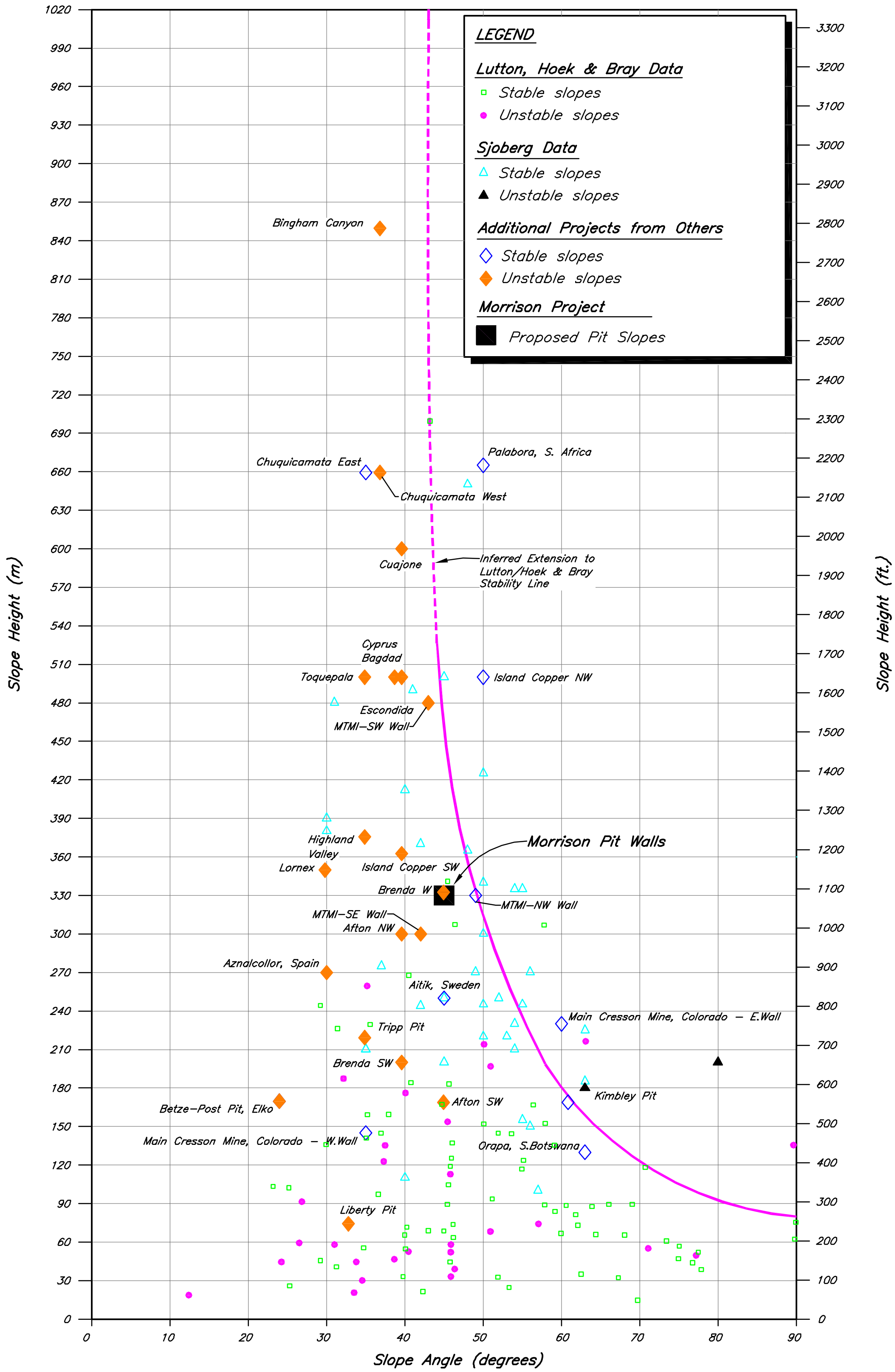
PACIFIC BOOKER MINERALS INC.

MORRISON COPPER/GOLD PROJECT

FEASIBILITY PIT SLOPE DESIGN
TYPICAL HORIZONTAL DRAIN INSTALLATION

Knight Piésold CONSULTING

PROJECT/ASSIGNMENT NO.	REF. NO.	
VA101–102/8	2	
FIGURE 7.2		REV. 0



NOTES

1. Original Data Points after Lutton 1970, Hoek and Bray 1981, and Sjoberg 1996.
2. Additional data from Knight Piesold projects and Others.

XREF FILE : –

REV. 1	26SEP'06	SLOPE ANGLE UPDATED

VANCOUVER B.C. CAD FILE: M:\1\01\00102\08\A\Acad\Figs\A12.dwg 1=1 PLOT 1=1(PS) Sept. 26 2006 by:WAL

PACIFIC BOOKER MINERALS INC.

MORRISON COPPER/GOLD PROJECT

FEASIBILITY PIT SLOPE DESIGN
SLOPE HEIGHT VERSUS SLOPE ANGLE
PRECEDENT FOR HARD ROCK SLOPES

Knight Piésold CONSULTING

PROJECT/ASSIGNMENT NO.	REF. NO.	REV.
VA101-102/8	2	1

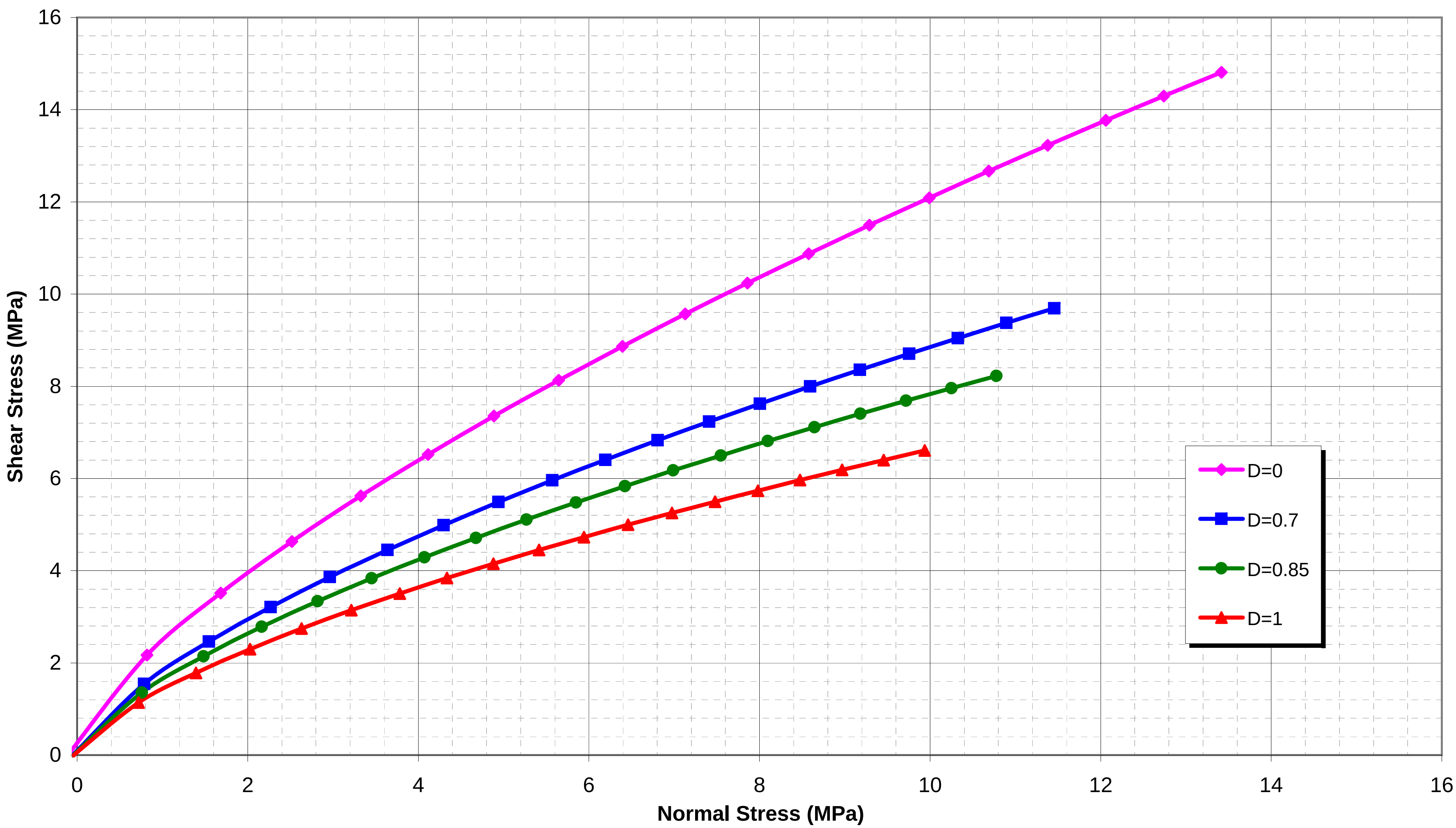
FIGURE 7.3

Knight Piésold
CONSULTING

APPENDIX A
(Rev 0)

ROCK MASS STRENGTH CURVES

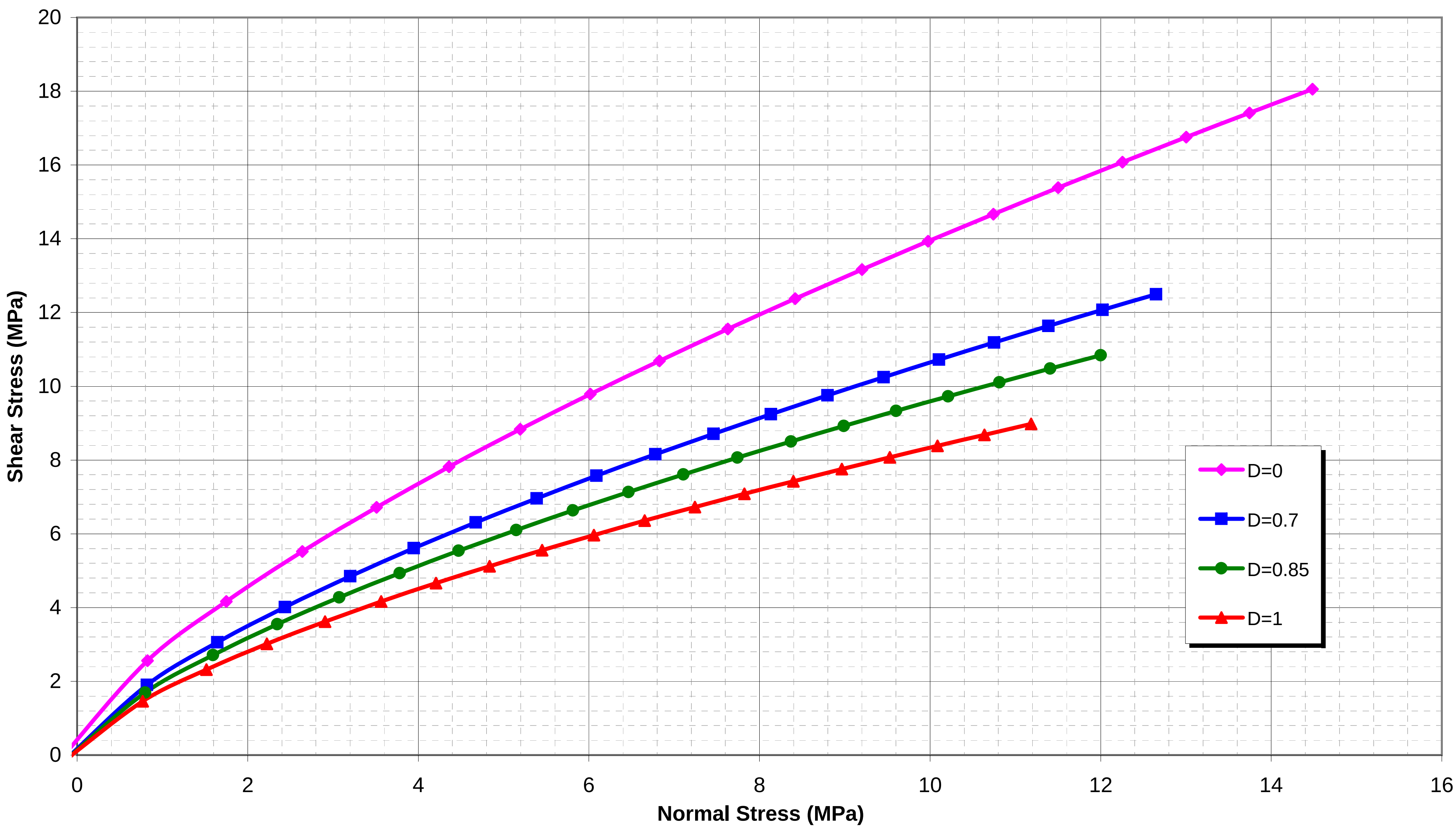
Figure A.1 rev 0	Jurassic Sediments
Figure A.2 rev 0	Intrusives
Figure A.3 rev 0	Fault Zone



Note:
(1) Rock mass strength derived from UCS, RMR/GSI, mi and D values by using Hoek-Brown Criterion (Hoek et. al., 2002).
(2) UCS = 80 MPa, RMR = 55, GSI = 50, mi = 17.
(3) D is disturbance factor. D = 0 and 1 refer to undisturbed and disturbed rock mass, respectively.

Rev. 0 - Issued for Report

PACIFIC BOOKER MINERALS INC.			
MORRISON COPPER/GOLD PROJECT			
PREFEASIBILITY PIT SLOPE DESIGN ROCK MASS STRENGTH CURVES JURASSIC SEDIMENTS			
Knight Piésold CONSULTING	PROJECT / ASSIGNMENT NO. VA101-00102/8	REF NO. 2	REV. 0
	FIGURE A.1		



Note:
(1) Rock mass strength derived from UCS, RMR/GSI, mi and D values by using Hoek-Brown Criterion (Hoek et. al., 2002).
(2) UCS = 90 MPa, RMR = 60, GSI = 55, mi = 20.
(3) D is disturbance factor. D = 0 and 1 refer to undisturbed and disturbed rock mass, respectively.

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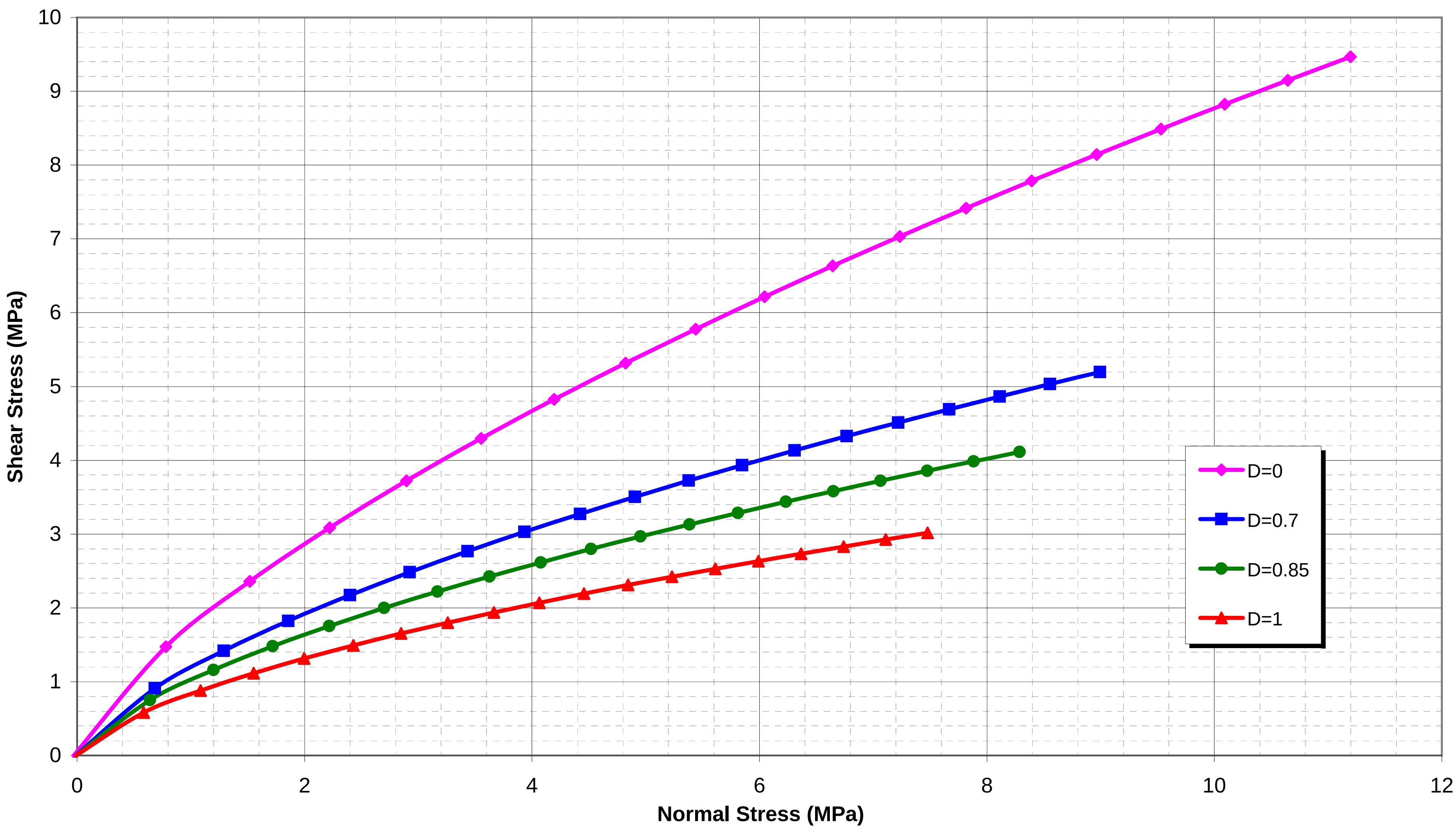
PACIFIC BOOKER MINERALS INC.			
MORRISON COPPER/GOLD PROJECT			
PREFEASIBILITY PIT SLOPE DESIGN ROCK MASS STRENGTH CURVES INTRUSIVES			
Knight Piésold CONSULTING	PROJECT / ASSIGNMENT NO. VA101-00102/8	REF NO. 2	REV. 0
	FIGURE A.2		



Note:
(1) Rock mass strength derived from UCS, RMR/GSI, mi and D values by using Hoek-Brown Criterion (Hoek et. al., 2002).
(2) UCS = 60 MPa, RMR = 40, GSI = 35, mi = 15.
(3) D is disturbance factor. D = 0 and 1 refer to undisturbed and disturbed rock mass, respectively.

Rev. 0 - Issued for Report

PACIFIC BOOKER MINERALS INC.

MORRISON COPPER/GOLD PROJECT

PREFEASIBILITY PIT SLOPE DESIGN
ROCK MASS STRENGTH CURVES
FAULT ZONE

Knight Piésold
CONSULTING

PROJECT / ASSIGNMENT NO.	REF NO.	REV.
VA101-00102/8	2	0

FIGURE A.3

Knight Piésold
CONSULTING

APPENDIX B
(Rev 0)

OPEN PIT GEOTECHNICAL MONITORING

(Pages B-1 to B-3)

APPENDIX B

OPEN PIT GEOTECHNICAL MONITORING

Pro-active geotechnical monitoring is recommended for the Morrison Project during all stages of the pit development. The monitoring program should be implemented as a staged approach and include detailed geotechnical and tension crack mapping, as well as a suitable combination of surface displacement monitoring, and the installation of Time Domain Reflectometry (TDR), Multiple Point Borehole Extensometers (MPBXs) and piezometers. Suitable staffing resources should be allocated to collect, process and interpret the geotechnical monitoring data on a weekly basis or as frequently as required. The timely identification of accelerated movements from surface displacement monitoring and tension cracks will be critical. Up-to-date reports on the status of highwall stability around the entire open pit should be compiled and discussed regularly with operations personnel.

An introduction to the open pit geotechnical monitoring measures and requirements are discussed below:

B.1 GEOTECHNICAL MAPPING

Detailed geotechnical mapping should be carried out along all newly formed benches along the pit highwalls. Detailed information to be noted should include the orientation of the main fracture sets, the type, thickness, extent (persistence) and frequency of any infilling (clay, gouge, chlorite, sericite etc.), the distribution of joint spacings, the nature of the fracture surfaces (smooth, planar, polished, slickensided etc.) and any observations of seepage. Detailed maps for each bench face and a complete database should be compiled to include all the recorded geotechnical data. The occurrence of adverse conditions, such as soft clay bands that are coincident with the bedding fractures and large-scale features should be particularly noted and highlighted. All relevant (and particularly adverse) geotechnical information should be updated on weekly mine plans to ensure that mine planners and operations personnel are aware of the current geotechnical conditions along the highwalls. The geotechnical mapping will also provide the qualitative and quantitative information needed to conduct ongoing highwall stability assessments during mining activities. In addition, any seeps observed in the walls should be noted and the quantities of flow should be quantified to evaluate any changes over time as a function of mining and potential infiltration of surface water. An increase in seepage volumes may suggest a changing situation that may be caused by dilating discontinuities or slip.

B.2 TENSION CRACK MAPPING

Detailed tension crack mapping should be carried out along all newly formed benches. Detailed information to be noted should include the surveyed location, orientation, aperture and both vertical and lateral extents of all tension cracks. The development of all tension cracks should be very carefully observed. The frequency of mapping and observations should be commensurate with the rate of development of individual cracks. Initial mapping and inspections should be carried out on a weekly basis. Simple extensometers should be installed across any significant tension cracks to confirm the rate and overall extent of movement. A detailed map and database should be compiled to include all the recorded data. The occurrence of tension cracks should be highlighted and presented on mine plans on a weekly basis so that mine planners and operations personnel are aware of the current ground conditions along the pit highwalls. In some cases, the development of tension cracks and the associated potential for wall instability should be evaluated on a daily basis in conjunction with operational staff. Areas of slope movement that are associated with the development of tension cracks should also be monitored with surface displacement prisms as discussed below. Most of these systems can be equipped with automated warning devices if required.

B.3 SURFACE MOVEMENT MONITORING

Surface displacement monitoring survey prisms should be established along the highwalls to detect the onset of any possible movement/sliding at various locations within the vertical sequence of mining development of the open pit. An initial series of surface displacement monitoring prisms should be established along the crest of the highwalls as early in the mine-sequence as possible so that baseline information can be obtained. A subsequent series of surface displacement monitoring prisms should be established along all newly exposed benches. Prism surveying, should be undertaken at regular intervals to develop a comprehensive record of highwall deformation. An automated monitoring system is recommended. Data should be evaluated on an ongoing basis to enable the early detection of instability and allow for safe mining operations.

B.4 TIME DOMAIN REFLECTOMETRY MONITORING

Time domain reflectometry (TDR) is an inexpensive means of monitoring early movement or slip within a pit slope and provides similar information which is similar to that obtained from using inclinometers. TDR is able to locate the depth to a shear plane or zone within a slope by means of detecting the depth of a reflected voltage pulse that is sent along a coaxial cable that is installed within a drill hole. Reflection of the voltage pulse in the coaxial cable occurs at a damaged location along the coaxial cable that represents a location of where shearing has occurred within the slope. One of main advantages of TDR is that monitoring can continue after extensive shearing has occurred to detect multiple shear zones without losing the instrument location. This form of instrumentation will provide early information on the initiation of any possible deep-seated instabilities within the rock mass and help to confirm the depth to failure and geometry of any unstable sliding blocks as well as the occurrence of any shearing or opening along the toppling set of fractures in the north highwall. The requirements for the TDR installations should be based on the initial slope monitoring information and evaluated as part of the ongoing geotechnical monitoring program. TDR installations can be integrated with additional standpipe piezometers in order to maximize the amount of information obtained benefits from the additional drill holes.

B.5 MULTI-POINT BOREHOLE EXTENSOMETER (MPBXS) MONITORING

This type of extensometer is a relatively inexpensive means of very accurately monitoring displacements at a number of pre-specified points down a single borehole. The anchor displacements are measured relative to a reference point, which is either at the toe or the hole collar. A change in distance between each anchor and the reference point indicates that movement is occurring between these two locations. Comparison of the displacements between anchors allows a displacement profile to be created for that particular hole. Similar to TDR, the recorded displacements can be used to provide early information on the initiation of any possible deep-seated instabilities within the rock mass and help to confirm the depth to failure and the geometry of any unstable sliding blocks. The requirements for the extensometer installations should be based on the initial slope monitoring information and incorporated into the ongoing geotechnical monitoring program. Depending on the exact configuration, these instruments can be read remotely providing that power and lightning protection is provided and automated data logger based systems are also available.

B.6 PIEZOMETER MONITORING

Enhanced depressurization will be required in order to provide an adequate factor of safety for the highwalls. As such, the extent to which the groundwater pore pressure decreases is important to assess. It is recommended that piezometers be installed to allow long-term monitoring of groundwater depressurization over the life of the mine. Piezometers will be installed progressively during mine operations and locations for new piezometers should be reviewed on an annual basis.

APPENDIX C
(Rev 0)

SIMILAR LARGE MINING OPERATIONS IN BRITISH COLUMBIA

(Pages C-1 to C-3)

APPENDIX C

SIMILAR LARGE MINING OPERATIONS IN BRITISH COLUMBIA

A technical review of other large open pit mining operations has been completed for the Morrison Pit feasibility study. A brief discussion of slope stability considerations at some similar open pit mines is presented below:

C.1 BELL MINE

The Bell Mine is a porphyry copper-gold open pit mine in the Babine Lake region of British Columbia. The mine is located approximately 20 km south of the Morrison deposit. It operated from 1972 to 1992 and the ease of grade control and relatively good stability contributed to its success. The open pit was over 300 m of depth and the pit walls were developed with 12.2 m (40 ft) benches. There were 16 m safety berms left on every second bench down to the 2180 ft level and 21 m safety berms every third bench afterward (Dirom, G.E., et. al., 1995).

The North Wall of the open pit has the highest structural stability with an overall slope angle of 48 to 50 degrees. The intact rock strength ranges from 55 to 175 MPa. The slope has experienced some instabilities as there was a wedge failure in the Northeast and in the Northwest there was a haul road failure. Corrective actions were taken including re-sloping of the walls above the failure areas and stepping the walls in below the failure areas to reduce the slope angles locally.

The Southeast Wall of the open pit is of intermediate stability in the upper part with moderate to high rock strength. The stability in this section is largely a function of adverse structural features either striking parallel or sub-parallel to pit walls or dipping towards the pit bottom. The overall slope angle is 44 to 46 degrees. The stability of the East, West and Southwest Walls are the same as that of the upper Southeast Wall. The lower Southeast Wall is a shattered or broken zone with lower intact rock strength. The overall pit slopes in this area are between 34 to 36 degrees. The general mine practice to stabilize the overburden slopes above the pit walls was to re-slope to 20 to 25 degrees and establish safety berms at the interface between the overburden and the rock slope. Drainage ditches redirected surface water away from the overburden slopes which were mainly composed of till. The South Wall encountered failure at the rock-overburden contact.

In comparison with other mines, the Bell Mine had good stability and even though bench scale failures did occur, they did not remain a problem after the material had been removed from the bench. Regular scaling of the pit walls, safety berm cleanup and the installation of horizontal drains to dewater potential wedges are examples of the measures that were taken to increase slope stability. One of the reasons for the good stability was the low groundwater inflows to the pit, an average of 1000 litres/min. This was unexpected due to the fact that the pit bottom lies 230 m below the level of Babine

Lake. This is likely due to the low overall rock mass permeability and lack of continuity of major unhealed structures.

C.2 GRANISLE MINE

The Granisle Mine is another porphyry copper-gold open pit mine in the Babine Lake region of British Columbia. It is located 8 km southeast of the Bell Mine. This mine along with the Bell Mine would be the most akin to the proposed Morrison open pit as they have similar geology and are situated in close proximity to one another. The mine commenced production in 1966 and closed in 1982. The open pit was initially mined in 9.1 m (30 ft) benches which were later increased to 10.7 m (35 ft) below the 2470 ft bench. No major slope instability data has been recorded during the development of Granisle Mine. Groundwater inflows at the Granisle Mine were two to three times higher than those found at the Bell Mine (Dirom, G.E., et. al., 1995).

C.3 HIGHLAND VALLEY MINE

The Highland Valley Mine, situated near Kamloops, British Columbia, includes the Valley Pit, which accounts for the majority of the mine production. The ultimate pit is projected to be about 630 m deep. The West Wall has been developed to a depth of about 400 m, while the northeast wall is slightly lower and includes about 200 m of overburden. The rock units are mainly diorite, quartz monzonite and porphyry which are relatively highly jointed with three to four well defined joint sets. The UCS of the intact, unaltered rock is typically 120~140 MPa, but localized argillaceous alteration results in very low rock mass strength, of less than 3 MPa.

The slopes include inter-ramp angles of 38 to 45 degrees, and large-scale failures have developed in the flatter west wall. These failures are thought to be controlled by toppling type of movement followed by “graben-like” displacement of the blocks. The extensive slope monitoring systems have recorded movement on the order of 25 to 200 mm/day, with larger movements observed in the spring during snowmelt and it was associated elevated groundwater pressure. An extensive drainage program is included to control groundwater pressures in the rock mass.

C.4 ISLAND COPPER MINE

The Island Copper Mine, situated near Port Hardy on Vancouver Island, British Columbia, was a copper-gold-silver-molybdenum-rhenium mine that was in production from 1971 to 1996. The porphyry deposit occurred as two lenses within an andesite unit and the host rocks consisted of basalt and rhyolite of fairly high strength and stiffness. The open pit experienced no significant slope stability problems during operations but a deep slurry wall was constructed during the last stages of mining to prevent the inflow of the sea. Rupert Inlet lies immediately adjacent to the pit

The 500-m high North Slope incorporated an inter-ramp slope angle of 50 degrees. Flatter slope angles of about 35 degrees were incorporated into the 200-m south wall.

The rock mass strengths were estimated to range from a friction angle of 24 degrees with cohesion of 0.05 MPa to a friction angle of 40 degrees with cohesion of 0.09 MPa (Sjoberg, 1996). Minor slope failures occurred in the west and north slopes due to a concentration of faults in these areas. The north and northwest walls have continued to display instability since closure. The West Wall has exhibited instability that has resulted in restricted access to this slope. The potential for failure on the West Slope was noted prior to mine closure and remediated by constructing buttresses.