



December 23, 2021

Our File Ref.: 210216

Landric Homes Inc.
1173 Cyrville Road, Suite 202
Ottawa, ON
K1J 7S6

Attention: Matthew Firestone

Subject: Slope Stability Analysis
6001-6005 Renaud Road
Orleans, Ontario

Pursuant to your request, LRL Associates Ltd. (LRL) completed a slope stability analysis at the above referenced location. The purpose of this analysis was to evaluate the current condition of the site, and to determine if the proposed residential development will negatively affect the stability of the slope in both the short and long term.

1 SITE AND PROJECT DESCRIPTION

The site is located at 6001-6005 Renaud Road, in Orleans ON. Currently, the site is occupied by two (2) single family dwellings. The majority of the site is covered with manicured/landscaped grasses. Some mature trees are also present. Currently access to the site comes by way of Renaud Road. Generally, the site is gently sloped downwards from the south to north. The site is bounded by Ziegler Street to the north, Renaud Road to the south, 232 Ziegler Street to the west, and 6021 Renaud Road to the east.

At the time of generating this report, it is our understanding that the site is being developed to accommodate four (4) residential blocks, consisting of a total of thirty-six (36) units. The blocks will be three (3) story, complete with a walk-out style basement. Access to the new site will come from both Renaud Road and Ziegler Street.

2 PROCEDURE

A site visit was carried out by a member of our geotechnical team on December 16, 2021. During this site visit, the site was visually inspected for any signs of tension cracking, erosion, and/or signs of past slope failure

The subsurface conditions of the site was obtained by reviewing the borehole data from the Geotechnical Report, dated April 23, 2021, completed by Paterson Group, submitted to LRL by the Client.

The proposed slope profiles that were inputted into the modelling software was obtained from the Grading Plan, generated by LRL, dated December 21, 2021.



3 SLOPE DESCRIPTION

The slope under review herein is located throughout the site, as the entirety of the site gently slopes downwards from the south to north. The difference in grades from north to south is approximately 3 m.

Based on observations made during the site visit, no signs of current or former slope failure, tension cracking, nor erosion was observed within the slope or its surroundings.

4 SUBSURFACE CONDITIONS

The previously completed boreholes indicate that the site is comprised of localized fill material at the surface consisting of silty clay to silty sand, overlying silty sand, overlying silty clay, overlying glacial till material.

5 SLOPE STABILITY ANALYSES

The slope modelling program, Slide 5.0 (Rocscience), was used to implement the Bishop simplified method of slices. One (1) slope profile named Section A-A was selected for the proposed condition and modeled to check the conditions of the slope. The proposed loading for the residential units was included in the model. The slope was analyzed under both the undrained (short term failure) and drained (long term failure) conditions.

The seismic analysis was performed by incorporating the seismic coefficient (k_h) into the modelling. The peak ground acceleration (PGA) for this area is equal to 0.33 for the 2% in 50 year probability of exceedance as per the NBC 2015. The value for k_h was taken as 50% of the PGA, which equates to 0.17. The minimum factor of safety (FoS) with regards to seismic condition is 1.10.

Each retaining wall greater than 1.0 m proposed onsite was checked for global stability.

The field measurements in conjunction with known published data of the materials encountered onsite were used for selection of appropriate soil modelling parameters in the slope stability analyses.

The results of the analyses are potentially dependent on the assumption of groundwater condition. During the development of this report, no information on the groundwater level was available throughout the year. However, as a conservative approach the analysis was completed assuming full saturation throughout the slope profile. The location of the slope profile (Section A-A) as well as the location of the retaining walls that were checked for global stability are shown on the Grading Plan, attached to this report.

Soil Parameters used in Slope Stability Analysis

Soil Type	Effective cohesion (c') - KPa	Angle of internal friction - degrees	Bulk unit weight (γ_B) – KN/m ³
Drained Parameters (Long Term)			
Pavement Structure	0	42	21.0
Silty Sand	0	35	17.5
Silty Clay	8	34	18.5
Glacial Till	8	42	20.5
Undrained Parameters (Short Term)			
Pavement Structure	0	42	21.0
Silty Sand	0	35	17.5
Silty Clay	65	-	18.5

Glacial Till	8	42	20.5
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The design load of 75 kPa (design bearing pressure at serviceability limit state) for the residential units was included within the modelling.

The below table is a summary of the factor of safety (FoS) values for each section that was ran as part of the modelling.

Values for Slope Stability Modelling

Section	Drained Condition	Undrained Condition	Seismic
<i>Factor of Safety</i>			
A-A (Overall Stability)	1.928	1.928	1.462
B-B (Global Stability)	2.992	2.988	2.279
C-C (Global Stability)	2.133	8.092	4.524
Min. Required	1.500	1.500	1.100

These results indicate that the proposed development will not have a negative effect on the stability of the slope; in both the long and short term.

The model results are attached for your reference.

6 CONCLUSIONS

Based on the information presented herein, the proposed development may be constructed safely given the conceptual plan does not differ than what is illustrated on the Grading Plan, generated by LRL.

If any additional structures are considered to be constructed beyond what was indicated/proposed, or if the grading will be altered than what was originally illustrated on the Grading Plan dated December 21, 2021; LRL should be consulted to ensure that the results of this report is still valid.

7 GENERAL COMMENTS AND LIMITATIONS OF REPORT

The conclusion and recommendations are provided in this report are based on subsoil properties at the auger holes locations. The material reflected in this report are best judgement in light of information obtained from localized auger holes 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 for 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, P. Eng.
Geotechnical Engineer



Encl. Mark-up of Grading Plan Showing Slope Profile Locations
Slope Stability Analysis Results





PLAN

PAVEMENT STRUCTURE

COURSE	MATERIAL	THICKNESS (mm)	
		AUTOMOBILE PARKING	TRUCK ROUTE (HEAVY TRAFFIC)
SURFACE	HL 3 A/C (PG 58-28)	50	40
BINDER	HL 8 A/C (PG 58-28)	-	50
BASECOURSE	OPSS GRANULAR "A"	150	150
SUBBASE	OPSS GRANULAR "B" TYPE II	300	450

NOTE: REFER TO GEOTECHNICAL INVESTIGATION BY PATERSON GROUP DATED APRIL 23, 2021. IN PREPARATION FOR PAVEMENT CONSTRUCTION AT THIS SITE, ANY SURFICIAL OR NEAR SURFACE/SUBGRADE LEVEL TOPSOIL AND ANY SOFT, WET OR DELETERIOUS MATERIALS SHOULD BE REMOVED FROM THE PROPOSED PAVED AREAS. THE EXPOSED SUBGRADE SHOULD BE INSPECTED AND APPROVED BY GEOTECHNICAL PERSONNEL AND ANY SOFT AREAS EVIDENT SHOULD BE SUBCAVATED AND REPLACED WITH SUITABLE EARTH BORROW APPROVED BY THE GEOTECHNICAL ENGINEER. THE SUBGRADE SHOULD BE SHAPED AND CROWNED TO PROMOTE DRAINAGE OF THE SITE DRAINAGE STRUCTURES, FOLLOWING APPROVAL OF THE PREPARATION OF THE SUBGRADE, THE PAVEMENT GRANULARS MAY BE PLACED.

LEGEND:

- EXISTING PROPERTY LINE TO REMAIN
- PROPOSED CURB
- PROPOSED DEPRESSED CURB
- PROPOSED TERRACING (3:1 MIN.)
- PROPOSED SILT FENCE AS PER OPSD 219.110
- PROPOSED FENCE
- PROPOSED DOOR ENTRANCE/EXIT
- PROPOSED GRASS AREA (100mm TOP SOIL & SOD)
- PROPOSED CONCRETE FEATURES/SLAB
- PROPOSED HEAVY DUTY ASPHALT
- PROPOSED LIGHT DUTY ASPHALT
- PROPOSED RIP RAP
- PROPOSED ELEVATION
- PROPOSED HIGH POINT ELEVATION
- PROPOSED SWALE ELEVATION
- PROPOSED BOTTOM OF CURB / ASPHALT ELEVATION
- PROPOSED TOP OF CURB ELEVATION
- PROPOSED EXPOSED BOTTOM OF RETAINING WALL
- PROPOSED TOP OF RETAINING WALL
- MATCH INTO EXISTING ELEVATION
- EXISTING ELEVATION
- PROPOSED OVERLAND MAJOR FLOW ROUTE
- PROPOSED STORM SEWER
- PROPOSED SANITARY SEWER
- PROPOSED WATERMAIN
- PROPOSED 135mm^Ø SAN SERVICE
- PROPOSED 25mm^Ø PEX WTR SERVICE
- PROPOSED STORM WATERMAIN
- EXISTING STORM SEWER
- EXISTING SANITARY SEWER
- EXISTING WATERMAIN
- EXISTING MANHOLE
- PROPOSED CATCHBASIN-MANHOLE/CATCHBASIN
- PROPOSED MANHOLE
- PROPOSED CURB STOP
- PROPOSED PIPE INSULATION
- PROPOSED 100 YEAR HIGH WATER LEVEL
- STORM WATERSHED EXTENT
- WATERSHED NAME
- RUNOFF COEFFICIENT
- AREA IN HECTARES

USE AND INTERPRETATION OF DRAWINGS

GENERAL CONDITIONS OF THE CONTRACT FOR CONSTRUCTION ARE PART OF THE CONTRACT DOCUMENTS AND DESCRIBE USE AND INTENT OF THE DRAWINGS. THE CONTRACTOR SHALL BE RESPONSIBLE FOR OBTAINING ALL NECESSARY PERMITS AND APPROVALS FROM THE LOCAL AUTHORITIES. THE CONTRACTOR SHALL BE RESPONSIBLE FOR OBTAINING ALL NECESSARY PERMITS AND APPROVALS FROM THE LOCAL AUTHORITIES. THE CONTRACTOR SHALL BE RESPONSIBLE FOR OBTAINING ALL NECESSARY PERMITS AND APPROVALS FROM THE LOCAL AUTHORITIES.

BY USE OF THE DRAWINGS FOR CONSTRUCTION OF THE PROJECT, THE OWNER CONFIRMS THAT HE HAS REVIEWED AND APPROVED THE DRAWINGS. THE CONTRACTOR CONFIRMS THAT HE HAS VISITED THE SITE, FAMILIARIZED HIMSELF WITH THE LOCAL CONDITIONS, VERIFIED FIELD DIMENSIONS AND CORRELATED HIS OBSERVATIONS WITH THE REQUIREMENTS OF THE CONTRACT DOCUMENTS.

AS INSTRUMENTS OF SERVICE ALL DRAWINGS, SPECIFICATIONS, CAD FILES OR OTHER ELECTRONIC MEDIA AND COPIES THEREOF FURNISHED BY THE ENGINEER ARE HIS PROPERTY. THEY ARE TO BE USED ONLY FOR THIS PROJECT AND ARE NOT TO BE USED ON ANY OTHER PROJECT, INCLUDING REPEATS OF THE PROJECT. CHANGES TO THE DRAWINGS MAY ONLY BE MADE BY THE ENGINEER.

UNLESS THE REVISION TITLE IS ISSUED FOR CONSTRUCTION, THESE DRAWINGS SHALL BE CONSIDERED PRELIMINARY AND SHALL NOT BE USED AS A CONSTRUCTION DOCUMENT.

THESE DRAWINGS ILLUSTRATE THE WORK TO BE DONE. THE ENGINEER IS NOT RESPONSIBLE FOR THE MEANS, METHODS, TECHNIQUES, SEQUENCES, AND PROCEDURES USED TO DO THE WORK, OR THE SAFETY ASPECTS OF CONSTRUCTION, AND NOTHING ON THESE DRAWINGS EXPRESSED OR IMPLIED CHANGES THIS CONDITION. CONTRACTOR SHALL DETERMINE ALL CONDITIONS AT THE SITE AND SHALL BE RESPONSIBLE FOR KNOWING HOW THEY AFFECT THE WORK. SUBMITTAL OF A BID TO PERFORM THIS WORK IS A KNOWLEDGE OF THE RESPONSIBILITIES, AND THAT THEY HAVE BEEN FULLY CONSIDERED IN PLANNING OF THE WORK, AND THE PRICE. NO CLAIMS FOR EXTRA CHARGES DUE TO THESE CONDITIONS WILL BE FORTHCOMING.

UNAUTHORIZED CHANGES:

IN THE EVENT THE CLIENT, THE CLIENT'S CONTRACTORS OR SUBCONTRACTORS, OR ANYONE FOR WHOM THE CLIENT IS LEGALLY LIABLE MAKES OR PERMITS TO BE MADE ANY CHANGES TO ANY REVISIONS, SPECIFICATIONS, OR OTHER CONSTRUCTION DOCUMENTS PREPARED BY LRI ASSOCIATES LTD. (LRI) WITHOUT OBTAINING LRI'S PRIOR WRITTEN CONSENT, THE CLIENT SHALL ASSUME FULL RESPONSIBILITY FOR THE RESULTS OF SUCH CHANGES. THEREFORE THE CLIENT AGREES TO WAIVE ANY CLAIM AGAINST LRI AND TO RELEASE LRI FROM ANY LIABILITY ARISING DIRECTLY OR INDIRECTLY FROM SUCH UNAUTHORIZED CHANGES.

IN ADDITION, THE CLIENT AGREES TO THE FULLEST EXTENT PERMITTED BY LAW, TO INDEMNIFY AND HOLD HARMLESS LRI FROM ANY DAMAGES, LIABILITIES OR COSTS, INCLUDING REASONABLE ATTORNEY'S FEES AND COST OF DEFENSE, ARISING FROM SUCH CHANGES.

GENERAL NOTES:

EXISTING SERVICES AND UTILITIES SHOWN ON THESE DRAWINGS ARE TAKEN FROM THE BEST AVAILABLE RECORDS, BUT MAY NOT BE COMPLETE OR TO DATE. CONTRACTOR SHALL VERIFY IN FIELD FOR LOCATION AND ELEVATION OF PIPES AND CHECK WITH THE UTILITY COMPANIES BEFORE DIGGING OR PERFORMING WORK.

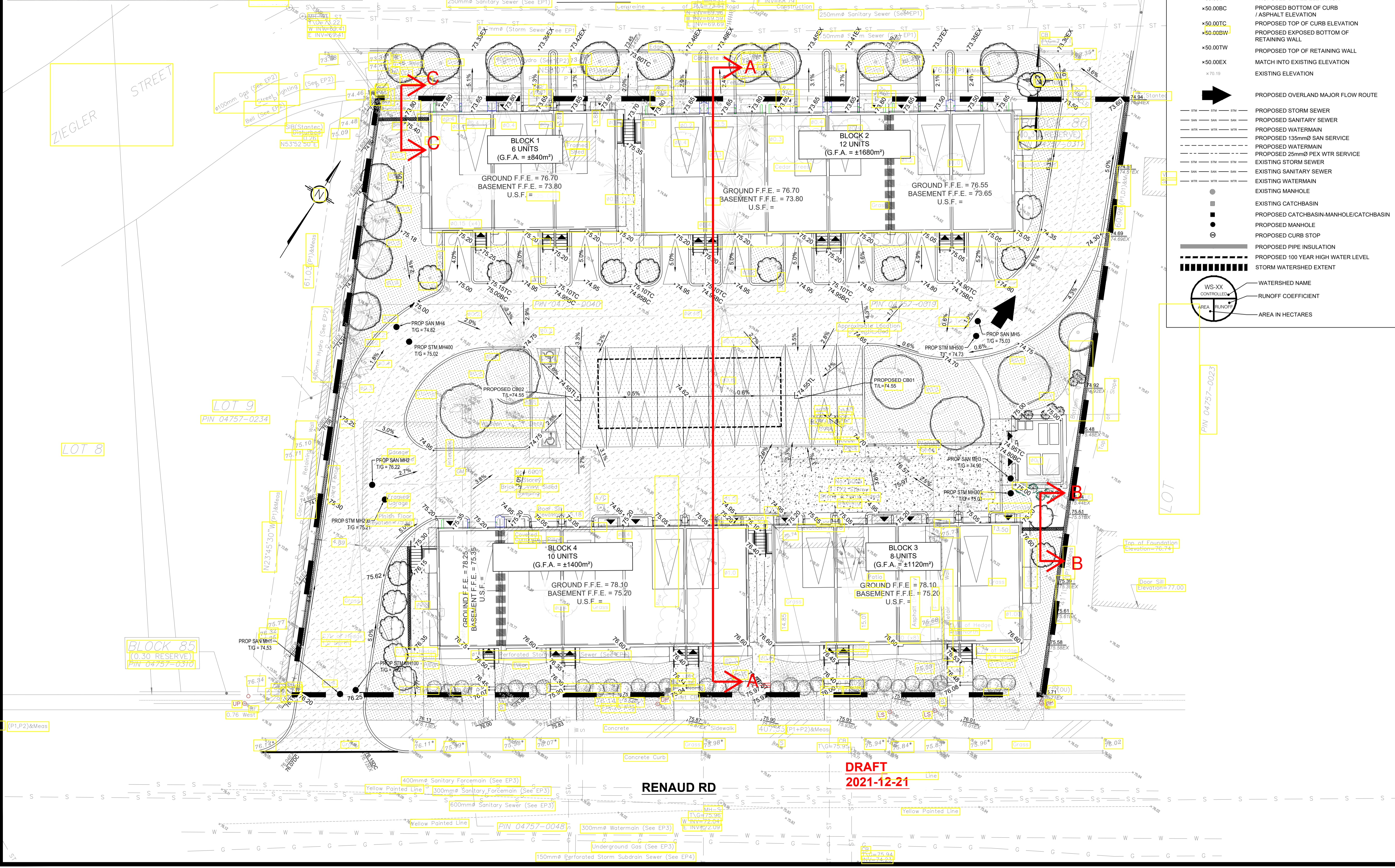
CONTRACTOR IS ADVISED TO COLLECT INFORMATION ON SOIL CONDITIONS BEFORE START OF CONSTRUCTION.

THE ENGINEER WAIVES ANY AND ALL RESPONSIBILITY AND LIABILITY FOR PROBLEMS WHICH ARISE FROM FAILURE TO FOLLOW THESE PLANS, SPECIFICATIONS AND THE DESIGN INTENT THEY CONVEY, OR FOR PROBLEMS WHICH ARISE FROM OTHERS' FAILURE TO OBTAIN AND/OR FOLLOW THE ENGINEER'S GUIDANCE WITH RESPECT TO ANY ERRORS, OMISSIONS, INCONSISTENCIES, AMBIGUITIES OR CONFLICTS WHICH ARE ALLEGED.

CONTRACTOR TO VERIFY ALL DIMENSIONS AND NOTIFY THE ENGINEER OF ANY DISCREPANCIES BEFORE WORK COMMENCES. DO NOT SCALE DRAWINGS.

SCALE: #####

NOT FOR CONSTRUCTION TENDER OR PERMIT



No.	REVISIONS	BY	DATE
01	ISSUED FOR CLIENT APPROVAL	X.X.	XX XXX 2020

NOT AUTHENTIC UNLESS SIGNED AND DATED

LRJ
ENGINEERING | INGÉNIERIE

5430 Canotek Road | Ottawa, ON, K1J 9G2
www.lri.ca | (613) 842-3434

CLIENT: **LANDRIC HOMES**
1173 CYRILLE RD, SUITE 202,
OTTAWA ON K1J 7S6

DESIGNED BY: A.S. DRAWN BY: A.S. APPROVED BY: V.J.

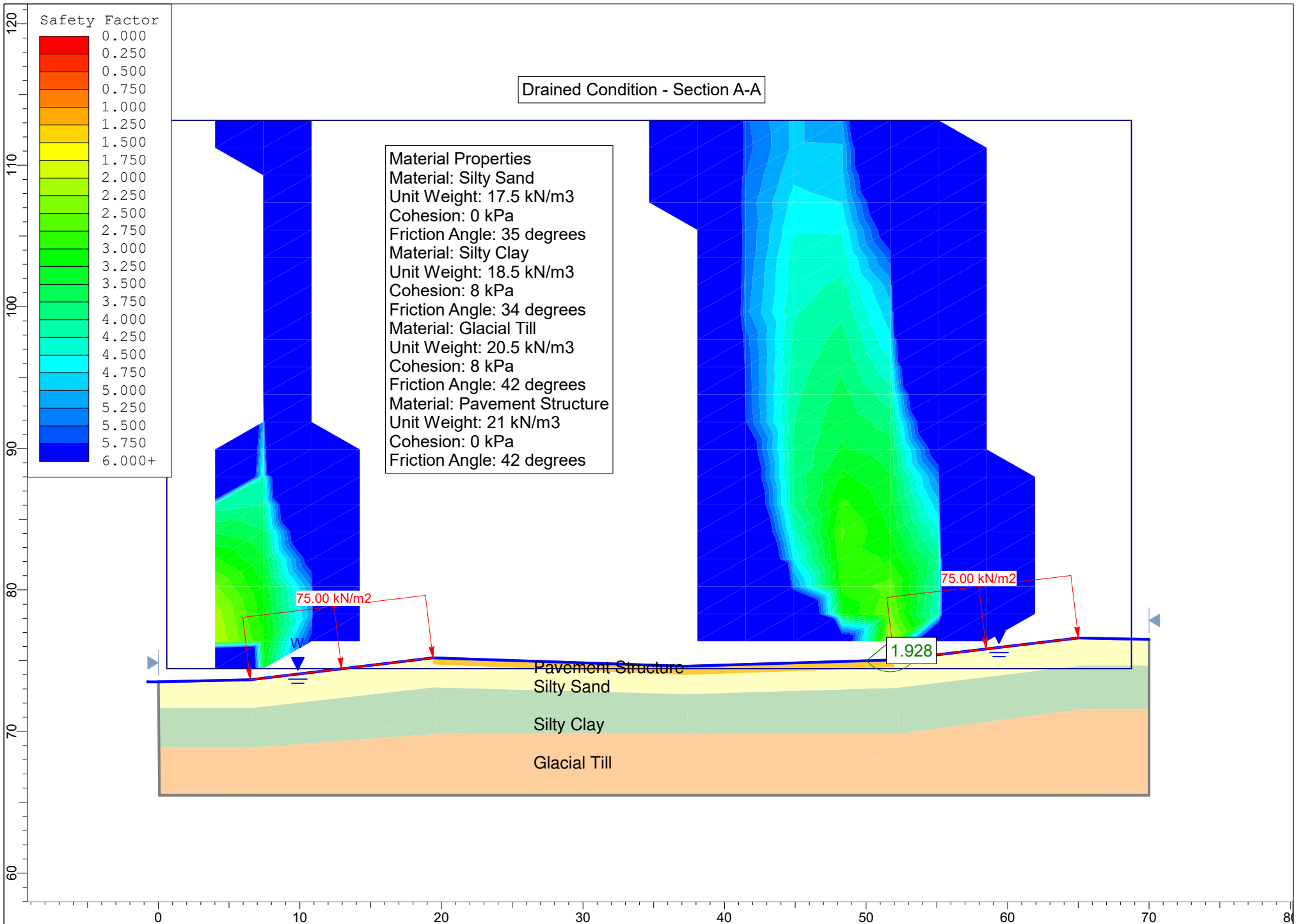
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OTTAWA, ONTARIO**

DRAWING TITLE: **GRADING AND DRAINAGE PLAN**

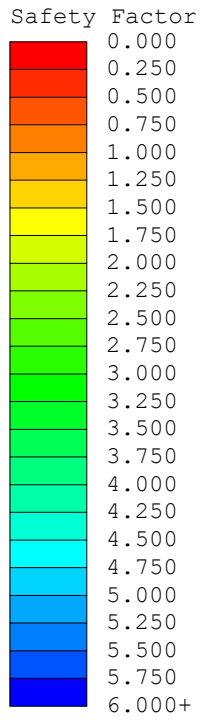
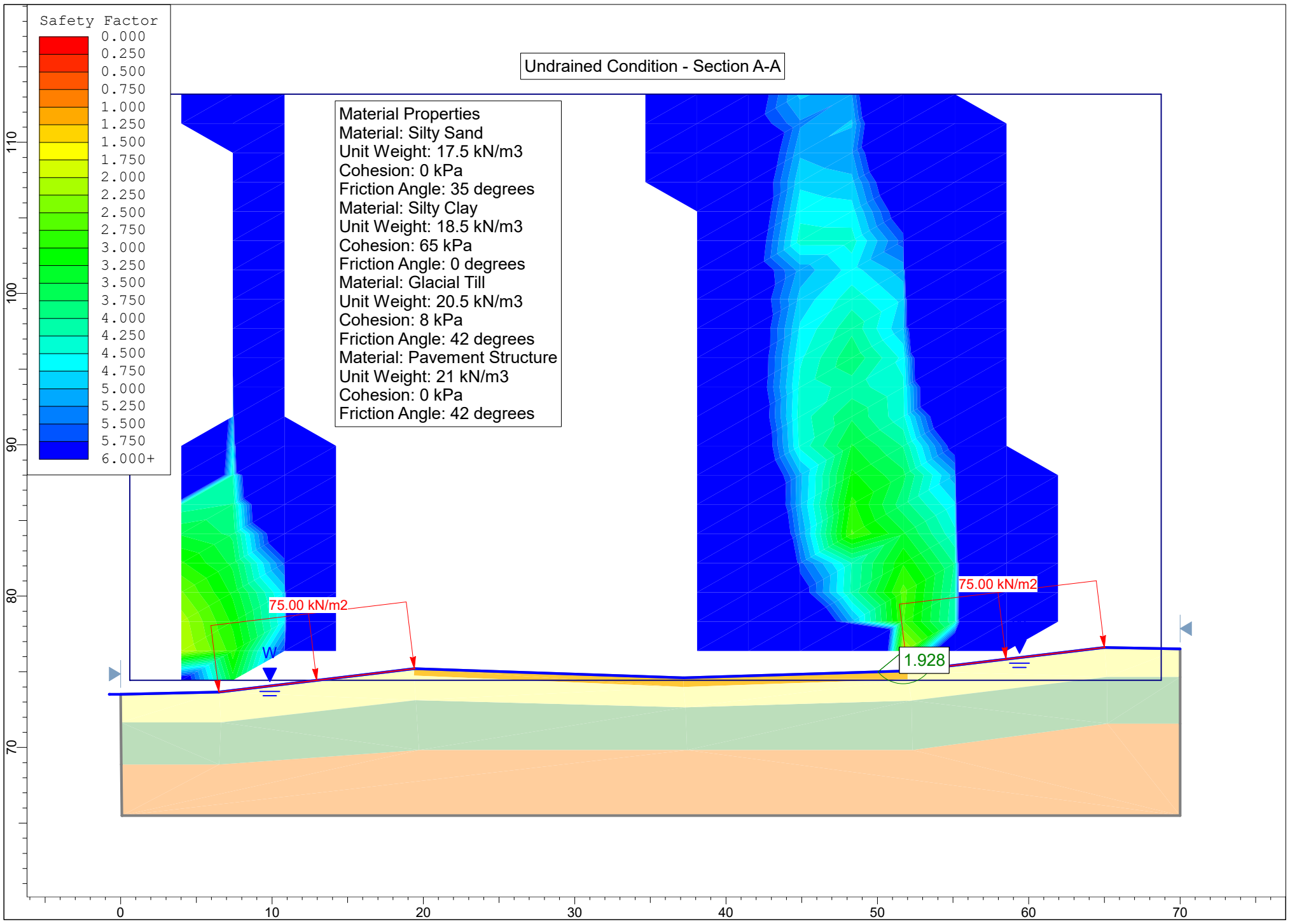
PROJECT NO: 210216
DATE: NOVEMBER 2021

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Undrained Condition - Section A-A



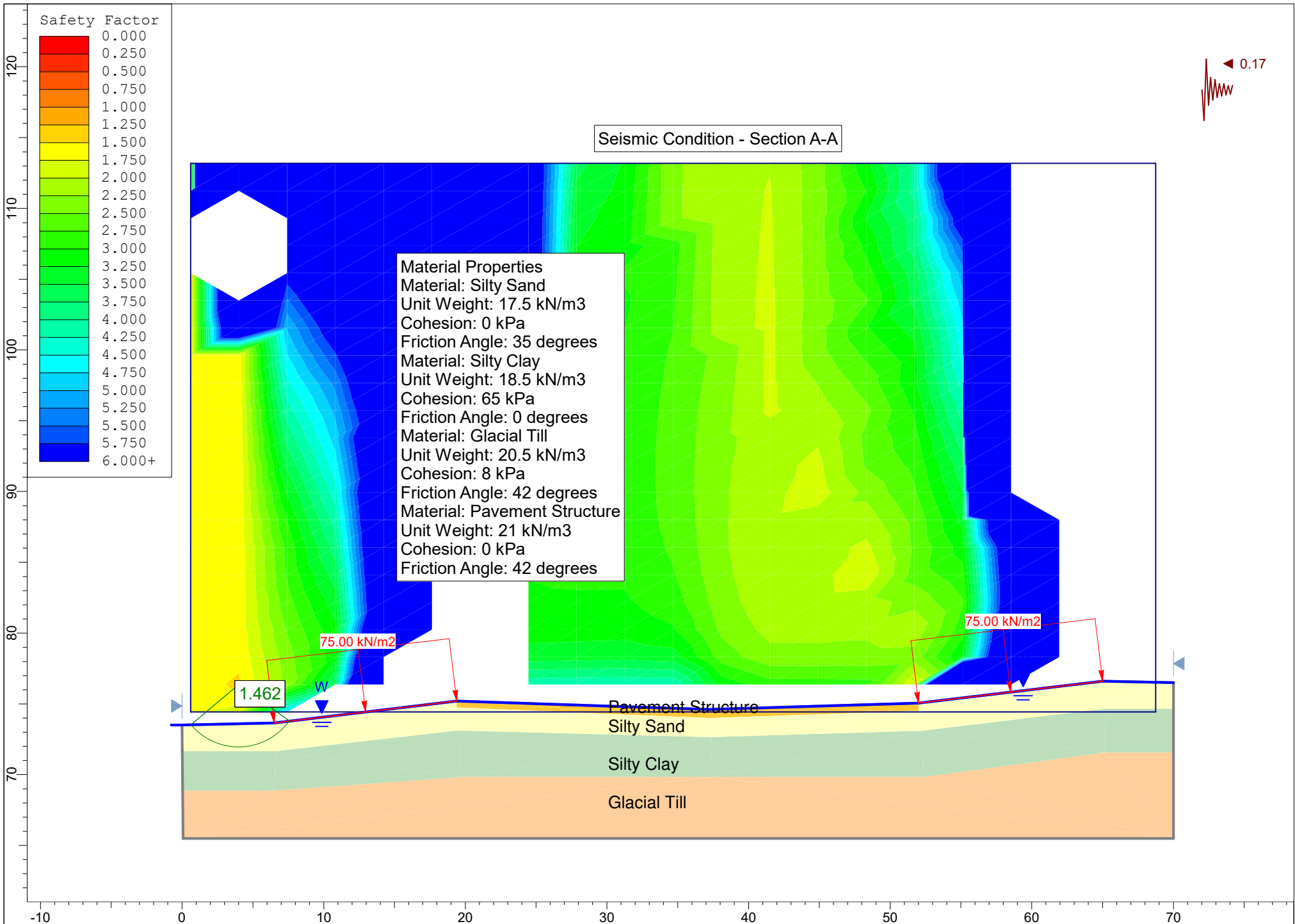
Material Properties

- Material: Silty Sand
- Unit Weight: 17.5 kN/m³
- Cohesion: 0 kPa
- Friction Angle: 35 degrees
- Material: Silty Clay
- Unit Weight: 18.5 kN/m³
- Cohesion: 65 kPa
- Friction Angle: 0 degrees
- Material: Glacial Till
- Unit Weight: 20.5 kN/m³
- Cohesion: 8 kPa
- Friction Angle: 42 degrees
- Material: Pavement Structure
- Unit Weight: 21 kN/m³
- Cohesion: 0 kPa
- Friction Angle: 42 degrees

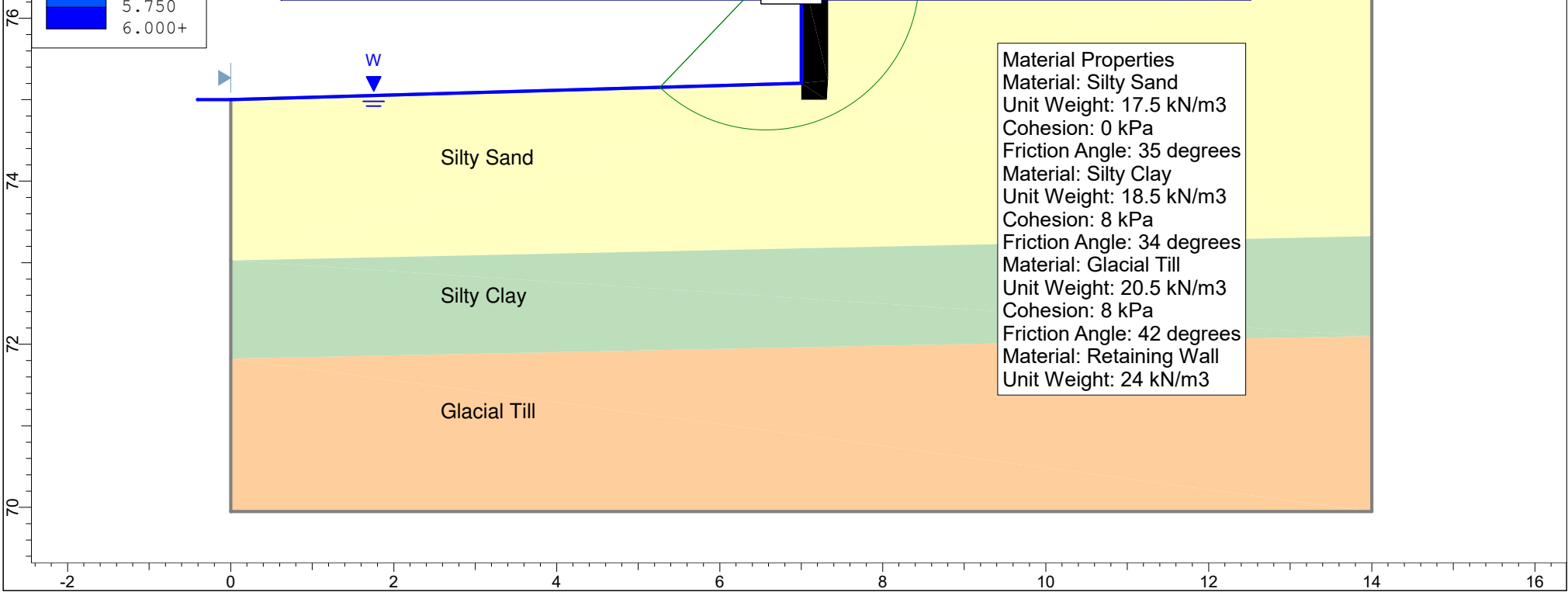
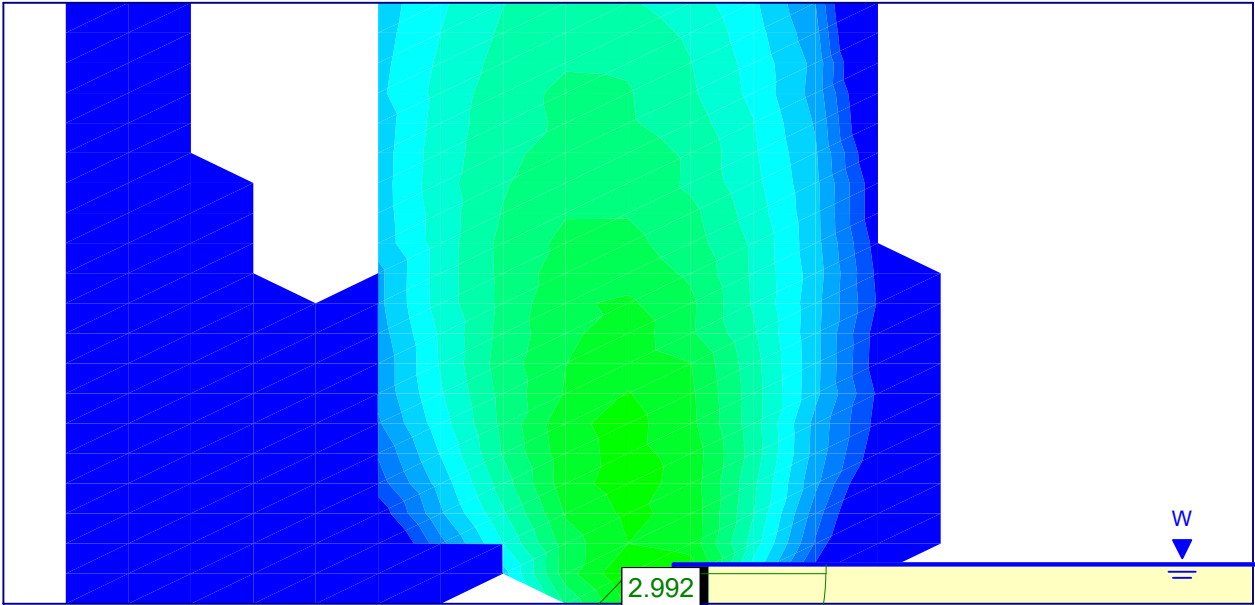
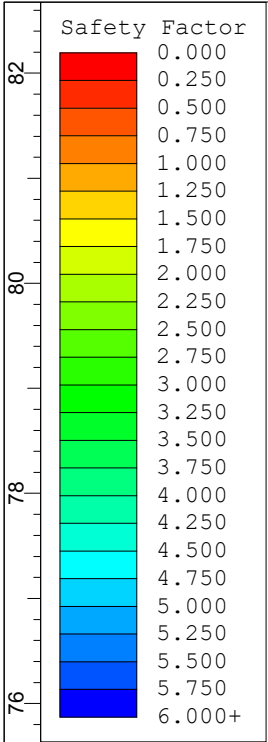
75.00 kN/m²

75.00 kN/m²

1.928



Global Stability - Drained Condition - Section B-B



Material Properties	
Material:	Silty Sand
Unit Weight:	17.5 kN/m ³
Cohesion:	0 kPa
Friction Angle:	35 degrees
Material:	Silty Clay
Unit Weight:	18.5 kN/m ³
Cohesion:	8 kPa
Friction Angle:	34 degrees
Material:	Glacial Till
Unit Weight:	20.5 kN/m ³
Cohesion:	8 kPa
Friction Angle:	42 degrees
Material:	Retaining Wall
Unit Weight:	24 kN/m ³

