

Dr. Robert Bagoff, Chair
West Orange Township Planning Board
West Orange Township
66 Main Street
West Orange, NJ 07052

August 12, 2025

RE: Further Evaluation of Langan Slope Stability Analysis, January 14, 2025, revised June 18, 2025
PB-24-01 West Essex Highlands, Inc
Block: 179 Lot: 32 Zone: IH-1
Warner Road
Project 2151.001

Dear Chair Bagoff,

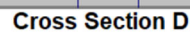
As was previously testified, the above-referenced executive summary and letter report, and the basis of analysis prepared by Langan, dated January 14, 2025, last revised June 18, 2025, present a flawed slope stability analysis, particularly in how they reflect the actual conditions on the eastern slope of the site. At the Planning Board meeting, it was asked why I had not prepared our own slope stability analysis. I had assumed that there would have been some rebuttal to my testimony, but since there was not, I have taken upon myself, with the approval of my client, to provide our approach to the modeling. I have recreated their stability model in the northeastern part of the site, between the location of proposed Building "D" and the existing residential properties along Howell Drive, to perform a sensitivity analysis of the bedrock parameters and the resulting Factors of Safety (FOS). The focus is on Cross Sections C & D, as identified by Langan.

Recreation of Slope Stability Model Cross Sections C and D

To further evaluate the slope stability at the site, Cross Sections C and D were recreated in the slope stability software Slide by RocScience using a combination of the above-mentioned Langan reporting, West Orange Township topography provided by We Care from the Spring 2010, and subsurface interpolation. Cross Sections C and D were evaluated as they are most likely to threaten the down-slope homes on Howell Drive, the homes immediately adjacent to the steep slope in this part of the site. For the surface topography, we used the Township-wide aerial topographic survey provided by our client, We Care, as we do not have access to the applicants' survey. However, there is no significant difference between the two surveys. Subsurface layers were inferred from the boring logs supplied in the Langan report and applied to the approximate corresponding location on the cross-section. Interpolation of subsurface conditions in locations without specific borings also differs slightly. As the model geometry assumptions were not noted in the Langan report, at locations outside of the subsurface exploration and around rock outcrops, Princeton Hydro interpolated thicker layers of medium sand as opposed to assuming the presence of dense material, which is a more realistic representation of what is on site. Princeton Hydro also extended the cross-section on either end to capture more of the slope. We used the GLE/Morgenstern-Price method of slope stability analysis to recreate Langan's results. Figures 1 and 2 below provide a visual comparison between the Langan model and the Princeton Hydro model. We were able to recreate their results with their modeled conditions. We then used this base model to input the actual conditions obtained from the boring logs into Cross Sections C and D.







Page | 3

Sensitivity Analysis of Geologic Strength Index (GSI)

As I previously testified, a weak rock mass, particularly in the northeastern area of the site, was indicated by the low Rock Quality Designation (RQD) values. A Geological Strength Index (GSI) value reflective of the poor and very poor joint conditions, common in heavily fractured rock, should be considered. A ten-foot-thick layer of bedrock with weaker parameters was added to the models below the decomposed bedrock layer to represent the 10 feet of rock coring performed during the soil borings. Model trials of Cross Sections C and D were evaluated with a GSI value of 20. The other rock material properties selected by Langan were maintained to inform this sensitivity analysis. Figures 3 and 4 below provide a zoomed view of the potential failure surfaces with factors of safety below 2.0 for both cross sections.

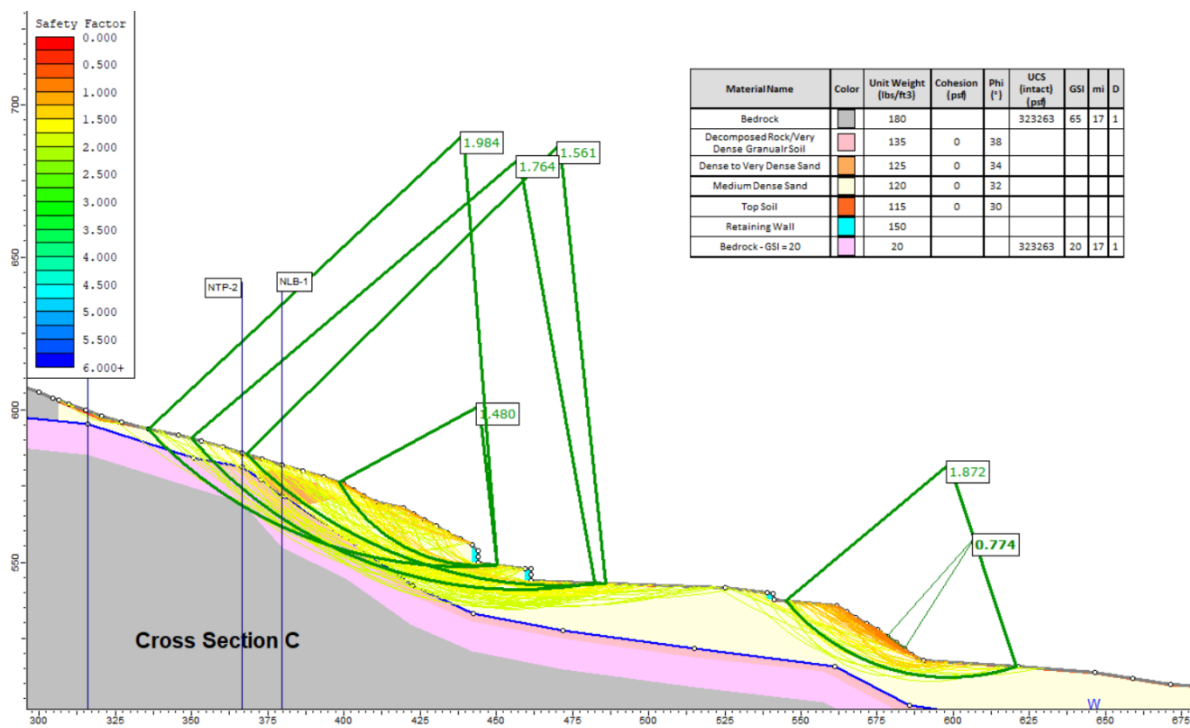


Figure 3: Cross Section C with Bedrock Layer of GSI=20

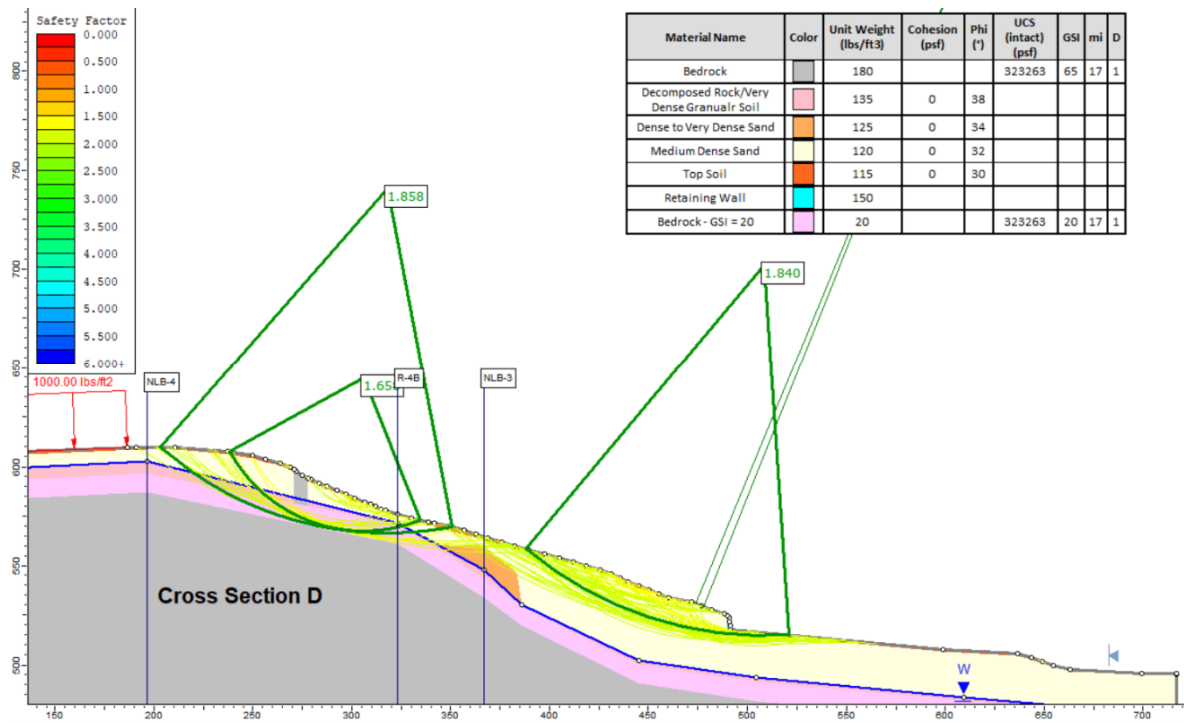


Figure 4: Cross Section D with Bedrock Layer of GSI=20

Numerous slip surfaces extending deeper into the subsurface were uncovered for both cross sections.

Factor of Safety Considerations

Engineer Manual (EM) 1110-1-2908 Engineering and Design Rock Foundations, distributed by the U.S. Army Corps of Engineers November 1994, details design considerations for the evaluation of rock slope stability. In particular:

The calculated factor of safety is primarily dependent upon the geometry of the potential failure path selected for analyses and the shear strength representative of the potential failure surface. In addition, other factors such as ground water conditions, potential for erosion, seismic loading, **and possible blast-induced loosening of the rock mass must also be considered** (Section 8-13, bold and underlined for emphasis).

A design factor of safety is considered a minimum design or evaluation benchmark. Often, to account for uncertainties related to subsurface conditions, design parameters, risk tolerance, and other variables, a higher factor of safety is considered. EM 1110-1-2908 further states:

For major rock slopes where the consequence of failure is severe, the minimum required calculated factor of safety is 2.0. For minor slopes, or temporary construction slopes where failure, should it occur, would not result in bodily harm or major loss of property, the minimum required factor of safety is 1.3 (Section 8-13).

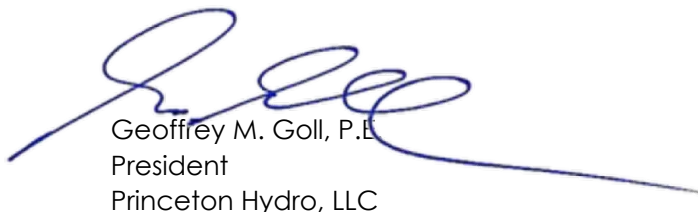
It is my professional opinion that the proximity of the residential properties in the northeastern area of the site, in particular, along Howell Drive to the toe of the slope represents a severe consequence of failure as it relates to bodily harm and property loss. Limited laboratory testing was performed on the encountered rock at the site, with no rock testing performed on the rock at the northeast area of the site. As I previously testified, the stability model omitted representation of the Feltville Formation, related concerns about weathering that may occur between rock contacts, and the impact of the buried sanitary sewer utility along the toe of the slope. Due to the uncertainties regarding the subsurface conditions and their corresponding design parameters, the higher factor of safety should be evaluated for the project site.

In conclusion, the uncertainty associated with the subsurface conditions of the less competent Feltville Formation downslope of the proposed Building yields considerable hesitation to the assertion that construction will not affect the short- or long-term stability of the slope. Variation of a single design parameter, GSI, which is estimated by visual assessment by Langan of isolated rock outcrops, caused significant variation in the model results.

I will be available at a scheduled Planning Board meeting to discuss my observations and conclusions.

Thank you.

Sincerely,



Geoffrey M. Goll, P.E.
President
Princeton Hydro, LLC

cc: WeCare