Bonatti

DRY GULCH HDD CROSSING
A Challenging Pullback Operation

OUR ID:
FIGURES

13 local companies

more than **75** years of experience

97% average local workforce

8,500 employees

19,000,000 hours worked in 2023

855,000,000 euro: revenues 2023

OUR ID:
WHAT WE DO

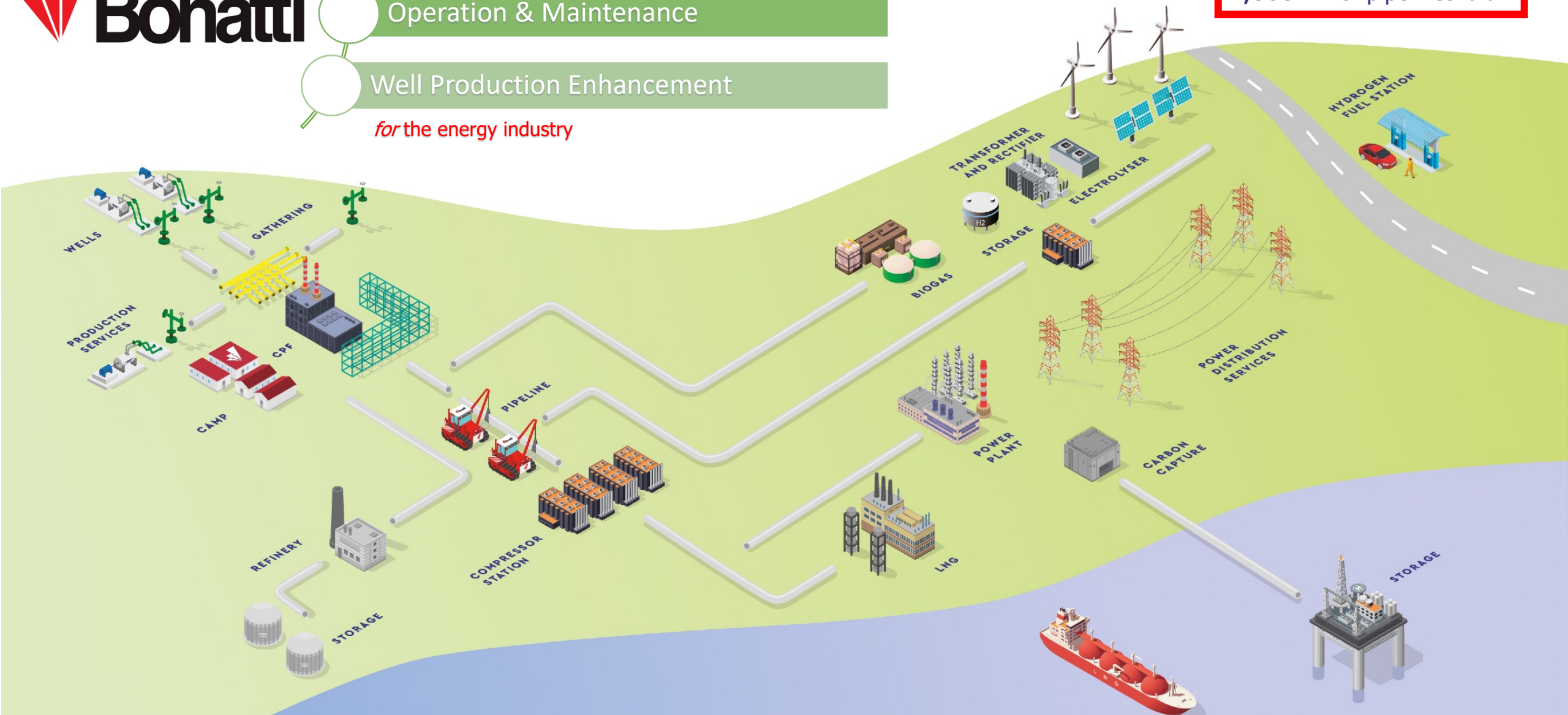
Bonatti

- EPC & construction of plants and pipelines
- Operation & Maintenance
- Well Production Enhancement

for the energy industry

OUR REFERENCES

in the last 5 years:
25 EPC projects executed
30 compressors installed
4,000 km of pipelines laid



OUR ID:
HOW WE WORK

Our Project's **total approach** is the key-factor in our clients' satisfaction.

Our model consists in managing the entire project lifecycle in **direct execution throughout all phases**:

- Engineering
- Procurement
- Logistics
- Civil construction
- Mechanic
- Piping Prefab. & Erection
- E&I installations
- Commissioning
- Start-up

OUR ID:
OUR ENGINEERING CAPACITY

3 engineering centres:
Fano, Italy
Milano, Italy
San Miguel de Allende, Mexico

Engineering capacity of about 700,000 hours/year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CANADA - TRANS MOUNTAIN EXPANSION PROJECT (SPREAD 5B)

Oil pipeline construction and pre-commissioning for TRANS MOUNTAIN PIPELINE L.P.

Introduction

The TMEP Pipeline Project – Spread 5B interests a challenging area of British Columbia (Canada), characterized by extreme geomorphological conditions proper of the mountainous regions. In particular the pipeline route intersects a Dry Gulch channel, which consist in a deep canyon originated as a glacial meltwater channel.

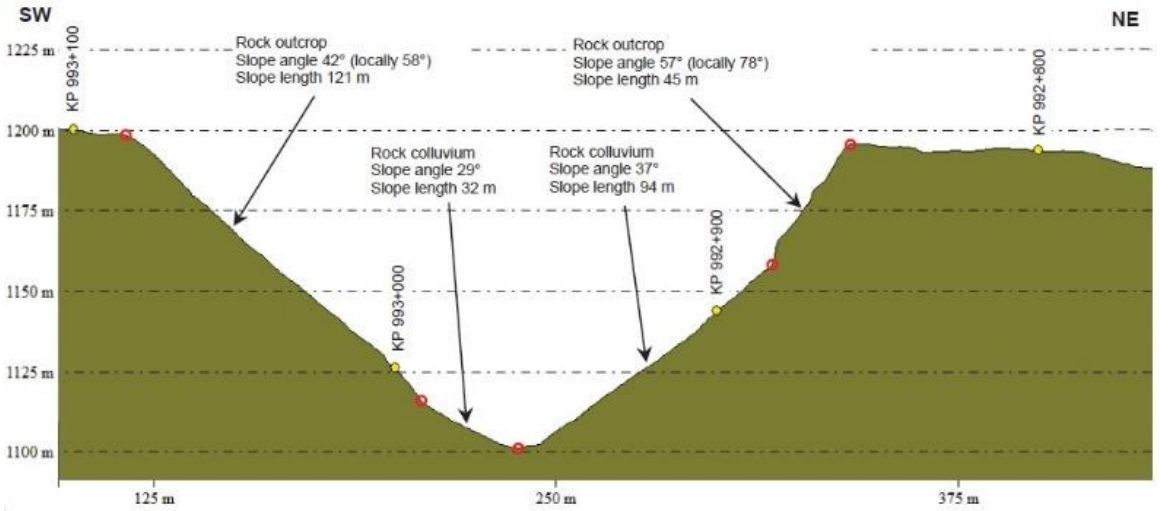
Project Background

The existing NPS 24 crude oil Trans Mountain Pipeline (TMPL) system, built in the early 50's, is approximately 1,176 km long commencing at a storage terminal in Edmonton, AB and ending at the Westridge Marine Terminal in Burnaby, BC.

Owner is currently developing the Trans Mountain Expansion Project (TMEP), looping of the existing TMPL system. Spread 5B of the TMEP Project covers the construction of approximately 89 Km (KP 987+100 to KP 1,076+000) of 914 mm (NPS 36) OD pipeline.
Bonatti (in joint venture with Kiewit Corporation) scope of work covers pipeline construction activities for the pipeline segment from KP 987+100 to KP 1,038+100.

Dry Gulch Geomorphological, Geological and Geotechnical setting

Dry Gulch is a steep V-shaped canyon
The span between the top of the northeast wall and the top of southwest wall is about 225 m.



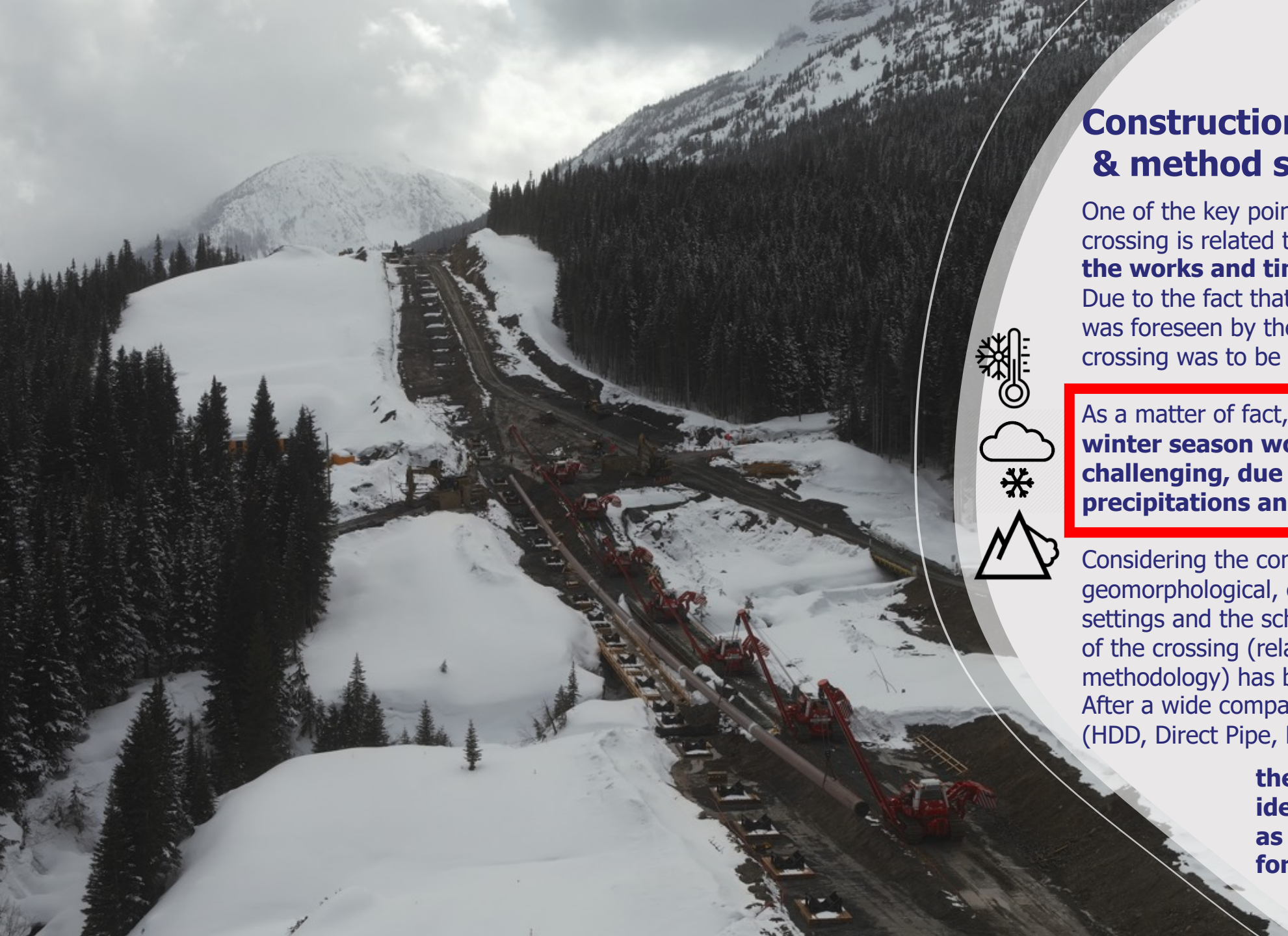
The Gulch is frequently interested by snow-avalanches, which makes the bottom not accessible for most of the year.

From a geological and geotechnical point of view, Dry Gulch represents a unique system due to the contact between two stratigraphic units which determine brittle faulting and fracturing of the rock mass.

Another key aspect is the thickness of accumulated talus, and depth to groundwater table, at the bottom of the gulch which are unknown. There is unconfirmed moderate (uMod) ML/ARD potential associated with the stratigraphic unit to the southwest of Dry Gulch.

Finally, depending on the chosen crossing method, management of rockfall hazard and snow avalanches prior to and during construction could require extensive temporary and/or permanent retention measures.

Figure 1: Dry-Gulch view



Construction schedule restriction & method selection

One of the key point for the construction of the crossing is related to **schedule for completion of the works and time window available.**
Due to the fact that the completion of the project was foreseen by the end of 2023, the Dry Gulch crossing was to be completed by summer of 2023.

As a matter of fact, in **this specific area during winter season work condition are very challenging, due to low temperatures, snow precipitations and high avalanche risk.**

Considering the complex framework of the geomorphological, geological and geotechnical settings and the schedule restrictions the feasibility of the crossing (related to the construction methodology) has been carefully assessed.
After a wide comparison of various technologies (HDD, Direct Pipe, Microtunnel, Raise boring)

the Project Management identified the HDD methodology as the most sustainable option for the crossing execution.

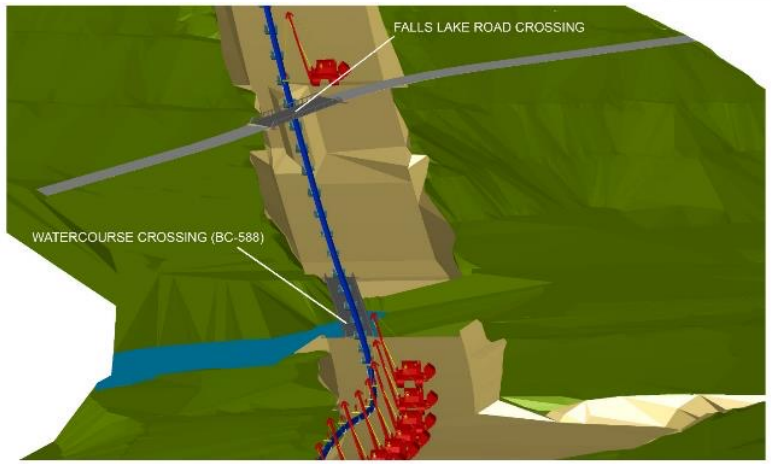
HDD preparation works design

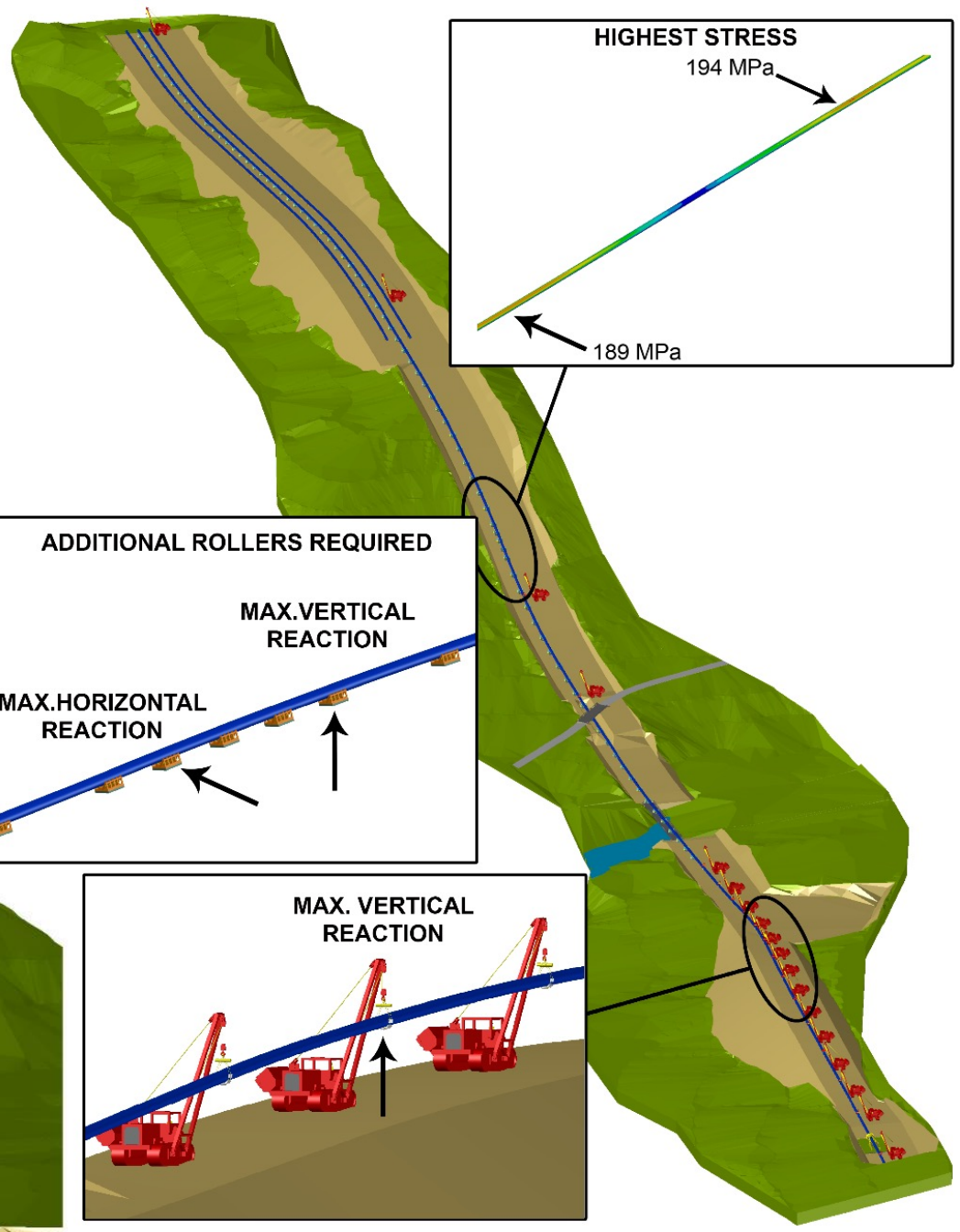
The selected perforation profile has a **total length of 1,842 m, with an horizontal distance of 1,794.4 m**.
The feasibility of the HDD has been confirmed in August 2021, when a 1,622 m exploration borehole has been successfully drilled along the actual pilot hole alignment from the South pad to about 200 m from the North Pad exit point.
The exploration borehole confirmed a low risk of frack out and bore collapse phenomena through the rock layers, increasing to moderate in the surficial layers

Particular relevance for this strategy assumes the design of the drag section and the fabrication of the pipeline string, as **the area surrounding the Dry Gulch is featured by uneven terrain, steep slopes, several creeks and by a winding ROW, due to environmental constraints**.

The final selected option was pulling three off pipeline strings (the longest of about 1,100 m) from the Southern side, mostly driven by the limitation of earth works and environmental impact and supported by the low risk of bore collapsing, as requiring 2 tie-in welds during the pullback.

The selected pullback ROW is challenging, as it is featured by hilly and rocky terrain with horizontal and vertical deviations, a 17° slope 220 m long, the crossing of two watercourses and one road.





HDD preparation works design

For this purpose, a complex study for the string preparation has been performed, including an integrated 3D Model/FEM Analysis.

A FEM analysis has been conducted to analyse both the static and cinematic behaviour of the pipe string during the pullback phase. In particular, FEM simulation produced the following results:

- Verification that the maximum stress applicable to the string during lifting and pulling operations;
- Definition of the distribution of the equipment and of the vertical and lateral loads required;
- Definition of the optimal distribution of roller supports and of the vertical and lateral loads required for designing their foundations, under pullback and hydrotest conditions;
- Identification of the optimum positioning of the station for the tie-in of two strings;
- Calculation of any possible longitudinal or vertical uplift displacement, possibly requiring additional restraints or anchors.

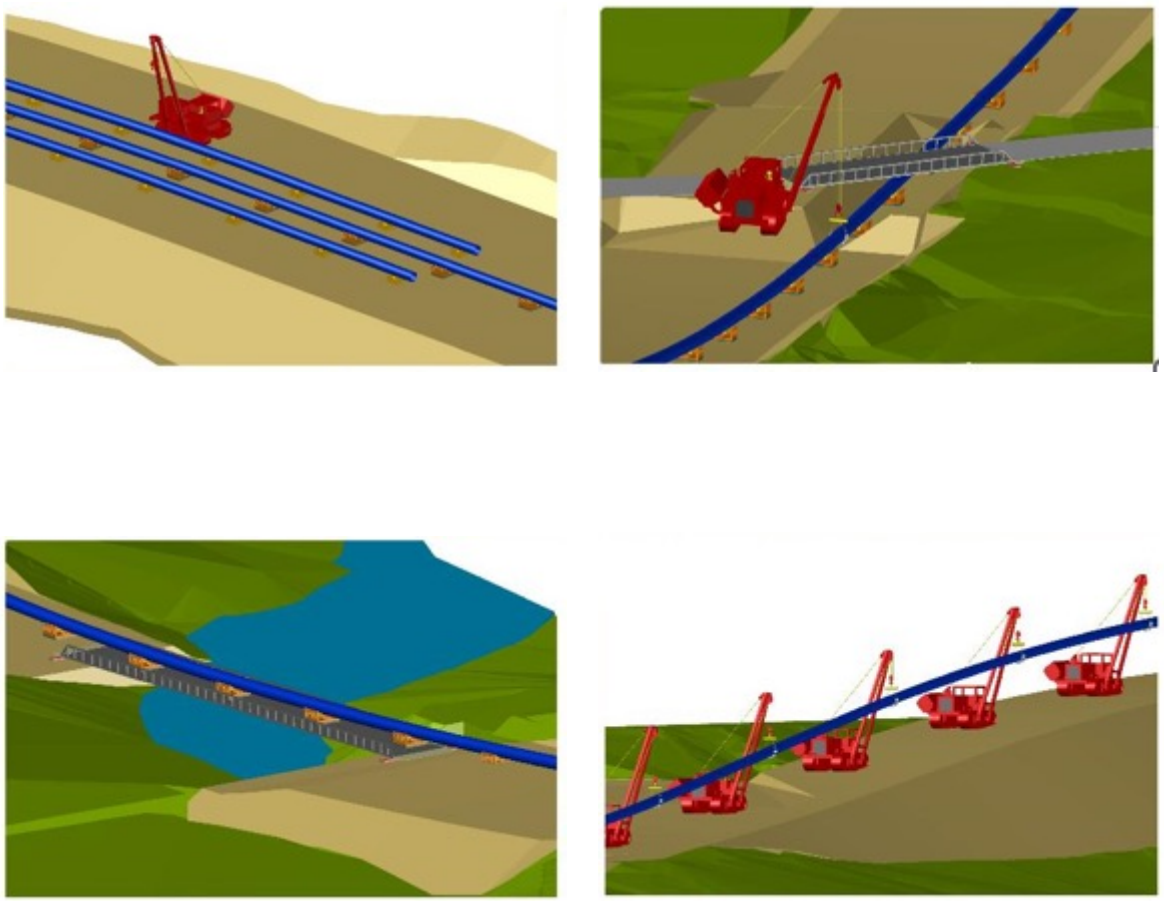


Figure 2. 3D Model for pipeline string preparation works

Pipeline strings and rollers way preparation

Given the project timeline, Bonatti/Kiewit developed a suitable schedule, able to accommodate the required deadlines, using different teams working in parallel.

For what concern the works proper of the HDD execution, the pilot hole confirmed the findings of the exploration borehole at previous stage and the low risk of bore collapse along the majority of the HDD alignment. Subsequently, the reaming phase started late October 2022 and progressed across the winter.

In parallel, works for the preparation of prefabricated string and his associated working ROW have been carried out. Later, the section between Falls lake Rd and Drilling Pad required significant earthworks to built the 10 m high launching pad for the overbreak section. **The preparation of the pullback ROW required about 91,000 cm of earth works overall and 16,000 cm of imported material from adjacent areas.**

By Fall 2022 the preparation of foundations and installation of Bridges on Falls Lake Rd. and Falls Lake Creek were completed and further grading of the drag section was completed in late 2022.

Afterwards, stringing and welding of the first two strings (2 of 378 m) were completed by the end of January 2023, while fabrication of the main string (1100 m) was completed within March 2023.

Figure 3: Preparation of Launching Platform and drilling Pad

Preliminary hydrotest of the strings was planned for April 2023 – 1 month before the actual pullback – allowing the completion supports installation and equipment mobilisation.
After the completion of pre-hydrotest and the reaming phase, pullback started at the end of May and was completed at the beginning of June 2023, allowing for final tie-ins by the Month of July in accordance with the targeted schedule.

Pullback execution

The final pullback preparation activities started in September 2023, with the mobilization on site of 8 cranes and 17 sidebooms required for pipeline strings management during pullback and the installation of the HDPE buoyancy control pipe inside the 36” pipeline strings.

The pullback eventually started the 18th of October and was smoothly and safely completed in 52 hours, 30 of which required for the 2 tie-ins and with an average pulling rate ranging from 80m/hours to 120m/hour, beyond the best estimate scenario.

Figure 5: Pullback – Pullback execution

Figure 6: Pullback – Falls Lake Road crossing & overbreak section detail

The maximum pulling force resulted within the expected range and also the continuous monitoring of the vertical and lateral loads on the cranes and sidebooms confirmed the loads being consistently within the calculated acceptable limits.


FALLS LAKE
BRITISH COLUMBIA
50 KILOMETRES NORTHEAST OF HOPE, BC

Bonatti

#peoplemade