



HELICAL PILE INSTALLATION AT SENTIER DES GRÈVES

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STAIRS 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.

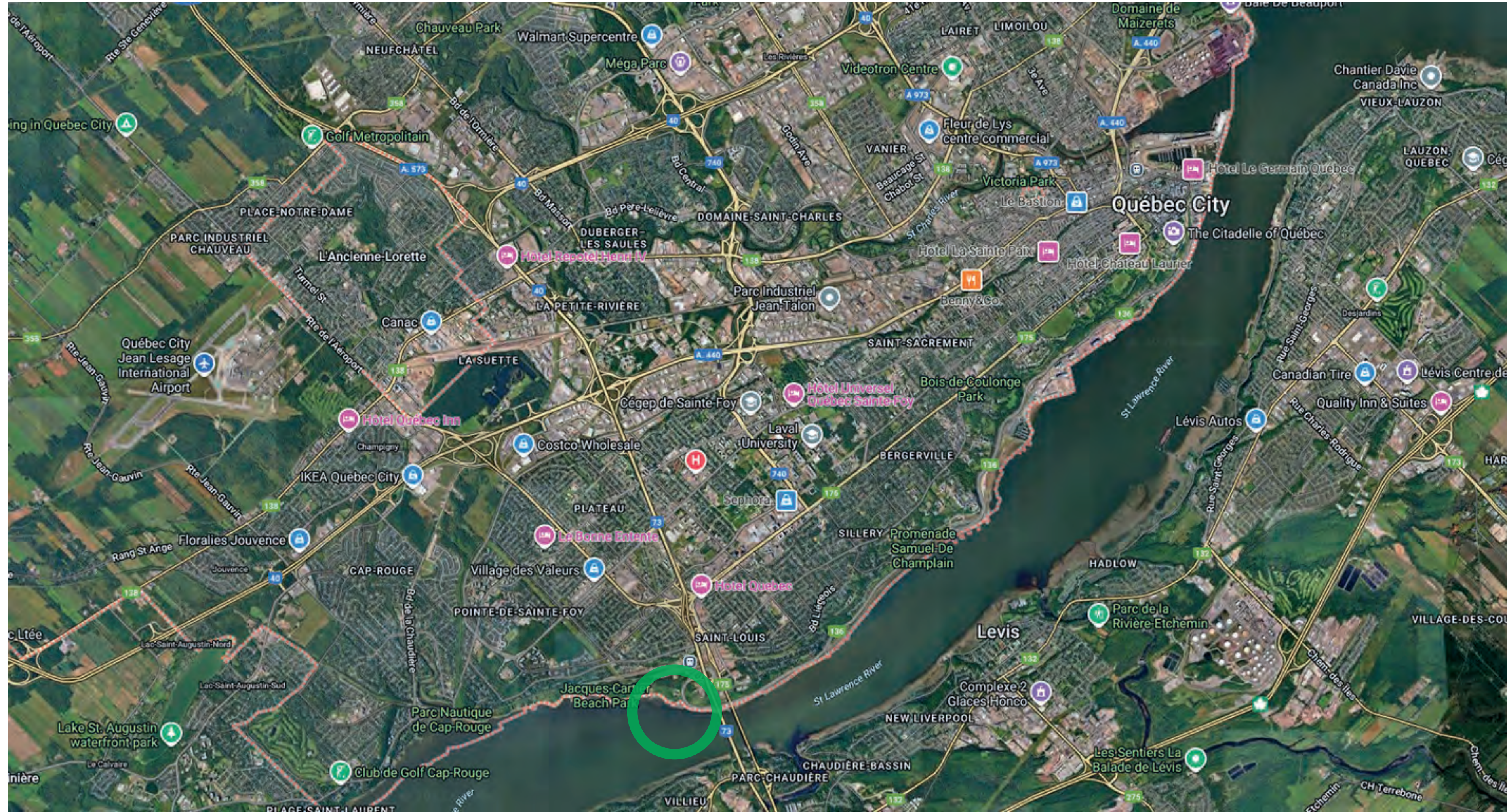


PRELIMINARY WORK

- One year before the project began, engineers working on it approached Techno Metal Post to see if this project would be feasible using helical piles.
- Other foundation techniques would have severe challenges due to installation conditions.
- It was determined that we could install the piles under these extreme conditions.
- Then plans and specifications were drawn up for this project to be completed using helical piles.



PROJECT LOCATION





PROJECT LOCATION





DESCRIPTION OF SLOPE

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





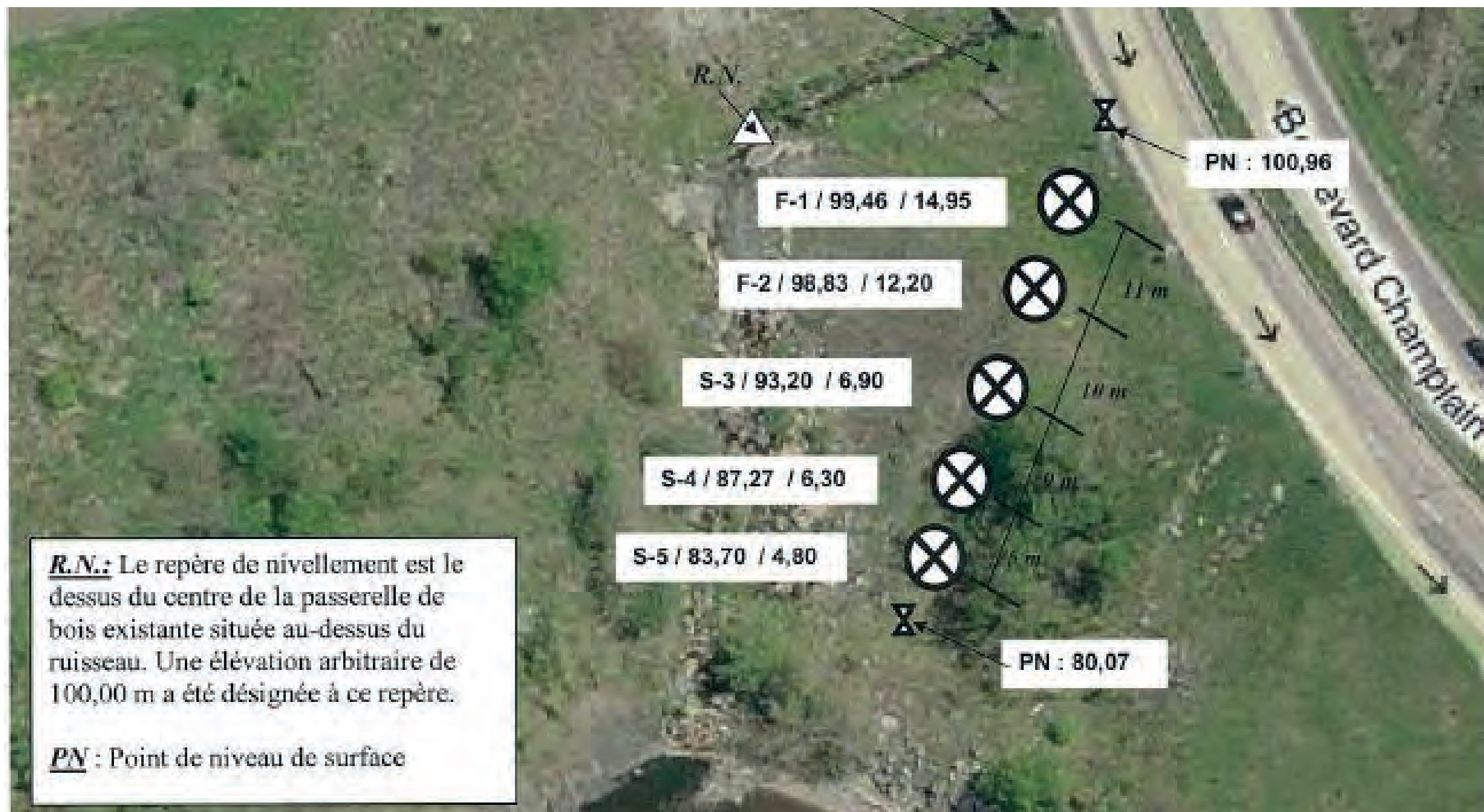
DESCRIPTION OF SOIL

Geotechnical report done by Qualitas (SNC-Lavalin)

- Two (2) boreholes done at top of slope.
- Fill layer ($\pm$ 7 feet) followed by Till layer.
- Three (3) Pionjar tests done into the slope.
- Refusal between 16 feet and 23 feet.



BOREHOLES LOCATIONS





BOREHOLES LOCATIONS

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

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

COUPE STRATIGRAPHIQUE					ÉCHANTILLONS				RÉSULTATS D'ESSAIS					
PROFONDEUR (mètres)	ELEVATION (mètres)	DESCRIPTION DES SOLS ET DU ROC	SYMBOLE	NIVEAU D'EAU	POSITION	TYPE	NUMÉRO	RECUPÉRATION (%)	ODEUR	R.Q.D. (%)	CAROTTIER FENDU		CHANTIER	LABORATOIRE
											COUPS PAR 10 cm	INDICE N		
0,10	99,46	Terre végétale					CF-1	85	A	—	2-2-5-14	7		
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					CF-2	55	A	—	9-14-8-11	22		
2,0							CF-3	35	A	—	6-5-8-19	13		
							CF-4	15	A	—	12-28-14-8	42		
3,0	96,46						CF-5	65	A	—	50-refus	—		
4,0		Till: Sable graveleux et silteux variant à gravier sableux avec un peu de silt; présence de cailloux et blocs; compacité moyenne					CF-6	15	A	—	20-15-11-15	26		
5,0							CF-7	30	A	—	10-17-refus	—		
6,0							CF-8	0	—	—	N / D	—		
7,0							CF-9	15	A	—	5-13-7-6	20		
8,0							CF-10	15	A	—	17-15-8-14	24		
9,0							CF-11	10	A	—	12-11-12-14	23		
							CF-12	50	A	—	14-12-14-refus	26		
							CF-13	46	A	—	23-17-10-8	27		
10,00														
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. FB				



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).

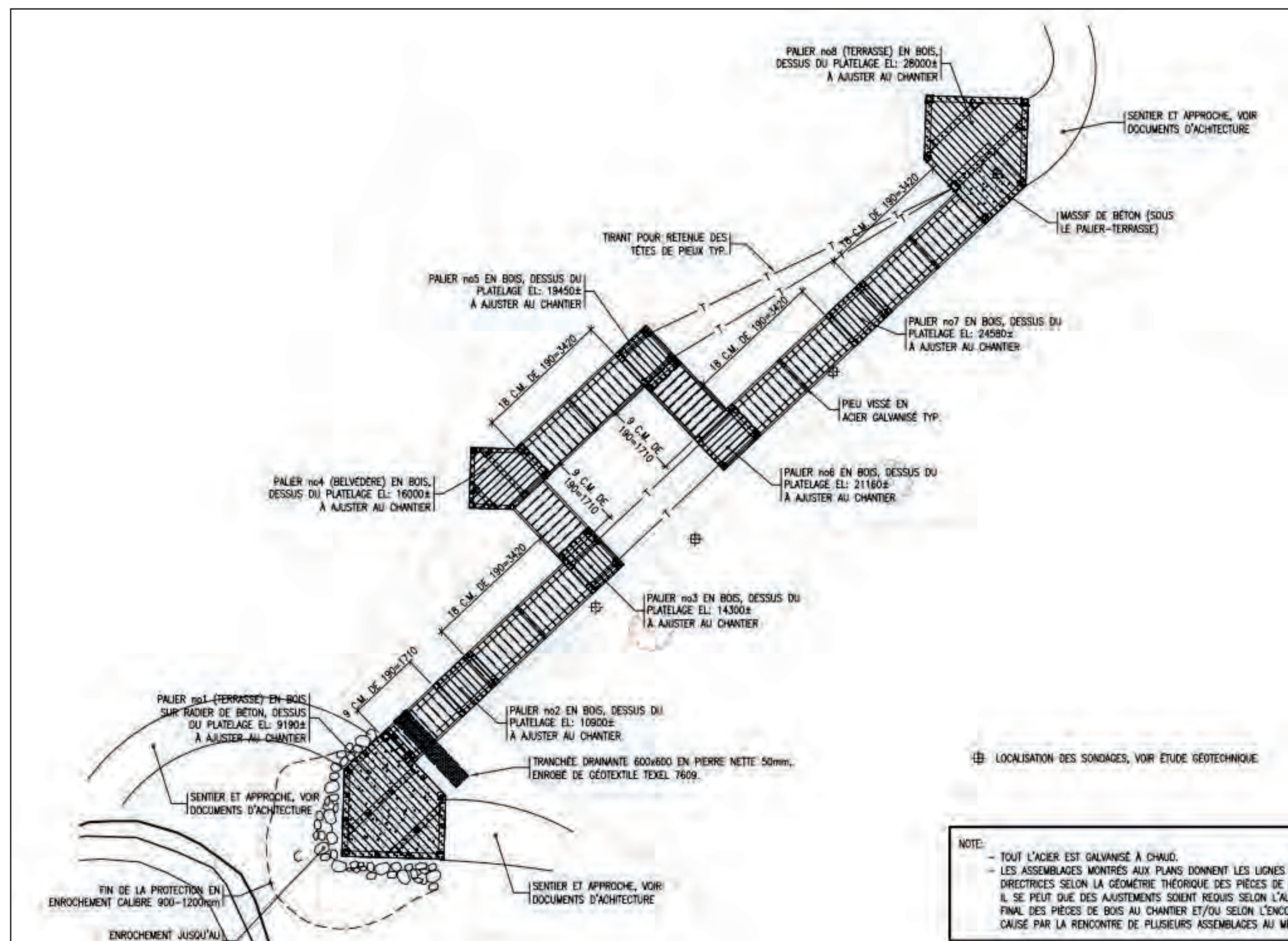


OPTIONS CHOSEN BY GEOTECHNICAL & STRUCTURAL ENGINEER

- 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).

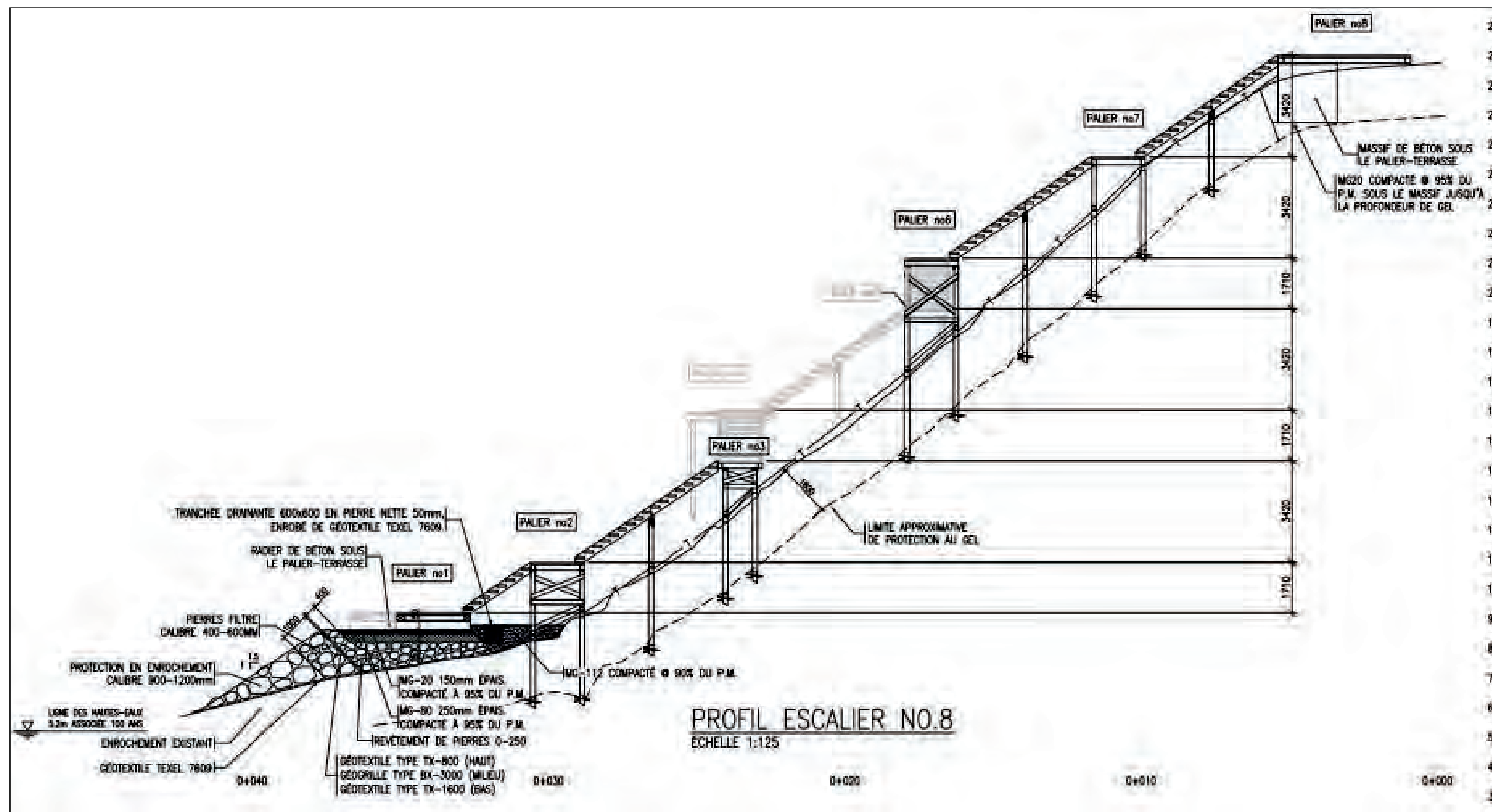


PLAN





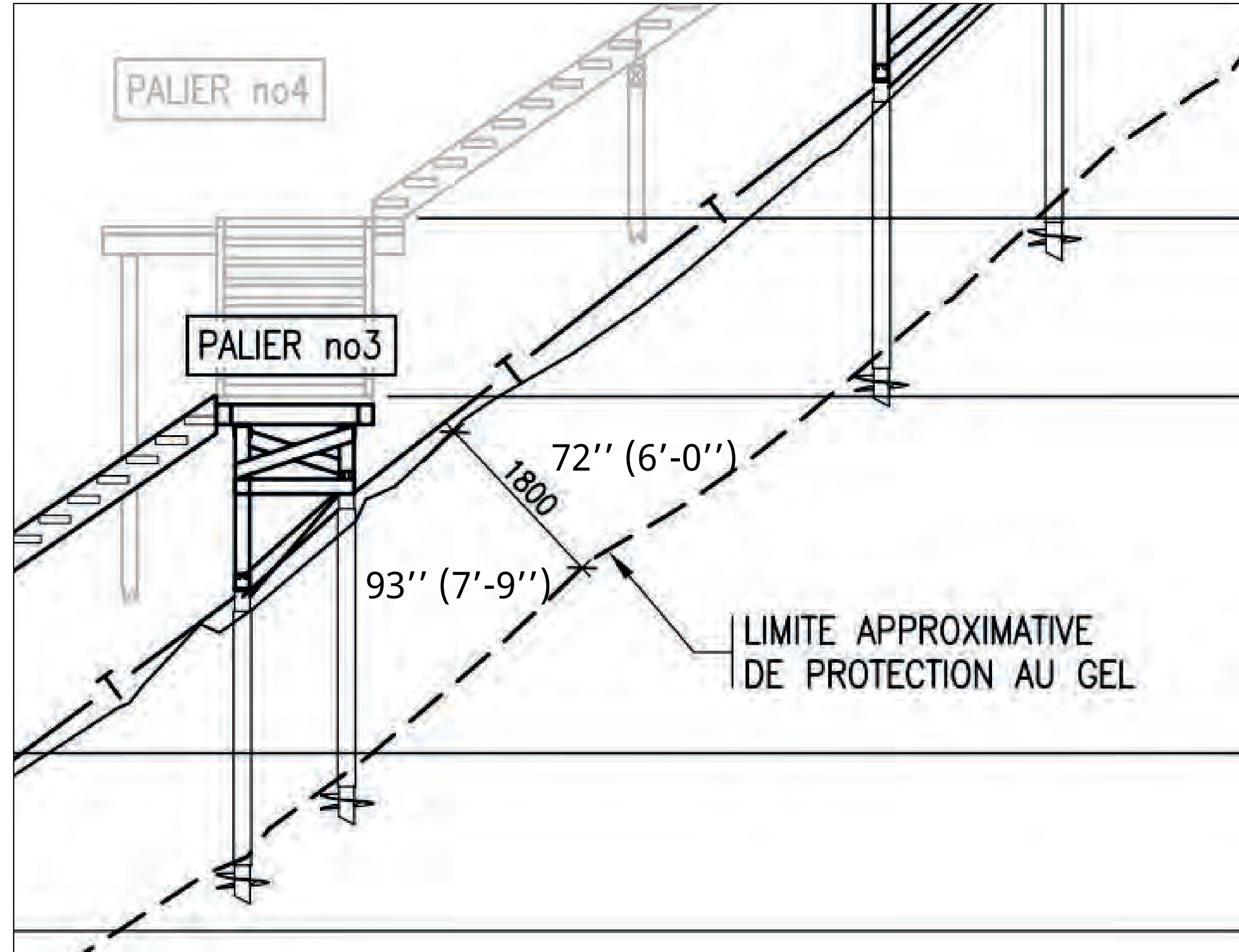
ELEVATION PLAN





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 $\pm 3/16''$ (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).



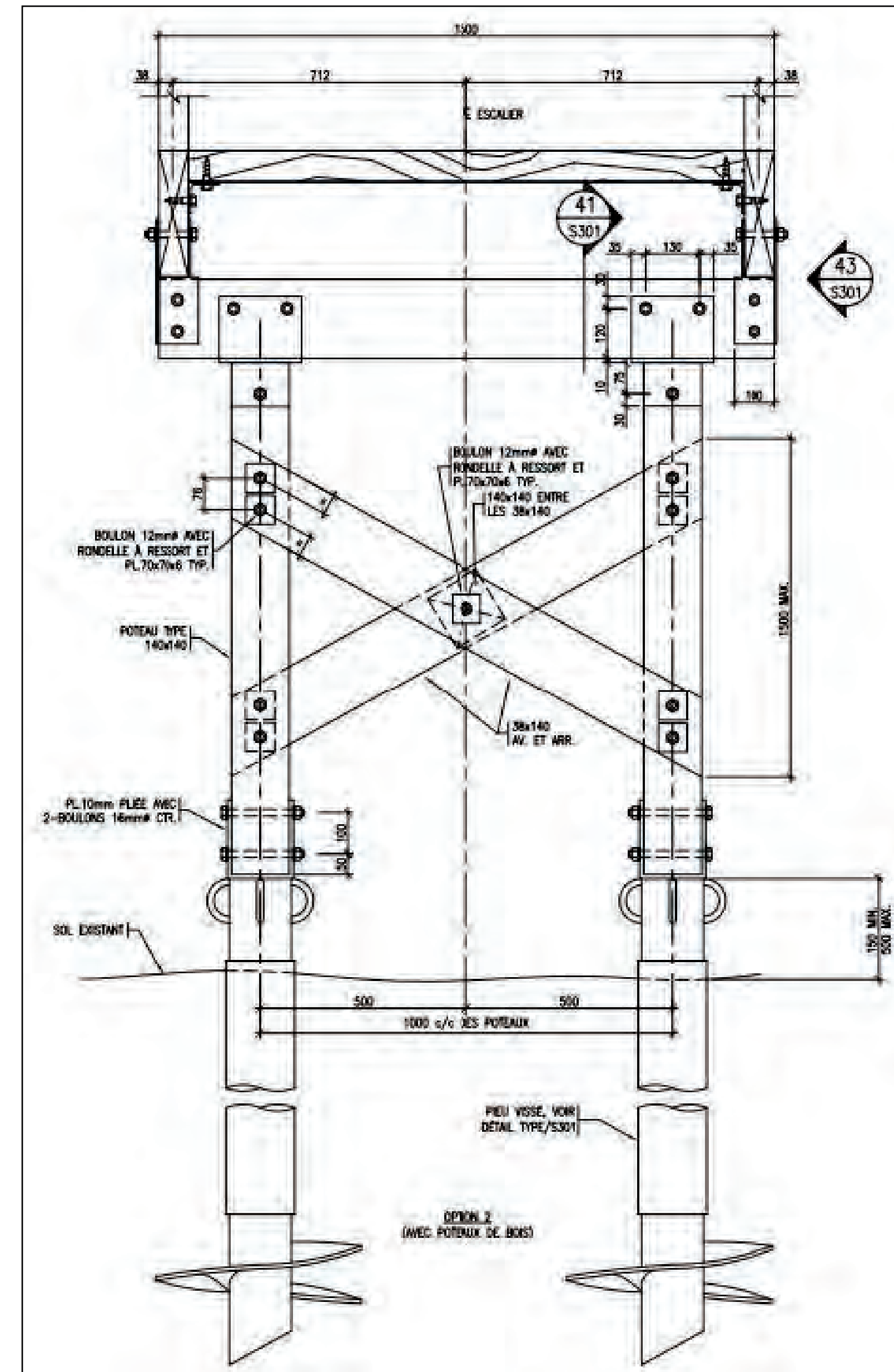
HELICAL PILE STANDARD

- 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 plate to connect to a 6'' x 6'' wood posts placed with 2 bolts.
- Maximum height of stairs above grade $\pm 12'$.
- Braced wood posts were placed to avoid lateral shaking.

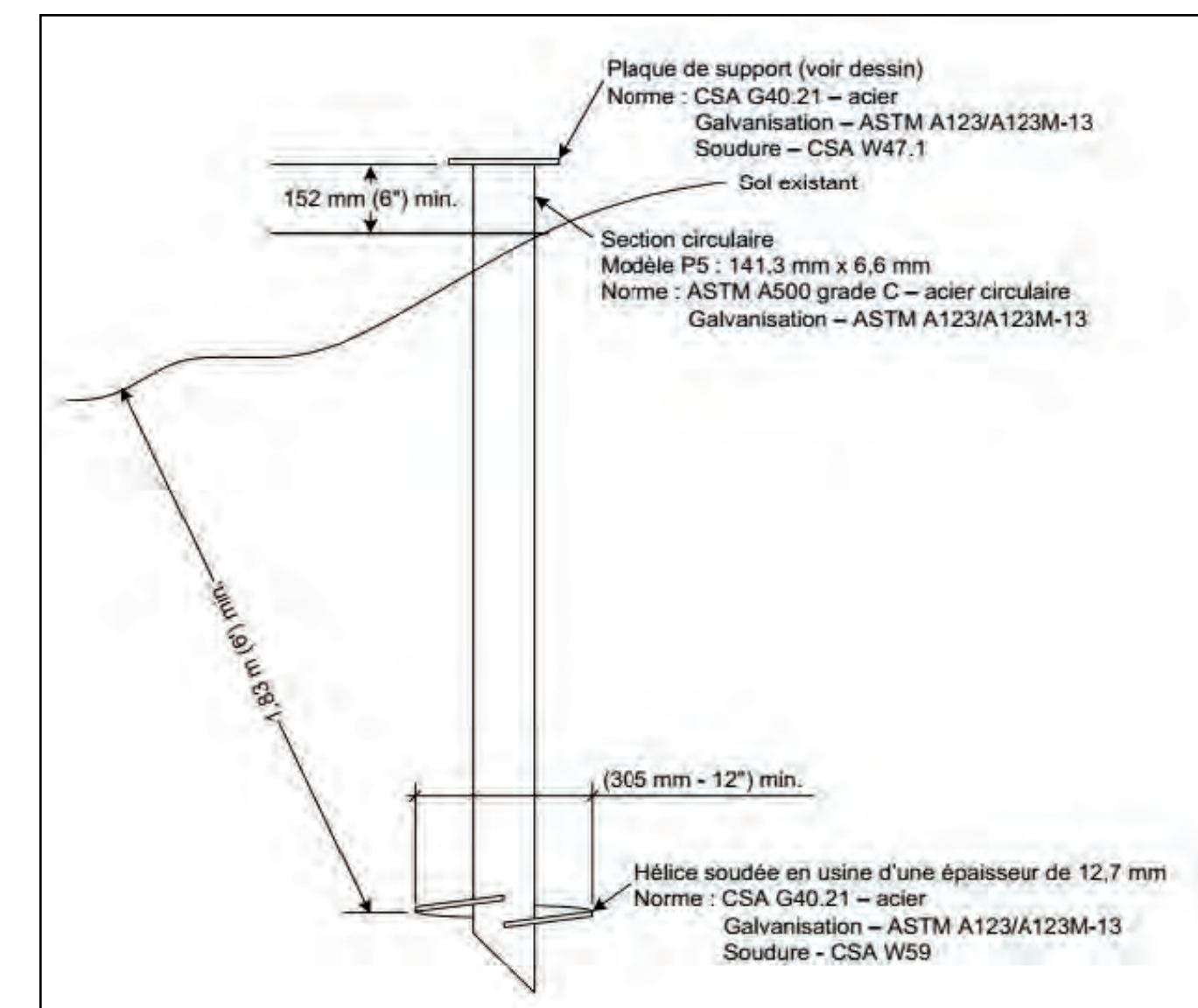
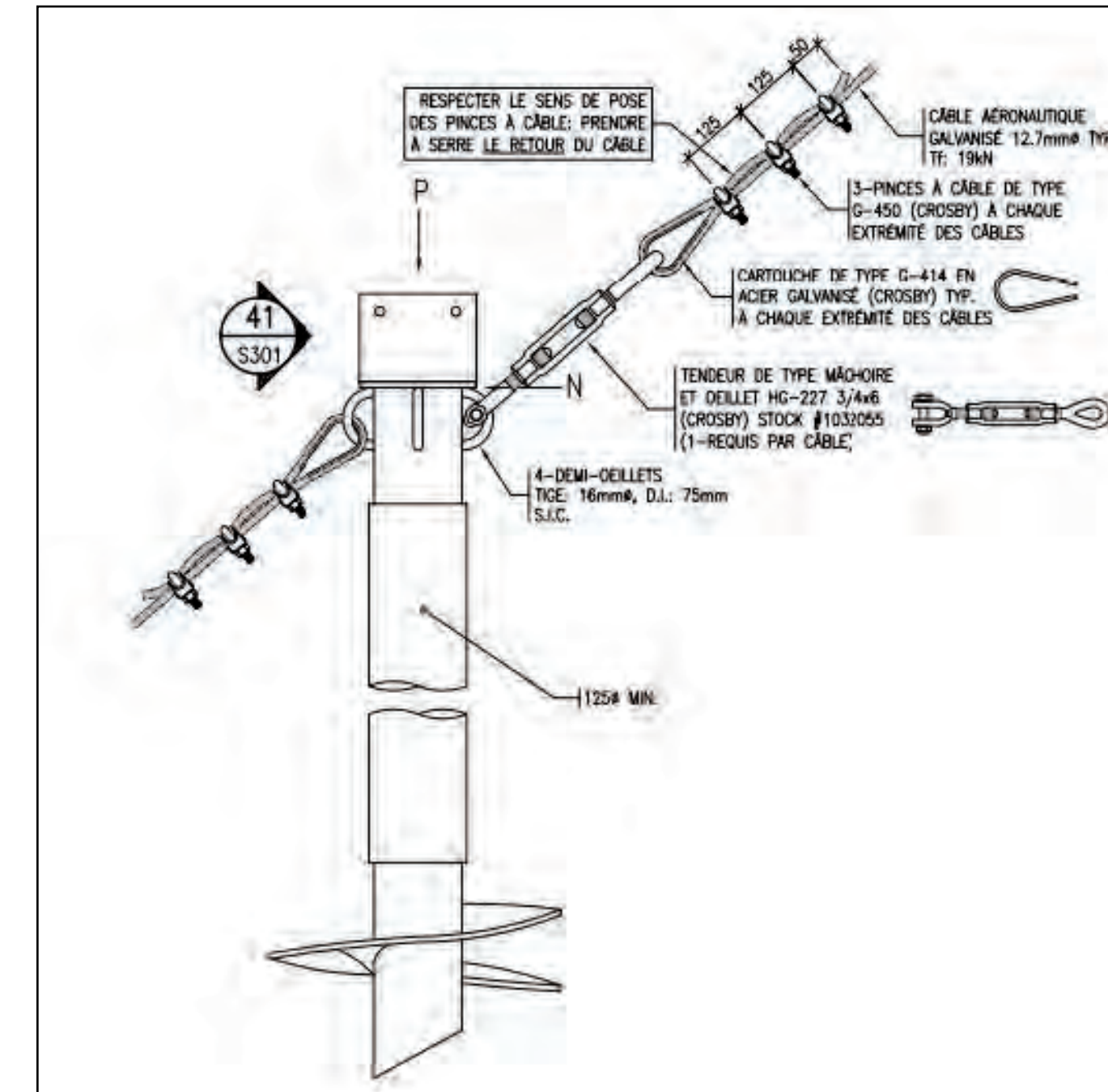




HELICAL PILES CROSS-SECTION

Concern: Lateral push of the backfill soil could push the pile heads towards the bottom of the slope over the years.

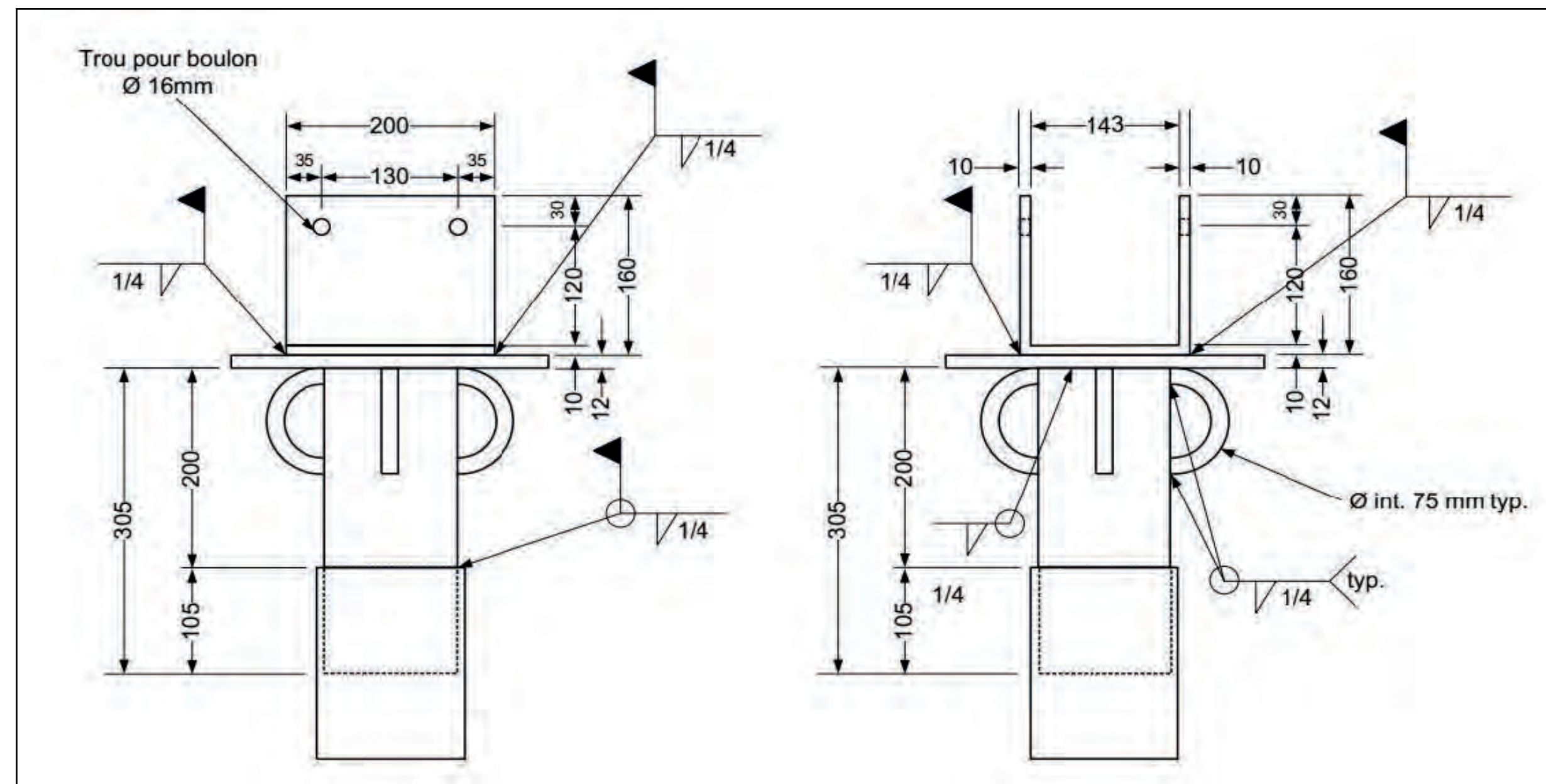
Solution: Installation of steel cables between each pile connecting them and then to the top of a concrete abutment. This ensured the lateral stability of the piles for the long term.





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

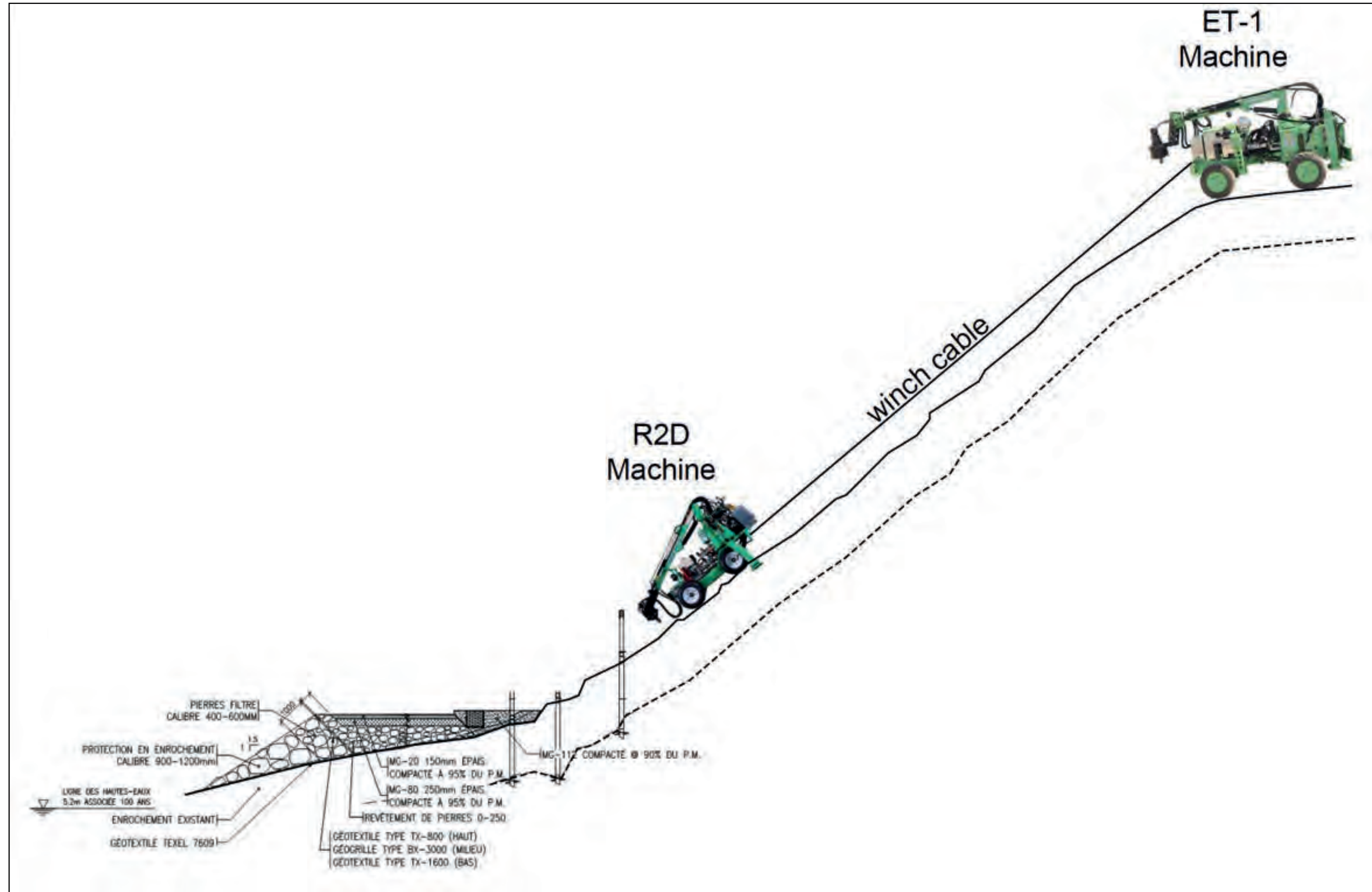




CABLES FOR LATERAL SUPPORT



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

- A surveyor was hired to layout and mark where each pile is to be placed.
- 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

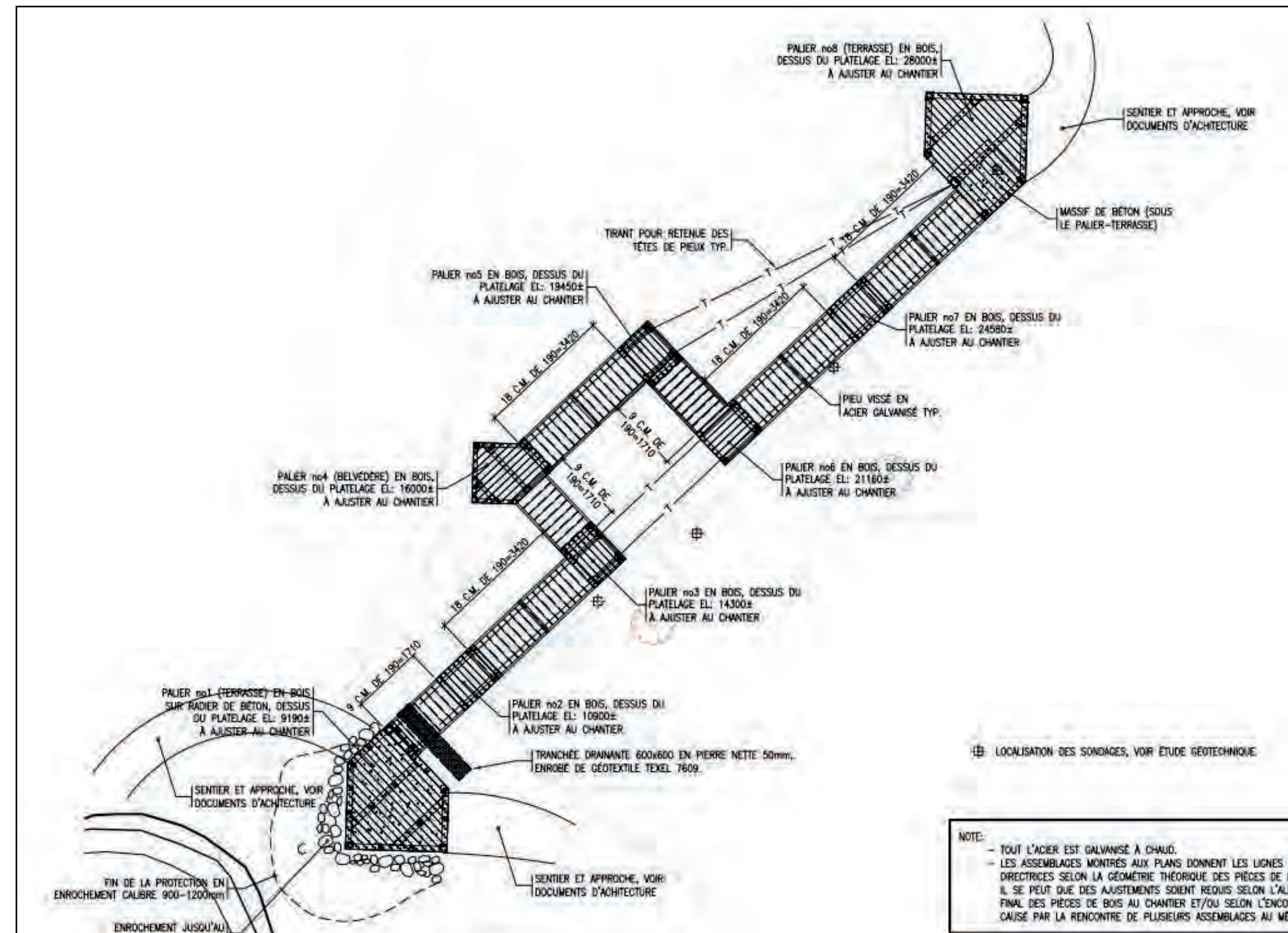
The slope was so steep that each installer had to be harnessed at all time for safety.





ELEVATION PROCESS

- The installation was done in two stages: one for the main row of piles and the other for the second row since the R2D could not move laterally because of the winch restraint.





CONSTRUCTION





CONSTRUCTION





CONSTRUCTION





COMPLETED PROJECT





COMPLETED PROJECT





COMPLETED PROJECT

