May, 2017

Our File Ref.: 160845

EMB Developments Inc.
1199 Notre Dame, C.P. 779
Embrun, Ontario
K0A 1W0

Subject: Slope Stability Analysis
Menard East Subdivision
Embrun, Ontario

Pursuant to your request, LRL Associates Ltd. (LRL) completed a slope stability analysis at the above referenced location for the proposed Menard East Subdivision Development. The purpose of this analysis was to evaluate the current condition of the site and of the subject slope, and to establish if the proposed development will affect the slope's stability.

1 SITE AND PROJECT DESCRIPTION

The site under investigation is legally described as Part of Lot 9 Concession 7, Geographic Township of Russell, United Counties of Prescott & Russell, Ontario. The site is located along the east side of St. Pierre Road, and accessible at the most westerly end of Rue Labelle Street. Currently the site is vacant, and at the time of the investigation it was covered by snow. Overall, the land is considered to be relatively flat, except for the west portion of the site, where it is sloped down towards a creek.

It is our understanding that the proposed site will be developed to accommodate a total of one hundred and two single (102) residential lots, sanitary and storm sewer facilities, walkway and streets. The site will be serviced with available municipal services and a proposed stormwater management pond at the south-west corner within the project boundaries Access to the subdivision will come from Rue Labelle Street at the west side and Richelieu Street at the south side of the subdivision.

2 PROCEDURE

A site visit was carried out by a member of our geotechnical team on March 7 and 8, 2017. During this site visit, a total of two (2) boreholes were drilled, one at the top of the crest, and another near the bottom of the slope, within the floodplain.

The boreholes were advanced using a track mounted CME 75 drill rig equipped with 200 mm diameter continuous flight hollow stem auger supplied and operated by Strata Drilling Group. A "two man" crew experienced with geotechnical drilling operated the drill rig and equipment.

Sampling of the overburden materials encountered in the boreholes was carried out at regular depth intervals using a 50 mm diameter drive open conventional spoon sampler in conjunction with standard penetration testing (SPT) “N” values, and in-situ vane shear tests. The boreholes were advanced to depth 6.25 m below ground surface (bgs). Upon completion, the boreholes were backfilled and compacted using a combination of silica sand, bentonite, and overburden cuttings.

The fieldwork was supervised throughout by a member of our engineering staff who oversaw the drilling activities, cared for the samples obtained and logged the subsurface conditions encountered within each of the boreholes. All soil samples collected from the boreholes were placed and sealed in plastic bags to prevent moisture loss. The recovered soil samples collected from the boreholes were classified based on visual examination of the materials recovered and the results of the in-situ testing. All soil samples were transported to our office for further examination by our geotechnical engineer

3 SLOPE DESCRIPTION

The slope under review herein is located in the southwest portion of the property and faces southwest toward the creek. The slope is about 10.5 m long, followed by about a 20.0 m flood plain at the location where the slope profile was obtained for the model. The slope is vegetated with tall wild grasses, and at the time of investigation, there was some light snow cover. Based on observations made during the site visit, there does not appear to be any signs of current or former slope failure within the current slope or its surroundings.

The existing slope profile was observed to have an overall slope of about 2.6 horizontal to 1 vertical (2.6H:1V), and 1.8H:1V at the steepest location. The total height of the slope from crest to toe was measured to be approximately 3.8 m.

4 SUBSURFACE CONDITIONS

4.1 General

A review of local surficial geology maps provided by the Department of Energy, Mines and Resources Canada suggest that the surficial geology for this area consist of blue-grey clay, silt, and silty clay; calcareous and fossiliferous at depth, commonly reworked; non-calcareous and non-fossiliferous at surface to depth about 2.0 m.

The completed boreholes indicate that the slope is composed of fill material at the surface, underlain by a 1.1 to 1.5 m thick deposit of silty sand, and then soft to very soft silty clay to clay.

Groundwater was carefully monitored during this field investigation and measured immediately after drilling. The water level was found ranging from 2.9 to 3.0 m bgs on completion of drilling. The boreholes were left open for two hours after drilling, and the water level was further measured to be ranging from 0.9 and 1.0 m bgs.

5 SLOPE STABILITY ANALYSES

The slope modelling program, Slide 5.0 (Rocscience), was used to implement the Bishop simplified method of slices. The slope profile for the existing slope conditions, as measured in the field was used and modeled to check the existing condition of the slope. The slope was analyzed under both the undrained and drained conditions (i.e. short and long term).

The field measurements in conjunction with known published data of the Eastern Ontario region were used for selection of appropriate soil modelling parameters. The analysis was completed assuming full saturation throughout the floodplain and bottom section of the slope, and saturation beneath the fill material for the remaining profile. The selected profile was considered conservative as it represents the worst case (steepest slope profile) scenario.

The following soil parameters were used as part of the analyses.

Soil Type	Effective cohesion (c') - KPa	Angle of internal friction (ϕ') - degrees	Bulk unit weight (γ_B) – KN/m^3
Drained Parameters (Long Term)			
Fill	3	29	18.5
Silty Sand	2	32	19.0
Silty Clay	5	34	18.5
Undrained Parameters (Short Term)			
Fill	25	-	18.5
Silty Sand	2	32	19.0
Silty Clay	30	-	18.5

The model was ran with the designed house load for the undrained and drained condition. The factor of safety (FoS) values obtained were 2.09 and 1.58 respectively. A FoS of 1.5 or greater is considered to be safe with regard to slope stability. The designed house load was not provided (design bearing pressure at serviceability limit state) during our field investigation. However a typical value assumed to be 75 kPa for similar type of residential construction was included within the model.

These results indicate that the construction of any proposed dwelling, built at a minimum setback of 14.0 m, will not affect the stability of the slope and will remain safe in both the long and short term. The model results are attached for your reference.

6 CONCLUSIONS/RECOMMENDATIONS

Based on the information presented herein, the slope will remain stable in both the short and long term. Regardless of the results however, the following recommendations should be adhered to during the construction and post construction to ensure the long term stability of the slope.

- The existing vegetation cover near and within the existing slope should not be disturbed any more than is absolutely necessary to develop the lots and related facilities as part of the subdivision, as it promotes stability and erosion control to the slope. Furthermore, grass should be reinstated after the installation is completed.
- The proposed final grades must match the existing grades as proposed on the drawings. If it is decided that grade raises are needed, LRL must be contacted to ensure that the results of this report are still applicable.
- Any site drainage should be diverted away from the slope and/or the slope should be protected from erosion to ensure that the slope profile does not change with time.
- The slope profile outside any excavation areas should not be modified in any way as part of these works. If modifications to the slope profile are proposed beyond to what was presented, LRL should be consulted to ensure that the results of this report are still valid.

- If any additional structures beyond what was indicated in the plans, LRL should be consulted to ensure that the results of this report are still valid.

7 GENERAL COMMENTS AND LIMITATIONS OF REPORT

The conclusion and recommendations are provided in this report are based on information at the boring locations. The material reflects in this report are best judgement in light of information obtained from localized boring and information available with LRL at the time of report preparation.

This report is prepared for and is intended solely for its client and authorized engineers. Unless otherwise agreed in writing, no portion of this report, or any part thereof may be used or decisions made based on it by separate entity, are the responsibility of such entity. LRL accepts no responsibility for damage, if any, suffered by any separate entity as a result of decisions made or suffered from illegal use of this report. The findings are relevant for the date of the site investigation and any changes on the ground profile or subsurface condition at later date, LRL should be retained to review and for further recommendations.

We trust this report provides sufficient information for your present purposes. If you have any questions concerning this report or if we may be of further services to you, please do not hesitate to contact our office.

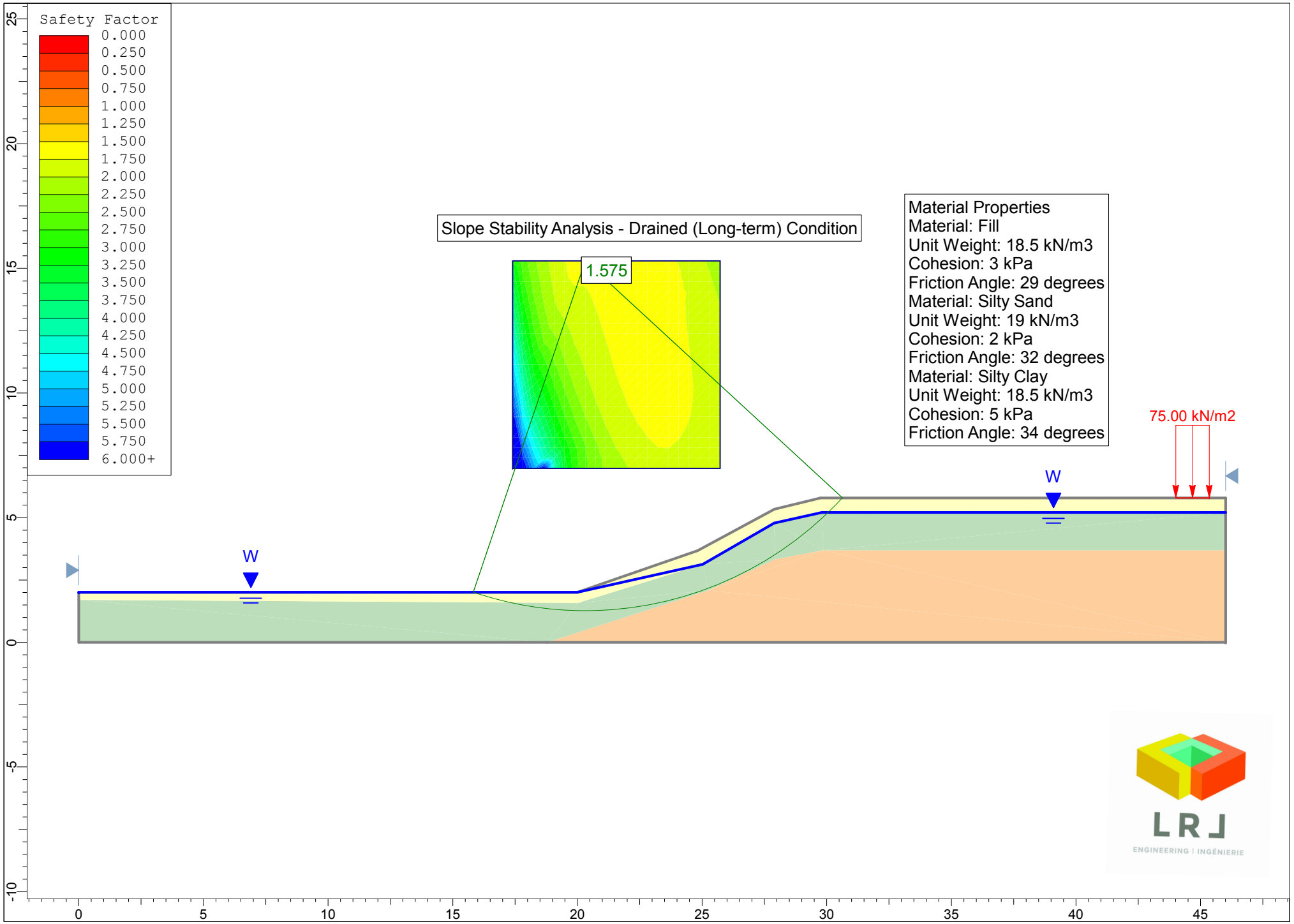
Yours truly,

LRL Associates Ltd.

Brad Johnson, B.Sc. Eng.
Geotechnical Services

Stéphane Leclerc, P.Eng.
Principal Engineer

Encl. Slope Stability Analysis Results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1.750
2.000
2.250
2.500
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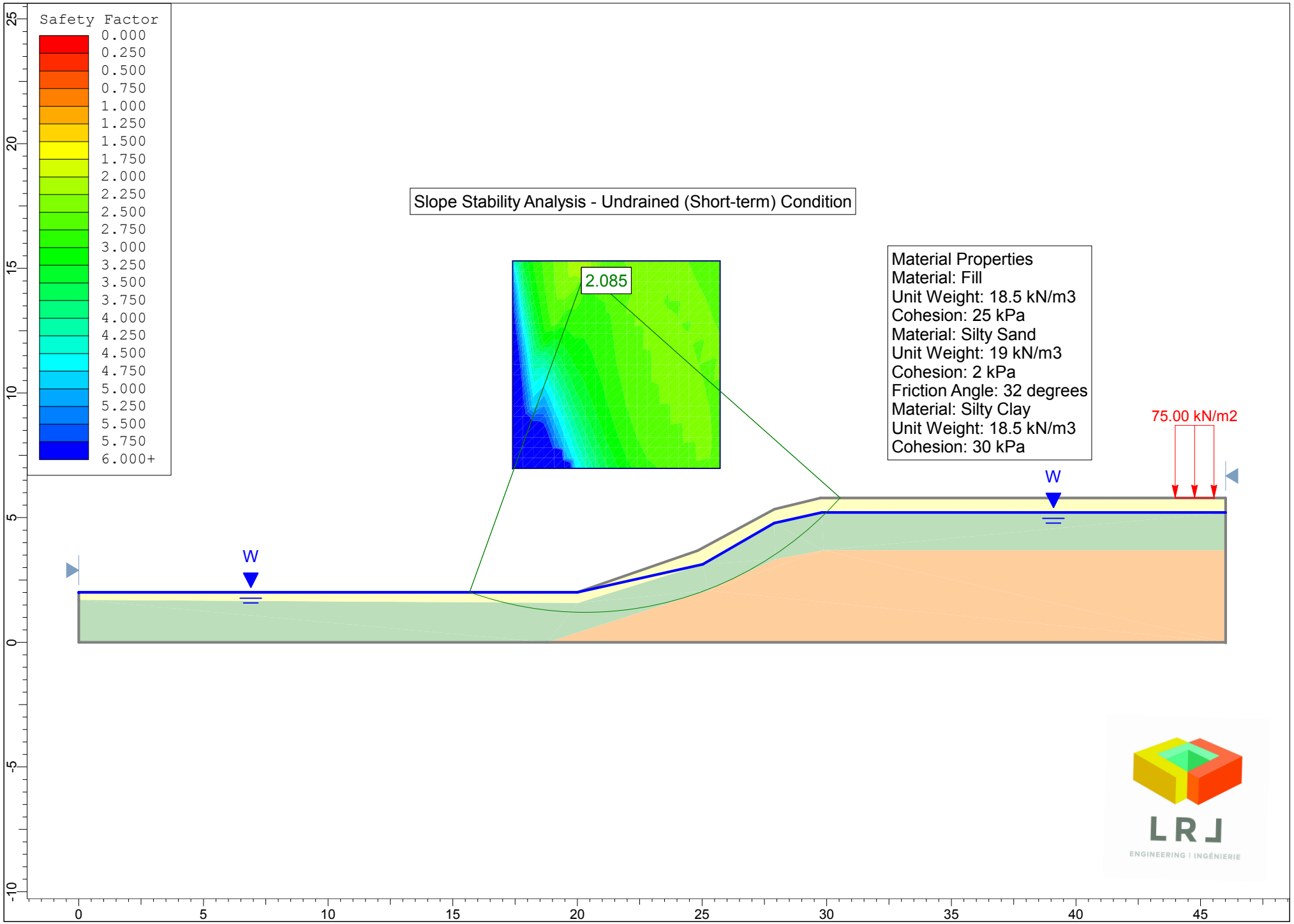
3.000
3.250
3.500
3.750
4.000
4.250
4.500
4.750
5.000
5.250
5.500
5.750
6.000+
Slope Stability Analysis - Drained (Long-term) Condition
1.575
Material Properties
Material: Fill
Unit Weight: 18.5 kN/m3
Cohesion: 3 kPa
Friction Angle: 29 degrees
Material: Silty Sand
Unit Weight: 19 kN/m3
Cohesion: 2 kPa
Friction Angle: 32 degrees
Material: Silty Clay
Unit Weight: 18.5 kN/m3
Cohesion: 5 kPa
Friction Angle: 34 degrees
75.00 kN/m2
W
W
25
20
15
10
5
0
-5
-10
0
5
10
15
20
25
30
35
40
45


Safety Factor
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0.500
0.750
1.000
1.250
1.500
1.750
2.000
2.250
2.500
2.750
3.000
3.250
3.500
3.750
4.000
4.250
4.500
4.750
5.000
5.250
5.500
5.750
6.000+
Slope Stability Analysis - Undrained (Short-term) Condition
2.085
Material Properties
Material: Fill
Unit Weight: 18.5 kN/m3
Cohesion: 25 kPa
Material: Silty Sand
Unit Weight: 19 kN/m3
Cohesion: 2 kPa
Friction Angle: 32 degrees
Material: Silty Clay
Unit Weight: 18.5 kN/m3
Cohesion: 30 kPa
75.00 kN/m2
W
W
25
20
15
10
5
0
-5
-10
0
5
10
15
20
25
30
35
40
45