534-53

DRAFT

GEOTECHNICAL ASSESSMENT OF DRAGLINE SPOIL STABILITY ALONG THE NORTH CREST OF C-PIT AT TRAPPER MINE

Prepared for:

TRAPPER MINING, INC.

November 7, 2022

Prepared by:

AGAPITO ASSOCIATES, INC.
715 Horizon Drive, Suite 340
Grand Junction, CO 81506

1536 Cole Blvd., Bldg. 4, Suite 310
Lakewood, CO 80401

DRAFT

GEOTECHNICAL ASSESSMENT OF DRAGLINE SPOIL STABILITY ALONG THE NORTH CREST OF C-PIT AT TRAPPER MINE

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

DISCLAIMER: *This report contains professional opinions based on information provided by the Owner. Agapito Associates, Inc. makes no warranties, either expressed or implied, as to the accuracy or completeness of the information herein. Opinions are based on subjective interpretations of geotechnical data; other equally valid interpretations may exist. Identification and control of hazardous conditions are the responsibilities of the Owner.*

1 INTRODUCTION

As requested by Trapper Mining, Inc. (Trapper), Agapito Associates, Inc. (Agapito) has completed a geotechnical evaluation of the long-term stability of the proposed dragline spoil pile to be constructed along the north crest of C-Pit (see Figures 1 and 2). Agapito understands that the proposed spoil pile will need to remain stable for 6 to 8 years before the spoils are returned to backfill the pit. The spoils from C-Pit will be placed on top of decades-old reclamation spoil that dips and thickens to the north (see Figure 2). Boreholes indicate that the thickness of the existing spoil, where the overburden and I Seam was previously extracted, ranges between 38 and 83 feet (ft). The cross-sectional area of the proposed spoil pile ranges between 32,930 and 38,798 square feet (ft^2) and the heights (excluding the underlain old spoil) will range between 141 and 168.5 ft (see Figure 2).

Given the sloping nature of the terrain and the presence of old, weathered spoil material in the foundation, a global stability analysis is necessary to assess the integrity of the spoils over the storage period in support of Trapper's ground control plan. On this basis, Agapito will analyze five representative cross-sections through the proposed C-Pit excavation and the spoil pile construction along the north crest of the pit (see Figures 1 and 2). This assessment will therefore assess the following factors that are generally accepted to affect the stability of waste dumps:

- Foundation geometry
- Foundation stratigraphy
- Spoil pile geometry
- Characteristics of the spoil material
- Surface water and groundwater conditions
- Seismicity

2 SPOIL PILE AND FOUNDATION GEOMETRY AND CHARACTERIZATION

As C-Pit is excavated, spoil material will be placed along the north crest of the pit using a dragline. The planned dimensions of final piles will be 415 to 450 ft wide at the base and 141 to 168.5 ft high. Previous work undertaken at the Colowyo Mine indicates that the spoil material in the Williams Fork Formation has a steep overall angle of repose of around 38°.[1]

In regard to the foundation of the spoil pile, boreholes indicate that the spoil will sit on between 38 and 83 ft of reclaimed spoil material that dips and thickens to the north. Underlying the spoil material, the stratigraphy is comprised of interbedded units of carbonaceous shale, mudstone, siltstone, and sandstone of the Williams Fork Formation. The main coal seams are the L Seam, the M Seam, and the Q Seam. The spoil along with the underlying stratigraphy generally dips to the north at an approximate angle of 8°.

[1] Shannon & Wilson, Inc. (2009), "Geotechnical Study Collom Temporary Soil Fill, KCCC – Colowyo Mine," Report Revision PR-03, August 5th.

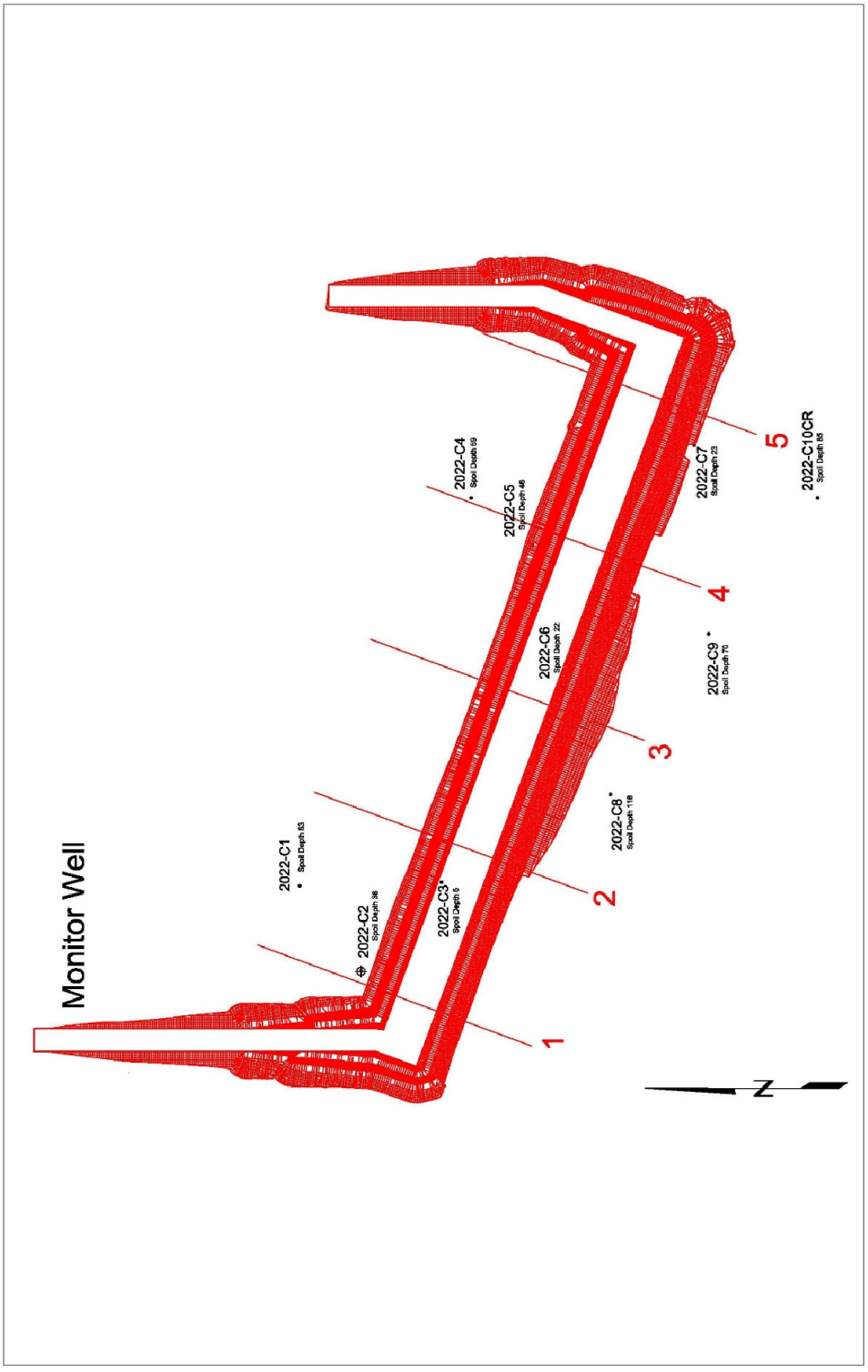

Figure 1. Proposed C-Pit Excavation Showing Boreholes and Existing Spoil Thickness

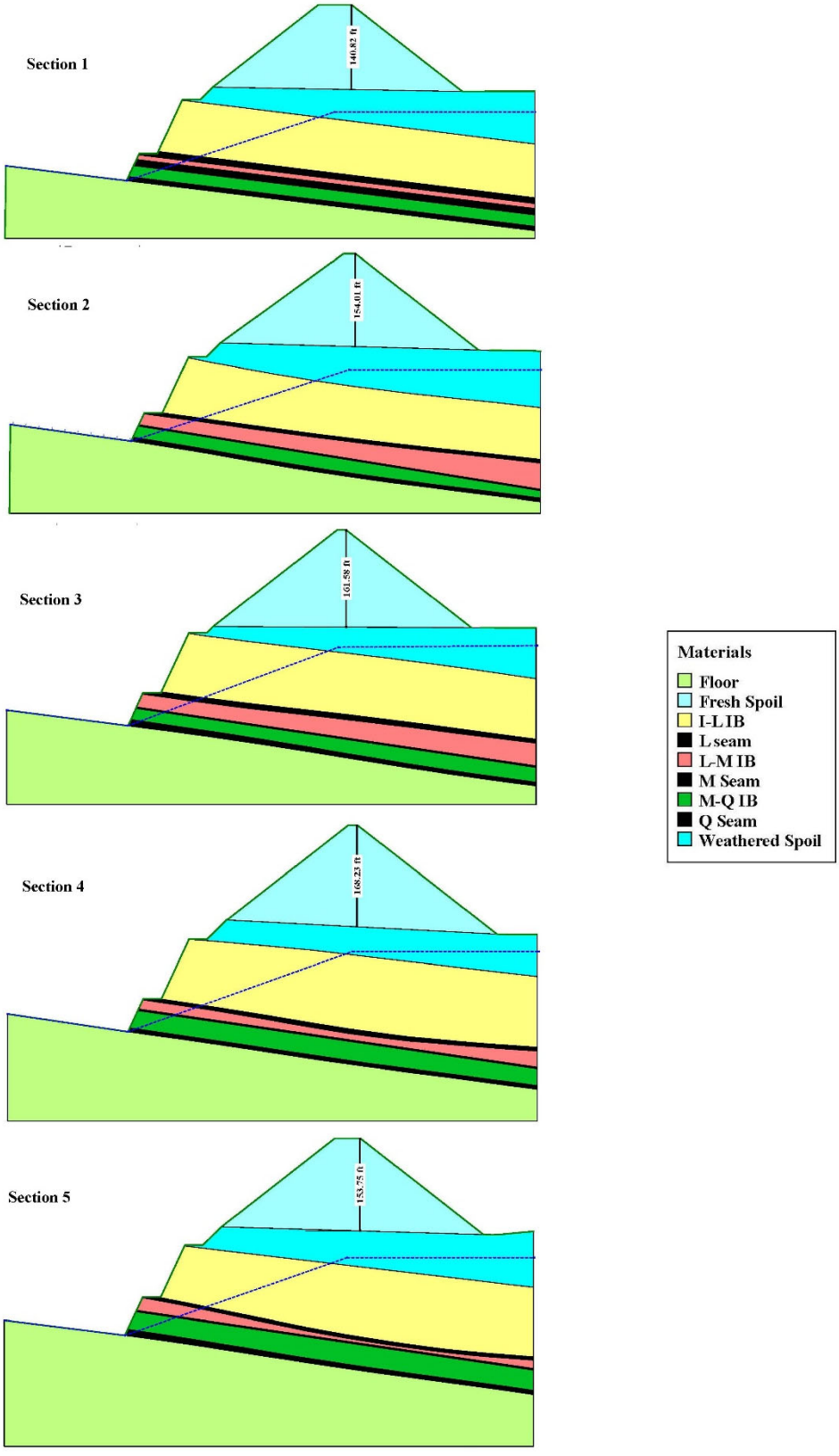

Figure 2. Proposed Dragline Spoil Pile Sections

3 SPOIL MATERIAL AND FOUNDATION CHARACTERIZATION

The physical properties of the underlying coal seams and the interburden strata in the foundation were retained from previous studies conducted by Agapito at the mine.[2] To simplify the stability analysis, the interburden (IB) layers between the main coal seams were composited into single representative layers using a thickness-weighted average of the physical properties of the individual layers.

The shear strength parameters adopted in this assessment for the spoil material were derived from large-scale direct shear (LSDS) testing previously performed on Trapper spoil material samples by Agapito[3] and on neighboring Colowyo Mine spoil samples by others.[4] The LSDS tests at Trapper were undertaken on decades-old and weathered spoil samples and utilized a relatively large 12-inch × 12-inch × 6-inch (length-width-height) mold, which better represents the long-term shear strength of the spoils. These results were considered appropriate for use on the existing reclamation spoil material in the foundation. The LSDS tests undertaken on spoil material samples at Colowyo Mine better represent the shear strength parameters for fresh spoil material and therefore, the average results of these tests will be adopted in this assessment for the spoil material placed by the dragline (see Figure 3).

Table 1 lists the relevant physical properties for the various spoil material, rock, and coal that were modeled in this assessment.

Table 1. Spoil and Rock Physical Properties Used in the Stability Analysis

Material	Density (pcf)	Cohesion (psi)	Friction Angle (°)
Fresh Spoil	110.0	5.2	34.9
Weathered Spoil	110.0	3.3	34.0
I-L IB	137.5	364.5	33.2
L Seam	81.8	115.9	16.8
L-M IB	143.2	320.2	34.5
M Seam	79.4	122.8	17.8
M-Q IB	128.5	370.8	33.7
Q Seam	85.1	113.7	16.3
Floor	124.8	170.6	31.5

Monitoring wells installed in the vicinity of the proposed C-Pit have recorded static water levels at around 21 ft below the surface. On this basis, the water level was assumed to be approximately 21 ft below the bottom of the proposed spoil pile in the numerical model, except where drawdown

[2] Agapito Associates, Inc. (2016), "Geotechnical Design and Operational Considerations for Highwall Mining, N Dip Pit, Trapper Mine," report 534-36 to Trapper Mining, Inc., August 9, 191 pp.

[3] Agapito Associates, Inc. (2020), "Nighthawk Strike Pit Spoils Pile Geotechnical Evaluation, Trapper Mine," report to Trapper Mining, Inc., 534-46, April, 38 pp.

[4] Shannon & Wilson, Inc (2009), "Geotechnical Study Collom Temporary Soil Fill, KCCC – Colowyo Mine," Report Revision PR-03. August 5th.

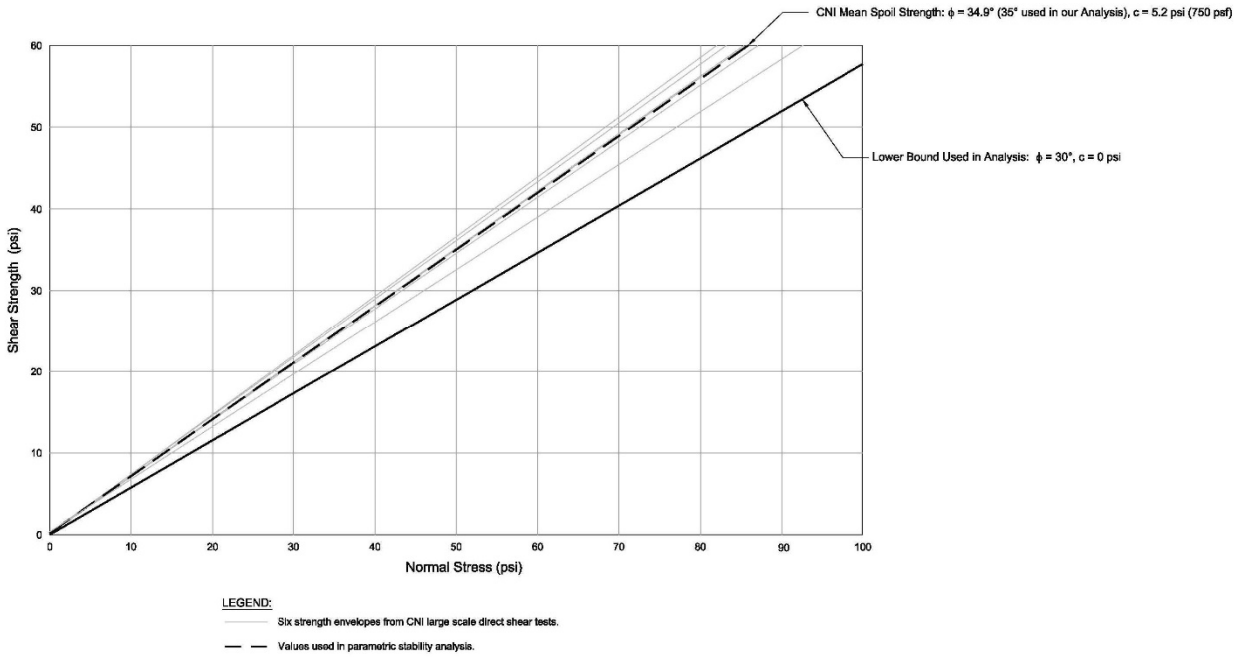

Figure 3. Summary of Strength Test Results on Colowyo Spoil Samples[4]

is expected from C-Pit excavation. The water table was assumed to be static in order to develop pore pressures in the subsurface and no transient flow calculations were made.

United States Geologic Survey (USGS) data indicates that the peak ground acceleration with a 10% probability of exceedance in 50 years is about 0.05g (gravity).[5] Therefore, Agapito's evaluation of the anticipated seismic conditions for this assessment was performed using a pseudo-static analysis with a horizontal acceleration of 0.05g.

4 ACCEPTANCE CRITERIA

Hawley and Cunning[6] provide guidelines for suggested stability acceptance criteria based on classical deterministic criteria for waste dumps. Based on the conditions outlined in this assessment for a static analysis, a moderate consequence and a moderate confidence have been chosen. This equates to a minimum design Factor of Safety (FoS) of 1.3 for deep-seated stability, which has been deemed appropriate for the geotechnical conditions in this assessment.

A moderate consequence was chosen based on the following characteristics of the proposed spoil piles:

- Slopes formed at their angle of repose (i.e., 38°)

[5] USGS (2002), "Interpolated Probabilistic Ground Motion for the Conterminous 48 States by Latitude-Longitude," 2002 data, from USGS web data.

[6] Hawley, M. and J. Cunning (2017), "Guidelines for Mine Waste Dump and Stockpile Design," Clayton, Vic: CSIRO PUBLISHING, DOI: 10.1071/9781486303519.

- Slope heights less than 330 ft
- The absence of any critical infrastructure located within the potential runout shadow

A moderate confidence was chosen based on the following conditions of the proposed spoil piles:

- Moderate confidence in the accuracy of the foundation conditions, spoil properties, and piezometric pressures
- Input parameters for stability assessment adequately defined
- A long monitoring history of spoil dump performance at the mine

The allowable bearing capacity required for a shallow strip footing should exceed an FoS of 3 against its shear failure. It is generally accepted that a footing with a length-to-width ratio of more than five is classified as a strip footing. Additionally, a foundation is classified as shallow if the depth is less than or equal to its width.

5 STABILITY ANALYSIS

The stability analysis was carried out using the limit-equilibrium software SLOPE/W.[7] As this program utilizes a two-dimensional (2D) analysis, the five sections lines shown in Figures 1 and 2 were selected to assess the planned spoil construction using Morgenstern-Price's method of analysis. Each analysis has assessed the stability of both the south- and north-facing spoil slopes in each section.

5.1 Slope Stability Results

The results of the stability analysis are presented in Figures 4 through 8 and are summarized in Table 2. The results indicate that the slopes in all five analyzed sections attain a minimum FoS of 1.3, which is Agapitos's threshold for long-term stability of the spoil slopes.

Table 2. Results of Slope Stability Analysis for the Proposed Dragline Spoil Pile

Location	Maximum Slope Height (ft)	South Slope Factor of Safety (FoS)	North Slope Factor of Safety (FoS)
Section 1	141.0	1.35	1.44
Section 2	154.0	1.37	1.42
Section 3	161.5	1.35	1.40
Section 4	168.5	1.29	1.35
Section 5	154.0	1.30	1.40

[7] GeoStudio (2022), "SLOPE/W Features," available at https://www.geoslope.com/products/slopew/features.

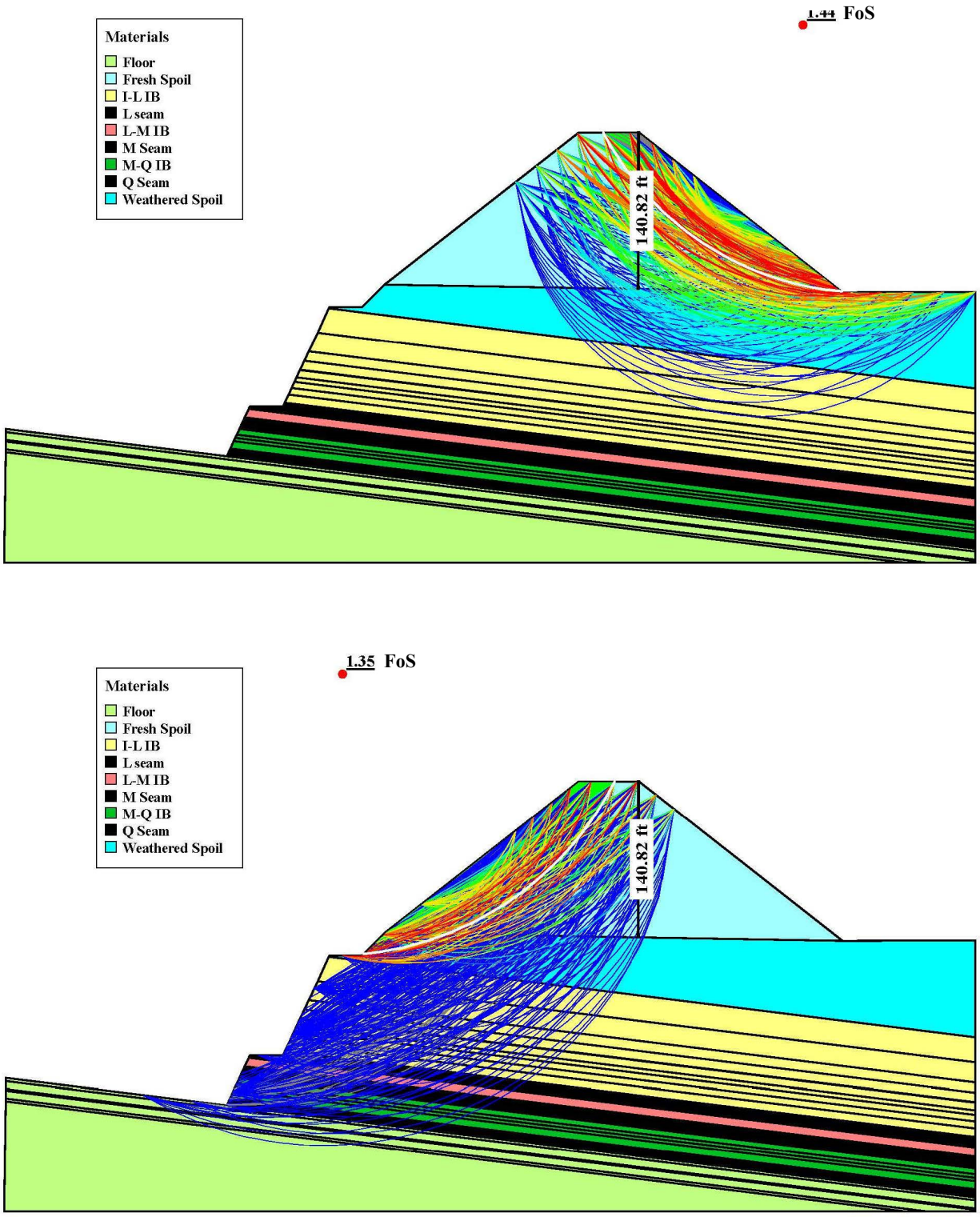

Figure 4. Slope Stability Results for the Spoil Slopes in Section 1

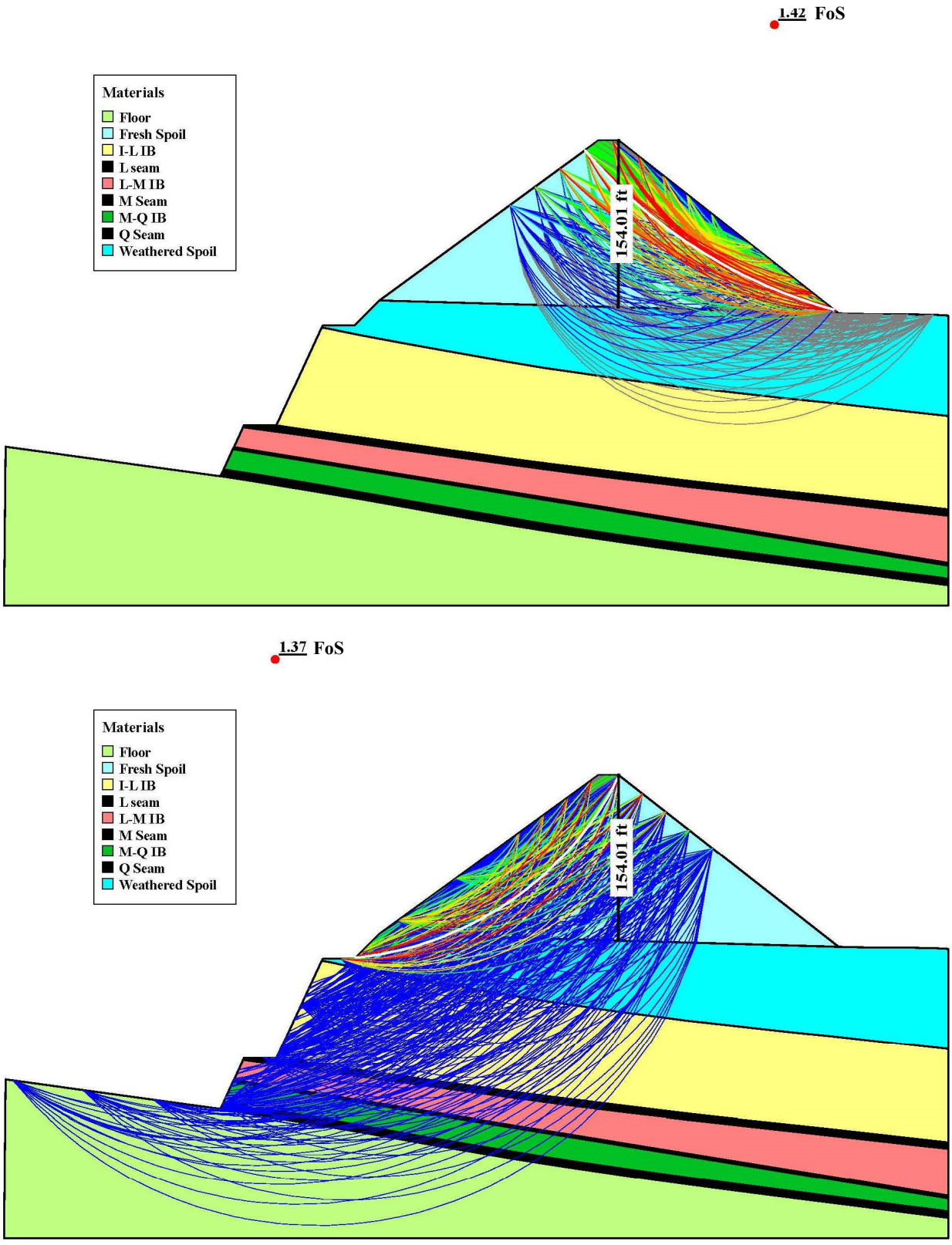

Figure 5. Slope Stability Results for the Spoil Slopes in Section 2

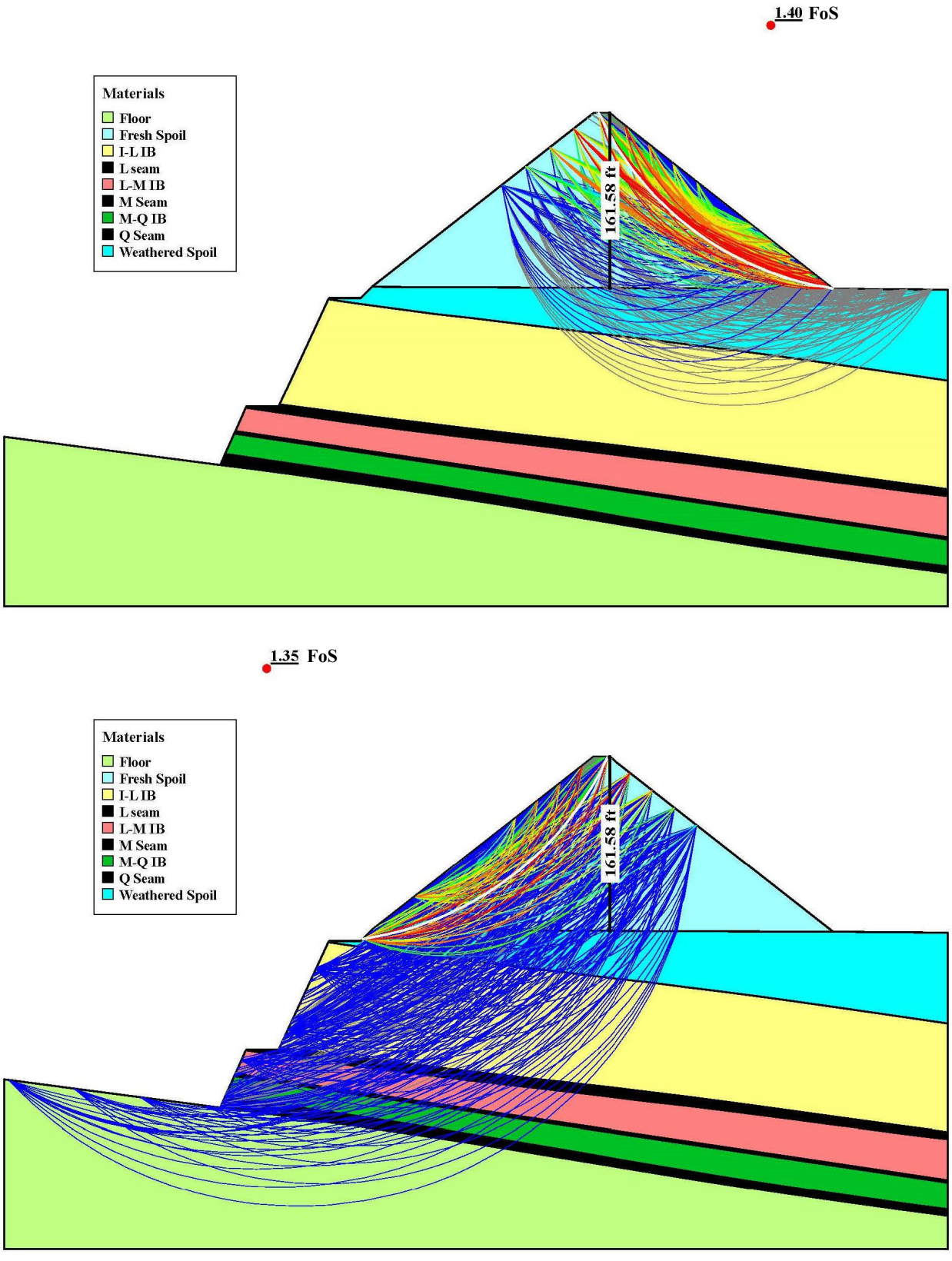

Figure 6. Slope Stability Results for the Spoil Slopes in Section 3

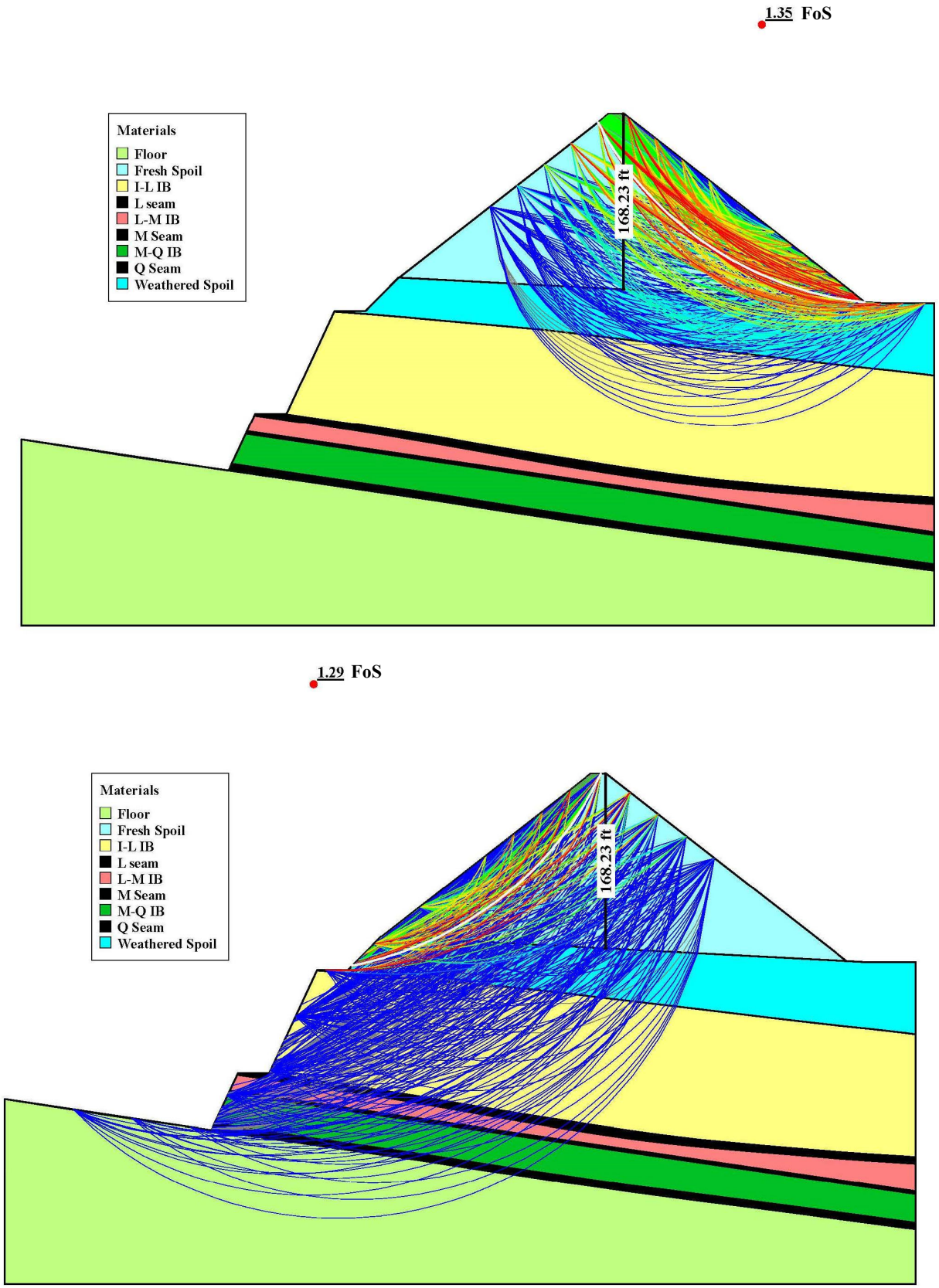

Figure 7. Slope Stability Results for the Spoil Slopes in Section 4

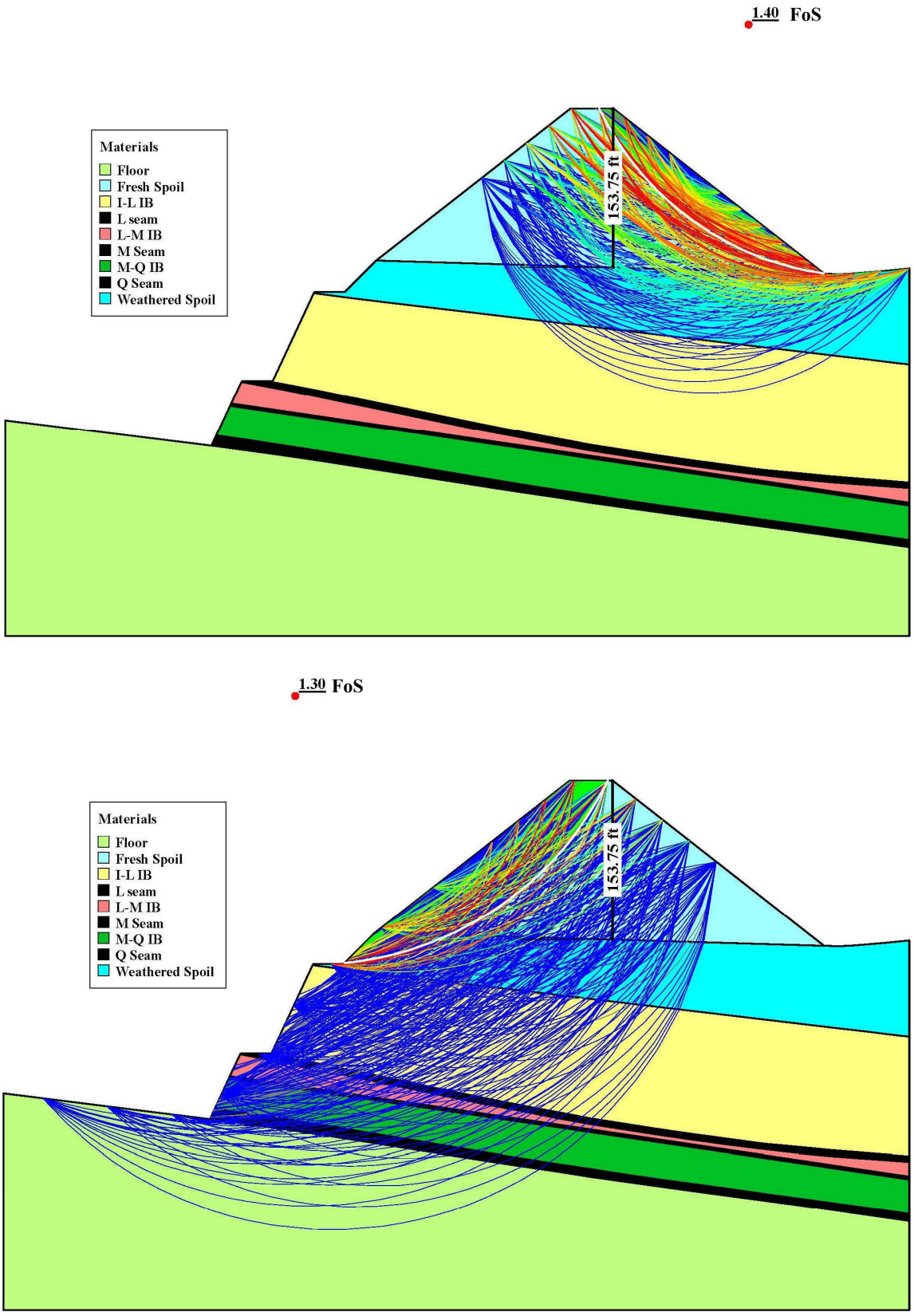

Figure 8. Slope Stability Results for the Spoil Slopes in Section 5

5.2 Foundation Stability Analysis

In addition to the numerical modeling, Agapito performed a foundation bearing-capacity analysis to assess if the existing spoil material in the foundation could withstand the load of the planned spoil pile. The proposed spoil pile was assumed to exert a constant strip load over a maximum 450-ft-wide space, which was a conservative assumption given that the actual shape of loading under the spoil pile will be pyramidal in shape. A constant load, equivalent to 168.5 ft of uniformly thick spoil material, at a unit weight of 110 pounds per cubic foot (pcf), amounted to a strip load of 18,535 pounds per square foot (psf).

This load, when applied to the foundation spoil of semi-infinite thickness (cohesion of 475 psf and friction angle of 30°) yielded an FoS of around 50 against bearing capacity shear failure, which is well in excess of 3. The actual FoS against foundation failure is likely to be higher in light of the conservatively high load assumption. As a comparison, building foundations are typically designed to have an FoS value of 4.

6 CONCLUSIONS AND RECOMMENDATIONS

Agapito has completed a geotechnical study to assess the global stability of the proposed spoil pile along the north crest of the planned C-Pit excavation. The spoil pile will store spoils over a 6-to-8-year timeframe and will be placed on north-dipping reclaimed spoil. A summary of the stability assessment and recommendations are as follows:

- Analysis results obtained from 2D numerical models developed along five representative vertical sections through the proposed C-Pit excavation and spoil pile indicate that the pile is likely to have FoS values equal to or greater than 1.3, which is the criterion outlined in this assessment for long-term stability. Therefore, the proposed spoil pile is likely to be stable over the anticipated storage period (6 to 8 years).
- The bearing capacity of the old spoils far exceeds an FoS of 3, which is recommended against shear failure in the foundation for the estimated loads of the spoil pile.
- Although this study assumed a water table 21 ft below the new spoil pile, effects of transient ingress of surface water into the spoil pile have not been studied. It is therefore recommended that adequate drainages be created and maintained along the updip perimeter of the spoil pile to direct water flow away from the pile.
- Lastly, given the placement location of the spoil pile atop the overburden above the C-Pit highwall mining zones, the surcharge from the existing spoils should be considered in designing the C-Pit highwall mining panels.