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A HELICAL PILE INSTALLATION AT SENTIER DES GRÈVES

Presented by:
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STAIRCASE AT SENTIER DES GRÈVES

- Quebec City wanted to link the riverbank of the St-Lawrence River to the top of the hill near the city’s bridges and thus complete the Champlain Trail.
- This trail serves as the main pedestrian artery of Quebec City and one of its most popular attractions.

PRELIMINARY WORK

- One year before construction began, the project’s engineering team approached Techno Metal Post to see whether helical piles would be a feasible foundation solution.
- Other foundation methods would have encountered severe challenges due to the installation and site conditions.
- It was determined that a helical pile installation would be successful despite these extreme conditions.
- Detailed plans and specifications were then prepared incorporating the helical piles.

PROJECT LOCATION

PROJECT LOCATION

DESCRIPTION OF SLOPE

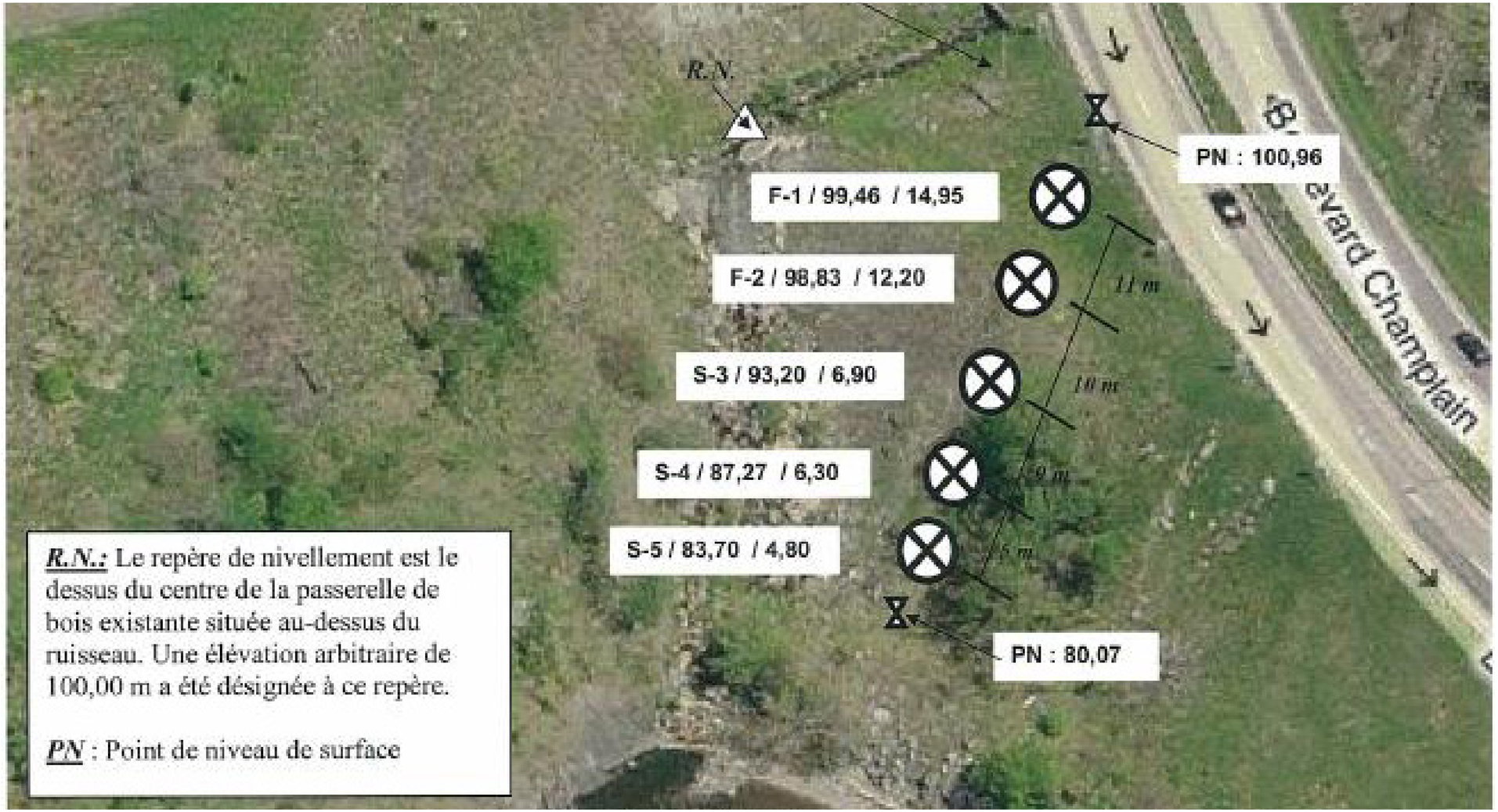
- ± 40 degree angled slope
- ± 65 feet high
- ± 80 feet long

DESCRIPTION OF SOIL

Geotechnical report done by Qualitas (SNC-Lavalin)

- Two (2) boreholes were done at the top of the slope.
- Fill layer (± 7 feet) was then followed by the till layer.
- Three (3) Pionjar tests were conducted within the slope.
- Refusal between 16 feet and 23 feet.

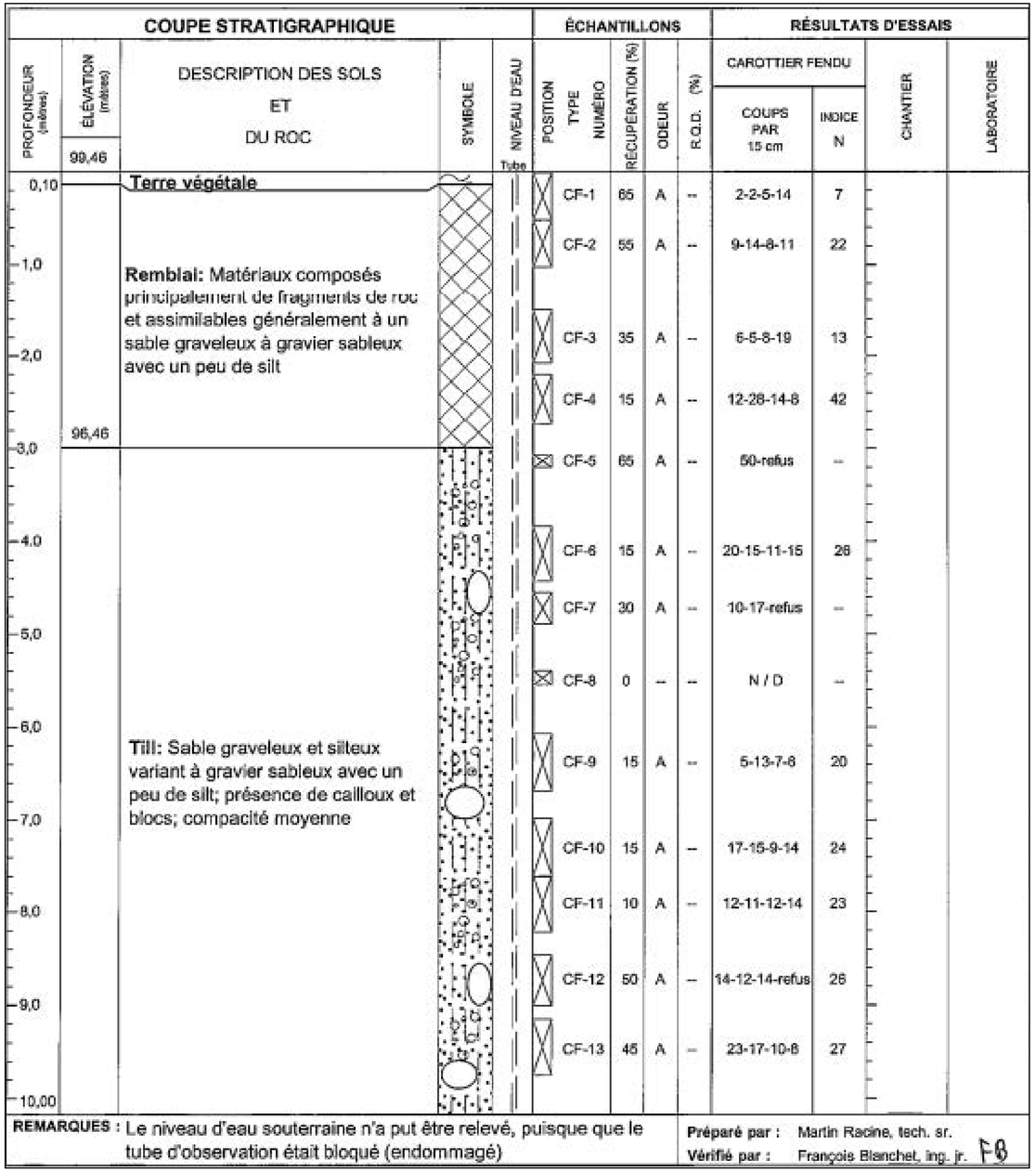
LOCATION OF BOREHOLES



LOCATION OF BOREHOLES

Fill: Material composed of rock fragments (sand and silt).

Till: Sand and gravel, with some silt, cobbles and boulders.



COUPE STRATIGRAPHIQUE

PROFONDEUR (mètres)	ÉLÉVATION (mètres)	DESCRIPTION DES SOLS ET DU ROC	SYMBOLE	NIVEAU D'EAU
	99,46			Tube
0,10		**Terre végétale**		
1,0		**Remblai:** Matériaux composés principalement de fragments de roc et assimilables généralement à un sable graveleux à gravier sableux avec un peu de silt		
2,0				
3,0	96,46			
4,0		**Till:** Sable graveleux et silteux variant à gravier sableux avec un peu de silt; présence de cailloux et blocs; compacité moyenne		
5,0				
6,0				
7,0				
8,0				
9,0				
10,00				

ÉCHANTILLONS

POSITION	TYPE NUMÉRO	RÉCUPÉRATION (%)	ODEUR	R.Q.D. (%)
	CF-1	65	A	--
	CF-2	55	A	--
	CF-3	35	A	--
	CF-4	15	A	--
	CF-5	65	A	--
	CF-6	15	A	--
	CF-7	30	A	--
	CF-8	0	--	--
	CF-9	15	A	--
	CF-10	15	A	--
	CF-11	10	A	--
	CF-12	50	A	--
	CF-13	45	A	--

RÉSULTATS D'ESSAIS

CAROTTIER FENDU: COUPS PAR 15 cm	CAROTTIER FENDU: INDICE N	CHANTIER	LABORATOIRE
2-2-5-14	7		
9-14-8-11	22		
6-5-8-19	13		
12-28-14-8	42		
50-refus	--		
20-15-11-15	26		
10-17-refus	--		
N / D	--		
5-13-7-6	20		
17-15-9-14	24		
12-11-12-14	23		
14-12-14-refus	26		
23-17-10-8	27		

REMARQUES : Le niveau d'eau souterraine n'a put être relevé, puisque que le tube d'observation était bloqué (endommagé)

Préparé par : Martin Racine, tech. sr.
Vérifié par : François Blanchet, ing. jr.

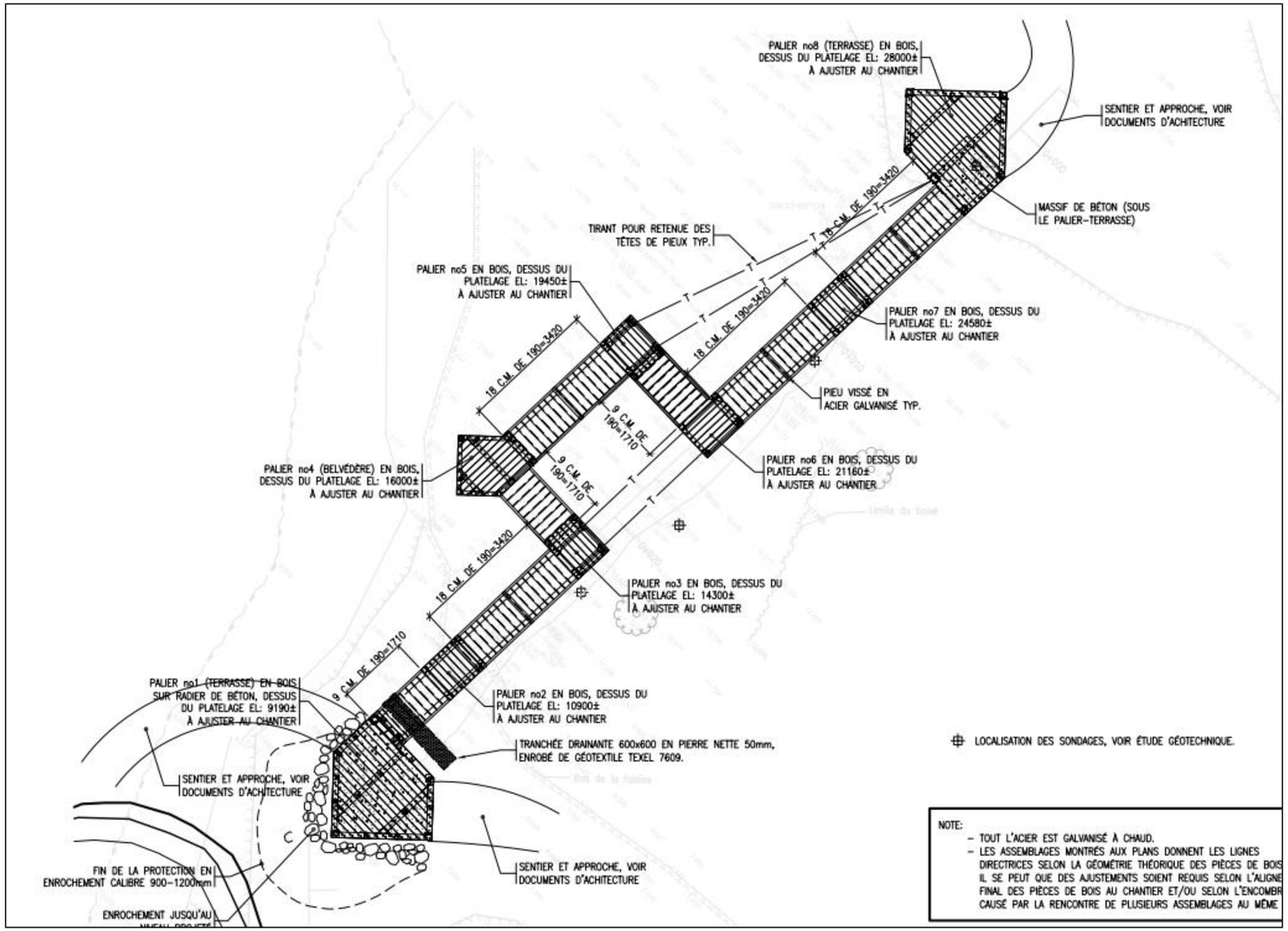
OPTIONS CONSIDERED FOR A FOUNDATION

- Conventional foundations are not recommended because of the fill layer (potential for settlement).
- Helical piles (possible cobbles and rock fragments, difficult access).
- Driven piles (difficult access and high cost).
- Bored piles (difficult access and high cost).

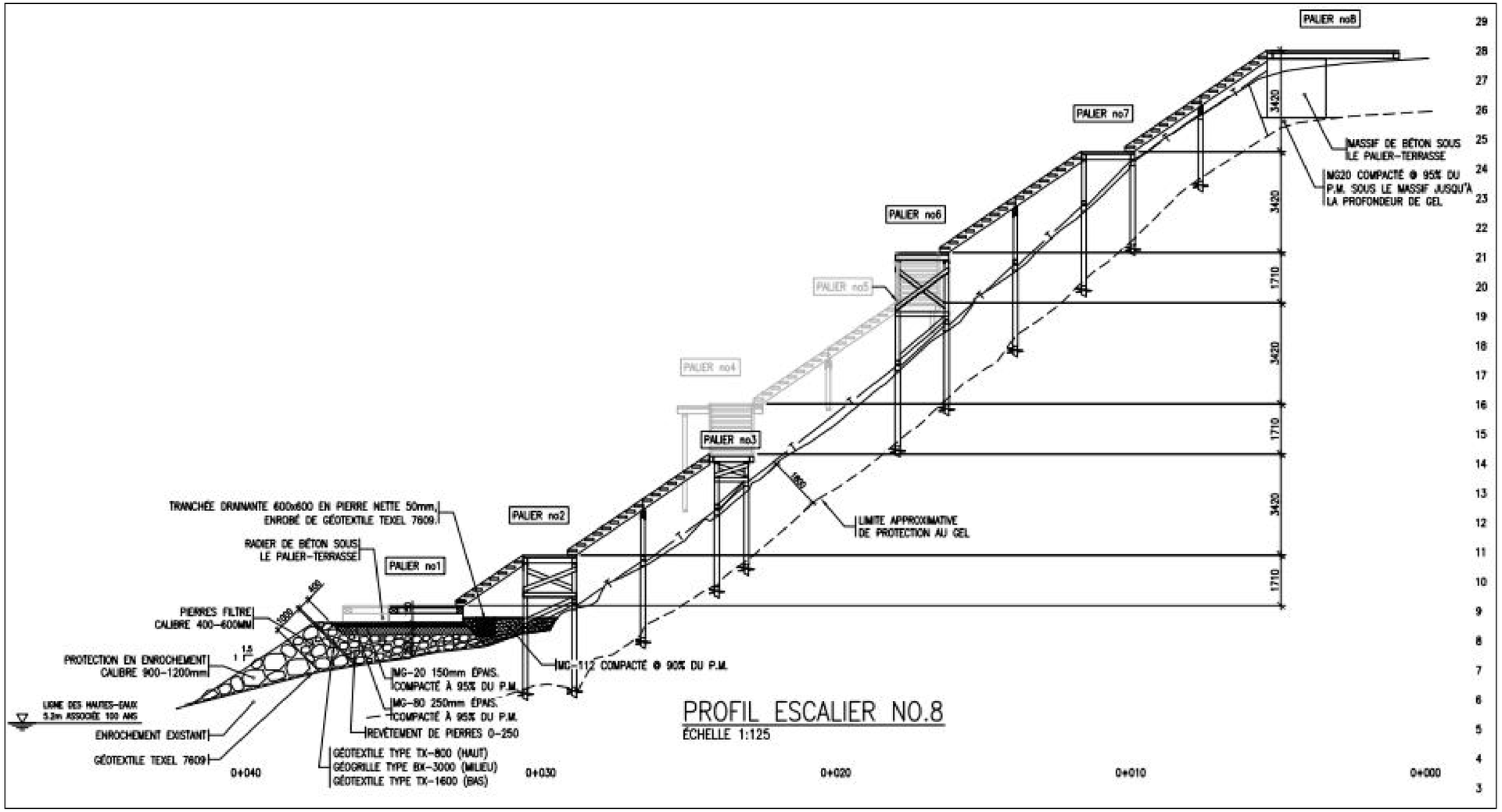
OPTIONS CHOSEN BY GEOTECHNICAL & STRUCTURAL ENGINEER

- Structural design of wood stairs done by WSP.
- Helical piles became the best option because of:
  - Low cost
  - Access with Techno Metal Post installation equipment
  - Speed of installation
- Minimum pile diameter = 5 inch (125mm).
- Minimum pile thickness = 0.25 inch (6.4mm).

PLAN

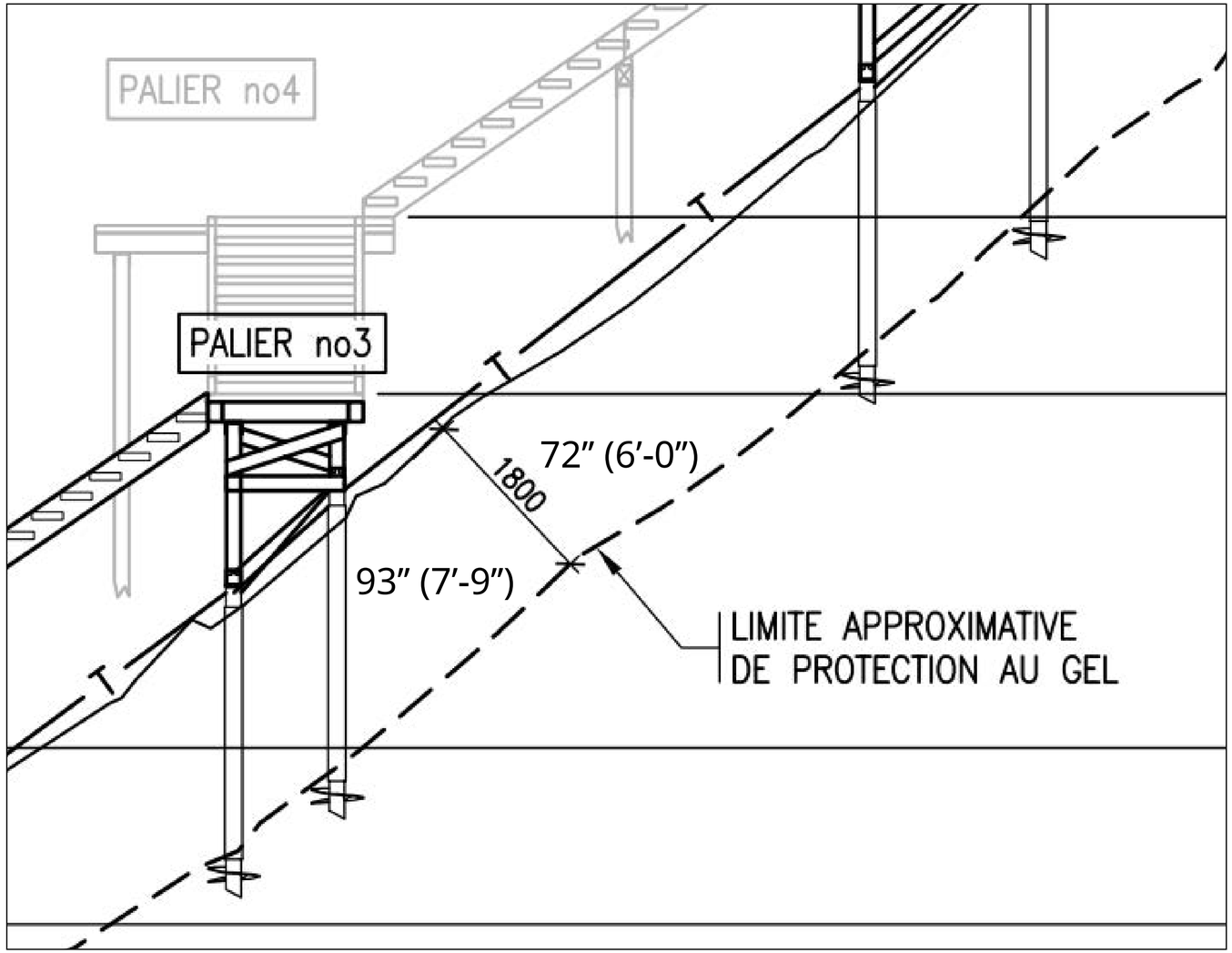

PALIER no8 (TERRASSE) EN BOIS, DESSUS DU PLATELAGE EL: 28000± À AJUSTER AU CHANTIER
SENTIER ET APPROCHE, VOIR DOCUMENTS D'ACHITECTURE
MASSIF DE BÉTON (SOUS LE PALIER-TERRASSE)
TIRANT POUR RETENUE DES TÊTES DE PIEUX TYP.
PALIER no5 EN BOIS, DESSUS DU PLATELAGE EL: 19450± À AJUSTER AU CHANTIER
PALIER no7 EN BOIS, DESSUS DU PLATELAGE EL: 24580± À AJUSTER AU CHANTIER
PIEU VISSÉ EN ACIER GALVANISÉ TYP.
PALIER no4 (BELVÉDÈRE) EN BOIS, DESSUS DU PLATELAGE EL: 16000± À AJUSTER AU CHANTIER
PALIER no6 EN BOIS, DESSUS DU PLATELAGE EL: 21160± À AJUSTER AU CHANTIER
PALIER no3 EN BOIS, DESSUS DU PLATELAGE EL: 14300± À AJUSTER AU CHANTIER
PALIER no1 (TERRASSE) EN BOIS SUR RADIER DE BÉTON, DESSUS DU PLATELAGE EL: 9190± À AJUSTER AU CHANTIER
PALIER no2 EN BOIS, DESSUS DU PLATELAGE EL: 10900± À AJUSTER AU CHANTIER
TRANCHÉE DRAINANTE 600x600 EN PIERRE NETTE 50mm, ENROBÉ DE GÉOTEXTILE TEXEL 7609.
SENTIER ET APPROCHE, VOIR DOCUMENTS D'ACHITECTURE
SENTIER ET APPROCHE, VOIR DOCUMENTS D'ACHITECTURE
FIN DE LA PROTECTION EN ENROCHEMENT CALIBRE 900-1200mm
ENROCHEMENT JUSQU'AU
18 C.M. DE 190x3420
9 C.M. DE 190x1710
LOCALISATION DES SONDAGES, VOIR ÉTUDE GÉOTECHNIQUE.
NOTE:
- TOUT L'ACIER EST GALVANISÉ À CHAUD.
- LES ASSEMBLAGES MONTRÉS AUX PLANS DONNENT LES LIGNES DIRECTRICES SELON LA GÉOMÉTRIE THÉORIQUE DES PIÈCES DE BOIS IL SE PEUT QUE DES AJUSTEMENTS SOIENT REQUIS SELON L'ALIGNE FINAL DES PIÈCES DE BOIS AU CHANTIER ET/OU SELON L'ENCOMBR CAUSÉ PAR LA RENCONTRE DE PLUSIEURS ASSEMBLAGES AU MÊME

ELEVATION PLAN



FROST PROTECTION

- Approximate frost protection limit.
- Stair landing no.3.



LOADS TO BE SUPPORTED BY HELICAL PILES

- Number of piles = 36
- Compression = 5,625 lbs (25 kN)
- Helix has to be frost protected and bear on till layer at a minimum of 8 feet.
- Lateral = 1,125 lbs (5.0 kN) resisted by steel cables at the top of the piles in one direction. Cables to be attached to a concrete abutment at the top of the slope.
- Evaluation of lateral resistance done with LPILE software – Deflection of ±3/16” (4mm) when applying 1,125 lbs of lateral load.

HELICAL PILE DESIGN

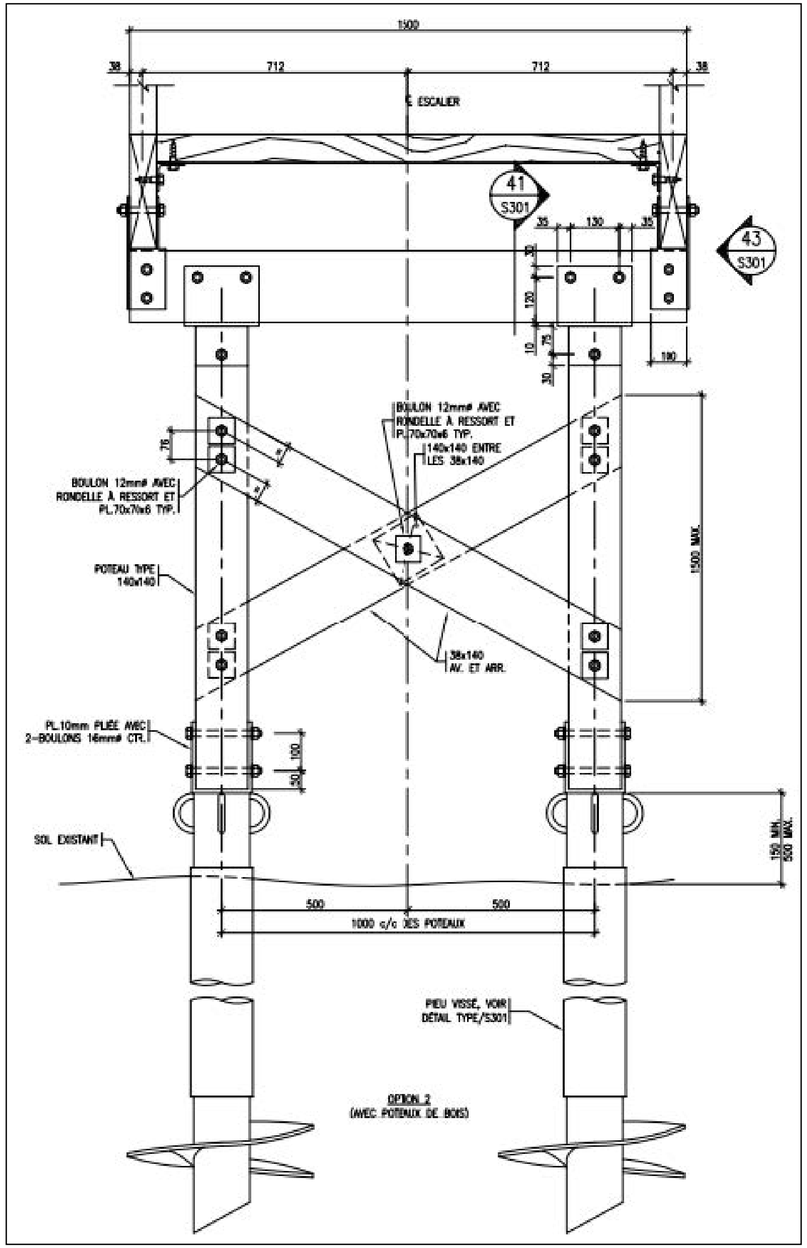
- Length = 5’-3” piles and extension.
- Couplings = Welded inside couplings on site.
- Helix size = 12”.
- Pile shaft diameter = 5.56 inch (141 mm).
- Pile shaft thickness = 0.25 inch (6.6 mm).

HELICAL PILE STANDARD

- Galvanization ASTM A123.
- ASTM A500 Grade C for pile shaft.
- CSA G40.21 300W (44 ksi) for helix and top plate.

STAIRS CROSS-SECTION

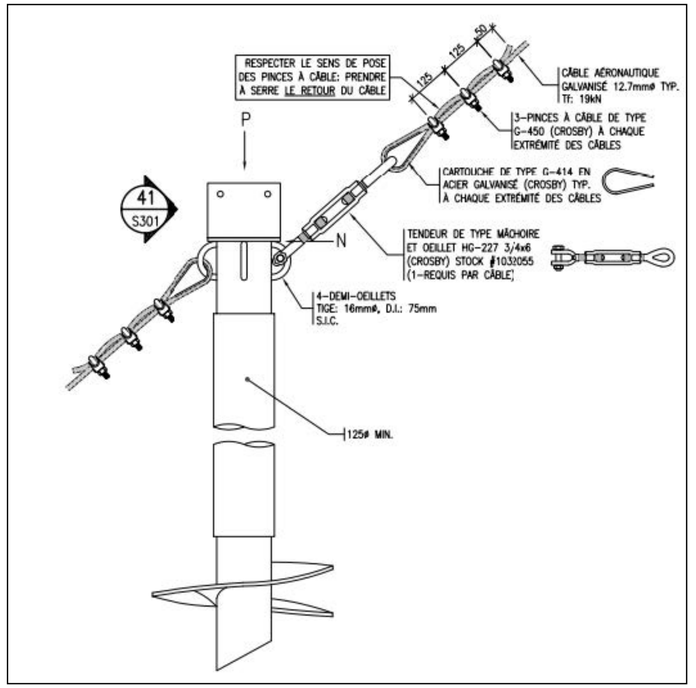
- Pile head is a minimum of 6” to a maximum of 20” above grade.
- U saddle top plates were connected to a 6” x 6” wood post using 2 bolts
- Maximum height of stairs above grade ±12’.
- Braced wood posts were placed to avoid lateral shaking.

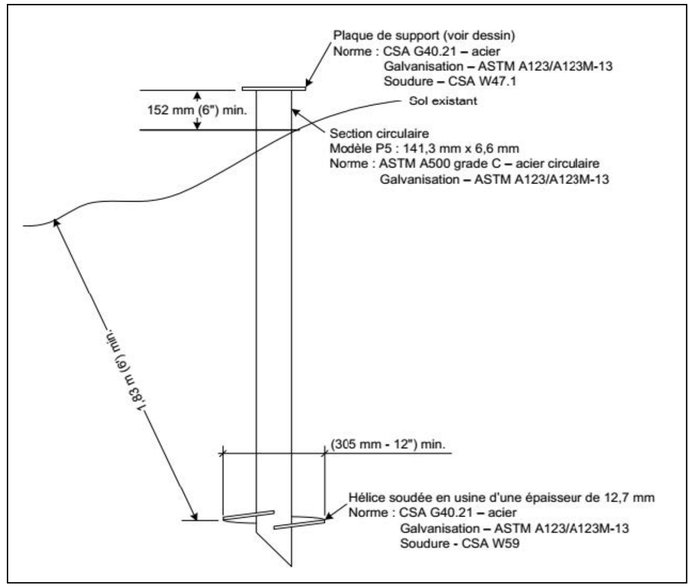


HELICAL PILES CROSS-SECTION

Challenge: Lateral pressure from the backfill could cause the pile heads to shift downslope over the years.

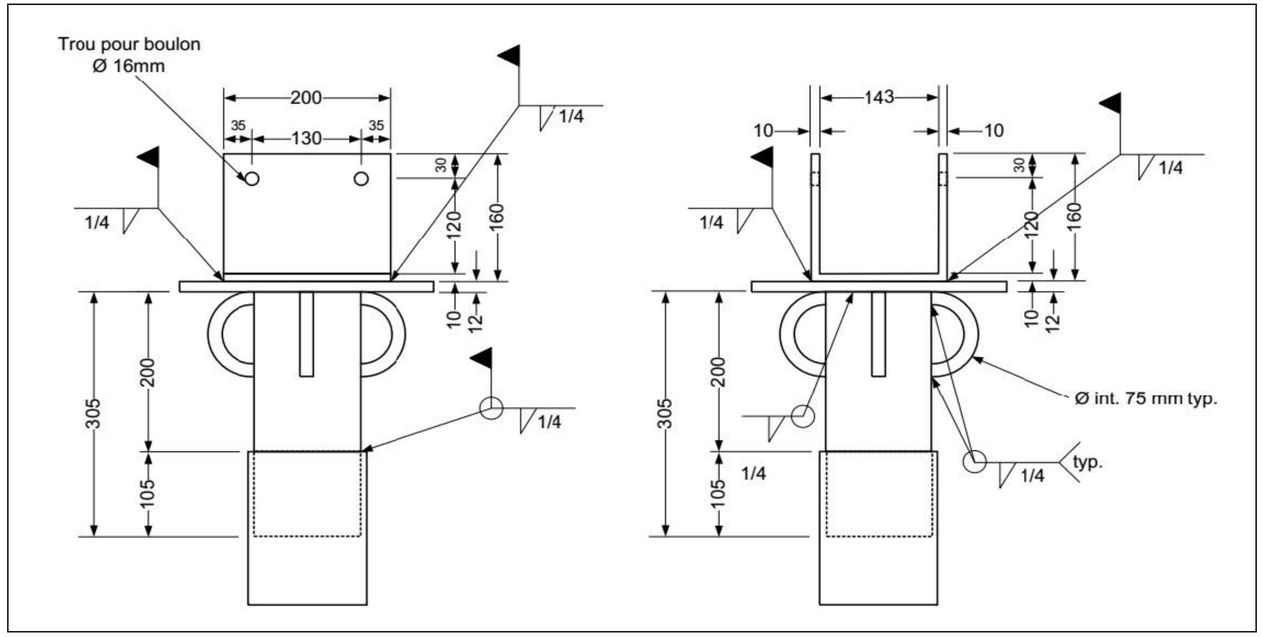
Solution: Steel cables were installed between the piles and anchored to the top of a concrete abutment, ensuring long-term stability.





ELEVATION PLAN

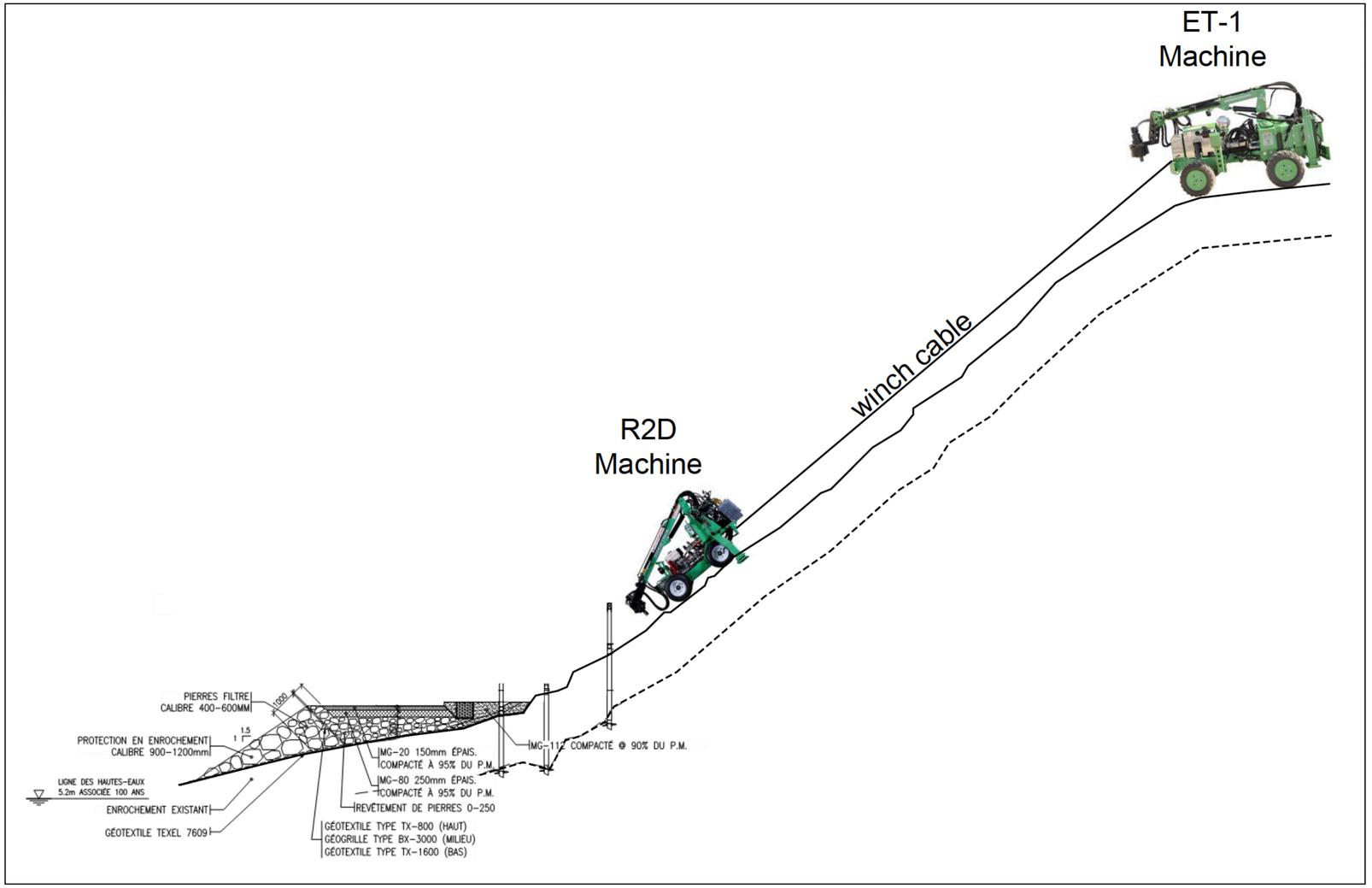
- Top plate is 12” x 12” x ½” with inside couplings and a half-eyelet welded in the shop.
- U saddle top plate is 8” x 6” x 3/8” and it is welded on site.
- Top plate arrangement allows for offset (± 2 inch) of helical piles.



HELICAL PILES & PLATES

CABLES FOR LATERAL SUPPORT

SLOPE CHALLENGE-INSTALLATION



INSTALLATION EQUIPMENT

We used two (2) of our standard equipment to carry out this project.

R2D

ET1

INSTALLATION EQUIPMENT

INSTALLATION EQUIPMENT

INSTALLATION EQUIPMENT

INSTALLATION OVERVIEW

- We used the ET1 machine to winch the R2D machine.
- Reach bearing capacity for the piles:
  - 8 to 12 feet deep
  - Average achieved torque = 3,300 lb-ft
  - Harnessed the installation crew
  - It took three (3) installers for the project. The one at the top of the slope used cables to lower the piles, extensions, heads, and supplies to the installer on the hill.

INSTALLATION OVERVIEW

- Installation took five (5) days.
- Surveyors were used to determine the center of the wood pile installed on the steel helical pile top plate.
- We had to install two (2) piles at a time, weld the extensions and complete the installation of these two piles before proceeding to the next step. Welded customized heads used for the placement of the wood piles.
- Installation equipment limitations encountered, which required specific techniques based on slope conditions and the boom length.

INSTALLATION PREPARATION AND LAYOUT

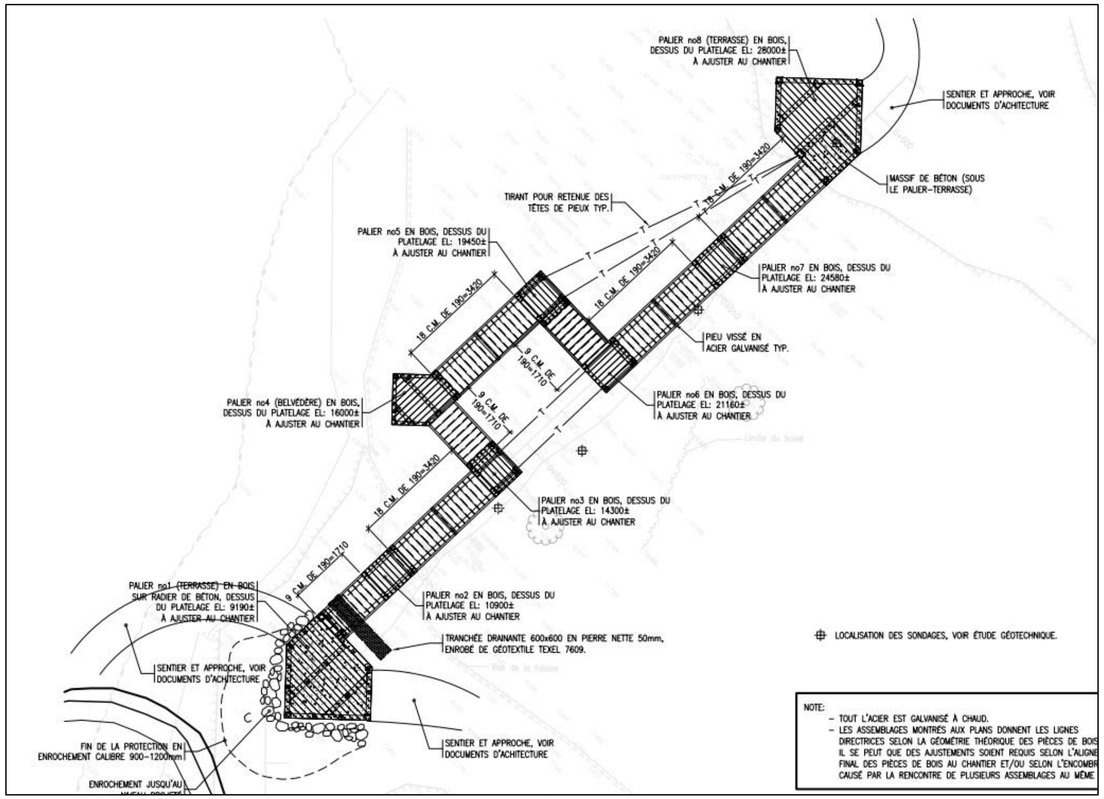
- Before the installation, a surveyor was hired to accurately lay out and mark the position of each pile.
- Once the flat pile head was installed, he returned to mark the exact center placement of the wooden columns.
- Then the U-shaped retaining plates were welded in place.

INSTALLATION SAFETY

The slope was so steep that each installer had to be harnessed at all time for safety.

ELEVATION PROCESS

- The R2D could not move laterally because of a winch restraint, causing the installation to be done in two stages: one for the main row of piles and the other for the second row.



CONSTRUCTION

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COMPLETED PROJECT

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