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October 28, 2025

**Chairman and Members of the West Orange Planning Board
66 Main Street
West Orange, NJ 07052**

**Re: Application No. PB24-01
West Essex Highlands, LLC
Warner Road
Block 179, Lot 32
Review of Applicant's Engineer's Slope Stability Analysis Reports, the Objector's
Engineer's Response Reports; and the Applicant's Engineer's Rebuttal Report
Our File: 115.WRP0179.V01**

Dear Planning Board:

In accordance with your authorization, Geotechnical Engineers from our office have reviewed the Applicant's and Objector's Engineering reports concerning slope stability along the ridge line on the eastern side of the site in the area of proposed Building D. For the purpose of this memorandum, the Applicant is West Essex Highlands, LLC. ("Applicant"). The Applicant's Engineer for analysis of the slope stability is Langan Engineering, LLC ("Langan"). The opposition is We Care ("Objector"). The Objector's Engineer is Princeton Hydro ("Princeton Hydro").

INTRODUCTION

The purpose of our work was to review the Applicant's Engineer's Stability Analysis Reports and the Objector's Engineer's Response reports and to:

1. Provide a technical opinion on the findings of each report.
2. Assess the need for additional evaluation by the Applicant.
3. Provide recommendations to the Board for the setting of requirements for monitoring and maintenance of the stability of the slopes during the construction and for maintenance thereafter.

CME's Geotechnical Engineers performed the following scope of work to accomplish this purpose:

1. We read and evaluated the reports submitted to the Planning Board as summarized in the list of references in the following section of this letter.
2. We visited the area of the site in question on October 2, 2025, along with Paul W. Anderson, PE, the Applicant's Site Engineer, to evaluate conditions along the ridge in relation to the descriptions contained in the Applicant's and the Objector's reports.



3. We reviewed the project Architectural and Civil Site Plans contained in our files.
4. We reviewed the geologic reports and reference standards cited in the Applicant's and Objector's Engineer's reports.
5. We performed a qualitative evaluation of the stability calculations based on approximate methods of stability evaluation based on our experience with similar projects.
6. We provided recommendations for limiting stormwater infiltration in the area where it would potentially reduce the stability of the slope.
7. We provided recommendations for monitoring and maintenance of slope stability during construction.

Our scope of services did not include an independent analysis of the stability of the slope in the area of the study. This memorandum is based on review of the field and laboratory data, calculations and evaluation contained within the analysis reports prepared by the Applicant's and Objector's Engineers based on our experience as Geotechnical Engineers on similar projects.

REFERENCE DOCUMENTS

Our review is based primarily on the information contained in the following outline of References:

1. **Applicant's Engineer's reports prepared by Langan Environmental and Environmental Services LLC ("Langan"):**
 - A. Report Entitled "Global Stability Study for Eastern Slope near Building D; West Essex – Highlands Development West Orange, New Jersey" dated January 14, 2025.
 - B. Report Entitled "Global Stability Study for Eastern Slope near Building D; West Essex – Highlands Development West Orange, New Jersey" originally dated January 14, 2025 as revised on June 18, 2025.
 - C. Rebuttal Report Entitled "Global Stability Study for Eastern Slope near Building D; West Essex – Highlands Development, West Orange. New Jersey" dated September 15, 2025.
2. **Applicant's Engineer's Report prepared by Anderson Consulting Services LLC.:**
 - A. Report Entitled "Drainage Report West Essex Highlands, Block 179, Lot 32, West Orange New Jersey" dated March 12, 2023, revised through October 3, 2023.
 - B. Rebuttal Letter Entitled "Drainage Report West Essex Highlands, Block 179, Lot 32, West Orange New Jersey" dated March 12, 2023, revised through October 3, 2023.
3. **Applicant's Engineer's Subsurface Investigation Reports for the Site Stormwater Management System prepared by Sor Consulting Engineers, Inc.:**
 - A. Report Entitled "Subsurface Investigation Report, Proposed Residential Developments, West Orange., New Jersey, Report No. 21-C-01" dated April 19, 2021.



- B. Report Entitled *"Subsurface Investigation Report, Subsurface Stormwater Management System, West Orange, New Jersey, Report No. 23-C-16"* dated May 23, 2023.
 - C. Report Entitled *"Subsurface Investigation Report, Subsurface Stormwater Management System, West Orange., New Jersey, Report No. 24-C-02"* dated February 12, 2024. (This report contains Test Pit data for the Recharge Basin Design in the Area of Building D and Howell Road Cul de Sac.)
 - D. Report Entitled *"Supplementary Subsurface Investigation Report, Subsurface Stormwater Management System, West Orange., New Jersey, Report No. 24-C-02"* dated April 4, 2024.
4. **Objector's Engineer's Reports prepared by Princeton Hydro:**
- A. Letter Report entitled *"PB-24-01 West Essex Highlands, Inc. Block 179, Lot: 32 Zone 1H-1, Warner Road, West Orange Township, Essex County"* dated March 10, 2025. (This report is primarily a review of Stormwater Management Issues.)
 - B. Letter Reports entitled *"Review of Langan Slope Stability Analysis"* dated January 14, 2025, revised June 18, 2025, and *"PB-24-01 West Essex Highlands, Inc., Block 179 Lot:32: Zone 1H-1"* dated July 16, 2025.
 - C. Letter Reports entitled *"Further Evaluation of Langan Slope Stability Analysis"* dated January 14 2025, revised June 18, 2025, and *"PB-24-01 West Essex Highlands, Inc, Block 179 Lot 32: Zone 1H-1, Warner Road"* dated August 12, 2025.
5. **Drawing Files Submitted to the Planning Board:**
- A. *"Proposed Building D , Garden Homes Diagrammatic Site Study Sections"* prepared by Appel Group Architects and Issued for Planning Board, 05/09/2023.
 - B. Architectural Drawings entitled *"West Essex Highlands Garden Homes"* prepared by Appel Group Architects Issued for Planning Board on 12/20/23.
 - C. Drawings entitled: *"Preliminary and Final Site Plan, West Essex Highlands. Block 179, Lot 32 and Block 179.17 Lots 8 and 9"* prepared by Anderson Consulting Services LLC, originally dated 06/07/2023, revised through 10/01/2024 (per NJDEP comments).
6. **Miscellaneous References:**
- A. *"Bedrock Geologic Map of the Caldwell Quadrangle, Essex and Morris Counties"* by Richard A Volkert. The relevant section of this Map was included in the Langan report of June 18, 2025, as Figure No. 2 and is attached herewith for ease of reference.
 - B. *"Surficial Geology of the Caldwell Quadrangle, Essex and Morris Counties, New Jersey"* by Scot D. Stanford, 2005 prepared in cooperation with the U.S. Geological Survey National Geologic Mapping Program.
 - C. Map entitled: *"Landslide Susceptibility for Essex County, New Jersey"* by Scott D. Stanford for the New Geological Society and dated 2001.



PROJECT UNDERSTANDING

General

This section of the Memorandum describes our review of the proposed construction features as they relate to the evaluation of the slope stability of the ridge in the area of Building D. Our description is based on the interpretation of the drawings submitted for Planning Board Review and included in the CME files as Planning Board Engineer. These are in addition to the Applicant's and the Objector's reports and correspondence related to the slope stability and stormwater management submittals as referenced above.

We have attached a copy of Langan Drawing entitled "*Investigation Plan*" for use in understanding the discussion in this memorandum. We have added markup notes using Acrobat Tools with references to the discussion in the text to assist the readers.

Proposed Building D

We understand that the building design is at a preliminary phase. Our review of the reference Architectural Drawings (Reference 5A) and the Preliminary and Final Site Plan (Reference 5C) indicate the following considerations for this evaluation of the slope stability issues raised by the Applicant's and Objector's Engineers:

1. **Building Footprint Layout:** The footprint of the proposed Building D consists of 2 parallel end sections with a center segment angled at approximately 40 degrees from the alignment of the end sections. The centerline alignment of the building roughly follows the line of the ridge. The nearly uniform width of the footprint is 80 feet. The length of the southern section is approximately 200 feet, the central section is approximately 405 feet and the northerly section of the footprint is approximately 220 feet. The overall length of the building, measured along a line drawn between the centers of the north and south end walls, is approximately 800 feet.
2. **Basement Floor Levels:** We understand that the uniform first residential floor level is Elevation 618 feet. We understand that the lowest building floor grades are for the parking levels under the building. Our review of the Preliminary & Final Site Plan indicates that the garage level on the northern entrance will be +606 feet which is 3 to 4 feet below existing grade along the north building wall and approximately 9 feet above the top of rock encountered at Langan test boring NLB-4. The proposed parking entrance on the south side of the building is shown at elevation 582 feet which is approximately 14 feet below the existing grade at the entrance. The high point of the ridge is near Boring No. LB-3.



The elevation of rock at Boring LB-3 was reported at elevation 605 which is approximately 23 feet above the level of the entrance to the parking level at the south building wall. The grading of the garage floor levels below the building is not indicated on the reference drawings. We have considered that the floor will be approximately level for the purpose of this evaluation.

3. **Building Height and Loading as Considered for the Slope Stability Evaluation:** The Architectural and Site Plans divide the building into two parts separated at the main entrance. The part to the north of the entrance is designated as Building D.1 and the segment to the south is designated as Building D.2. Review of the Architectural elevation details indicates that Building D.1 includes 5 floor levels from the garage to the 4th Residential Floor. Review of the architectural elevations indicate that the southern section of the building will include 2 garage floor levels at elevations at 582 and 594, respectively, and that there will be 4 residential levels. In addition, there will be a roof-top assembly area. We anticipate that code-required floor live loads will range from 40 to 100 pounds per square foot. Langan has assigned an average area footprint load of 1,000 psf for Building D. The assumed loading is equivalent to an average combined dead and live loading of 144 psf for Section D.2 and 166 psf for Building D.1. Structural drawings indicating the building floor details, and construction type were not available to check the likely distributed dead loading. The assumed loading is not, in our opinion, an upper-bound assumption, and assumes a relatively low average area dead load for the structure. The load distribution indicated in the Langan report indicates that the building influence on the slope is likely not to be a determinant in the stability of the slope. The evaluation did not include an evaluation of the benefits of "weight credit" achieved by removal of the existing soils in the basement, or directly consider the maximum past pressure that was imposed on the glacial soil deposits and underlying rock by prior glacial activity.

Proposed Yard Grading Along Ridge Line

Our review indicates that the building location shown on the Stability Investigation drawings conforms to the layout shown on the Preliminary & Final Site Plan drawings. The rear wall line of the building measures approximately 10 to 40 feet from the line on the reference drawing connecting the high points on the ridge. We have marked out a line representing the line at which the slope steepens to more than 15 degrees downward to the east and northeast. The line is shown on the markup and ranges from approximately 40 feet at the northeast corner of Building D.1 to 140 feet at a point opposite the main entrance to the building.



Proposed Grading in Front of Building D

The grading indicated on the Preliminary & Final site plans SP15 and SP16 indicate that the finished grading will conform closely to the existing grade to the rear of the proposed building. The finished grades in front of the building are shown on the drawing markup attached to this letter for reference. The proposed grade follows the centerline profile of "Road D". The roadway grade at the southwest corner of Building D.2 is shown at elevation 585 feet which is approximately 5 feet below the existing grade at that location. The roadway climbs to approximately elevation 592 at the entrance to the upper parking deck at the entrance. The proposed grade is approximately 2 feet above the existing grade at that point. The grade at the northern end of the building is near elevation 608 which is about 2 feet below the existing grade.

The existing grades at the front building lines are generally higher than the finished grade at the wall and the grades along Road D. Cuts of up to 10 feet are indicated near the south end of Building D.2 near to the high point of the ridge.

Stormwater Management (SWM) and Infiltration Basins

The proposed limits of site grading are shown on the Langan Investigation Plan and correspond to the limits indicated on the Preliminary & Final Site Plan. The mapping indicates that the limits of grading will be 5 to 20 feet from the rear building line. The limit is within the line defining the high point of the ridge indicating that site runoff from the landscaped zone would be directed towards the building and to a stormwater collection system of yard inlets along the rear of Building D.1. The plan indicates that the discharge from the rear yard drains will be directed through the building to Stormwater Infiltration Basin 11.

We understand that all the building roof drainage and the yard drainage including Road D will be directed to Basins 10 and 11. We further understand that these basins have been designed to retain a volume of runoff determined in accordance with the current regulations. Review of the designs is beyond the scope of this study. We have included this description for consideration of the potential impact of concentrated stormwater infiltration on slope stability. The following description is based on information provided on Preliminary & Final Site Plan Drawing SP56:

1. **Basin No. 10:** The location of the basin is shown on the attached markup of the Investigation Plan. The basin details on the Site Plan indicate that the basin will be an open detention basin with a rim near elevation 580 feet, an outlet structure with a grate near elevation 576, a low-level outlet near elevation 576.3 and an invert out near elevation 573.75 feet. The basin is shown to be approximately 220 feet long and 60 feet wide. The 10-year recurrence storage elevation is shown as elevation 577.06 feet. The 100-year recurrence storage elevation is shown as elevation 578.3 feet. Bedrock was reported at



Test Pit D2 in 2021 at 9 feet depth at the southern end of the basin location. This is estimated to be at approximate elevation 568 feet. Seepage was encountered at a depth of 6 feet which is anticipated to be near elevation 571 feet. Bedrock was not encountered in Test Pit D1 which extended to 16 feet depth which is estimated to be equivalent to below elevation 567 feet. Groundwater seepage was reported at a depth of 10 feet which is estimated to be equivalent to elevation 573 feet.

2. **Basin No. 11:** Basin No. 11 is a subsurface infiltration basin. The storage is shown to be approximately 325 feet long. The width is not indicated on the reference plan. The inflow is through a 12" porous HDPE pipe at 0 slope discharging into a gravel bed 2.42 feet in thickness, with base at elevation 590. The gravel bed is overlain by a select fill which is, in turn, overlain by a porous pavement. The storage elevation at the 10-year recurrence event is shown to be at elevation 591.27 feet and at the 100-year recurrence to be elevation 592.06. Rock was not encountered and is estimated to be below elevation 579 feet at Test Pit E-1 and to be below elevation 576 feet at Test Pit E-2. Seepage was encountered at estimated elevation 584 feet at Test Pit E-1 and at estimated elevation 581 at Test Pit E-2.

The elevations of the recharge basins are equivalent to that of the middle of the upper slope. The Applicant's Engineers should, in our opinion, review the results of mounding analyses at the basins near the ridge and confirm that concentrated infiltration will not affect the stability of the slopes by hydraulically surcharging rock joints that may increase seepage pressures on the slope below.

Emergency Access Roadway

The emergency access roadway is located to the north of Building D.1 and will connect the Road D Cul de Sac to the Howell Drive Cul de Sac. It will cross the top of the ridge near Langan Boring NLB1 and is at the top of the slope on Langan Analysis Section C-C. The centerline of the road is approximately 170 feet horizontally from the retaining walls on the west edge of 15 Howell Drive. The grading of the road will direct runoff to the Howell Drive Cul de Sac. The original stormwater management investigation reports (References 3A and 3B) indicated that porous pavement and infiltration was being considered for this road, but the Preliminary & Final Site Plan does not indicate that this is included in the current plan. It would not be appropriate, in our opinion, to employ infiltration on the slope at this location which is above the residence at 15 Howell Drive. Langan has considered a live load of 250 psf which is, in our experience, equivalent to the highway live load surcharge recommended for earth retaining structures and is, in our opinion, conservative for a road with limited usage.



Construction Considerations

Our review of the reference reports indicates that a principal concern for slope stability expressed by Princeton Hydro is that the construction, which involves excavations in rock to a depth of approximately 25 feet below the top of rock at the high point of the ridge, could lead to disturbance and weakening of the slope, particularly if blasting is used. We understand that Langan's reply indicates that it is their opinion that it is too early in the planning stage to determine whether blasting needs to be employed, and, if it is required, the size of the blasting charge can be controlled to reduce vibration effects on the slope. For the purpose of our review, we recommend that the following construction-related conditions be addressed in the requirements that are set forth in this Planning Board Review and subsequent Municipal Reviews of the application for construction permits:

1. Clearing Site
2. Protection of the forestry on the slope
3. Soil Erosion and Sediment Control
4. Limitation of surcharges and equipment loads
5. General Excavation
6. Rock Excavation
7. Dewatering and control of runoff
8. Final Grading and Landscaping

REVIEW OF EXISTING SITE CONDITIONS

General

This section covers a review of the existing topographic, geologic and subsurface conditions. Our review is based on both the descriptions contained in the Applicant's and Objector's Engineer's reports and the references cited above.

Geologic and Seismic Design Considerations

The existing ridge is a segment of a prominent geological feature known as the Second Watchung Mountain. The bedrock Geology mapping was included on the map entitled "*Bedrock Geologic Map of Caldwell Quadrangle*" (Reference 6A). A section of this map is contained in the Langan Report dated June 18, 2025 as Figure No. 2. We have attached an extracted copy of Figure No. 2 for ease of reference by the Board. Our interpretation of the information is as described below:

1. The bedrock on the upper ridge is included in the unit described as the Preakness Basalt with map symbol Jp. The basic map description is given as Dark Greenish Gray to black fine-grained, dense and hard. Quarried basalt is usually high strength from deep within



the formation. Our Geotechnical Engineers observed the outcrop of the rock referenced as Outcrop No. 4. The height of the exposure was only 4 to 6 feet. The appearance of the rock indicated that it has been weathered and somewhat softer than fresh cuts exposed in outcrops or as was exposed in the highway cut for Route 280 to the southwest of the site. The principal jointing pattern indicated jointing with dip favorably downward into the slope and steep, nearly vertical joints. Some of the exposed rock showed a series of tight vertical cracks spaced as close as 1 or 2 inches. We anticipate that the outcrops represent the materials that were near the edge of the volcanic flow, and that the outcrops have been exposed and undergone substantial deterioration.

2. The reference map indicates that jointing in the igneous rocks (i.e., the basalt) consists of columnar joints that are rated due to cooling and joints due to faulting. A prominent fault is mapped approximately 2,000 feet from the site, as shown on the copy of Langan Figure No. 2. Tectonic jointing is reported to range from a few feet to many feet far from the mapped faults but become closely spaced near the faults. We note that several closely spaced faults were identified in the Route 280 cut into the Second Watchung Mountain.
3. The closest well to the site shown on the reference map is Well No. 53 and appears to have been drilled with a ground surface elevation near elevation 560 feet. The following results were indicated on the map for Well No. 53, assuming the surface elevation was near elevation 560 feet:

<u>Depth</u>	<u>Driller Description</u>	<u>Inferred Elevation</u>
0 to 35 feet	Sand and Clay	Top of basalt near Elev. 525 feet
35 – 165	Trap Rock	Base of basalt near Elev. 395 feet
165 – 300	Red Sandstone	Bottom of well near Elev. 260 feet

4. The surface contact between the Preakness Basalts and the Feltville formation red sandstones in the area near the site is mapped along the elevation 500 contour on the reference map. The mapping indicates that the bedding of the sandstones dip towards the west (into beneath the basalt sill on a slope of approximately 9 degrees from the horizontal).

The surficial soils reported in the borings and in the test pits performed by the Applicant's Engineers conformed to the description of Rahway Till Yellow Phase included on the surficial Geology Map. The description in the mapping indicates that the formation on the slopes contain concentrations of basalt cobbles and "flagstones" formed by both post-glacial mechanical weathering and glacial deformation of finely jointed basalt. This description agrees with the weathered appearance of the outcrops on the site. The confirmation that the site had been



glaciated indicates that the existing soils and rock have been subjected to relatively high surface loadings in the past.

Langan derived a horizontal ground acceleration to compute seismic effects on the slope stability using a recognized seismic coefficient of 0.5 times the peak acceleration of the maximum considered earthquake.

In general, descriptions of geologic conditions in the letters and reports prepared by the Applicant's and Objector's Engineers conform to the descriptions contained in the references reviewed by CME. There is disagreement principally in the determination of strength properties for the bedrock as discussed later in this letter.

Topographic Conditions

Topographic conditions are shown on the attached markup of the Langan submittal Investigation Plan, Drawing No. 1. The existing ridge line is shown on the Investigation drawing and is highlighted in Blue. The elevations along the ridge range from a high of elevation 614 feet near Langan Boring No. LB3, decreases to elevation 601 opposite the proposed building main entrance, and rises to approximately 610 at the north end of Building D.1. The eastern slope begins to steepen at distances of 40 to 120 feet of the ridge up to the northern end of the building where it reduces to approximately 15 feet. The ridge begins to trend further to the northwest to the north of the building. Outcrops of Basalt bedrock are primarily located along and below the line where the slope begins to steepen.

For the purpose of this review, the upper slope is considered to run from the 500 feet elevation contour to the ridge line. We have computed local slope based on the spacing of 10 feet contours in several areas. This evaluation indicates that the slope varies locally from 21 degrees to 29 degrees. The residence at 15 Howell Drive (represented on Langan Analysis Section C-C) is built on a terraced lot between elevation 540 and 544. Terraced retaining walls provide a grade separation of about 12 feet. The residence on 13 Howell Drive has a level bench near elevation 518. A single retaining wall on the rear yard provides a grade separation on the order of 12 feet high, as well.

The lower slope below the 500 contour decreases to 7.5 degrees to 10 degrees. Locally the slope steepens to 23 degrees along the rear lot lines of the residences on Rosemont Terrace and Mayfair drive. It is anticipated that the reduction in the slope is associated with the underlying transition to the Feltville formation sandstone beginning near the 500 feet contour based on the bedrock geology mapping.



The ridge and slope area are wooded. We understand that the wooded area on the slope is protected by regulation. Effective maintenance of the health of the forested area is necessary to maintain the benefits of the forest towards the stability of the slope.

West Orange Sanitary Sewer Easement

The West Orange Sanitary Sewer easement traverses the upper slope from the top of the ridge (where it is to the south of the building) to its intersection on Howell Drive between the residences at 11 and 13 Howell Drive. The easement appears graded as a side hill bench. Langan has indicated the location and inferred depth in the analysis sections. The section results did not include sections going through the sewer.

Slope Hazard Mapping

The slope hazard mapping for Essex County that has been reproduced in the Langan Report identifies an area of risk on the slope. The risk is categorized as Landslide Case BIII, Weakly Cemented Rock and Soil (Hazus Number 3) Slope angle 10 to 15 degrees. The map legend indicates that the slope was determined by measuring spacing of 20 feet contours on the Caldwell Quadrangle Map. The slope angle on the upper slope, as determined by the spacing of contours created by aerial survey, is steeper than indicated by the contours and ranges from 17 to 29 degrees, which may require a re-evaluation of the Hazus Class by the Agency publishing the map. The range indicated by the spacing of the contours could put it into Class BV, Hazus No. 7. We were not able to obtain additional background information on the basis of the classification in time for this review. The analyses performed by both Langan and Princeton Hydro do not, in our opinion, indicate instability under the assumed conditions.

SUBSURFACE INVESTIGATION REVIEW

General

Our review of the Slope Stability Investigations included review of reports and subsurface exploration logs and laboratory test result reports contained in the CME files for the Planning Board Application review. Langan performed explorations on the slope for the slope stability investigation being evaluated herein. Sor Engineering ("Sor") performed a geotechnical evaluation for the site buildings including Building D near the ridge. In addition, they performed 3 additional investigations for analysis and design of stormwater management systems including Basins 10 and 11 on the western side of Building D. The layout of explorations is shown on the Langan Investigation Plan. A copy of this plan marked with our notes is contained in this report to assist the Board in understanding our descriptions.



Field and Laboratory Investigation Performed by Langan for the Applicant

The report indicates that the investigation included field examination of rock outcrops on the slope, and two series of test borings and 3 series of test pit explorations on the slope. The first phase included 4 test borings (LB-1 – LB-4) and 8 test pits located on the slope to the east of Proposed Building D and are arrayed primarily along analysis Sections A and B on their Investigation Plan. The first series of borings were performed in December of 2024. The first series included 8 test pits TP-1 to TP-8 which were performed in November of 2024.

The report indicates that a series of 6 shallow test pits were performed in April of 2025 around the outcrops and included Test Pits R1A, R1B, R-2, R3, R-4A and R-4B. This series of test pits was performed in April of 2025.

The third series of explorations included 4 test boring (NLB1-NLB4) and 5 test pits (NTP-1 to NTP-5). The Borings were arrayed along Analysis Sections C and D. Test Pit NTP 3 was performed between Sections C & D and Test Pit NTP-5 was performed approximately 110 feet south of the analysis Section D. The test borings in this series were performed in early May of 2025.

The Langan Reports indicate that the borings were performed using all terrain drilling equipment and were drilled using mud-rotary drilling techniques. The logs indicate that casing was advanced which would be necessary to core bedrock. The borings were advanced to depths ranging between 19 and 50 feet below the grade at the ground surface at the boring location. The logs indicate that Standard Penetration Test sampling procedures were used to obtain samples of soil encountered in the borings. Core samples were taken in the rock using N size double tube core samplers.

The overburden soils were reported to have been classified visually. There were no index testing results, such as moisture content and grain size tests, included in the report. Two unconfined compression tests were performed on samples of the basalt bedrock.

Field and Laboratory Testing Performed for Stormwater Management System Design

A geotechnical report and 3 reports related to investigations to provide criteria for design of stormwater management systems were performed for the Applicant by Sor. The reports are included in the list of references presented previously. We reviewed the results of boring logs and test pits that were performed along the west side of proposed Building D including those in the area of proposed infiltration Basins Nos. 10 and 11. These were contained in the report dated May 23, 2023. This report, which contained the Logs of Sor Engineering Boring B-12 and Test Pits E1, E-2, D1 and D2, was reviewed for this letter. The Boring B-12 was drilled to refusal on



rock. The test pits extended to depths of 12, 14, 16 and 9 feet below the existing grade respectively. Bedrock was reported encountered only in Test Pit D2.

The report included the results of grain size tests, moisture content and falling head permeability test results for bulk samples taken from the test pits.

INFERRED SUBSURFACE CONDITIONS

General

Our review indicates that Langan has prepared a generalized stratigraphy for their stability analysis that conforms generally to the anticipated geology contained on the reference geologic mapping of bedrock and surficial geology of the Caldwell Quadrangle. The stratigraphy is shown on the attached markup of the Langan Analysis Sections A through D. Our review is summarized below. In addition, we have reviewed comments on the inferred stratigraphy provided by Princeton Hydro for the Objector in this section of the letter.

Generalized Stratigraphy for Stability Evaluation

The soil overburden varied from 7 to 20 feet thick in the borings that encountered the underlying Basalt. Borings LB-2 and LB-4 were advanced to depths of 50 and 45 feet and did not encounter Basalt. The soil overburden conformed to the following generalized stratum as established by Langan for their evaluation of the stability of the slope:

Topsoil: The boring's sample descriptions indicate a "topsoil" layer approximately two feet thick with field standard penetration test values indicating that the layer is generally in a loose state of compaction. Langan has assigned a strength envelope with cohesion of 0 psf and a friction angle of 30 degrees.

Medium Dense Sands: Medium dense sands with field standard penetration test values indicating that they are in a medium dense state were indicated on the Analysis Sections below the topsoil in the NLB borings on Cross Sections C and D. On Analysis Sections A and B, the medium dense sands are shown as an inclusion within the dense to very dense glacial tills. Langan has assigned a strength envelope equivalent to a cohesion intercept of 0 psf and an angle of internal friction of 32 degrees.

Dense to Very Dense Sands with varying percentages of Silt and Gravel: Most of the borings encountered dense sands with field blow counts indicating that the materials are dense to very dense. Boulders were encountered within this layer. These sands conform generally with the materials described as yellow Rahway till on the Surficial Geology



Mapping. The apparent density indicates that the materials were likely to have been deposited by the glacier and subject to heavy pressures from the overlying glacier. These soils extended to the decomposed rock layer in most of the borings directly underlain by the Basalt formation. Langan has assigned a strength envelope based on a cohesion of 0 psf and an angle of internal friction of 34 degrees.

The bedrock formation, as described by Langan based on observations of the outcrops and descriptions and photographs of rock cores in their report, conformed, based on our understanding, to the following description:

Decomposed Rock: This description, in our experience, describes the zone of deterioration of the parent bedrock material and, in at least one classification system, may be represented as rock with a standard penetration resistance less than 50 blows per inch. The area was glaciated, and it is apparent that the igneous rock had been worked by the action of the glacier. The decomposed layer appears to be a few feet thick. Langan has assigned a strength envelope based on a cohesion of 0 psf and an angle of internal friction of 38 degrees.

Basalt Bedrock: The outcrops of basalt as mapped on the drawings are of low height. Langan reported a joint set dipping downward to the east on a slope of 17 degrees. A downward dip to the east is not, in our experience, a favorable inclination, which would be downward towards the west. Langan indicated a contact rock on rock friction angle of 35 degrees. Unconfined compressive strength test results were examined for 2 rock samples obtained from Boring LB-3, reportedly from 8.5 to 10.5 feet. We anticipate that the core samples were taken from the same segment of core since the depth of the sample is listed as the same range. We reviewed the core box photo (Exhibit C – Select Rock Core Photographs) in the Langan Rebuttal Report (Reference 1C) but were unable to identify the section of core from which the samples were taken. The laboratory report prepared by RSA Geolab of Union, New Jersey, indicated an unconfined compressive strength of 515,719 pounds per square foot (psf) which is equivalent to 3,580 pounds per square inch (psi) for C1-A. The result for C1-B was 323,260 psf (2,200 psi). The results are a small fraction of the anticipated strength range for Basalt and roughly equivalent to that of a low to medium strength concrete. The wet density of the core was recorded to be 182.3 pounds per cubic foot (pcf) which we understand to be in the normal range. Langan, in their Rebuttal Report, attributed the unusually low strength to porosity, and crystalline grain size characteristics in the rock which would likely have been subjected to external cooling at the edge of the sill.

Langan has used the Slope/W computer software which utilizes the Rock Mass Rating (RMR) and Geologic Strength Index (GSI) to model a representative strength for failure



surfaces passing through the rock. Langan employed a GSI of 65 in their initial analysis and considered a GSI of 50 in their supplementary analysis for their Rebuttal Memorandum. Princeton Hydro recommended a low value of the index of 20.

Sandstone Bedrock (Feltsville Formation): The geologic mapping indicates that the sandstone contact with the Basalt Sill is likely located near the elevation 500 contour and that the sandstone dips below the basalt on a westerly inclination on the order of 10 degrees from the horizontal. Langan recognized in their Rebuttal Report (Ref.1C) that Borings LB-2 and LB-3 were likely to have been drilled into decomposed Sandstone bedrock and terminated at elevations 472 and 503 feet, respectively, which is below and slightly above elevation 500, which is the approximate contact indicated on the Geologic Maps. The analysis sections do not include the decomposed Sandstone bedrock in the failure surface penetrating the rock. We anticipate that strength indicated for the Decomposed Rock would be appropriate for the decomposed sandstone (cohesion = 0) since the failure surfaces in the overlying soil are likely to be the determinant factor for assessing the stability of the slope.

Groundwater Conditions

In our experience, establishment of a consistent groundwater surface in jointed bedrock in the area of a slope with relatively high topographic relief is very difficult to achieve. In addition, the intact rock has a very low permeability. The rock formation, however, has a variable secondary permeability which is created by the complex network of intersecting fractures. Depending on the width of the fractures, the filling and surface roughness of cracks surcharged by water levels high up on the slope can develop localized high hydrostatic pressures which could affect the local stability of the soil overburden.

The persistent wetland delineated on the site plan in the stream valley about 350 feet west of the ridge is an indication of a possible groundwater level. The plan indicates a persistent stream that may give an indication of the groundwater levels behind the ridge. The nearest stream to the west of the ridge is shown to emerge near elevation 592. The wetlands markers to the west of the building indicate potential water levels as high as elevation 606 feet to the north of the ridge.

The Langan explorations encountered seepage in Test Pit TP-1 at eleven feet below the ground surface at approximate elevation 595 at a point that is about 45 feet west of the crest of the ridge. Sor reported water seepage elevations ranging from elevation 584 at TP-E1 to elevation 581 at TP-E2, located in proposed infiltration Basin 11. They reported seepage at 10 feet below grade in Test Pit TP-D1 at elevation 571 feet which is 10 feet below that observed at TP-E2, which is only 45 feet away. The seepage level noted at Test Pit TP-D2 at elevation 572 is consistent with the level observed at TP-D1 which is 205 feet away.



Langan considered a seepage case in their analysis with the phreatic surface approximately following the top of the decomposed Rock. This approach is, in our opinion, reasonable provided there is no indication of spring activity or emerging seepage on the slope below the ridge under present conditions.

STABILITY ANALYSES

General

Both the Applicant's and the Objector's Engineers (the "Engineers") have utilized the Slope/W computer software program to perform the comparative analyses of the slope stability. This program is recognized as an effective analysis tool for complex slopes and is capable of performing searches to determine the critical failure surface that determines the stability of the slope. The Engineers disagree, as indicated in the Objector Report and the Langan Rebuttal, on the strength properties used for the strata and, in particular, for the bedrock, as determined by the Geological Strength Index. The presentation of the results in the report provides the geometry of the slope and sub-surface stratification model prepared by the user and the strength properties derived by the user and entered in the input file. The analyses have been performed using the Limiting Equilibrium Method which derives the safety factor as the limiting shearing resistance available on the assumed failure surface divided on the shearing resistance required on the surface to maintain equilibrium. The method of computation selected by Langan is the Morgenstern Price method which is considered the most rigorous method of analysis.

In our opinion, the method of analyses selected by the Engineers are appropriate for evaluation of the stability of the slope. A detailed summary of the computation results is summarized in the individual Engineer's reports and are not repeated in detail herein.

Required Minimum Factors of Safety

The Langan report references the Naval Facilities Command Manual DM7 standards for a recommended minimum factor of safety of 1.50 for static load cases and 1.15 for seismic load cases. This standard is, in our opinion, applicable as a standard for the slope in this case.

The Army Corps of Engineers Engineering Manual EM1110-2-1902 is consistent with the recommendation of DM-7.

Princeton Hydro has referenced Corps of Engineers Manual EM-1110-2-2908 Rock Foundations as requiring a minimum factor of safety of 2.00. This standard is not, in our opinion, applicable as a standard for the slope in this case.



Langan Analysis Cases

Our review of the cases contained in the Memorandum submitted on June 18, 2005, indicates the following interpretation of results:

Static Load Cases with No Groundwater – Analysis Plots in Report Appendix E:

1. Cases on all the analysis sections that involve circular surfaces penetrating into the bedrock yielded high factors of safety and are not, in our opinion, critical.
2. The critical factor of safety with minimum factor of safety on Analysis Section A was computed to be 2.201 under the proposed condition and only slightly less than 2.204 computed for the existing condition.
3. The critical factor of safety on Section B was computed to be 1.676.
4. The critical factor of safety on Section C under proposed conditions was 1.589 for a shallow surface passing through medium dense sands.
5. The critical factor of safety on Section D under proposed conditions was 1.936.

Seismic Static Case with No Groundwater – Analysis Plotted in Appendix F:

1. The critical factor of safety with minimum factor of safety on Analysis Section A was computed to be 1.65 under the proposed condition.
2. The critical factor of safety on Section B was computed to be 1.297.
3. The critical factor of safety on Section C under proposed condition was 1.259.
4. The critical factor of safety on Section D under proposed conditions was 1.473.

Static Case with Groundwater Phreatic Surface at Top of Decomposed Rock – Analyses Reported on Page 11 (but not plotted):

1. The critical factor of safety with minimum factor of safety on Analysis Section A was computed to be 2.20 under the proposed condition.
2. The critical factor of safety on Section B was computed to be 1.67.
3. The critical factor of safety on Section C under proposed condition was 1.59.
4. The critical factor of safety on Section D under proposed conditions was 1.94.

The computed minimum factors of safety exceed the requirements in the referenced standards listed above. The analysis plots for the groundwater case should be submitted.



Princeton Hydro Analysis Cases

Static Case with Groundwater Phreatic Surface at Top of Decomposed Rock Failure Surfaces in Soil Overburden:

1. The critical factor of safety on Section C was computed to be 1.589 for the proposed condition.
2. The critical factor of safety on Section D was computed to be 1.938 for the proposed condition.

Static Case with Groundwater Phreatic Surface at Top of Decomposed Rock Failure Surfaces in Weak Zone of Rock with GSI = 20:

1. The critical factor of safety on Section C was computed to be 1.76 for the proposed condition.
2. The critical factor of safety on Section D was computed to be 1.65 for the proposed condition.

The computed minimum factors of safety exceed 1.50 in the analysis cases presented by Princeton Hydro. There is a surface shown for analysis Section C with critical failure surface passing through the medium dense sands with factor of safety of 1.48 which is only slightly less than 1.50. Langan has questioned the assumed stratification on that section stating that it does not consider dense sands on that section, which were indicated by the borings.

Langan Rebuttal Analysis Cases

In Exhibit A of their rebuttal, Langan derives a lower-bound Rock Mass Rating and Geologic Strength Index of 50, which exceeds the value of 20 used by Princeton Hydro. They also performed analyses which indicate that the existing sanitary sewer trench would not significantly reduce the stability of the slope. The factors of safety exceed the values computed by Princeton Hydro, but the factors of safety using the GSI of 20 were, in our evaluation, satisfactory and do not indicate instability. The detailed results are contained in the Langan Rebuttal Case.

CONCLUSION AND RECOMMENDATIONS TO THE BOARD

General

We have described our review of the project based on the submittals to the Planning Board. Our evaluation of the Memoranda from the Applicant's and Objector's Engineers is as follows:

1. The description of subsurface conditions conforms to the reported bedrock and surficial geology with the exception that Langan did not consider the transition to the Feltsville



bedrock formation which appears to begin near Borings LB-2 and LB-4. Nevertheless, we do not anticipate that this will significantly modify the range of critical safety factors.

2. The results of the Langan analyses that included a presumed groundwater level at the surface of the decomposed rock were reported, but the computer output plots were not included. These output plots should be submitted for the record.
3. The results of the stability analyses by both the Objector's and the Applicant's Engineers exceed a safety factor of 1.50. On this basis, we may conclude that conventional analysis does not indicate instability for static and seismic stability.
4. The results of the analyses do not discount the concerns for the risk of landslide indicated by the Hazus mapping which underestimated the effective angle of the slope.
5. In our experience, landslides frequently occur in tandem with heavy rainfall. Neither of the Engineers has adequately considered the response of the slopes to heavy rainfall, and groundwater interflow. In addition, the Stormwater Management Plans propose introduction of substantial infiltration basins close to the top of the slope.
6. The Applicant's Engineers should propose and perform a stability evaluation using a conservative piezometric surface that would reflect the response of groundwater to heavy storm-induced rainfall.
7. The Applicant's Engineers should, in our opinion, review the mounding influence of the proposed infiltration Basins Nos. 10 and 11 and consider mitigation by either providing a cutoff (possibly using the building foundation walls) preventing infiltration flow to the east, or relocation of the basins further down the backslope.

Recommended Requirements to be Considered by the Board

The stability of the slope should not be considered a fixed or permanent condition. We recommend that the Planning Board and Municipal Agencies having jurisdiction establish and enforce the following requirements.

1. Clearing Site: The limits of earthwork and disturbance should be strictly adhered to maintain the stability of the slope.
2. Long-term measures should be required to maintain the health of the forestry on the slope. The health of the root systems provides reinforcement to the shallow topsoil layer on the slope.
3. The provisions of the Soil Erosion Plan should provide details for protection of the ridge and slope. Discharge of water from dewatering during construction should not be permitted.
4. Surcharges resulting from the stockpiling of materials and heavy equipment should not be permitted on the ridge immediately above the slope to avoid a reduction of the stability of the slope.
5. The requirements for construction should include an excavation and dewatering work plan addressing the stability of the slope during the construction. This work plan should be



prepared by a licensed Professional Engineer currently registered in the State of New Jersey.

6. Support of excavation should be required along the ridge. Cutting back the slope beyond the limits of the earthwork should not be permitted.
7. Rock excavation should be controlled to minimize vibrations and disturbance to the ridge. The design of blasting charges, if required, should consider the controlling distance to be the distance to the top of slope, which is in the maximum range of 40 to 100 feet.
8. Dewatering and control of runoff should be required. Ponding of water in the excavation could surcharge the joints in the rock and should not be permitted.
9. Slope indicators should be installed on the slope to monitor for movement during construction.
10. Installation of groundwater monitoring wells should be considered at infiltration basins located along the ridge.
11. Final grading and landscaping should be strictly performed to ensure that runoff is intercepted and prevented from runoff over the slope.

Closure

We appreciate the opportunity to assist the West Orange Planning Board in the review of slope stability issues related to the proposed construction in the area of the proposed Building D for the West Essex Highlands Development. Our review is based on our best professional judgement and on our experience in evaluating the stability of slopes. The construction should be monitored by qualified Geotechnical Engineers familiar with the anticipated conditions and requirements for maintenance of stability. Any variation in conditions encountered should be brought to our attention to determine if modifications of the conclusions and recommendations contained herein is necessary.



**Consulting & Municipal
ENGINEERS**

*Chairman and Members of the West Orange Planning Board
Application No. PB24-01, West Essex Highlands, LLC, Warner Road, Block 179, Lot 32
Review of Applicant's Engineer's Slope Stability Analysis Reports, the Objector's
Engineer's Response Reports; and the Applicant's Engineer's Rebuttal Report
October 28, 2025
Page 21 of 21*

If you have any questions or concerns regarding any portion of this report, please do not hesitate to contact our office.

Very Truly Yours,
CME Associates

A handwritten signature in blue ink, appearing to read 'Samuel N. Kleinberg', written over the printed name.

Samuel N. Kleinberg, PE
Principal Engineer

cc: Geniece Gary-Adams – Director of Planning & Development & Zoning Official
Zayibeth Carballo, PE, PLS, PP, CME, CFM, CFS – Township Engineer
Diana McGovern, Esq. – Planning Board Attorney
George Wheatle Williams, PP – Planning Board Planner
West Essex Highlands, LLC – Applicant
Bryan D. Placker, Esq. – Applicant's Attorney
Paul W. Anderson, PE – Applicant's Engineer