TATHAM ENGINEERING

Enhancing our communities

Hinds Brook Residential Development

EXISTING CONDITION NATURAL HAZARD ASSESSMENT

Homefield Management Ltd.

File 123069 | April 5, 2024

Document Control

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Date:

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Issue	Date	Description
1	April 5, 2024	Final Report

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1 Introduction

This report has been prepared in support of the proposed Hinds Brook residential development to be located at 496857 Grey Road 2 in the Town of The Blue Mountains. This report outlines the existing condition hydraulic analysis completed to assess the flood hazard limit across the development site. This report also considers the erosion hazards associated with Indian Brook to determine the natural hazard limit across the site.

1.1 SITE DESCRIPTION

The development site has the municipal address 496857 Grey Road 2 and is legally described as Concession 8 Part of Lot 29 RP-16R2439 Part 1. The site is located in the Town of The Blue Mountains south of Highway 26 and east of Grey Road 2 with approximately 58 m of frontage along Grey Road 2 as shown on Figure 1 enclosed at the back of this report. The site is approximately 36.5 ha in area and is irregularly shaped. It is generally bounded by an existing resort community and hazard land to the north, the Georgian Trail to the east, Grey Road 2 to the west and special agriculture, development and hazard land to the south. The development site is designated as primary settlement area and hazard land in the Grey County Official Plan. The Town Official Plan designates the site as rural and hazard. The site is zoned rural and hazard. A significant portion of the site is regulated by the Grey Sauble Conservation Authority (GSCA) including a wetland taking up the majority of the south portion of the property as well as erosion and flood hazards associated with Indian Brook at the north extent of the property. Finally, the southeast corner of the site is located in the Niagara Escarpment Plan area and is designated Escarpment Recreation Area.

1.2 STUDY AREA DESCRIPTION

The site is included in a larger study area that this report reviewed to determine the flood hazard limit for the site and surrounding areas. The study area limit is also shown on Figure 1.

1.3 OBJECTIVES AND DESIGN CRITERIA

The primary objective of this report is to assess the existing natural hazards, specifically flood and erosion, associated with Indian Brook to determine the developable limits across the site. The natural heritage constraints are being evaluated under a separate cover (report by others). The existing flood and erosion hazards will be evaluated in accordance with the relevant Town, Grey Sauble Conservation Authority (GSCA) and Ministry of Natural Resources and Forestry (MNRF) standards and guidelines.

1.4 GUIDELINE DOCUMENTS AND REFERENCES

This report was prepared recognizing the pertinent GSCA, Town and Provincial guidelines on water resources and the environment, including the following publications:

- *Policies for the Administration of the Development, Interference with Wetlands and Alterations to Shorelines and Watercourses Regulation Ontario Regulation 151/06*. Grey Sauble Conservation Authority (2010);
- *The Blue Mountains Engineering Standards*. Town of the Blue Mountains (2023);
- *Technical Guide*: *River & Stream Systems: Flooding Hazard Limit.* Ontario Ministry of Natural Resources Water Resources Section (2002);
- *Technical Guide*: *River & Stream Systems: Erosion Hazard Limit.* Ontario Ministry of Natural Resources Water Resources Section (2002);
- *Drainage Master Plan, Existing Conditions Report – Town of The Blue Mountains.* Tatham Engineering (2022); and
- A *Report On – Slope Stability Assessment – Proposed Residential Development - 496857 Grey Road 2 – Town of The Blue Mountains, Ontario.* DS Consultants Ltd. (January 4, 2024).

2 Existing Drainage Conditions

The flood hazard on the development property is caused by flooding of Indian Brook which crosses the north extent of the site. It is anticipated that Indian Brook, adjacent to the site, experiences a spill to Watercourses 41 and 52 north of the site. This spill will also be impacted by Watercourse 42 which is connected to Watercourse 52 at its downstream extent. As such, to accurately model the flood hazard limit across the site including the existing spill, this report's study area includes Watercourses 41, 42, 52 and Indian Brook from Grey Road 2, as the upstream extent, to Georgian Bay, as the downstream extent.

2.1 EXISTING HYDROLOGY

Runoff hydrographs from the Timmins Regional Storm, which was determined to govern regulatory inundation limits across the study area, were taken from the *Drainage Master Plan, Existing Conditions Report* prepared by Tatham Engineering for watercourses 41, 42, 52 and Indian Brook. To save computation time, these hydrographs were truncated at 16 hours, well past the peak flow from the Timmins Regional Storm. Hydrograph data used for each of the watercourses are included as Appendix A. In addition to the Timmins Regional storm, hydrographs for the 1:2 year return frequency storm are also provided as the 1:2 year return frequency storm flood line was requested to be modelled by the natural heritage consultant to assist in setting an appropriate setback from fish habitat. Given the proximity of the study area to Georgian Bay, the inflow hydrographs account for the entire drainage area to each watercourse outlet at Georgian Bay. This is a conservative assumption with respect to modeling the flood limit across the site and study area. Additionally, the hydrologic model from which the inflow hydrographs are derived is uncalibrated and thus is believed to be conservative. The Timmins Regional Storm peak flows for each watercourse included in the study area are summarized in Table 1.

Table 1: Watercourse Peak Flows

WATERCOURSE ID	TIMMINS REGIONAL STORM PEAK FLOW (M^3/S)	TIME OF PEAK FLOW (HR:MIN)
41	0.761	7:00
42	1.401	7:05
52	12.120	9:20
Indian Brook	223.77	8:30

3 Existing Condition Hydraulic Model

3.1 MODEL TERRAIN

The terrain for the model was created using a combination of Ontario Digital Terrain Model (DTM) retrieved from Ontario GeoHub as well as site topographic survey and survey of critical culvert and bridge crossing locations. The DTM, as retrieved from Ontario GeoHub was in the Canadian Geodetic Vertical Datum (CGVD) 2013 whereas the topographic survey is in CVGD28:78 referenced to benchmark station 0011972U299. Benchmark Station 0011972U299 has a published CGVD2013 elevation of 187.322 m and a CGVD28:78 elevation of 187.695 m. Therefore, to convert the DTM elevations to CVGD28:78 elevation values, the DTM was shifted 0.37 m higher to convert to CVGD28:78. This DTM shift was verified by reviewing survey points along the Highway 26 centreline with the original DTM which were in the range of the 0.37 m vertical shift.

3.2 CULVERTS AND BRIDGES

Topographic survey of key culvert and bridge crossings was completed to confirm structure sizes and grades. This included:

- the bridge crossing of Indian Brook at Highway 26;
- the bridge crossing of Indian Brook at the Georgian Trail; and
- the culvert crossing of Watercourse 41 at Highway 26.

Culverts that were not surveyed but are included in the model had their approximate location, size and material assigned based on information in the *Drainage Master Plan, Existing Conditions Report* prepared by Tatham Engineering. For the culverts that were not surveyed, their inverts were estimated based on the Ontario DTM. The culverts included in the model are summarized in Table 2.

Table 2: Culvert Information

CULVERT/BRIDGE ID & LOCATION	CULVERT/ BRIDGE SIZE & DESCRIPTION	UPSTREAM INVERT (M)	DOWNSTREAM INVERT (M)	SOURCE
142 Indian Brook @ Highway 26	Bridge	N/A	N/A	Survey
143 Indian Brook @ Georgian Trail	Bridge	N/A	N/A	Survey
145 Watercourse 41 @ Lake Shore Road	2.70w x 1.10h Conc. Box	178.30	178.20	DMP/ Ontario DTM
146 Watercourse 41 @ Highway 26	2.41w x 2.10h Conc. Box	179.35	178.88	Survey
147 Watercourse 52 @ Lake Shore Road	2.40w x 0.80h Conc. Box	179.00	178.85	DMP/ Ontario DTM
148 Watercourse 52 @ Georgian Trail	1.50 m dia. CSP	181.10	181.00	DMP/ Ontario DTM
149 Watercourse 52 @ Highway 26	1.80w x 1.10h CSP Arch	182.00	181.80	DMP/ Ontario DTM
158 Watercourse 42 @ Bayview Avenue	Twin 0.60 m dia. CSP	177.30	177.30	DMP/ Ontario DTM
159 Watercourse 42 @ Lake Shore Road	1.90w x 1.10h CSP Arch	180.95	180.70	DMP/ Ontario DTM
160 Watercourse 42 @ Georgian Trail	1.55w x 1.20h CSP Arch	181.90	181.55	DMP/ Ontario DTM
161 Watercourse 42 @ Highway 26	2.40w x 1.00h Conc. Box	182.70	182.70	DMP/ Ontario DTM
999 Georgian Trail South East of Indian Brook	0.90 m dia. CSP	180.34	180.42	Survey
998 Georgian Trail South East of Indian Brook	0.60 m dia. CSP	181.54	181.46	Survey

3.3 BOUNDARY CONDITIONS

The flow hydrographs mentioned in Section 2.1 serve as the upstream boundary conditions for the model and are shown on Drawing FHL-1 which is enclosed as Figure 2 for reference.

The downstream boundary condition used was the Georgian Bay static high lake level of 177.50 m.

3.4 MODEL MESH

A 10 m base cell size 2-D mesh was created to initially discretize the study area. The mesh was refined with break lines to create a smaller cell size to better represent the terrain high and low points such as stream channels, banks, roads, trails, etc. SA/2-D connection areas used for culvert and bridge crossings were also enforced as break lines to refine the mesh at these key hydraulic features.

3.5 COMPUTATIONAL SETTINGS

A 16 hour duration 2-D unsteady flow simulation model was run using the shallow water equation, Eulerian-Lagrangian method (SWE-ELM) equation set and an adaptive timestep control for the Timmins Regional storm event.

3.6 MANNING'S ROUGHNESS COEFFICIENT

Manning's roughness coefficients were assigned based on land use data from the Southern Ontario Land Resource Information System (SOLRIS) 3.0 retrieved from Ontario GeoHub. The land use was overwritten for watercourses that did not show up in the SOLRIS data. Table 3 summarizes the land uses observed in the study area and the Manning's roughness coefficient assigned to each.

Table 3: Land Use and Manning's Roughness Coefficient

LAND USE	MANNING'S ROUGHNESS COEFFICIENT
Built Up Area - Impervious	0.080
Transportation	0.020
Built Up Area - Pervious	0.080
Open Water	0.040
Undifferentiated	0.070
Tilled	0.035
Coniferous Forest	0.160
Treed Swamp	0.120
Mixed Forest	0.160
Marsh	0.070
Deciduous Forest	0.160
Plantations - Tree Cultivated	0.160
Forest	0.160
Watercourse	0.035

3.7 RESULTS

The flood hazard limit was established as the flood maximum inundation limit during the Timmins Regional Storm as shown on Drawing FHL-1 enclosed with this report as Figure 2 for reference.

As anticipated, adjacent to the site, there is a spill from Indian Brook in a northeast direction, towards Watercourses 41 and 52. This includes overtopping of Highway 26 north of the site between Grey Road 2 and the Georgian Trail and overtopping of the Georgian Trail between Highway 26 and the site. Overall, the flood hazard is confined by the south bank of Indian Brook across the site with the exception of a small area in the northeast corner of the site which is inundated due to backwater from the Georgian Trail Bridge crossing of Indian Brook (culvert/bridge ID 143). This flooded area on site is outside of the riparian and effective flow areas for the watercourse and could potentially be used for stormwater management (SWM) in accordance with GSCA's *Policies for the Administration of the Development, Interference with*

Wetlands and Alterations to Shorelines and Watercourses Regulation Ontario Regulation 151/06 section 8.1.14.

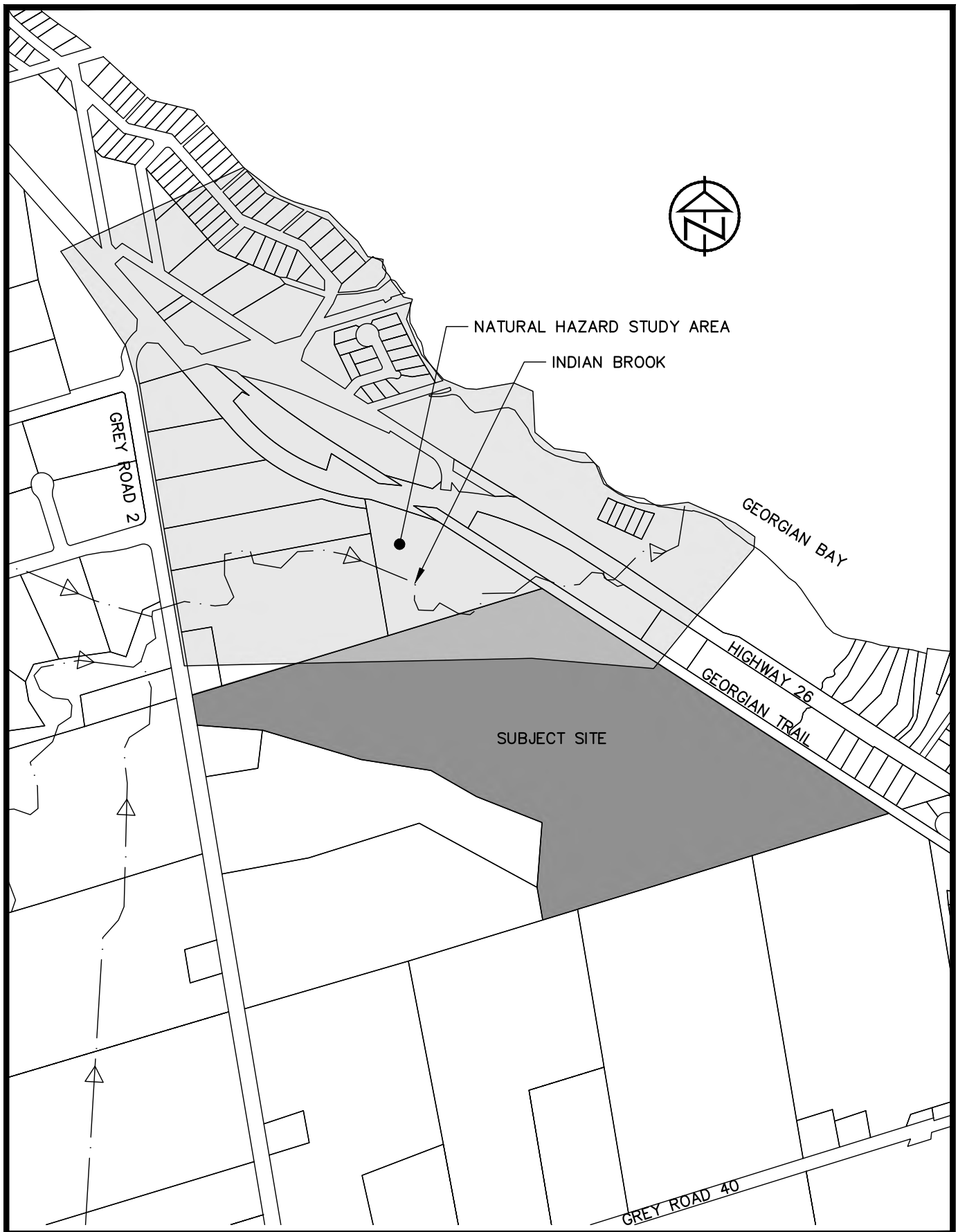
4 Erosion Hazard Limit

In addition to the flood hazard associated with Indian Brook, there is also an associated erosion hazard for the south bank of Indian Brook adjacent to the site. A *Report On – Slope Stability Assessment – Proposed Residential Development - 496857 Grey Road 2 – Town of The Blue Mountains, Ontario* was prepared by DS Consultants Ltd. dated January 4, 2024. A copy of the report is enclosed herein as Appendix C for reference. Included in this report are plans and cross sections detailing the long-term stable slope delineation.

5 Summary

As detailed in this report, Tatham Engineering has reviewed the existing natural hazard conditions associated with Indian Brook for the Hinds Brook Residential Development project to be located at 496857 Grey Road 2. The existing condition flood hazard limit has been determined for the study area and the site based on the 2-D unsteady flow HEC-RAS model. The erosion hazard limit has been determined by DS Consulting based on a detailed slope stability assessment for the south bank of the watercourse. Enclosed as Figure 3 for reference is Drawing NHL-1 which shows the overall natural hazard limit across the site which is the largest setback from the flood and erosion hazard limit plus a 6.0m access allowance.

The proposed development is shown on the Hinds Property Site Development Concept prepared by travis & associates dated February 23, 2024, enclosed as Figure 4 for reference which also shows the natural hazard limits delineated as detailed in this report. The proposed development is located outside of the established natural hazard limits except for the SWM pond which will be located partially within the backwater area south of the Georgian Trail bridge in accordance with GSCA policy as described in Section 3.7 if this report.



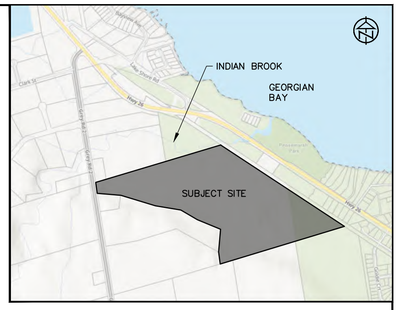
TATHAM ENGINEERING

HINDS BROOK
SITE LOCATION PLAN

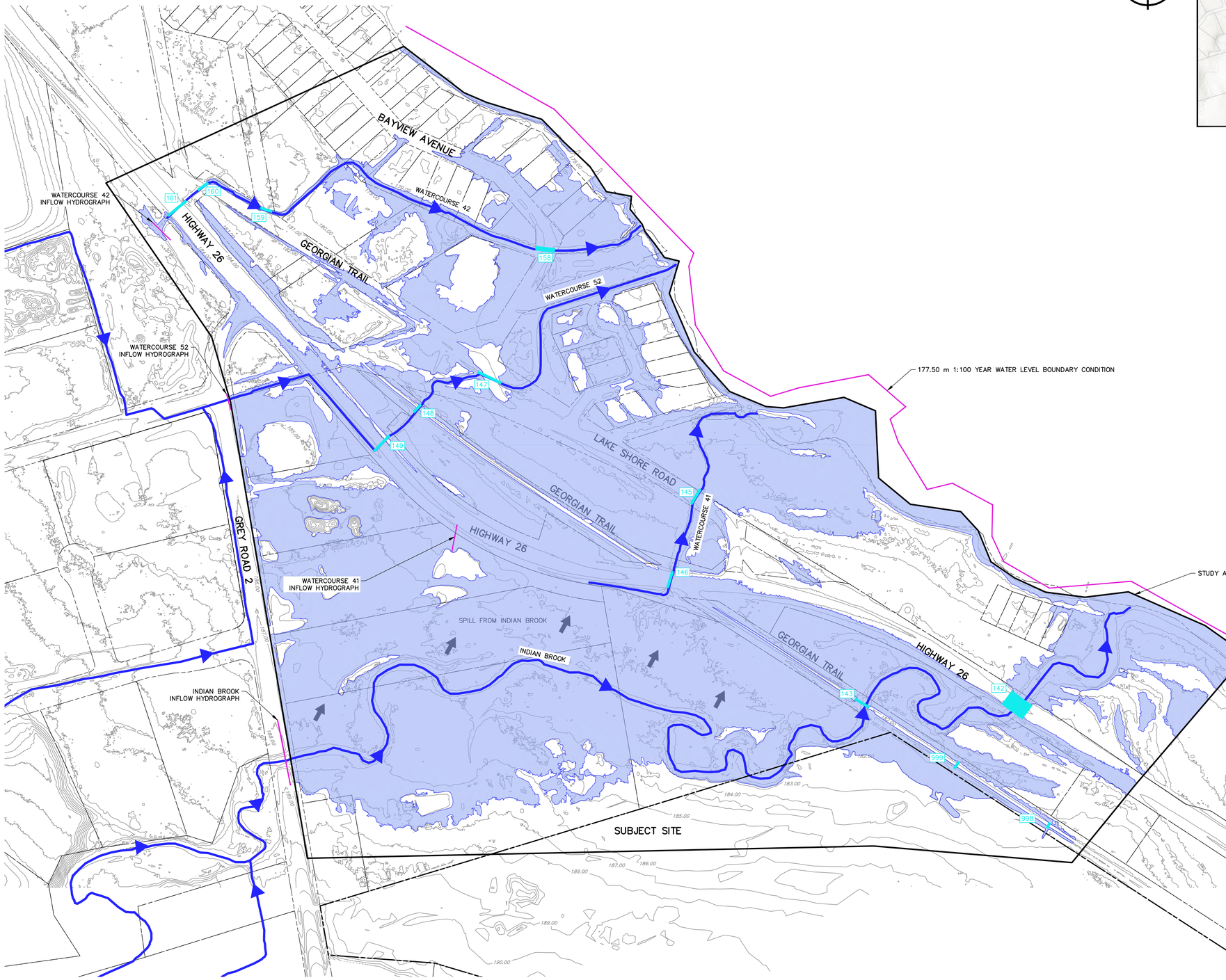
DWG. No. **FIG. 1**

SCALE: 1:10,000	DATE: AUG/23	JOB NO. 123069

Drawing Name: 123069–FIG. 1.dwg, Plotted: Feb 12, 2024



KEY PLAN



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CONTRACTOR MUST VERIFY ALL DIMENSIONS AND BE RESPONSIBLE FOR SAME. ANY DISCREPANCIES MUST BE REPORTED TO THE ENGINEER BEFORE COMMENCING WORK. DRAWINGS ARE NOT TO BE SCALED.

BENCHMARKS

ELEVATIONS HEREON ARE FROM ONTARIO LIDAR DERIVED DTM RETRIEVED FROM ONTARIO GEOHUB. ELEVATIONS HAVE BEEN ADJUSTED 0.37m HIGHER TO CONVERT FROM CGVD2013 TO CVGD28:78 AND FROM SITE TOPOGRAPHIC SURVEY REFERENCE TO BENCHMARK STATION 0011972U299,

NOTES

PROPERTY LINES ON THIS PLAN ARE FROM GREY COUNTY GIS PARCEL LINES.

LONG TERM STABLE SLOPE PROVIDED BY DS. CONSULTANTS INC. REPORT ON SLOPE STABILITY ASSESSMENT DATED JANUARY 4, 2024..

No.	REVISION DESCRIPTION	DATE
1.	NATURAL HAZARD ASSESSMENT	MAR. 7/24

ENGINEER STAMP

HINDS BROOK RESIDENTIAL DEVELOPMENT

TOWN OF THE BLUE MOUNTAINS

TATHAM ENGINEERING

EXISTING CONDITION FLOOD HAZARD LIMIT

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DRAWN: AO	DATE: NOV. 2023	
CHECK: JM	SCALE: 1:2500	

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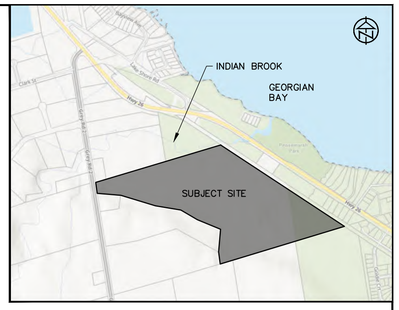

KEY PLAN

LEGEND

- SUBJECT SITE
- PROPERTY LINE
- FLOOD HAZARD LIMIT
- EXISTING 1:2 YEAR FLOOD LINE
- LONG TERM STABLE SLOPE
- 6.0m ACCESS ALLOWANCE (EROSION HAZARD LIMIT)

INDIAN BROOK

GEORGIAN TRAIL

HIGHWAY 26

1:2 YEAR FLOOD LINE DELINEATED FOR NATURAL HERITAGE CONSIDERATION.

LONG TERM STABLE SLOPE (FROM DS CONSULTANTS LTD.)

6.0m ACCESS ALLOWANCE (EROSION HAZARD LIMIT)

FLOOD HAZARD LIMIT

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No.	REVISION DESCRIPTION	DATE
1.	NATURAL HAZARD ASSESSMENT	MAR. 7/24

ENGINEER STAMP

HINDS BROOK RESIDENTIAL DEVELOPMENT

TOWN OF THE BLUE MOUNTAINS

TATHAM ENGINEERING

EXISTING CONDITION NATURAL HAZARD LIMIT

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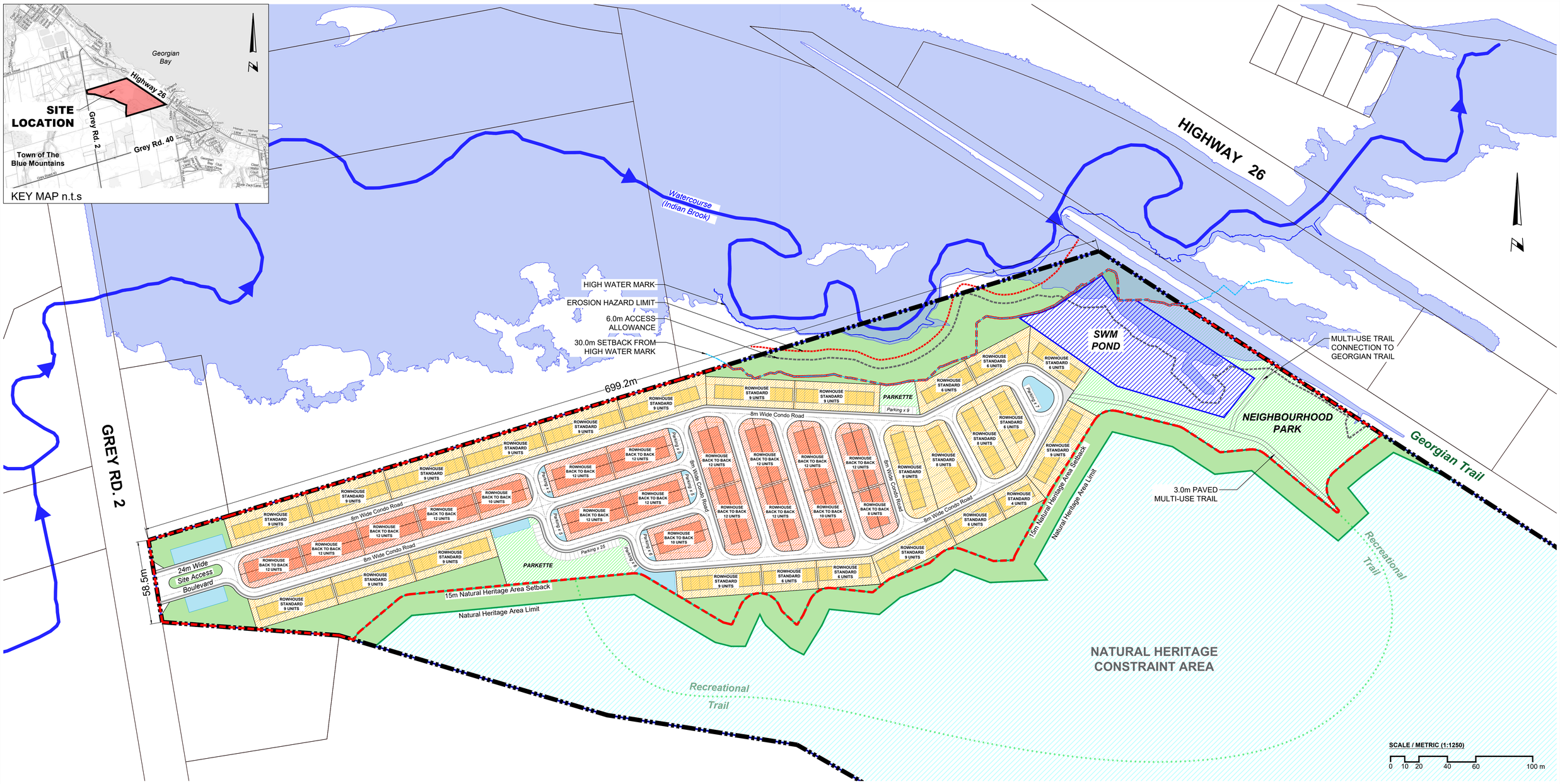
Drawing Name: 123069-FLD-1.dwg, Plotted: Mar 07, 2024



HINDS PROPERTY
SITE DEVELOPMENT CONCEPT

496857 GREY RD. 2
CON 8 PT LOT 29
RP 16R2439, PT PART 1
TOWN OF THE BLUE MOUNTAINS
COUNTY OF GREY

GENERAL NOTES

All site measurements are in Metric.
All proposed site development features and measurements are illustrated for project review and discussions.

Plan Drawing References:

- Tatham Engineering, Hinds Property, Conceptual Constraint Plan (2024)
- Grey County GIS, Site Location (2023)
- Town of The Blue Mountains, Zoning By-Law 2018-65

LEGEND

- Property Boundary (+/-36.49 ha)
- Development Area (+/-9.54 ha) - per Natural Features Constraints
- Residential Rowhouse - Standard (197 Dwelling Units)
- Residential Rowhouse - Back To Back (206 Dwelling Units)
- Neighbourhood Park & Parkette Areas (+/-1.14 ha or 12% of the Total Development Area)
- SWM Pond Area (+/- 0.71 ha)
- Open Space & Natural Heritage Setback Areas
- Natural Heritage Constraint Area
- Temporary Snow Storage Areas
- Floodplain Areas
- Watercourse
- Natural Heritage Constraint Area Limit
- 15m Natural Heritage Area Setback
- Recreational Trail
- 8m Wide Condo Road
- Condo Road Centerline *(6m Road, 12m Radius on Curb Centerline)*
- Sidewalk *(1.5m)*

Additional On-Site Parking - 73 Spaces *(2.75m x 5.5m)*

PROPOSED ZONING LOT PROVISIONS

ROWHOUSE STANDARD UNITS
- Min. Frontage: 6.1 m
- Min. Front Yard Setback: 5.0 m
- Min. Rear Yard Setback: 7.5 m
  (5.5 m for lots backing onto *Subject Lands*)
- Min. Interior Yard Setback: 1.2 m
- Min. Exterior Yard Setback: 4.0 m
- Approximate Building Footprint: 57.95 sq.m. (6.1 m x 9.5 m)

ROWHOUSE BACK TO BACK UNITS
- Min. Frontage: 6.7 m
- Min. Front Yard Setback: 4.75 m
- Min. Rear Yard Setback: n/a
- Min. Interior Yard Setback: 1.2 m
- Min. Exterior Yard Setback: 4.0 m
- Approximate Building Footprint: 48.91 sq.m. (6.7 m x 7.3 m)

SITE DEVELOPMENT CONCEPT SUMMARY

Total Site Area: +/- 36.49 ha
Total Development Area: +/- 9.54 ha
Total Number of Units: 403 Units
Density per Total Development Area: +/- 43 Units/ha

Revision#.	Date D/M/Y	Description / Notes
1.	31/01/2024	PRELIMINARY DRAFT / FOR REVIEW
2.	07/02/2024	REVISED DRAFT / FOR REVIEW
3.	23/02/2024	REVISED DRAFT / FOR REVIEW

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T.705-446-9917

File/CAD: T&A_HindsDevelopment.dwg
Date(d/m/y): 23/02/2024 | Drafted by: D.C. | Checked by: C.T.

D-1

Date Plotted: February 28, 2024

Appendix A:
Watercourse Hydrographs

Hydrograph Data Regulatory (Timmins) Storm

Time (H:MIN)	Watercourse 41 Hydrograph Flow (m^3/s)	Watercourse 42 Hydrograph Flow (m^3/s)	Watercourse 52 Hydrograph Flow (m^3/s)	Indian Brook Hydrograph Flow (m^3/s)
0:00	0.000	0.000	0.000	0.000
0:05	0.000	0.000	0.000	0.000
0:10	0.000	0.006	0.007	0.000
0:15	0.004	0.030	0.022	0.000
0:20	0.016	0.069	0.041	0.000
0:25	0.040	0.096	0.072	0.000
0:30	0.061	0.108	0.105	0.000
0:35	0.069	0.114	0.130	0.000
0:40	0.072	0.118	0.145	0.000
0:45	0.073	0.120	0.153	0.000
0:50	0.074	0.122	0.157	0.000
0:55	0.075	0.124	0.160	0.001
1:00	0.077	0.126	0.163	0.002
1:05	0.080	0.137	0.174	0.004
1:10	0.089	0.155	0.190	0.007
1:15	0.100	0.167	0.209	0.012
1:20	0.110	0.177	0.232	0.021
1:25	0.118	0.185	0.257	0.032
1:30	0.125	0.193	0.284	0.049
1:35	0.131	0.201	0.318	0.071
1:40	0.137	0.210	0.359	0.100
1:45	0.143	0.220	0.412	0.139
1:50	0.150	0.231	0.474	0.189
1:55	0.156	0.243	0.546	0.258
2:00	0.162	0.258	0.629	0.352
2:05	0.163	0.253	0.707	0.488
2:10	0.152	0.237	0.785	0.703
2:15	0.137	0.231	0.862	1.055
2:20	0.126	0.230	0.940	1.608
2:25	0.120	0.232	1.019	2.450
2:30	0.116	0.235	1.099	3.754
2:35	0.113	0.239	1.177	5.598
2:40	0.111	0.243	1.251	7.930
2:45	0.110	0.247	1.320	10.626
2:50	0.110	0.250	1.383	13.698
2:55	0.110	0.253	1.441	17.044
3:00	0.110	0.256	1.495	20.348
3:05	0.108	0.243	1.534	23.706
3:10	0.099	0.222	1.564	26.925
3:15	0.084	0.207	1.590	30.065
3:20	0.071	0.197	1.614	33.110
3:25	0.062	0.188	1.636	35.911
3:30	0.056	0.180	1.652	38.394
3:35	0.051	0.174	1.661	40.564
3:40	0.048	0.167	1.664	42.470
3:45	0.045	0.161	1.660	44.053
3:50	0.042	0.155	1.651	45.201
3:55	0.041	0.149	1.637	46.174
4:00	0.040	0.143	1.620	46.960
4:05	0.039	0.142	1.603	47.472
4:10	0.041	0.142	1.585	47.552
4:15	0.045	0.142	1.568	47.255
4:20	0.049	0.141	1.550	47.122
4:25	0.052	0.140	1.535	46.554
4:30	0.054	0.138	1.521	45.878
4:35	0.056	0.137	1.510	45.081
4:40	0.057	0.136	1.501	44.008
4:45	0.059	0.135	1.495	42.935
4:50	0.060	0.135	1.490	41.724
4:55	0.060	0.136	1.486	40.506
5:00	0.061	0.136	1.484	39.218
5:05	0.068	0.166	1.512	37.866
5:10	0.092	0.220	1.556	36.657
5:15	0.129	0.257	1.612	35.642
5:20	0.165	0.286	1.672	34.678
5:25	0.191	0.313	1.740	33.904
5:30	0.210	0.338	1.821	33.150
5:35	0.226	0.361	1.919	32.469
5:40	0.239	0.385	2.037	31.988
5:45	0.250	0.408	2.178	31.643
5:50	0.260	0.433	2.341	31.489
5:55	0.268	0.459	2.521	31.604
6:00	0.276	0.484	2.712	31.966
6:05	0.298	0.564	2.958	32.615
6:10	0.357	0.676	3.241	33.680
6:15	0.437	0.757	3.544	35.270
6:20	0.500	0.836	3.847	37.381
6:25	0.547	0.909	4.163	39.884
6:30	0.591	0.979	4.512	43.033
6:35	0.630	1.050	4.891	46.935
6:40	0.662	1.123	5.272	51.372
6:45	0.691	1.197	5.673	56.428
6:50	0.717	1.269	6.115	62.248
6:55	0.740	1.336	6.519	68.476
7:00	0.761	1.400	7.013	75.273
7:05	0.755	1.401	7.525	82.510
7:10	0.702	1.368	8.033	90.780
7:15	0.639	1.362	8.521	100.378
7:20	0.596	1.350	8.988	110.531
7:25	0.559	1.335	9.425	121.371
7:30	0.525	1.321	9.826	132.583
7:35	0.500	1.305	10.190	143.872
7:40	0.480	1.285	10.512	154.891
7:45	0.466	1.264	10.780	165.630
7:50	0.456	1.242	10.988	175.796
7:55	0.449	1.220	11.148	185.552
8:00	0.444	1.199	11.270	194.550

Time (H:MIN)	Watercourse 41 Hydrograph Flow (m^3/s)	Watercourse 42 Hydrograph Flow (m^3/s)	Watercourse 52 Hydrograph Flow (m^3/s)	Indian Brook Hydrograph Flow (m^3/s)
8:05	0.444	1.187	11.368	202.187
8:10	0.451	1.182	11.448	208.818
8:15	0.462	1.174	11.515	215.459
8:20	0.472	1.167	11.571	218.494
8:25	0.480	1.163	11.620	221.278
8:30	0.488	1.160	11.667	223.767
8:35	0.495	1.159	11.715	222.959
8:40	0.501	1.159	11.767	222.087
8:45	0.507	1.161	11.822	219.987
8:50	0.512	1.164	11.882	218.745
8:55	0.517	1.168	11.946	217.354
9:00	0.521	1.172	12.012	214.654
9:05	0.515	1.148	12.059	212.242
9:10	0.490	1.111	12.092	210.111
9:15	0.455	1.087	12.112	207.746
9:20	0.426	1.060	12.120	205.742
9:25	0.402	1.034	12.113	204.299
9:30	0.381	1.010	12.085	202.448
9:35	0.364	0.987	12.034	200.695
9:40	0.352	0.964	11.959	199.259
9:45	0.342	0.942	11.861	197.831
9:50	0.336	0.920	11.746	196.244
9:55	0.331	0.900	11.616	194.508
10:00	0.327	0.881	11.476	193.014
10:05	0.325	0.862	11.328	191.213
10:10	0.323	0.845	11.175	189.164
10:15	0.322	0.831	11.020	186.855
10:20	0.321	0.818	10.867	185.380
10:25	0.321	0.806	10.716	183.193
10:30	0.321	0.796	10.568	178.410
10:35	0.321	0.786	10.427	175.635
10:40	0.322	0.778	10.296	172.009
10:45	0.322	0.771	10.175	168.698
10:50	0.323	0.766	10.060	166.052
10:55	0.323	0.762	9.947	160.718
11:00	0.324	0.758	9.838	158.025
11:05	0.320	0.742	9.723	154.717
11:10	0.308	0.719	9.607	151.521
11:15	0.289	0.701	9.491	148.377
11:20	0.272	0.682	9.373	145.432
11:25	0.258	0.665	9.254	143.397
11:30	0.246	0.648	9.131	139.669
11:35	0.236	0.633	9.002	137.052
11:40	0.229	0.618	8.866	135.101
11:45	0.223	0.604	8.722	133.097
11:50	0.218	0.590	8.571	131.149
11:55	0.215	0.577	8.416	129.188
12:00	0.213	0.565	8.258	127.202
12:05	0.205	0.533	8.081	125.075
12:10	0.183	0.490	7.891	122.873
12:15	0.153	0.455	7.694	120.729
12:20	0.126	0.419	7.491	118.526
12:25	0.101	0.384	7.281	116.238
12:30	0.079	0.352	7.060	113.862
12:35	0.061	0.323	6.827	111.388
12:40	0.048	0.296	6.638	108.850
12:45	0.037	0.270	6.340	106.213
12:50	0.029	0.246	6.018	103.833
12:55	0.023	0.221	5.712	100.594
13:00	0.019	0.197	5.418	97.733
13:05	0.015	0.175	5.137	94.599
13:10	0.011	0.156	4.868	91.379
13:15	0.009	0.140	4.599	88.022
13:20	0.007	0.125	4.338	84.403
13:25	0.006	0.111	4.104	80.999
13:30	0.005	0.097	3.891	76.960
13:35	0.004	0.084	3.686	73.045
13:40	0.003	0.073	3.489	69.009
13:45	0.002	0.064	3.302	65.075
13:50	0.002	0.057	3.122	61.265
13:55	0.002	0.051	2.953	57.583
14:00	0.001	0.045	2.799	53.952
14:05	0.001	0.039	2.656	50.451
14:10	0.001	0.035	2.519	47.181
14:15	0.001	0.031	2.386	44.091
14:20	0.000	0.028	2.257	41.072
14:25	0.000	0.025	2.134	38.124
14:30	0.000	0.022	2.017	35.417
14:35	0.000	0.020	1.906	32.847
14:40	0.000	0.018	1.798	30.497
14:45	0.000	0.016	1.695	28.255
14:50	0.000	0.014	1.598	26.105
14:55	0.000	0.013	1.507	24.223
15:00	0.000	0.011	1.423	22.479
15:05	0.000	0.010	1.344	20.839
15:10	0.000	0.009	1.270	19.228
15:15	0.000	0.008	1.201	17.717
15:20	0.000	0.007	1.136	16.407
15:25	0.000	0.006	1.075	15.208
15:30	0.000	0.005	1.018	14.091
15:35	0.000	0.004	0.963	13.074
15:40	0.000	0.004	0.910	12.124
15:45	0.000	0.003	0.861	11.218
15:50	0.000	0.003	0.814	10.402
15:55	0.000	0.003	0.771	9.730
16:00	0.000	0.002	0.730	9.117

Hydrograph Data 1:2 Year Storm

Time (H:MIN)	Watercourse 41 Hydrograph Flow (m^3/s)	Watercourse 42 Hydrograph Flow (m^3/s)	Watercourse 52 Hydrograph Flow (m^3/s)	Indian Brook Hydrograph Flow (m^3/s)
0:00	0.000	0.000	0.000	0.000
0:05	0.000	0.000	0.000	0.000
0:10	0.000	0.000	0.000	0.000
0:15	0.000	0.000	0.000	0.000
0:20	0.000	0.000	0.000	0.000
0:25	0.000	0.000	0.000	0.000
0:30	0.000	0.000	0.000	0.000
0:35	0.000	0.000	0.000	0.000
0:40	0.000	0.000	0.000	0.000
0:45	0.000	0.000	0.000	0.000
0:50	0.000	0.000	0.000	0.000
0:55	0.000	0.000	0.000	0.000
1:00	0.000	0.000	0.000	0.000
1:05	0.000	0.000	0.000	0.000
1:10	0.000	0.000	0.000	0.000
1:15	0.000	0.000	0.000	0.000
1:20	0.000	0.000	0.000	0.000
1:25	0.000	0.000	0.000	0.000
1:30	0.000	0.000	0.000	0.000
1:35	0.000	0.000	0.000	0.000
1:40	0.000	0.000	0.000	0.000
1:45	0.000	0.000	0.000	0.000
1:50	0.000	0.000	0.000	0.000
1:55	0.000	0.000	0.000	0.000
2:00	0.000	0.000	0.000	0.000
2:05	0.000	0.000	0.000	0.000
2:10	0.000	0.000	0.000	0.000
2:15	0.000	0.000	0.000	0.000
2:20	0.000	0.000	0.000	0.000
2:25	0.000	0.000	0.000	0.000
2:30	0.000	0.000	0.000	0.000
2:35	0.000	0.000	0.000	0.000
2:40	0.000	0.000	0.000	0.000
2:45	0.000	0.000	0.000	0.000
2:50	0.000	0.000	0.000	0.000
2:55	0.000	0.000	0.000	0.000
3:00	0.000	0.000	0.000	0.000
3:05	0.000	0.000	0.000	0.000
3:10	0.000	0.000	0.000	0.000
3:15	0.000	0.000	0.000	0.000
3:20	0.000	0.001	0.001	0.000
3:25	0.001	0.003	0.002	0.000
3:30	0.001	0.004	0.002	0.000
3:35	0.002	0.004	0.003	0.000
3:40	0.002	0.005	0.004	0.000
3:45	0.003	0.005	0.004	0.000
3:50	0.003	0.005	0.005	0.000
3:55	0.003	0.006	0.005	0.000
4:00	0.003	0.006	0.006	0.000
4:05	0.003	0.006	0.006	0.000
4:10	0.003	0.006	0.007	0.000
4:15	0.004	0.006	0.007	0.000
4:20	0.004	0.007	0.008	0.000
4:25	0.004	0.007	0.008	0.000
4:30	0.004	0.007	0.008	0.000
4:35	0.004	0.007	0.008	0.000
4:40	0.004	0.007	0.009	0.000
4:45	0.004	0.007	0.009	0.000
4:50	0.004	0.007	0.009	0.000
4:55	0.004	0.007	0.009	0.000
5:00	0.004	0.007	0.009	0.000
5:05	0.004	0.007	0.009	0.000
5:10	0.004	0.007	0.009	0.000
5:15	0.004	0.007	0.009	0.000
5:20	0.004	0.007	0.009	0.000
5:25	0.004	0.007	0.009	0.000
5:30	0.004	0.007	0.009	0.000
5:35	0.004	0.007	0.009	0.000
5:40	0.004	0.007	0.009	0.000
5:45	0.004	0.007	0.009	0.000
5:50	0.004	0.007	0.009	0.000
5:55	0.004	0.007	0.009	0.000
6:00	0.004	0.007	0.009	0.000
6:05	0.004	0.007	0.009	0.000
6:10	0.004	0.007	0.009	0.000
6:15	0.004	0.007	0.009	0.000
6:20	0.004	0.008	0.010	0.000
6:25	0.005	0.008	0.010	0.000
6:30	0.005	0.008	0.010	0.000
6:35	0.005	0.008	0.010	0.000
6:40	0.005	0.008	0.010	0.000
6:45	0.005	0.008	0.010	0.000
6:50	0.005	0.008	0.010	0.000
6:55	0.005	0.008	0.010	0.000
7:00	0.005	0.008	0.010	0.000
7:05	0.005	0.008	0.010	0.000
7:10	0.005	0.008	0.011	0.000

Time (H:MIN)	Watercourse 41 Hydrograph Flow (m^3/s)	Watercourse 42 Hydrograph Flow (m^3/s)	Watercourse 52 Hydrograph Flow (m^3/s)	Indian Brook Hydrograph Flow (m^3/s)
7:15	0.005	0.009	0.011	0.000
7:20	0.005	0.009	0.011	0.000
7:25	0.005	0.009	0.012	0.000
7:30	0.006	0.009	0.012	0.000
7:35	0.006	0.010	0.012	0.000
7:40	0.006	0.010	0.012	0.000
7:45	0.006	0.010	0.012	0.000
7:50	0.006	0.010	0.012	0.000
7:55	0.006	0.010	0.013	0.000
8:00	0.006	0.010	0.013	0.000
8:05	0.006	0.010	0.013	0.000
8:10	0.006	0.010	0.013	0.000
8:15	0.006	0.010	0.013	0.000
8:20	0.006	0.011	0.014	0.000
8:25	0.006	0.011	0.014	0.000
8:30	0.007	0.011	0.014	0.000
8:35	0.007	0.011	0.014	0.000
8:40	0.007	0.012	0.015	0.000
8:45	0.007	0.012	0.015	0.000
8:50	0.007	0.012	0.015	0.000
8:55	0.007	0.012	0.015	0.000
9:00	0.007	0.012	0.015	0.000
9:05	0.007	0.012	0.016	0.000
9:10	0.007	0.013	0.016	0.000
9:15	0.008	0.013	0.016	0.000
9:20	0.008	0.014	0.017	0.000
9:25	0.008	0.014	0.017	0.000
9:30	0.008	0.014	0.018	0.000
9:35	0.008	0.014	0.018	0.000
9:40	0.008	0.015	0.018	0.000
9:45	0.009	0.015	0.019	0.001
9:50	0.009	0.016	0.019	0.001
9:55	0.009	0.016	0.020	0.001
10:00	0.009	0.016	0.021	0.001
10:05	0.010	0.016	0.021	0.002
10:10	0.010	0.017	0.022	0.002
10:15	0.010	0.018	0.024	0.003
10:20	0.011	0.020	0.025	0.004
10:25	0.012	0.020	0.026	0.005
10:30	0.012	0.021	0.028	0.006
10:35	0.013	0.021	0.029	0.007
10:40	0.013	0.023	0.032	0.009
10:45	0.014	0.025	0.035	0.010
10:50	0.015	0.027	0.038	0.012
10:55	0.016	0.028	0.040	0.015
11:00	0.017	0.029	0.043	0.018
11:05	0.017	0.029	0.046	0.021
11:10	0.018	0.033	0.051	0.024
11:15	0.020	0.039	0.057	0.028
11:20	0.023	0.043	0.064	0.033
11:25	0.025	0.045	0.072	0.039
11:30	0.027	0.046	0.079	0.045
11:35	0.028	0.047	0.085	0.052
11:40	0.032	0.067	0.109	0.060
11:45	0.045	0.102	0.137	0.070
11:50	0.066	0.123	0.172	0.082
11:55	0.103	0.235	0.286	0.098
12:00	0.195	0.430	0.422	0.120
12:05	0.330	0.517	0.583	0.155
12:10	0.366	0.424	0.630	0.214
12:15	0.278	0.285	0.635	0.307
12:20	0.193	0.236	0.629	0.441
12:25	0.155	0.225	0.679	0.632
12:30	0.140	0.231	0.790	0.908
12:35	0.130	0.237	0.935	1.268
12:40	0.120	0.234	1.073	1.735
12:45	0.107	0.227	1.191	2.415
12:50	0.093	0.224	1.289	3.466
12:55	0.082	0.223	1.368	5.065
13:00	0.074	0.221	1.429	7.281
13:05	0.067	0.216	1.471	10.087
13:10	0.062	0.208	1.497	13.547
13:15	0.057	0.198	1.511	17.541
13:20	0.053	0.189	1.517	21.807
13:25	0.049	0.180	1.517	26.137
13:30	0.046	0.172	1.512	30.382
13:35	0.043	0.164	1.503	34.556
13:40	0.041	0.155	1.490	38.183
13:45	0.039	0.145	1.473	41.242
13:50	0.036	0.137	1.452	43.765
13:55	0.034	0.129	1.430	45.599
14:00	0.033	0.122	1.408	46.650
14:05	0.032	0.115	1.386	47.317
14:10	0.030	0.107	1.363	47.534
14:15	0.029	0.098	1.339	47.010
14:20	0.027	0.092	1.315	46.346
14:25	0.026	0.087	1.291	45.456
14:30	0.024	0.083	1.267	44.286

Time (H:MIN)	Watercourse 41 Hydrograph Flow (m^3/s)	Watercourse 42 Hydrograph Flow (m^3/s)	Watercourse 52 Hydrograph Flow (m^3/s)	Indian Brook Hydrograph Flow (m^3/s)
14:35	0.023	0.079	1.242	43.008
14:40	0.023	0.076	1.216	41.469
14:45	0.022	0.073	1.189	39.937
14:50	0.021	0.070	1.162	38.404
14:55	0.021	0.067	1.134	36.859
15:00	0.021	0.065	1.106	35.384
15:05	0.020	0.063	1.079	33.890
15:10	0.020	0.061	1.051	32.415
15:15	0.020	0.059	1.025	30.984
15:20	0.020	0.058	1.000	29.606
15:25	0.020	0.056	0.975	28.236
15:30	0.020	0.055	0.952	26.895
15:35	0.020	0.054	0.928	25.669
15:40	0.020	0.053	0.906	24.520
15:45	0.020	0.052	0.885	23.417
15:50	0.020	0.051	0.864	22.383
15:55	0.020	0.050	0.845	21.400
16:00	0.020	0.050	0.826	20.475

Appendix B:
Slope Stability Assessment

REPORT ON

Slope Stability Assessment
Proposed Residential Development
496857 Grey Road 2
Town of Blue Mountains, Ontario

PREPARED FOR:

Homefield Communities

Project No. 23-301-100
January 4, 2024

DS CONSULTANTS LTD.
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Table of Contents

1. INTRODUCTION

DS Consultants Ltd. (DS) was retained by Homefield Communities (the client) to undertake a slope stability assessment for the proposed residential development located at 496857 Grey Road 2 in the Town of Blue Mountains, Ontario.

DS carried out a preliminary geotechnical investigation for the proposed residential development, documented in the Preliminary Geotechnical Report (No. 23-301-100) dated December 15, 2023. A total of five (5) boreholes were drilled by DS to depths ranging from 6.2 to 6.6 m for the geotechnical investigation. The location plan and logs of the boreholes (BH23-1 to BH23-5) are attached in **Appendix I**

Indian Brook (the creek) is located at the northeast part of the site. It is understood that a slope stability assessment is required by Grey Sauble Conservation Authority (GSCA) for the south bank slope of the creek.

The purpose of this study was to obtain subsurface conditions at the borehole locations and from the findings in the boreholes to assess the stability of the existing slopes and long-term stable slopes.

This report is provided on the basis of the terms of reference presented above and, on the assumption, that the design will be in accordance with the applicable codes and standards. If there are any changes in the design features relevant to the geotechnical analyses, or if any questions arise concerning the geotechnical aspects of the codes and standards, this office should be contacted to review the design. It may then be necessary to carry out additional borings and reporting before the recommendations of this office can be relied upon.

The site investigation and recommendations follow generally accepted practice for geotechnical consultants in Ontario. The format and contents are guided by client specific needs and economics. Laboratory testing for most part follows ASTM or CSA Standards or modifications of these standards that have become standard practice.

This report has been prepared for Homefield Communities, their designers, the Town of Blue Mountains and Grey Sauble Conservation Authority (GSCA). Third party use of this report without DS consent is prohibited.

2. SOIL AND GROUNDWATER CONDITIONS

As indicated above, DS carried out a preliminary geotechnical investigation for the proposed residential development, documented in the Preliminary Geotechnical Report (No. 23-310-100) dated December 15, 2023. A total of five (5) boreholes were drilled by DS to depths ranging from 6.2 to 6.6 m for the

geotechnical investigation. The location plan and logs of the boreholes (BH23-1 to BH23-5) are attached in **Appendix I**.

As shown in the boreholes, the soils at the site generally consisted of a layer of fill (or weathered soil) with topsoil at surface, extending to depths varying from 0.8 to 1.6 m below the ground surface. The native soils below consisted of cohesionless deposits of sandy silt to silty sand (till), sand to gravelly sand, silt (till) and sand and gravel. The cohesionless deposits were generally very dense, except for the top portion of the deposits (up to a depth of 2.5 m) which were compact to dense.

Borehole **BH23-5** was drilled near the subject slope area. In this borehole, fill material with topsoil at surface was found extending to a depth of 1.0 m. The native soils consisted of compact to very dense sand and gravel at depth of 1.0 to 1.9 m, very dense sandy silt to silty sand till at depth of 1.9 to 6.0 m, and very dense silt to sandy silt till below a depth of 6.0 m.

The groundwater level measured in the monitoring well in BH23-5 was at a depth of 0.4 m.

3. SLOPE STABILITY ASSESSMENT

Based on the borehole information, our site visit observations and derived slope profiles, a detailed stability study has been carried out to access the long-term stability of the slopes and to determine the long-term stable top of slope (LTSTOS) line. It is understood that Grey Sauble Conservation Authority (GSCA) requires a stability assessment of the slopes to define the long-term stable top of slope (LTSTOS) for the proposed residential development.

3.1 Slope Conditions and Profiles

A site visit was made on December 8, 2023 by a senior geotechnical engineer from DS Consultants Ltd. to visually inspect the slope conditions. Selected photographs (Photos **P1 to P10**) taken during our site visit are presented in **Appendix II**, showing the slope, creek (Indian Brook) and erosion conditions.

The locations of Cross Sections X1-X1 to X15-X15 referenced in the following are shown in **Drawing 1**.

Fifteen (15) profiles of existing slopes at Sections X1-X1 to X15-X15 (see **Drawing 1** for locations) were derived from the topographic survey map (as shown in **Drawing 1**) provided to us. The slope profiles are presented in **Drawings 2 to 16**.

Based on our site observations and the slope profiles, the site and slope conditions are described as follows:

- The top of slope areas generally consisted of grass and tree areas.
- The height of the slope was typically 2 to 4 m.
- The steepness of the slope ranged from steeper than 1H:1V (in the areas of Sections X1-X1, X9-X9, X11-X11, X12-X12 and X13-X13) to flatter than 2H:1V.

- The slopes were partially covered with trees, grasses and other vegetation (see Photos in **Appendix II**).
- Indian Brook (the creek) was located at the toe of the slope. The creek in the toe areas of the slope was typically 5 to 15 m wide. At the time of the site visit, the depth of water in the creek was about 0.5 to 1m. Erosions were observed at the creek bank at various locations, as shown in photographs in **Appendix II**.
- The soils at the creek bank generally consisted of sandy silt to silty sand (till). No evidence of fill material was found in the top of slope area near the creek. The top portion (about 0.5 m) of the soil was weathered, with grass and tree roots. Boulders and cobbles were present at the creek bed at various locations.

3.2 Erosion Conditions

As indicated in Section 3.1 of this report, Indian Brook (the creek) at the site is typically 5 to 15 m wide. Erosions were observed at the creek bank at various locations.

Based on the borehole information and our site observations, the soils at creek bank and at the toe of slopes generally consisted of dense to very dense sandy silt to silty sand till. In accordance with the Provincial Guidelines entitled "Understanding Natural Hazards" and according to the soil and creek conditions, it is our opinion that an erosion allowance of 8 m at the toe of the creek bank should be used for the setback of the long-term stable slope at the site. This value of erosion allowance (8 m) of the creek bank will be used to determine the long-term stable slope line to be discussed in the following.

3.3 Soil Parameters

Based on the borehole (BH23-5, see **Appendix I**) and our site observations (see **Section 3.1** of this report), soil parameters used in the slope stability analyses in the following sections are given on **Table 1**.

Table 1: Soil Parameters for Long-term Slope Stability Analyses

Soil Type	Unit Weight (kN/m^3)	Cohesion c' (kPa)	Friction Angle ϕ' (degree)
Weathered soil/fill (loose to compact sandy silt to silty sand)	19	1	33
Sandy till (dense to very dense sandy silt to silty sand till)	21	3	35
Silt/sandy till (dense to very dense silt to sandy silt till)	21	3	34

3.4 Stability of Existing Slope

Fifteen (15) slope profiles of the existing slopes at Sections X1-X1 through X15-X15 (see **Drawing 1** for locations) were derived from the topographic drawing (**Drawing 1**) provided to us by the client. The slope profiles are shown in **Drawings 2** to **16.** The steepness of existing slopes ranges from steeper than 1H:1V to flatter than 2H:1V.

In order to assess the stability of the existing slopes at the site, stability analyses have been carried out for the typical existing slope at Section X11-X11, as shown in **Drawing 12**. The existing slope at Section X11-X11 was about 0.9H:1V in steepness.

Long-term stability analyses of the existing slope at Section X11-X11 have been carried out with the computer program SLIDE (Version 2018) using the Bishop method, Janbu method and Morgenstern-Price method. The analysis results are presented in **Drawing 17**.

The calculated factor of safety (FS) of the existing slope at Section X11-X11 (about 0.9H:1V) is FS=1.225 (see D**rawing 17**), which is less than the minimum acceptable value of 1.5. Therefore, the existing slope at Section X11-X11 is considered not stable in terms of long-term stability based on GSCA's requirements, because the slope is steep (0.9H:1V). In addition, an erosion allowance of 8 m is required at the toe of the slope for long-term stability analysis of the slope, because Indian Brook (the creek) is located at the immediate toe of the slope.

3.5 Analyses of Long-term Stable Slopes

In order to determine the long-term stable slopes at the site, analyses of the modified 2H:1V slope at Section X11-X11, together with 8 m erosion at the toe of slope, have been carried out. The results are presented in **Drawing 18**. The calculated factor of safety (FS) value of the 2H:1V slope in **Drawing 18** is FS=1.661, which is greater than the minimum acceptable value of 1.5. The 2H:1V slope with 8m toe erosion allowance, as shown on **Drawing 18** (Section X11-X11), is considered stable in terms of long-term stability.

Based on the slope stability analysis results and the borehole information across the site, it can be concluded that a 2H:1V slope at the site, together with 8 m creek bank erosion at the toe of slope where required, is stable in terms of long-term stability.

Where the toe of the slope is away from the river water (at the time of our site visit) but is considered below the flood water level, as typically shown at Section X10-X10 (see **Drawing 11**), an erosion allowance of 8.0 m is also adopted at the toe of the slope to determine the long-term stable slope.

Accordingly, the long-term stable slopes at Section X1-X1 through Section X15-X15 are presented on **Drawing 2** through **Drawing 16**, respectively.

3.6 Long-term Stable Top of Slope (LTSTOS)

Accordingly, the points representing the geotechnical long-term stable top of slope at the cross sections are as follows.

- Point 'S1' on **Drawing 2** represents the long-term stable top of slope at Section X1-X1
- Point 'S2' on **Drawing 3** represents the long-term stable top of slope at Section X2-X2
- Point 'S3' on **Drawing 4** represents the long-term stable top of slope at Section X3-X3
- Point 'S4' on **Drawing 5** represents the long-term stable top of slope at Section X4-X4
- Point 'S5' on **Drawing 6** represents the long-term stable top of slope at Section X5-X5
- Point 'S6' on **Drawing 7** represents the long-term stable top of slope at Section X6-X6
- Point 'S7' on **Drawing 8** represents the long-term stable top of slope at Section X7-X7
- Point 'S8' on **Drawing 9** represents the long-term stable top of slope at Section X8-X8
- Point 'S9' on **Drawing 10** represents the long-term stable top of slope at Section X9-X9
- Point 'S10' on **Drawing 11** represents the long-term stable top of slope at Section X10-X10
- Point 'S11' on **Drawing 12** represents the long-term stable top of slope at Section X11-X11
- Point 'S12' on **Drawing 13** represents the long-term stable top of slope at Section X12-X12
- Point 'S13' on **Drawing 14** represents the long-term stable top of slope at Section X13-X13
- Point 'S14' on **Drawing 15** represents the long-term stable top of slope at Section X14-X14
- Point 'S15' on **Drawing 16** represents the long-term stable top of slope at Section X15-X15

Based on the long-term stable top of slope at Sections X1-X1 to X15-X15, and according to our field observations, the geotechnical long-term stable top of slope (LTSTOS) line (Line S0-S1-S2-S3-…-S14-S15-S16) is shown on **Drawing 1**.

This long-term stable top of slope (LTSTOS) line must be reviewed by GSCA for their approval.

GSCA can be invited to stake out the top of slope line, which may also take consideration other site features. Therefore, the final long-term stable top of slope (LTSTOS) at the site will be determined using the following criteria:

- If the geotechnical long-term stable top of slope determined in this slope stability assessment is further away from the creek slope than GSCA staked top of slope, then the geotechnical long-term stable top of slope determined in this slope stability assessment is considered as the final long-term stable top of slope (LTSTOS).

- If the geotechnical long-term stable top of slope determined in this slope stability assessment is closer to the creek slope than GSCA staked top of slope, then GSCA staked top of slope is considered as the final long-term stable top of slope (LTSTOS).

4. GENERAL COMMENTS AND LIMITATIONS OF REPORT

DS Consultants Ltd. (DS) should be retained for a general review of the final design and specifications to verify that this report has been properly interpreted and implemented. If not accorded the privilege of making this review, DS will assume no responsibility for interpretation of the recommendations in the report.

This report is intended solely for the Client named. The material in it reflects our best judgment in light of the information available to DS at the time of preparation. Unless otherwise agreed in writing by DS, it shall not be used to express or imply warranty as to the fitness of the property for a particular purpose. No portion of this report may be used as a separate entity, it is written to be read in its entirety.

The conclusions and recommendations given in this report are based on information determined at the test hole locations. The information contained herein in no way reflects on the environment aspects of the project, unless otherwise stated. Subsurface and groundwater conditions between and beyond the test holes may differ from those encountered at the test hole locations, and conditions may become apparent during construction, which could not be detected or anticipated at the time of the site investigation. The benchmark and elevations used in this report are primarily to establish relative elevation differences between the test hole locations and should not be used for other purposes, such as grading, excavating, planning, development, etc.

The design recommendations given in this report are applicable only to the project described in the text and then only if constructed substantially in accordance with the details stated in this report.

The comments made in this report on potential construction problems and possible methods are intended only for the guidance of the designer. The number of test holes may not be sufficient to determine all the factors that may affect construction methods and costs. For example, the thickness of surficial topsoil or fill layers may vary markedly and unpredictably. The contractors bidding on this project or undertaking the construction should, therefore, make their own interpretation of the factual information presented and draw their own conclusions as to how the subsurface conditions may affect their work. This work has been undertaken in accordance with normally accepted geotechnical engineering practices.

Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. DS accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report. We accept no responsibility for any decisions made or actions taken as a result of this report unless we are specifically advised of and participate in such action, in which case our responsibility will be as agreed to at that time.

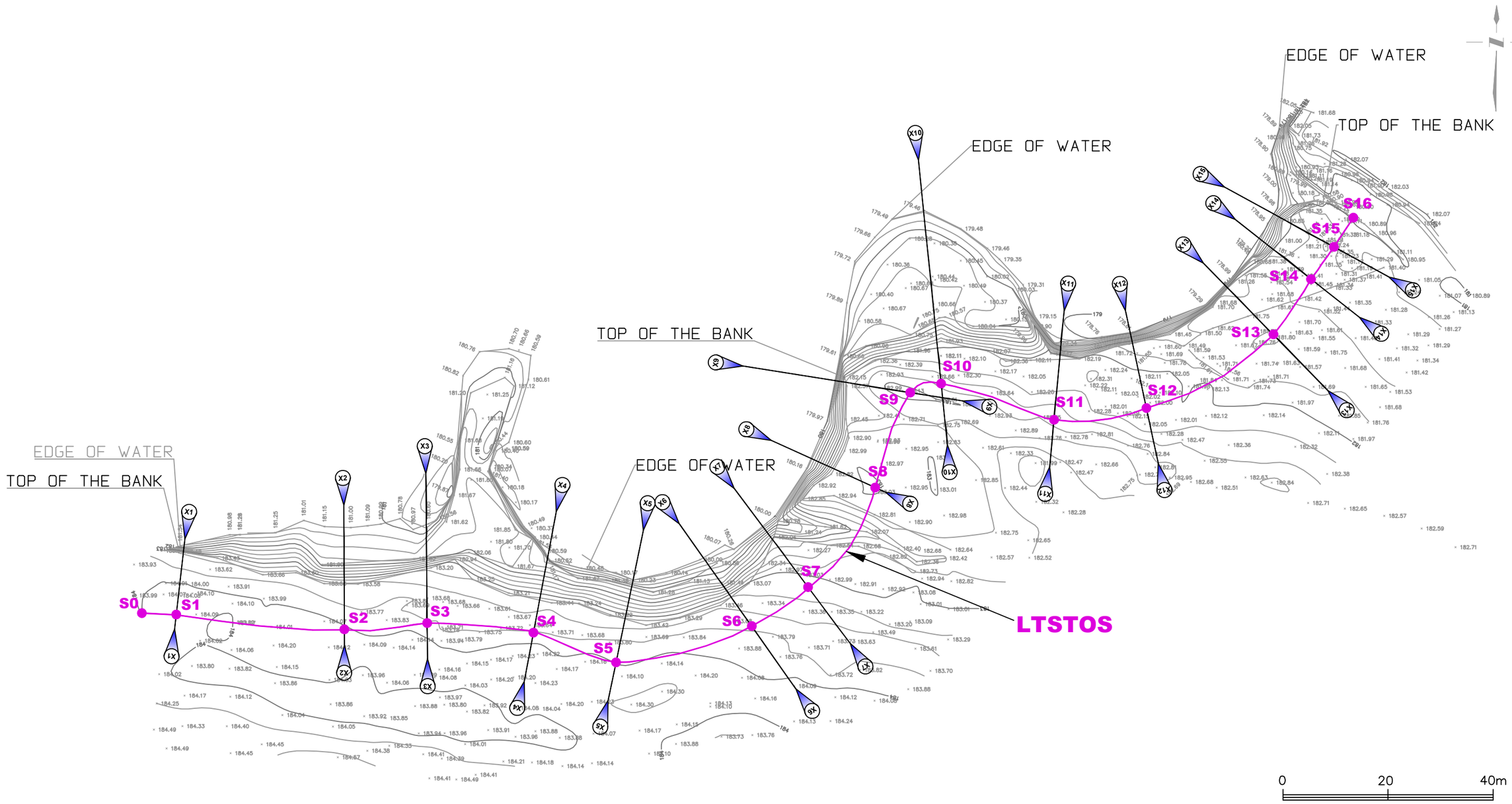
We trust that the information contained in this report is satisfactory. Should you have any questions, please do not hesitate to contact this office.

DS CONSULTANTS LTD

Alka Sangar, M.Eng., P.Eng.

Fanyu Zhu, Ph.D., P.Eng.

Drawings



S0 - S1 - S2 - S3 - S4 - S5 - S6 - S7 - S8 - S9 - S10 - S11 - S12 -S13 - S14 - S15 - S16
Long-Term Stable Top of Slope Line (LTSTOS Line)

DS CONSULTANTS LTD.
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Telephone: (905) 264-9393
www.dsconsultants.ca

Client: HOMEFIELD COMMUNITIES

Project: SLOPE STABILITY ASSESSMENT
496857 Grey Road 2, Town of Blue Mountains, ON

Title: **SLOPE LOCATION PLAN**

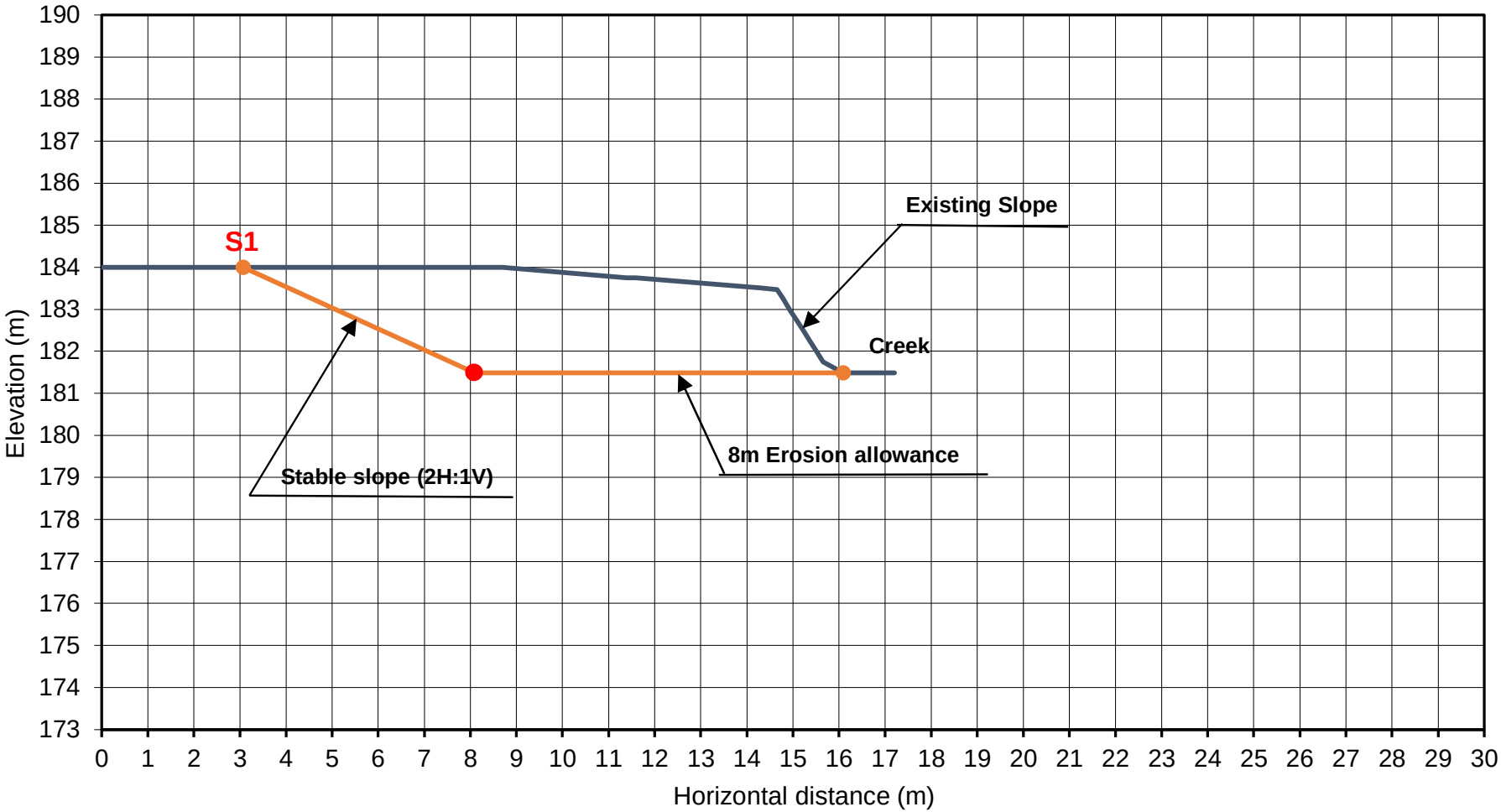
Size:	Approved By:	Drawn By:	Date:
11 X 17	A.S	S.Y	January 2024
Rev.	Scale: As Shown	Project No: 23-301-100	Drawing No. 1

Path:c:\0sharon\23-301-100 496857 grey road 2, town of blue mountain\7-misc\cad\drawing 1 - slope plan & profiles.dwg

23-301-100 - **Drawing 2**

Slope Profile at **Section X1-X1** (See Drawing 1 for Location Plan)

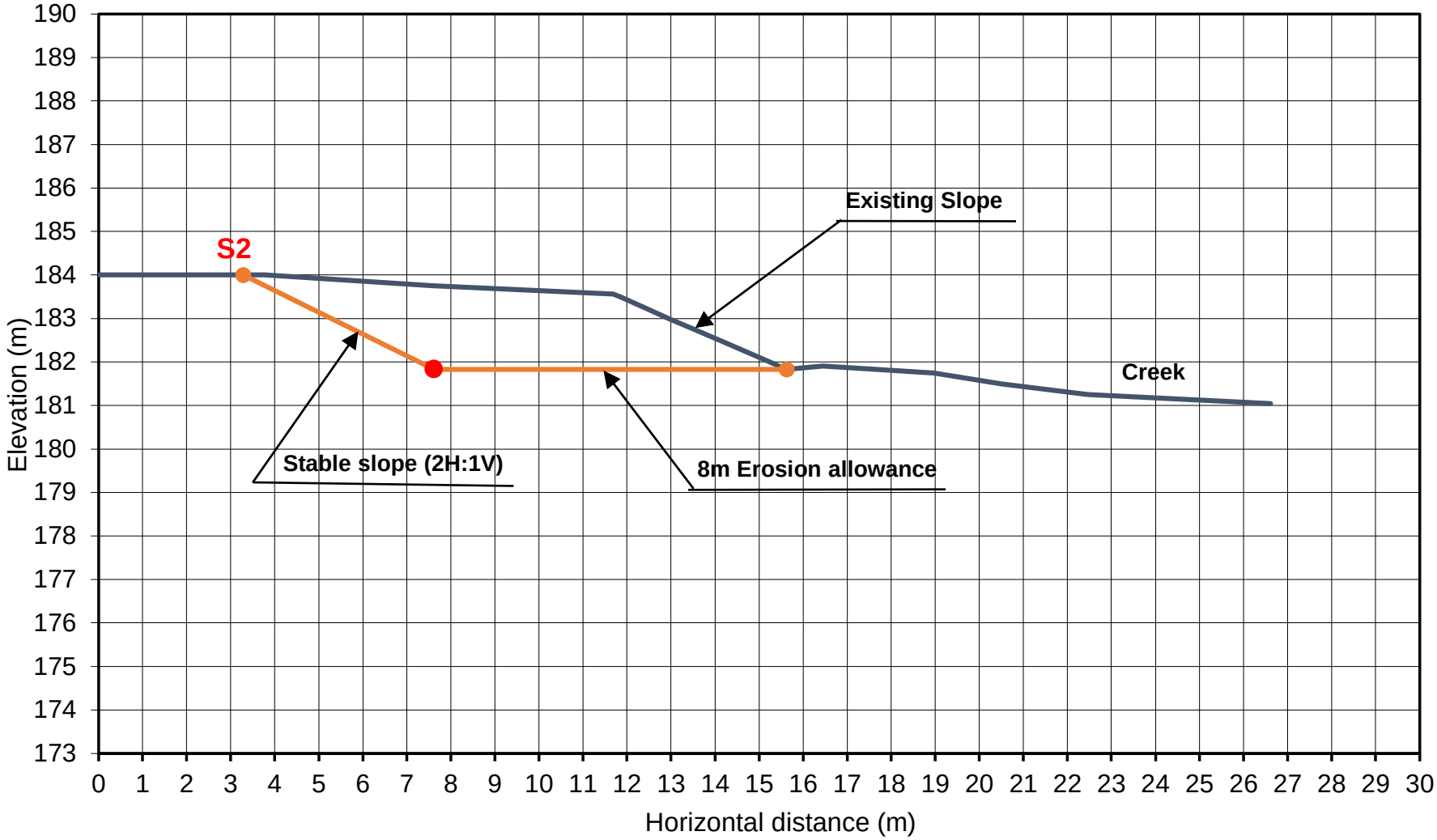
Point '**S1**': Long-term stable top of slope (LTSTOS)



23-301-100 - **Drawing 3**

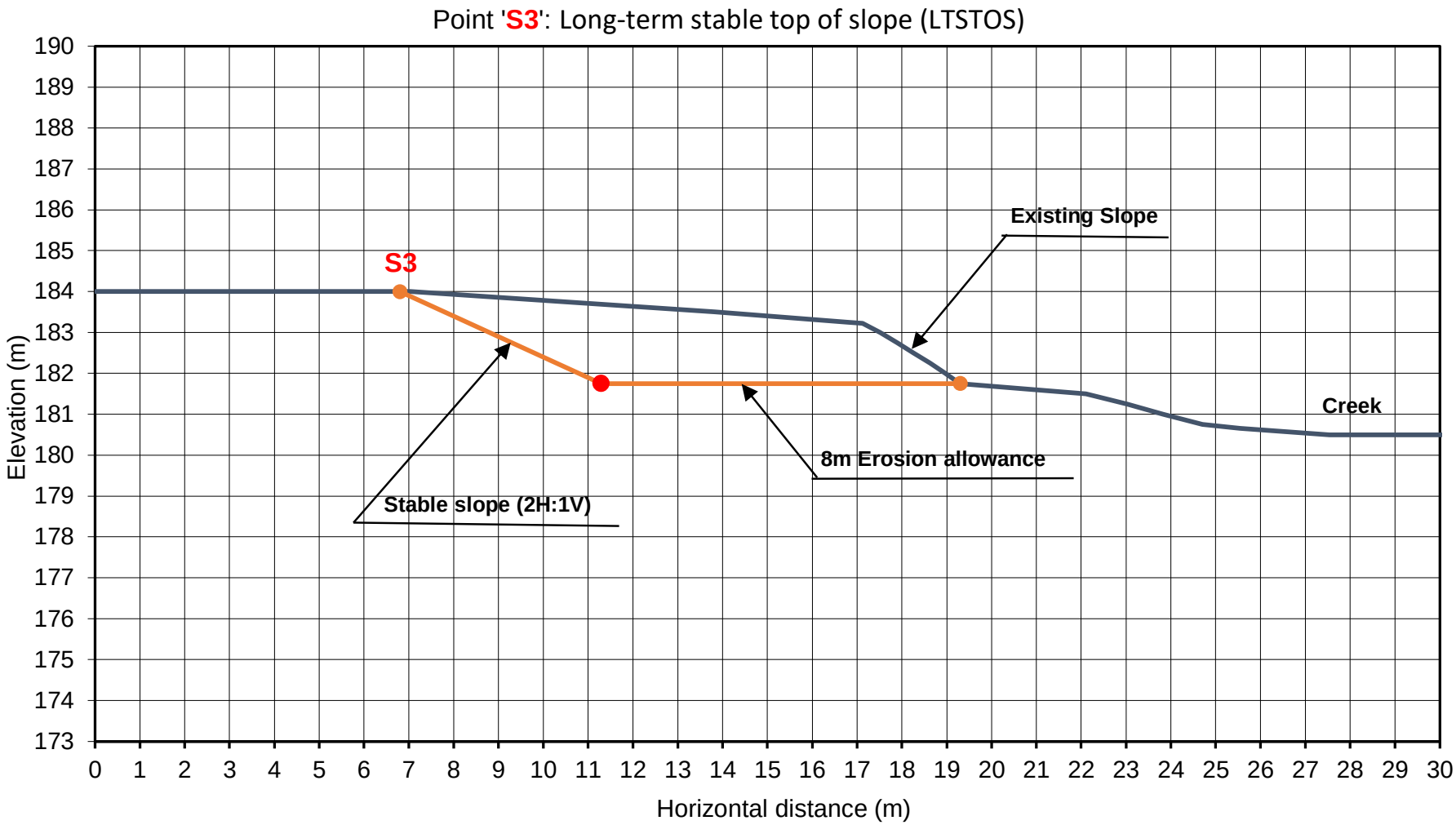
Slope Profile at **Section X2-X2** (See Drawing 1 for Location Plan)

Point '**S2**': Long-term stable top of slope (LTSTOS)



23-301-100 - **Drawing 4**

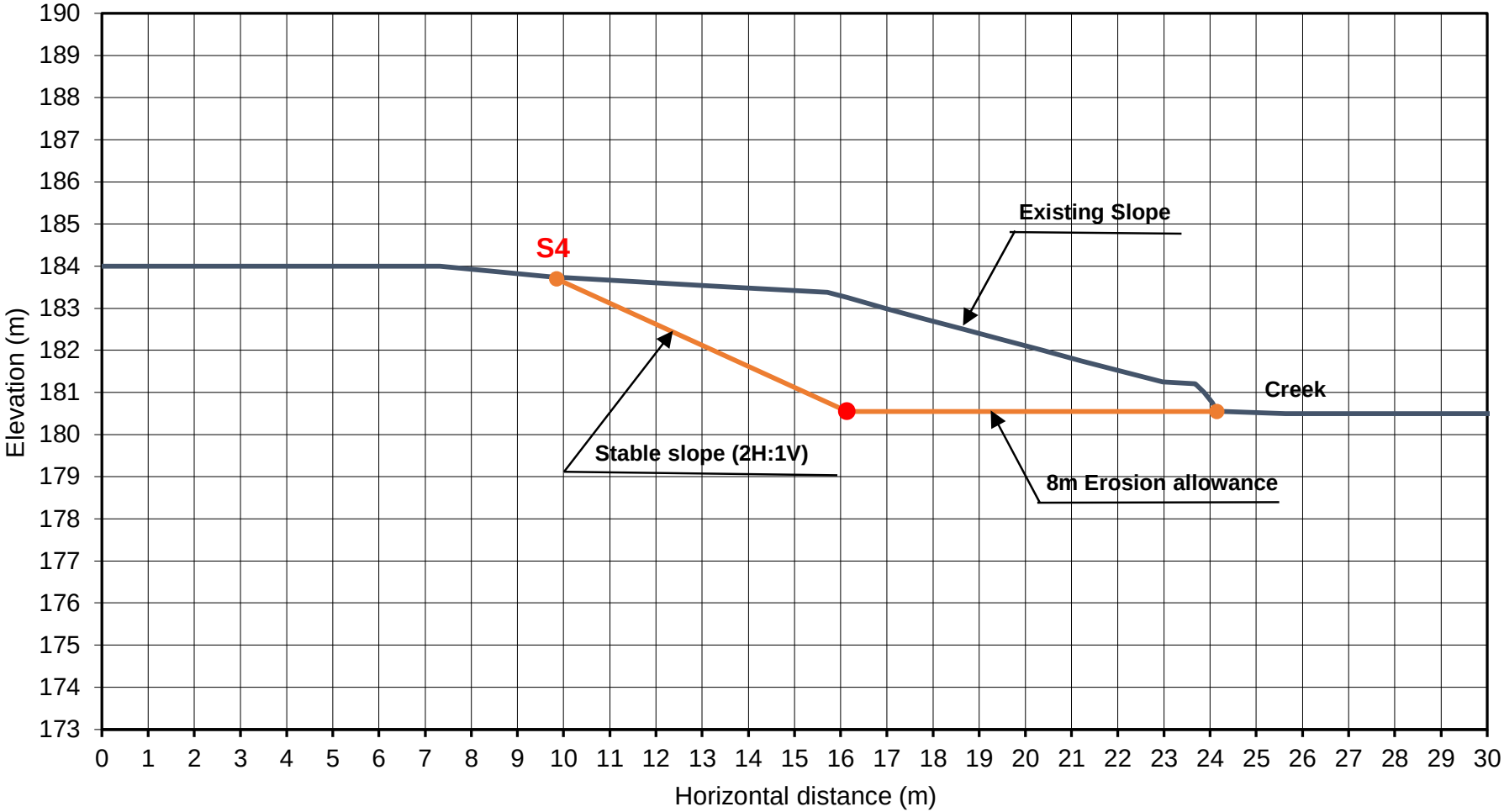
Slope Profile at **Section X3-X3** (See Drawing 1 for Location Plan)



23-301-100 - **Drawing 5**

Slope Profile at **Section X4-X4** (See Drawing 1 for Location Plan)

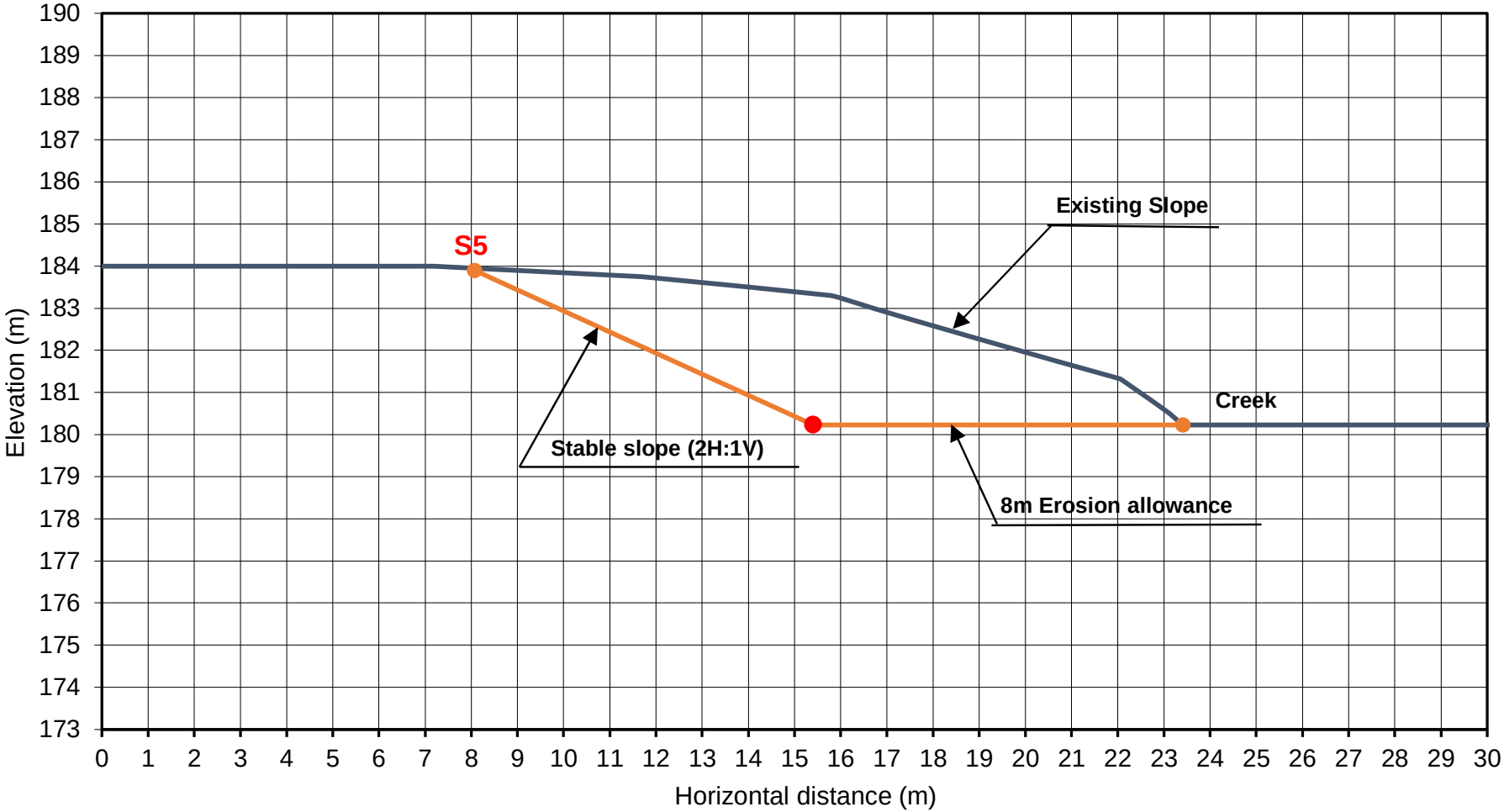
Point '**S4**': Long-term stable top of slope (LTSTOS)



23-301-100 - **Drawing 6**

Slope Profile at **Section X5-X5** (See Drawing 1 for Location Plan)

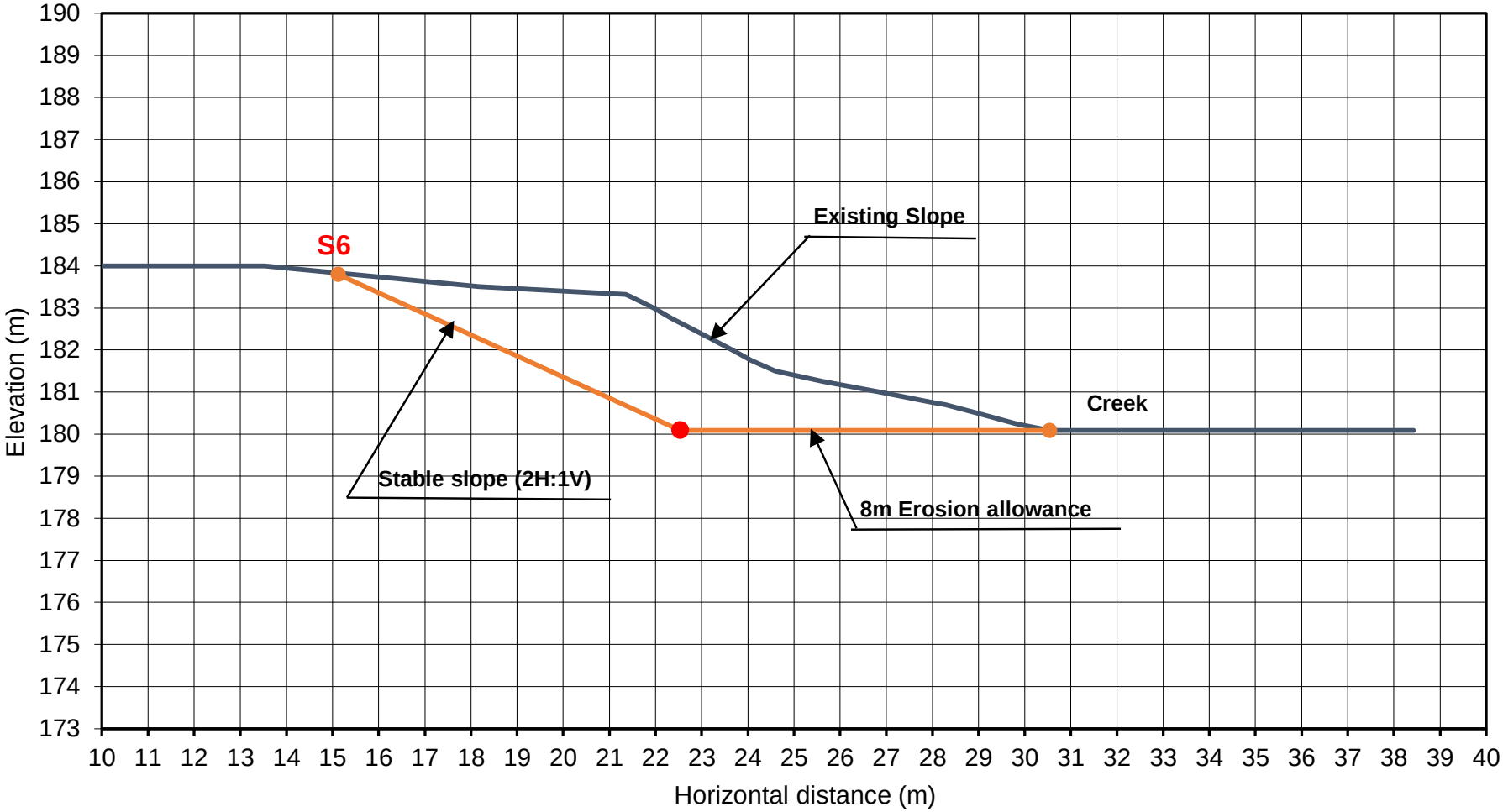
Point '**S5**': Long-term stable top of slope (LTSTOS)



23-301-100 - **Drawing 7**

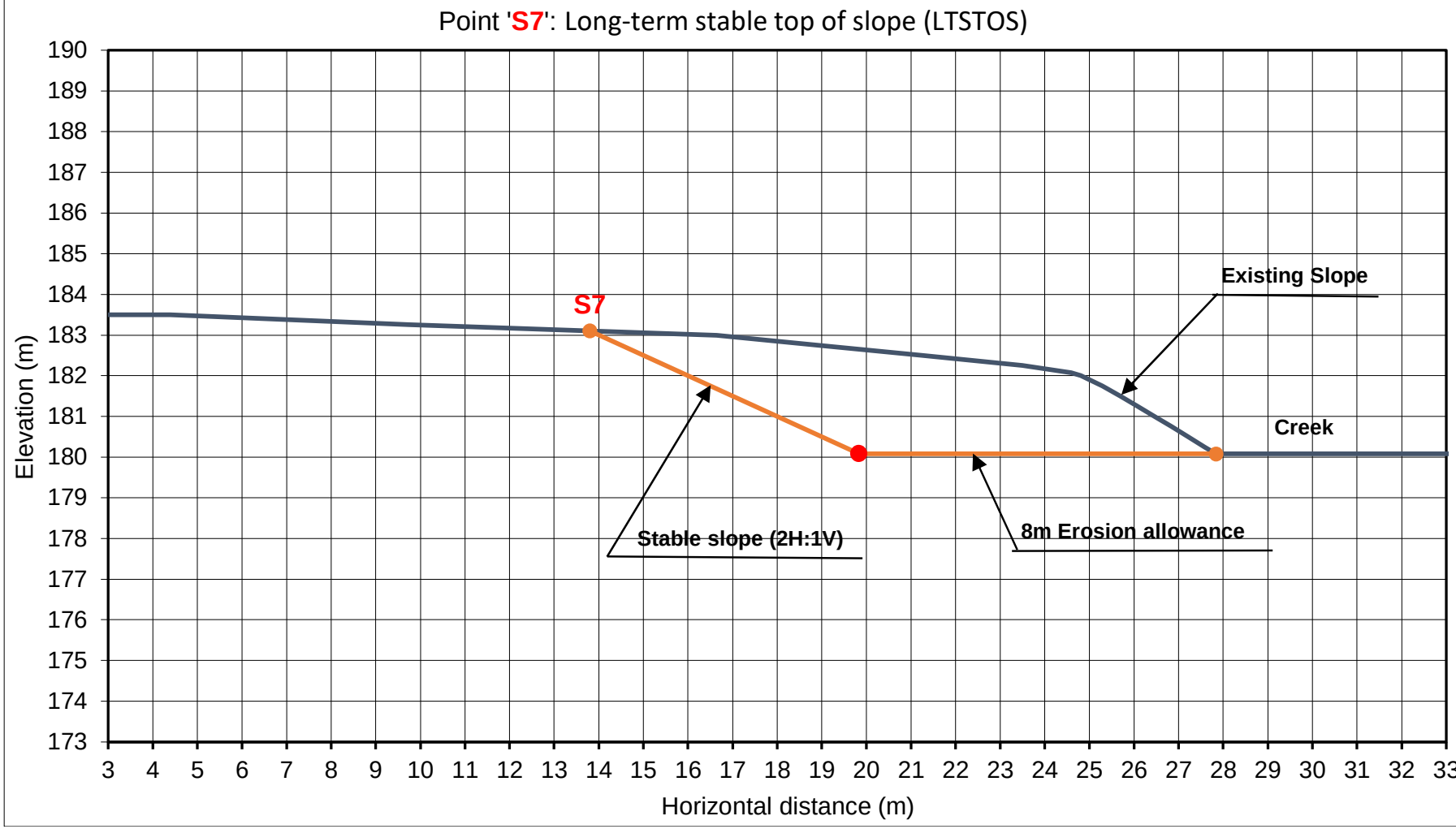
Slope Profile at **Section X6-X6** (See Drawing 1 for Location Plan)

Point '**S6**': Long-term stable top of slope (LTSTOS)



23-301-100 - **Drawing 8**

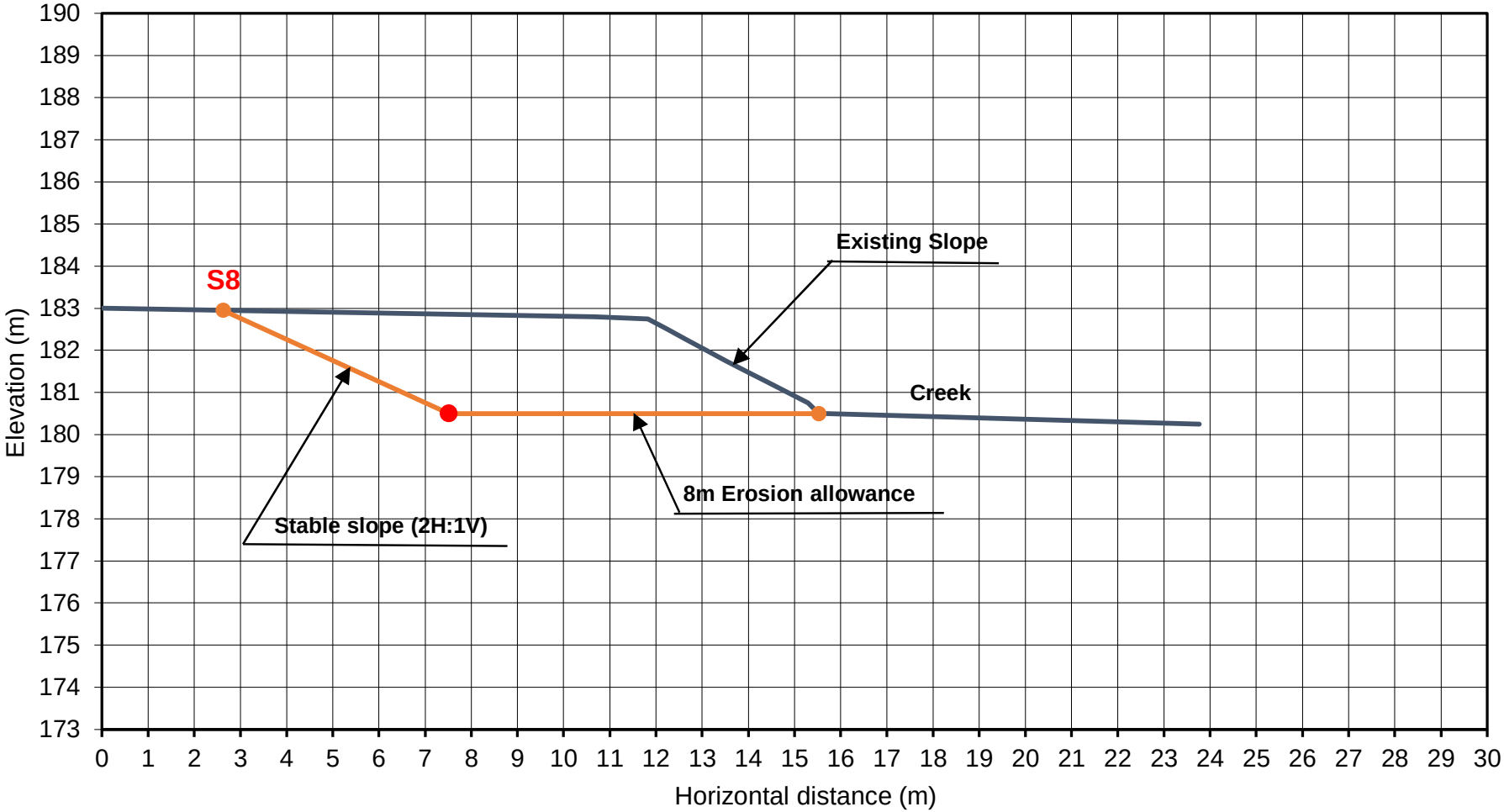
Slope Profile at **Section X7-X7** (See Drawing 1 for Location Plan)



23-301-100 - **Drawing 9**

Slope Profile at **Section X8-X8** (See Drawing 1 for Location Plan)

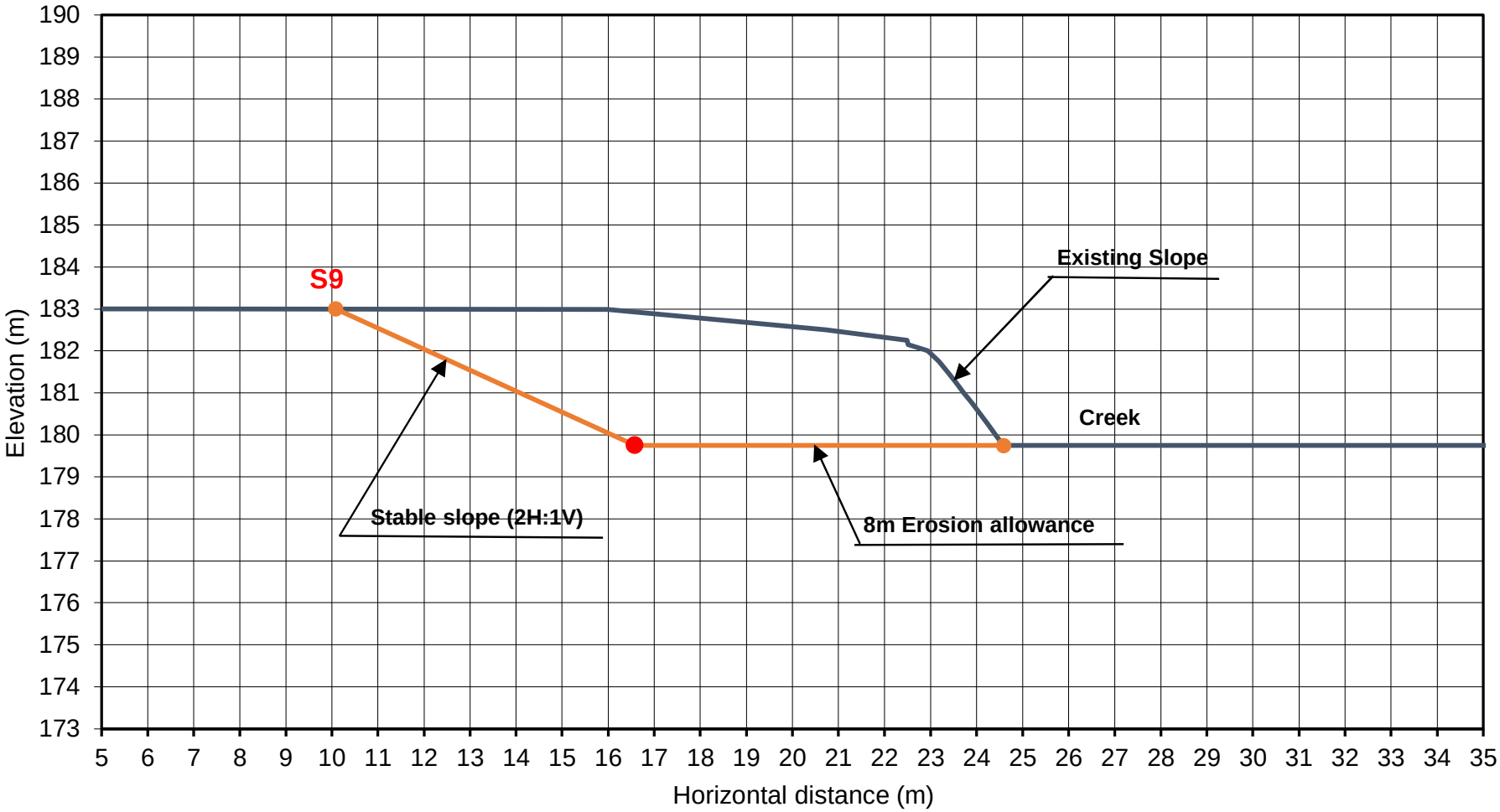
Point '**S8**': Long-term stable top of slope (LTSTOS)



23-301-100 - **Drawing 10**

Slope Profile at **Section X9-X9** (See Drawing 1 for Location Plan)

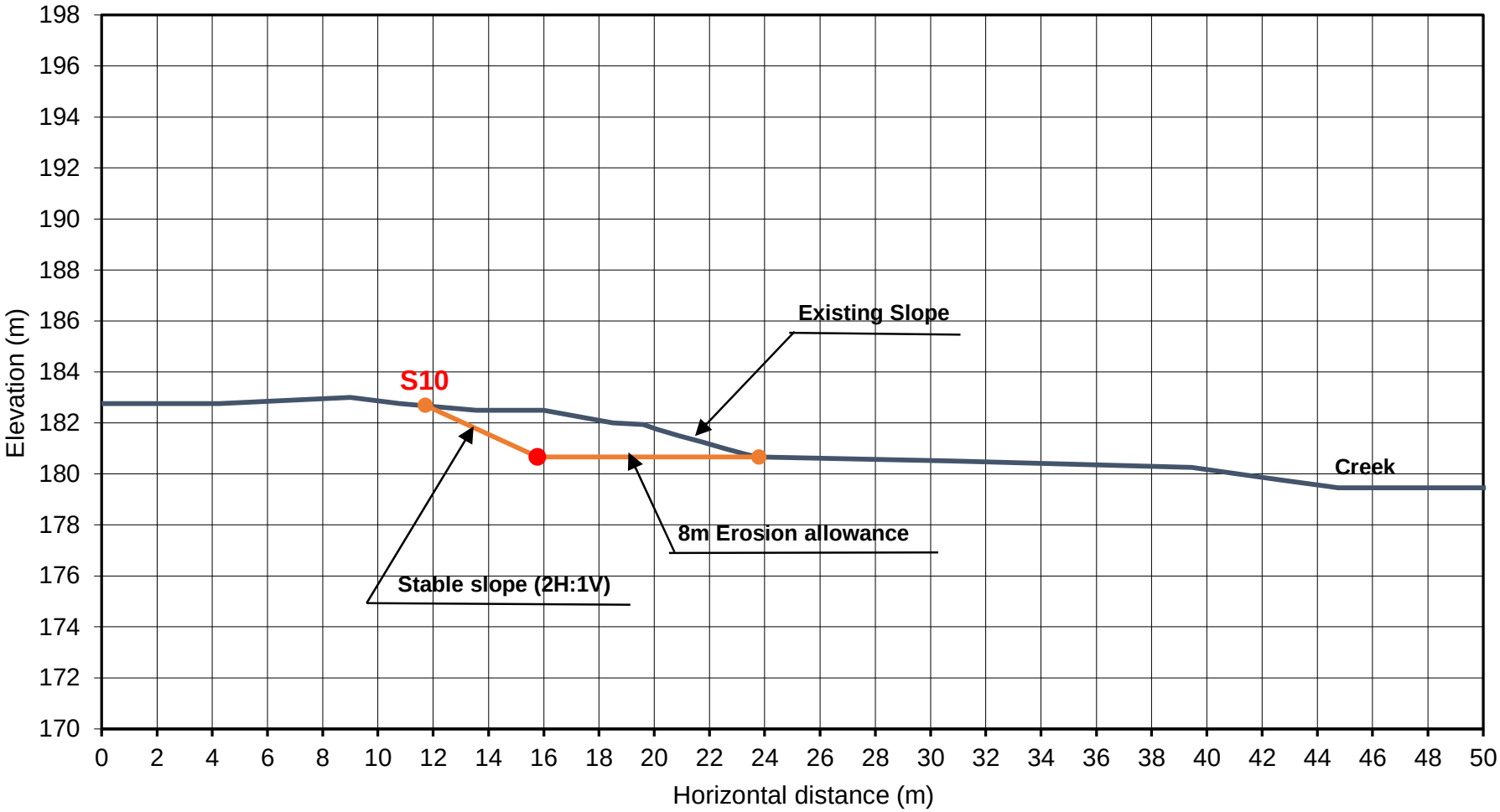
Point '**S9**': Long-term stable top of slope (LTSTOS)



23-301-100 - **Drawing 11**

Slope Profile at **Section X10-X10** (See Drawing 1 for Location Plan)

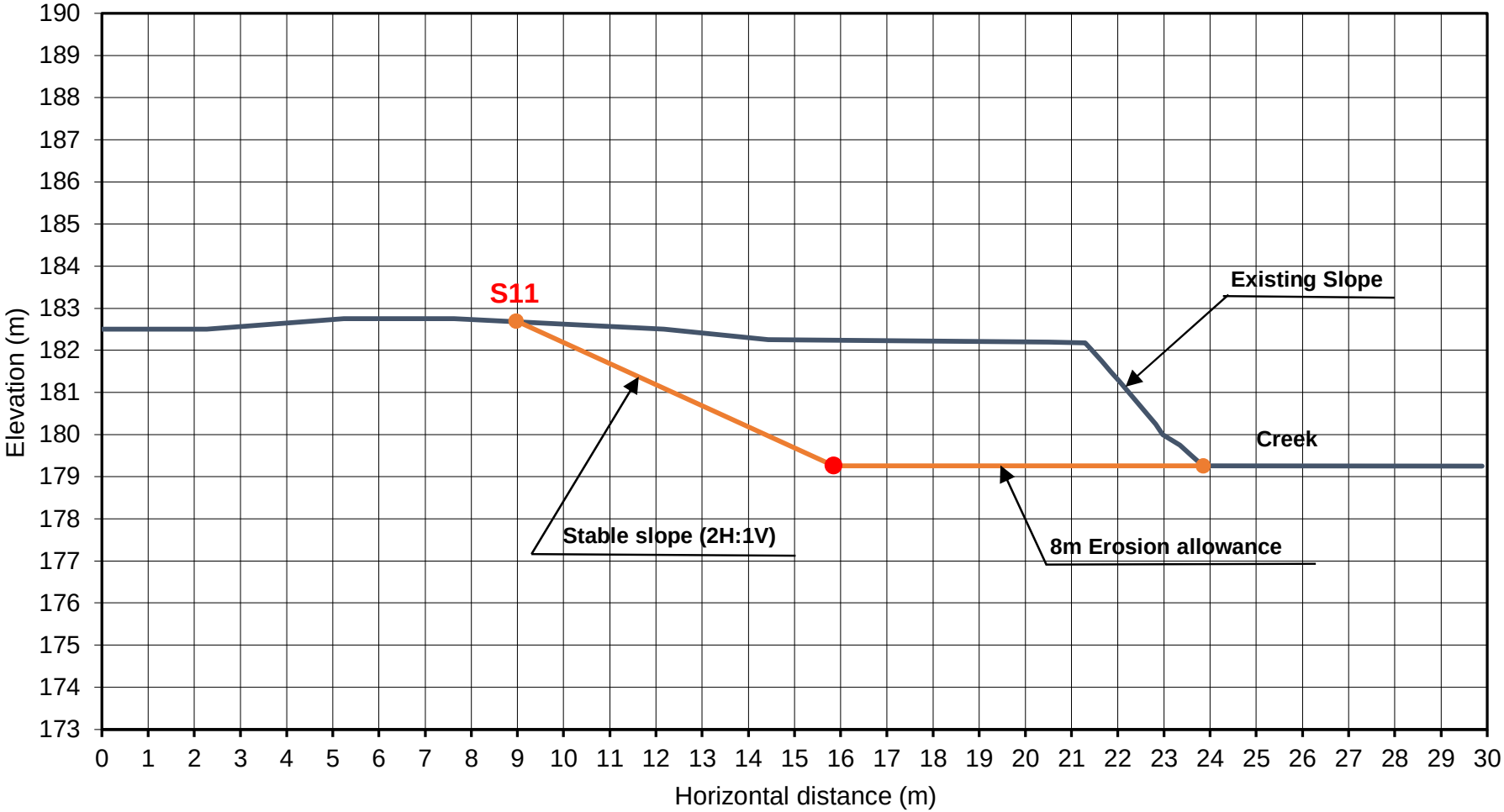
Point '**S10**': Long-term stable top of slope (LTSTOS)



23-301-100 - **Drawing 12**

Slope Profile at **Section X11-X11** (See Drawing 1 for Location Plan)

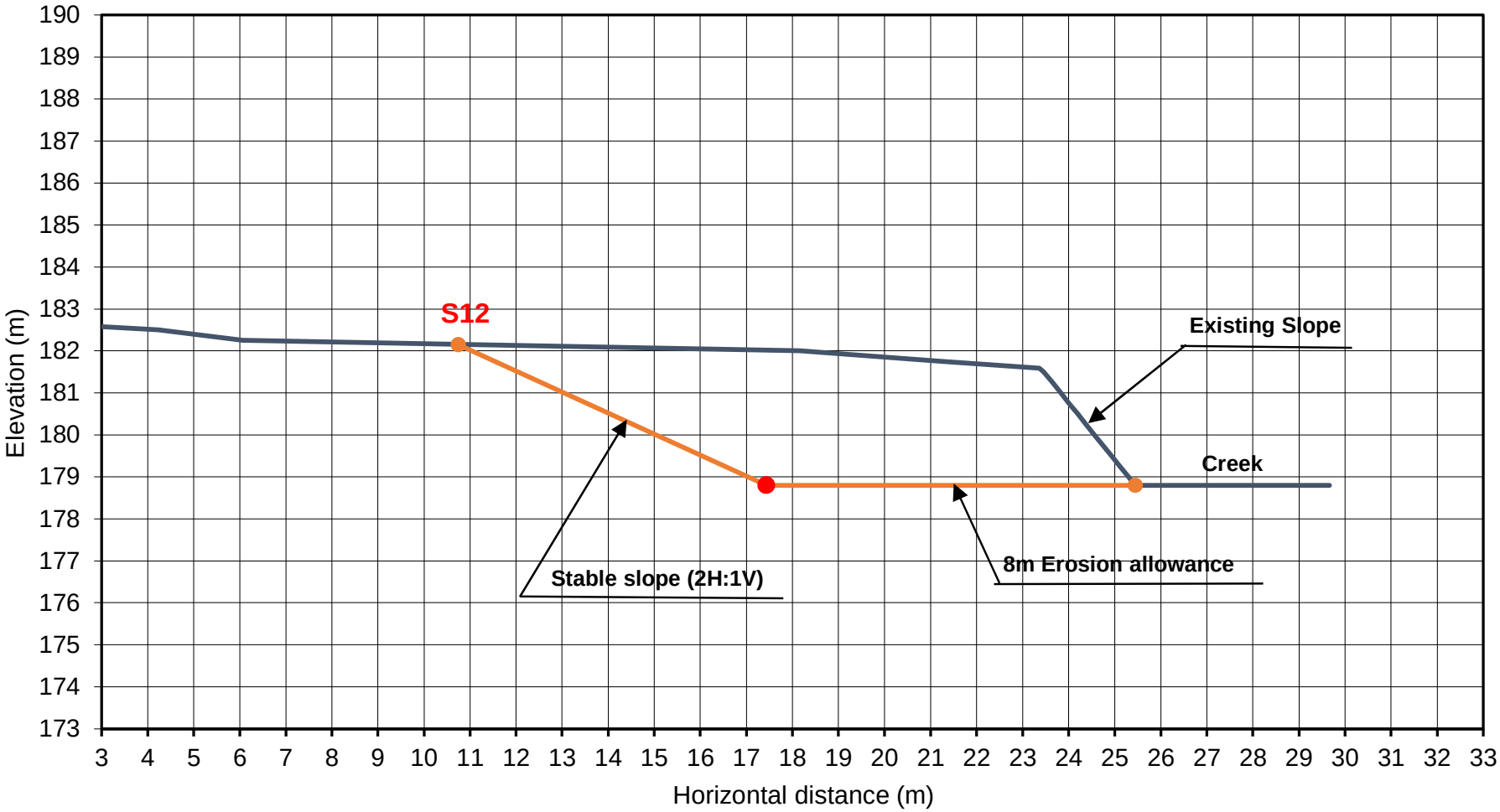
Point '**S11**': Long-term stable top of slope (LTSTOS)



23-301-100 - **Drawing 13**

Slope Profile at **Section X12-X12** (See Drawing 1 for Location Plan)

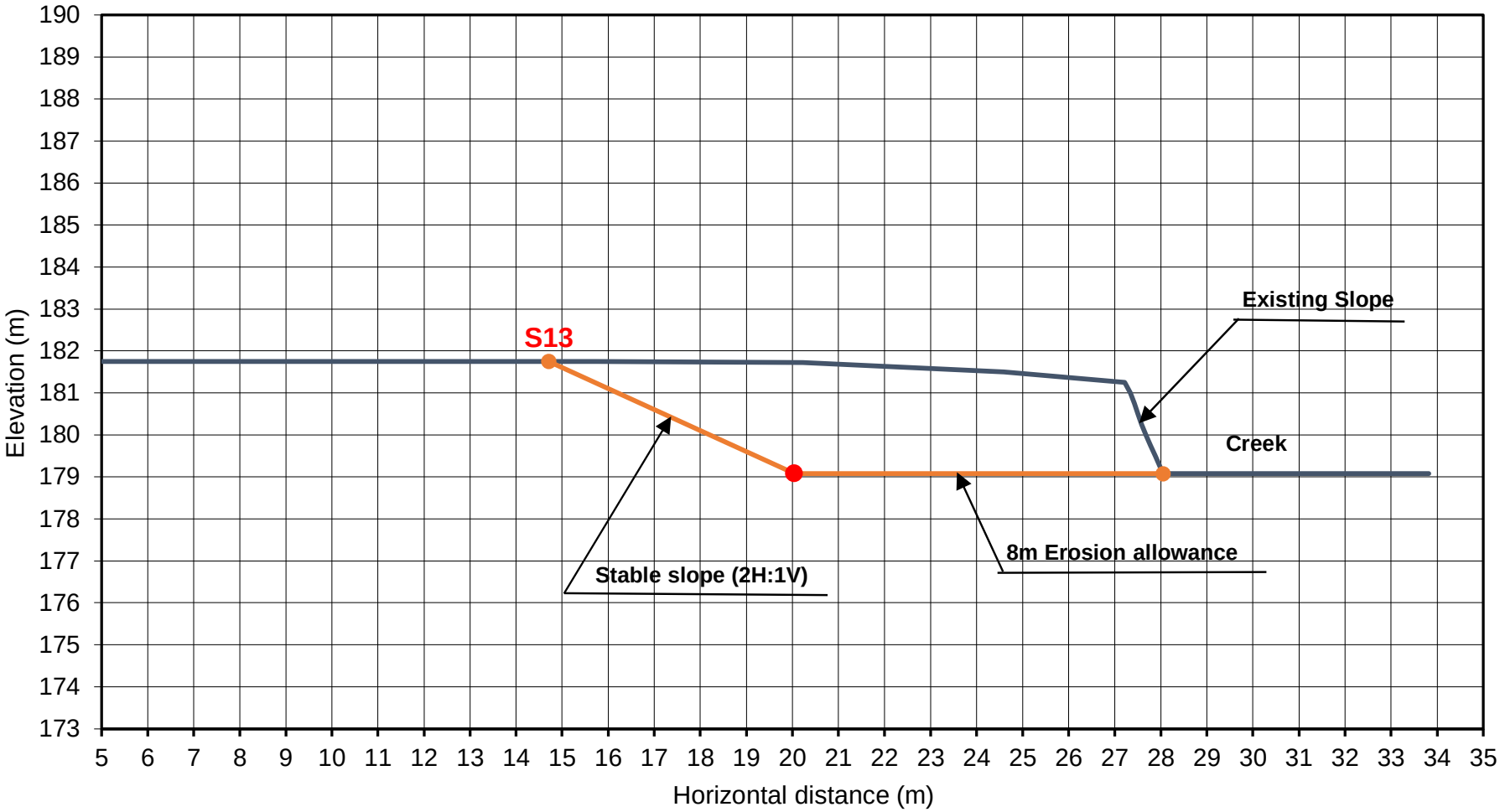
Point '**S12**': Long-term stable top of slope (LTSTOS)



23-301-100 - **Drawing 14**

Slope Profile at **Section X13-X13** (See Drawing 1 for Location Plan)

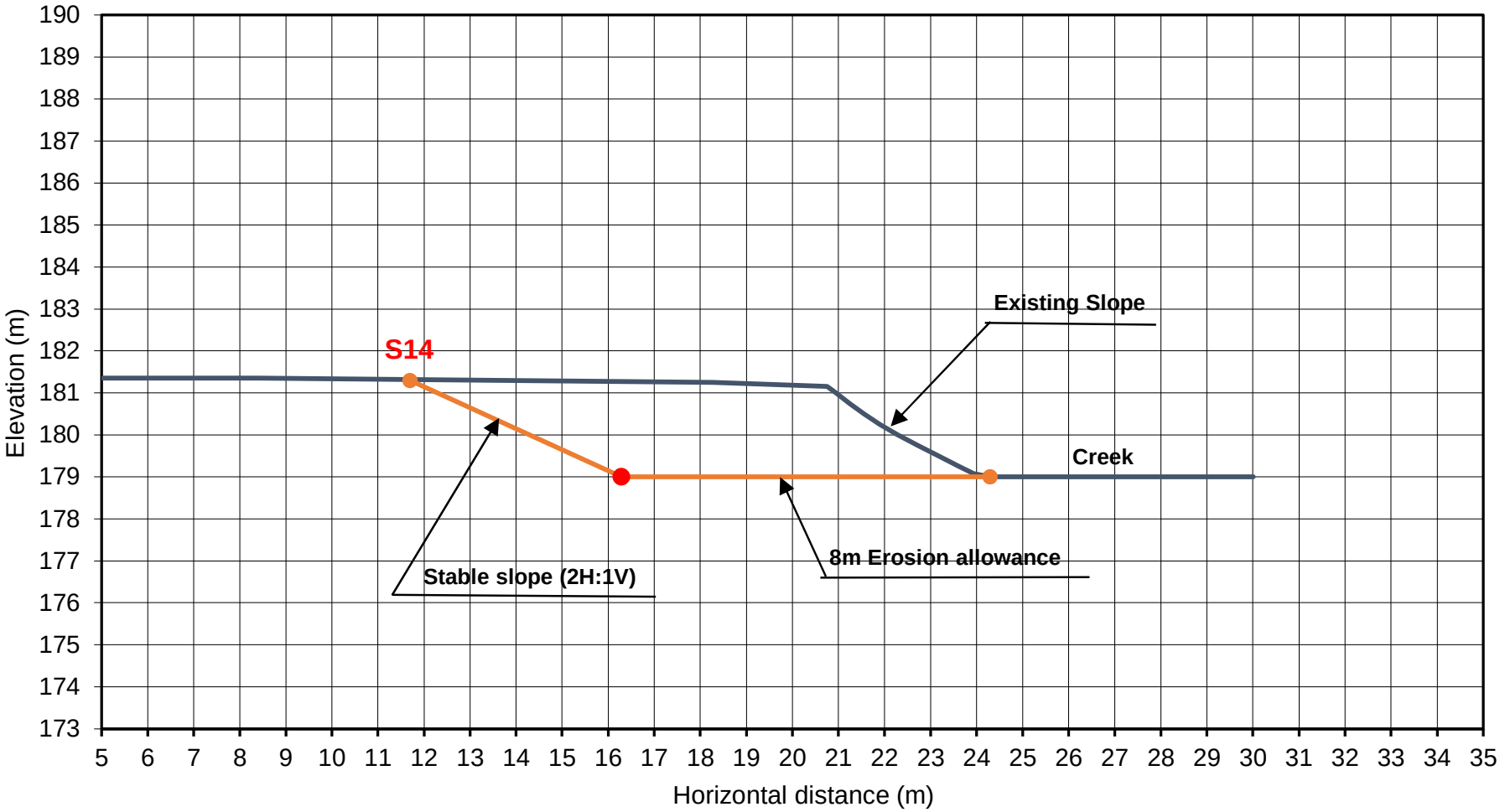
Point '**S13**': Long-term stable top of slope (LTSTOS)



23-301-100 - **Drawing 15**

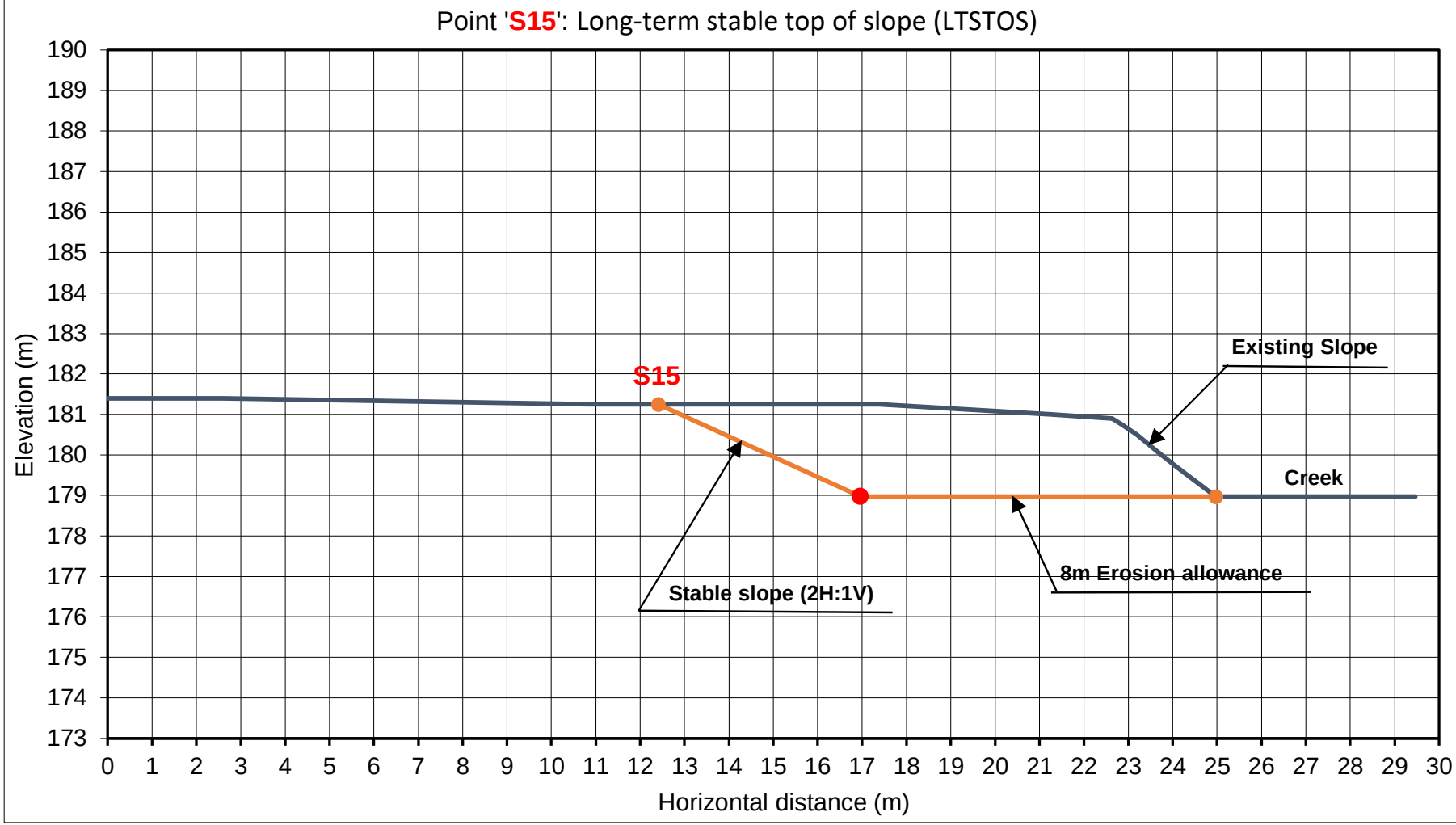
Slope Profile at **Section X14-X14** (See Drawing 1 for Location Plan)

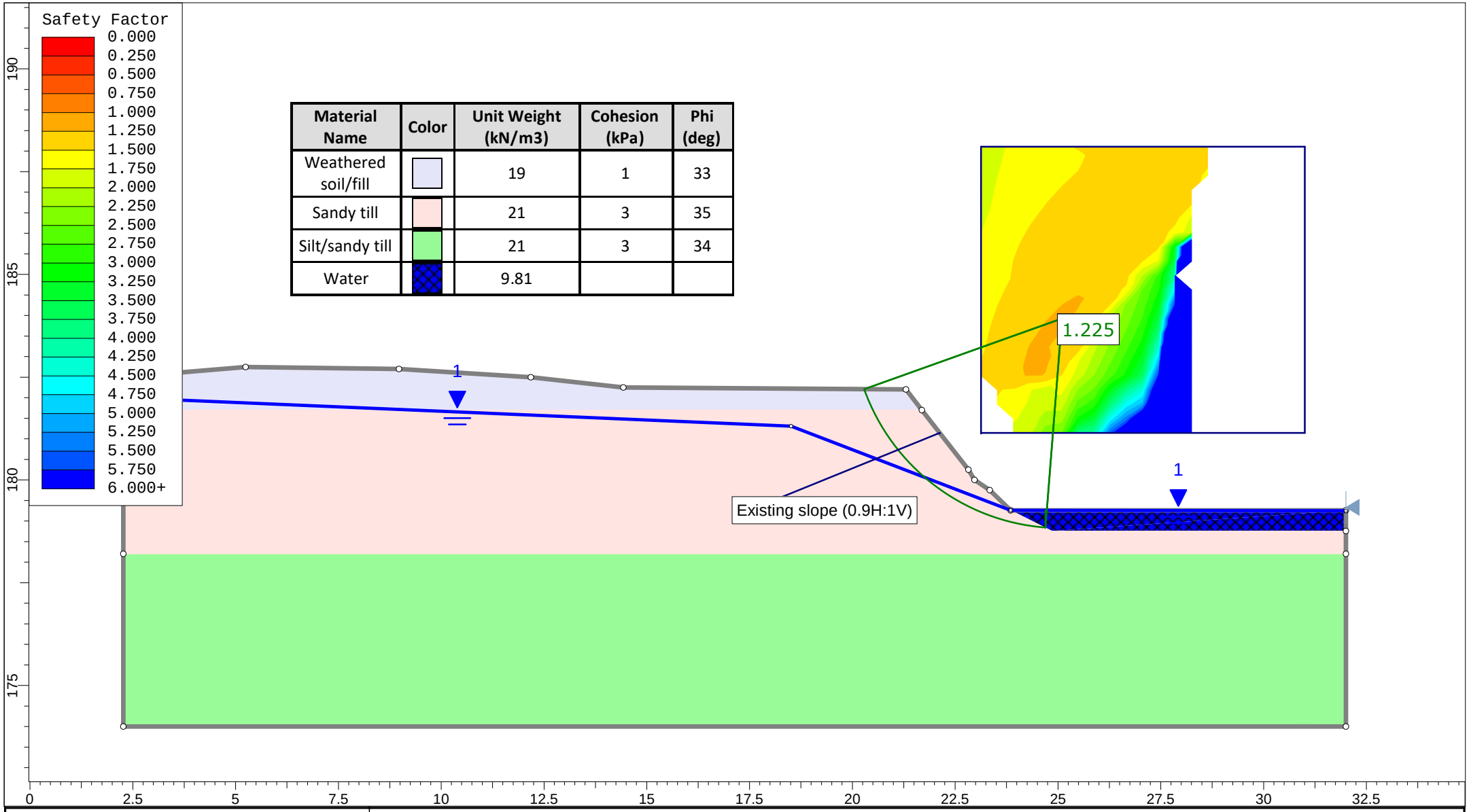
Point '**S14**': Long-term stable top of slope (LTSTOS)



23-301-100 - **Drawing 16**

Slope Profile at **Section X15-X15** (See Drawing 1 for Location Plan)



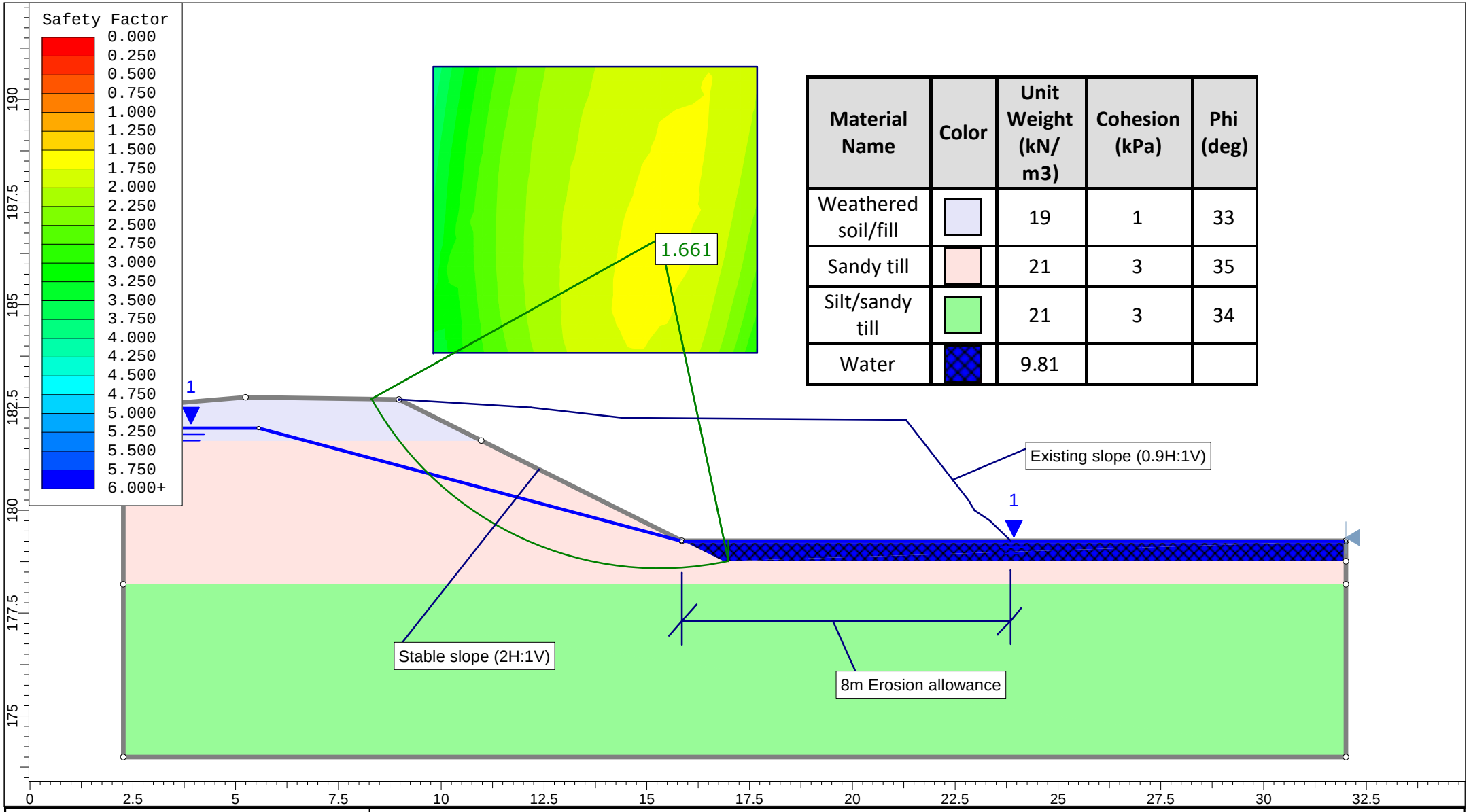


Material Name	Color	Unit Weight (kN/m3)	Cohesion (kPa)	Phi (deg)
Weathered soil/fill		19	1	33
Sandy till		21	3	35
Silt/sandy till		21	3	34
Water		9.81		

rocscience

SLIDEINTERPRET 9.002

Project	23-301-100 - Long-term Slope Stability Assessment, 496857 Grey Road 2, Blue Mountains, ON		
Group	Group 1	Scenario	Master Scenario
Drawn By	DS	Company	DS Consultants Ltd.
Date	January 2024	File Name	Drawing 17 - Existing Slope at Section X11-X11.slmd



Material Name	Color	Unit Weight (kN/m3)	Cohesion (kPa)	Phi (deg)
Weathered soil/fill		19	1	33
Sandy till		21	3	35
Silt/sandy till		21	3	34
Water		9.81		

rocscience

SLIDEINTERPRET 9.002

Project	23-301-100 - Long-term Slope Stability Assessment, 496857 Grey Road 2, Blue Mountains, ON		
Group	Group 1	Scenario	Master Scenario
Drawn By	DS	Company	DS Consultants Ltd.
Date	January 2024	File Name	Drawing 18 - Stable Slope at Section X11-X11.slmd

Appendix I

Location Plan and Logs of Boreholes by DS

J:\2023 Projects\23-301-100 Geo - 496857 Grey Road 2, Town of Blue Mountain, Ontario\Geotechnical

Legend

Monitoring Well

DS CONSULTANTS LTD.
6221 Highway 7, UNIT 16
Vaughan, Ontario L4H 0K8
Telephone: (905) 264-9393
www.dsconsultants.ca

Project: PRELIMINARY GEOTECHNICAL INVESTIGATION
496857 Grey Road 2, Town of Blue Mountain, ON

Title: **BOREHOLE LOCATION PLAN**

N

Client: HOMEFIELD COMMUNITIES

Size:	Approved By:	Drawn By:	Date:
8.5 x 11	L.M	K.T	December 2023
Rev: 0	Scale: As Shown	Project No.: 23-301-100	Figure No.: 1

Image/Map Source: *Google Satellite Image*

DS CONSULTANTS LTD.
Geotechnical ◆ Environmental ◆ Materials ◆ Hydrogeology

LOG OF BOREHOLE BH23-1

PROJECT: Preliminary Geotechnical Investigation
CLIENT: Homefield Communities
PROJECT LOCATION: 496857 Grey Road 2, Blue Mountain, ON
DATUM: Geodetic
BH LOCATION: See Drawing 1 N 4932642.81 E 544944.58

DRILLING DATA
Method: Solid Stem Auger
Diameter: 150mm
Date: Nov-23-2023

REF. NO.: 23-301-100
ENCL NO.: 2

(m) ELEV / DEPTH	DESCRIPTION	NUMBER	TYPE	BLOWS 0.3 m "N"	ELEVATION
190.8					
190.6 0.0	**TOPSOIL:** 150mm				
0.2	**FILL:** sandy silt, some clay, trace rootlets, some gravel, trace organics, dark brown, moist, loose	1	SS	7	
1	stone fragments, wet at 0.8m	2	SS	9	190
189.2	wet sand at 1.5m				
1.6	**SAND AND GRAVEL:** trace silt, with cobbles/boulders, brown, wet, very dense	3	SS	50/ 130mm	189
2 188.7					
2.1	grey below 1.8m **SANDY SILT TO SILTY SAND TILL:** trace clay, trace to some gravel, with cobbles/boulders, brown to grey, very moist to wet, very dense	4	SS	50/ 130mm	188
3		5	SS	50/ 75mm	
4	gravelly at 4.6m	6	SS	50/ 130mm	187 186
5					
6 184.6					185
6.2	**END OF BOREHOLE:** Notes: 1) 50mm dia. monitoring well installed upon completion. 2) Water Level Readings: Date: Water Level(mbgl): Dec. 5, 2023 1.18	7	SS	50/ 130mm	

GROUND WATER CONDITIONS: W. L. 189.6 m Dec 05, 2023

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

SHEAR STRENGTH (kPa): ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE & Sensitivity × LAB VANE; 20 40 60 80 100

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L

WATER CONTENT (%): 10 20 30

POCKET PEN. (Cu) (kPa)

NATURAL UNIT WT (kN/m³)

REMARKS AND GRAIN SIZE DISTRIBUTION (%)

GR SA SI CL

Auger grinding at 1.5m

Auger grinding at 3.1m

Auger grinding at 4.6m
33 45 17 6

GROUNDWATER ELEVATIONS
Measurement 1st 2nd 3rd 4th

GRAPH NOTES: +3, ×3: Numbers refer to Sensitivity; ○ ε=3% Strain at Failure

DS SOIL LOG-2021-FINAL 23-301-100GEO.GPJ DS.GDT 23-12-19

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Geotechnical ◆ Environmental ◆ Materials ◆ Hydrogeology

LOG OF BOREHOLE BH23-2

PROJECT: Preliminary Geotechnical Investigation
CLIENT: Homefield Communities
PROJECT LOCATION: 496857 Grey Road 2, Blue Mountain, ON
DATUM: Geodetic
BH LOCATION: See Drawing 1 N 4932695.67 E 545205.97

DRILLING DATA
Method: Solid Stem Auger
Diameter: 150mm
Date: Nov-22-2023

REF. NO.: 23-301-100
ENCL NO.: 3

(m) ELEV / DEPTH	DESCRIPTION	NUMBER	TYPE	BLOWS 0.3 m "N"	GROUND WATER CONDITIONS	ELEVATION	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
188.2							
0.0 / 188.0	**TOPSOIL:** 230mm						
0.2 / 187.4	**FILL:** sand and gravel, trace topsoil, dark brown, moist, loose	1	SS	9		188	
0.8 / 187.2	**SAND:** some gravel, trace silt, brown, wet, compact						
1.0 / 186.7	**SANDY SILT TILL:** some clay, trace gravel, brown, wet, compact	2	SS	15		187	
1.5	**SILTY SAND:** gravelly, trace clay, with cobbles/rock fragments, brown, wet, compact	3	SS	29	▽		25 44 25 7
2 / 185.9					W. L. 186.4 m Dec 05, 2023	186	
2.3	**SANDY SILT TO SILTY SAND TILL:** trace clay, some gravel, with cobbles/boulders, grey, very moist to wet, very dense	4	SS	71			
3		5	SS	50/ 150mm		185	
4						184	auger grinding at 4.6m
		6	SS	50/ 75mm			17 28 47 8
5						183	
6 / 182.0							
6.2	**END OF BOREHOLE:**	7	SS	50/ 50mm		182	

Notes:
1) 50mm dia. monitoring well installed upon completion.
2) Water Level Readings:

Date:	Water Level(mbgl):
Dec. 5, 2023	1.81

DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100)
SHEAR STRENGTH (kPa) (20 40 60 80 100)
○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE & Sensitivity × LAB VANE

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L
WATER CONTENT (%) (10 20 30)

POCKET PEN. (Cu) (kPa)
NATURAL UNIT WT (kN/m³)

GROUNDWATER ELEVATIONS
Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

GRAPH NOTES: +3, ×3: Numbers refer to Sensitivity; ○ ε=3% Strain at Failure

DS CONSULTANTS LTD.
Geotechnical ◆ Environmental ◆ Materials ◆ Hydrogeology

LOG OF BOREHOLE BH23-3

PROJECT: Preliminary Geotechnical Investigation
CLIENT: Homefield Communities
PROJECT LOCATION: 496857 Grey Road 2, Blue Mountain, ON
DATUM: Geodetic
BH LOCATION: See Drawing 1 N 4932693.05 E 545523.36

DRILLING DATA
Method: Solid Stem Auger/Hollow Stem Auger
Diameter: 150mm/200mm
Date: Nov-22-2023

REF. NO.: 23-301-100
ENCL NO.: 4

(m) ELEV / DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	BLOWS "N" 0.3 m	GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (kPa) ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE & Sensitivity × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) (10 20 30)	POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
187.2												
186.9 / 0.3	**TOPSOIL:** 50mm											
	FILL: sand and gravel, trace rootlets, trace silt, dark brown, very moist, loose		1	SS	7		187					
186.4												
0.8	**GRAVELLY SAND:** some silt, trace clay, with cobbles/boulders, brown, wet, compact		2	SS	17	▽						
							W. L. 186.2 m Dec 05, 2023					
			3	SS	16							29 54 14 3
184.9							185					
2.3	**SANDY SILT TILL:** trace clay, trace gravel, with cobbles/boulders, grey, very moist, dense to very dense		4	SS	46							
			5	SS	68		184					Switched to Hollow Stem
							183					
			6	SS	50/ 130mm							8 32 51 9
							182					
			7	SS	50/ 130mm		181					
180.6												
6.6	**END OF BOREHOLE:** Notes: 1) 50mm dia. monitoring well installed upon completion. 2) Water Level Readings: Date: Water Level(mbgl): Dec. 5, 2023 1.0											

GROUNDWATER ELEVATIONS
Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

GRAPH NOTES: +3, ×3: Numbers refer to Sensitivity; ○ ε=3% Strain at Failure

DS SOIL LOG-2021-FINAL 23-301-100GEO.GPJ DS.GDT 23-12-19

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LOG OF BOREHOLE BH23-4

PROJECT: Preliminary Geotechnical Investigation
CLIENT: Homefield Communities
PROJECT LOCATION: 496857 Grey Road 2, Blue Mountain, ON
DATUM: Geodetic
BH LOCATION: See Drawing 1 N 4932792.79 E 545632.71

DRILLING DATA
Method: Solid Stem Auger/Hollow Stem Auger
Diameter: 150mm/200mm
Date: Nov-22-2023

REF. NO.: 23-301-100
ENCL NO.: 5

(m) ELEV / DEPTH	DESCRIPTION	STRATA PLOT	NUMBER	TYPE	BLOWS "N" 0.3 m	GROUND WATER CONDITIONS	ELEVATION	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (kPa) ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE & Sensitivity × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	POCKET PEN. (Cu) (kPa)	NATURAL UNIT WT (kN/m³)	REMARKS AND GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
182.2												
182.0 0.0	**TOPSOIL:** 130mm											
0.1	**FILL:** sand and gravel, trace rootlets, dark brown to brown, very moist to wet, loose to dense		1	SS	14		182					
181.2 1.0	**SAND AND GRAVEL:** trace silt, with cobbles/boulders, brown, wet, dense		2	SS	45		181					
181.0 1.2	**SILTY SAND TO SANDY SILT TILL:** trace to some clay, trace gravel, with cobbles/boulders, brown to grey, very moist to wet, dense to very dense		3	SS	50/ 130mm							
			4	SS	50/ 100mm	▽	180	W. L. 179.9 m Dec 05, 2023				Switched to Hollow Stem Auger @2.3m
			5	SS	50/ 130mm		179					
			6	SS	50/ 100mm		178					9 30 51 10
							177					
176.2 6.0	**SILT TILL:** sandy, trace gravel, occasional cobble, grey, moist, very dense		7	SS	50/ 130mm		176					
175.6 6.6	**END OF BOREHOLE:** Notes: 1) 50mm dia. monitoring well installed upon completion. 2) Water Level Readings: Date: Water Level(mbgl): Dec. 5, 2023 2.25											

GROUNDWATER ELEVATIONS
Measurement 1st ▽ 2nd ▼ 3rd ▼ 4th ▼

GRAPH NOTES: + 3, × 3: Numbers refer to Sensitivity; ○ ε=3% Strain at Failure

DS SOIL LOG-2021-FINAL 23-301-100GEO.GPJ DS.GDT 23-12-19

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LOG OF BOREHOLE BH23-5

PROJECT: Preliminary Geotechnical Investigation
CLIENT: Homefield Communities
PROJECT LOCATION: 496857 Grey Road 2, Blue Mountain, ON
DATUM: Geodetic
BH LOCATION: See Drawing 1 N 4932757.62 E 545486.69

DRILLING DATA
Method: Solid Stem Auger
Diameter: 150mm
Date: Nov-22-2023

REF. NO.: 23-301-100
ENCL NO.: 6

ELEV / DEPTH (m)	DESCRIPTION	NUMBER	TYPE	BLOWS 0.3 m "N"	ELEVATION
184.2 / 0.0	**TOPSOIL:** 130mm				
184.0 / 0.1	**FILL:** sand, trace rootlets, trace gravel, brown, very moist to wet, loose to compact	1	SS	4	184
183.2 / 1.0	**SAND AND GRAVEL:** trace silt, trace clay, brown, wet, compact to very dense	2	SS	21	183
182.3 / 1.9	**SANDY SILT TO SILTY SAND TILL:** trace clay, trace to some gravel, occasional cobbles, grey, moist to wet, very dense	3	SS	67	182
		4	SS	50/100mm	
		5	SS	50/100mm	181
		6	SS	50/130mm	180
178.2 / 6.0	**SILT TO SANDY SILT TILL:** trace clay, trace gravel, grey, very moist, very dense	7	SS	50/130mm	179 / 178
177.8 / 6.4	**END OF BOREHOLE:**				

Notes:
1) 50mm dia. monitoring well installed upon completion.
2) Water Level Readings:

Date:	Water Level(mbgl):
Dec. 5, 2023	0.42

W. L. 183.8 m
Dec 05, 2023

DYNAMIC CONE PENETRATION RESISTANCE PLOT
20 40 60 80 100

SHEAR STRENGTH (kPa)
○ UNCONFINED + FIELD VANE & Sensitivity
● QUICK TRIAXIAL × LAB VANE
20 40 60 80 100

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L
WATER CONTENT (%)
10 20 30

POCKET PEN. (Cu) (kPa)

NATURAL UNIT WT (kN/m³)

REMARKS AND GRAIN SIZE DISTRIBUTION (%)

GR	SA	SI	CL
14	45	34	7

GROUNDWATER ELEVATIONS
Measurement 1st 2nd 3rd 4th

GRAPH NOTES: +3, ×3: Numbers refer to Sensitivity; ○ε=3% Strain at Failure

Appendix II

Site Photographs of Slopes

(Photos P1 to P10, taken on December 8, 2023,
See Drawing 1 for locations of Cross Sections X1-X1 to X15-X15)

Photo P1: Top of slope conditions in west part of site near Section X1-X1 (looking east)

Photo P2: Creek and slope conditions in west part of site near Section X1-X1 (looking east)

Photo P3: Top of slope conditions in area of Sections X3-X3 to X4-X4
(looking north toward river)

Photo P4: Slope and creek conditions in area of Sections X3-X3 to X4-X4
(looking south)

Photo P5: Top of slope conditions in area of Sections X4-X4 to X5-X5 (looking east)

Photo P6: Creek and slope conditions in area of Sections X4-X4 to X5-X5 (looking west)

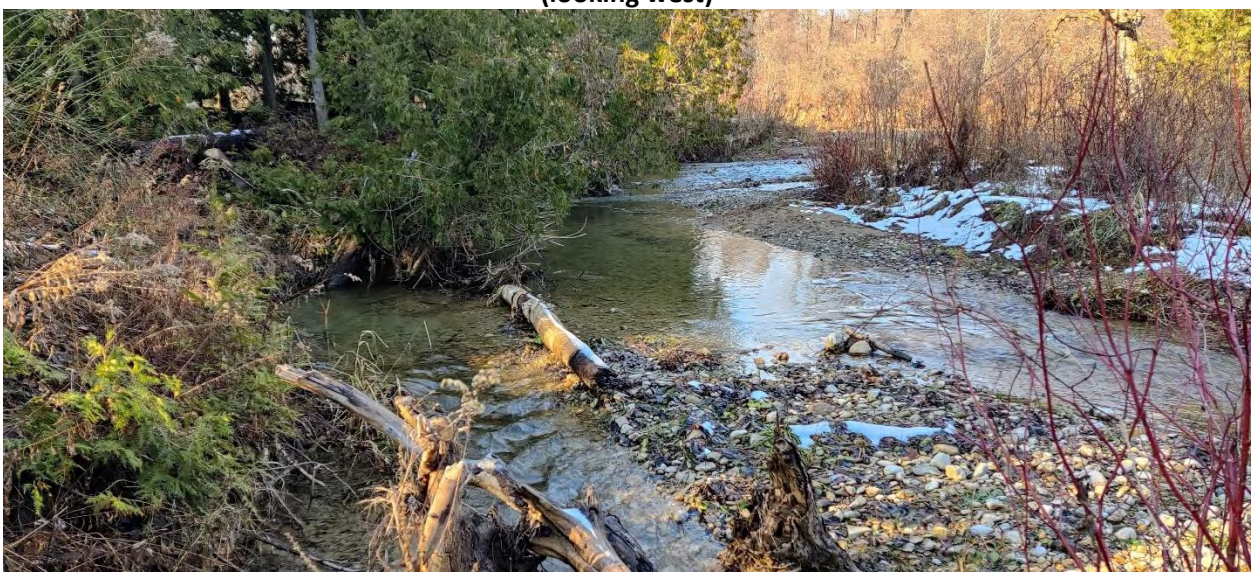

Photo P7: Creek and slope conditions in area to west of Section X10-X10 (looking southwest)

Photo P8: Creek and slope conditions in area to east of Section X10-X10 (looking southeast)

Photo P9: Top of slope conditions in east part of site near Section X13-X13 (looking east)

Photo P10: Creek and slope conditions in east part of site near Section X13-X13, with Erosions at lower portion of slope (looking east)