TRENCHLESS CROSSINGS

SURERUS MURPHY
A JOINT VENTURE COMPANY

Surerus Murphy understands that trenchless crossings are an important part of pipeline construction. Surerus Murphy uses tried and tested technology as well as innovative techniques to support assured delivery on projects.

During pipeline construction, a route will cross multiple features that either cannot be disturbed, or whereby the impact of the project would be reduced by alternative construction methods. When these obstacles are encountered, trenchless crossings are often the preferred solution.

During the Early Contractor Involvement (ECI) phase, we provide construction advice on how to utilize trenchless technology to support project delivery.

We work with clients early in the construction process to provide input on how to construct around situations that we can't move or control – such as utility corridors or existing roadways, and more. In many cases, a trenchless crossing solution is best.

MAJOR & MINOR CROSSINGS' EXPERTISE:

Minor trenchless crossings, which are usually up to 200m in length and in favorable ground conditions, are constructed using auger boring (tracked, guided or cradle), hammer boring or by Horizontal Directional Boring (HDB) techniques.

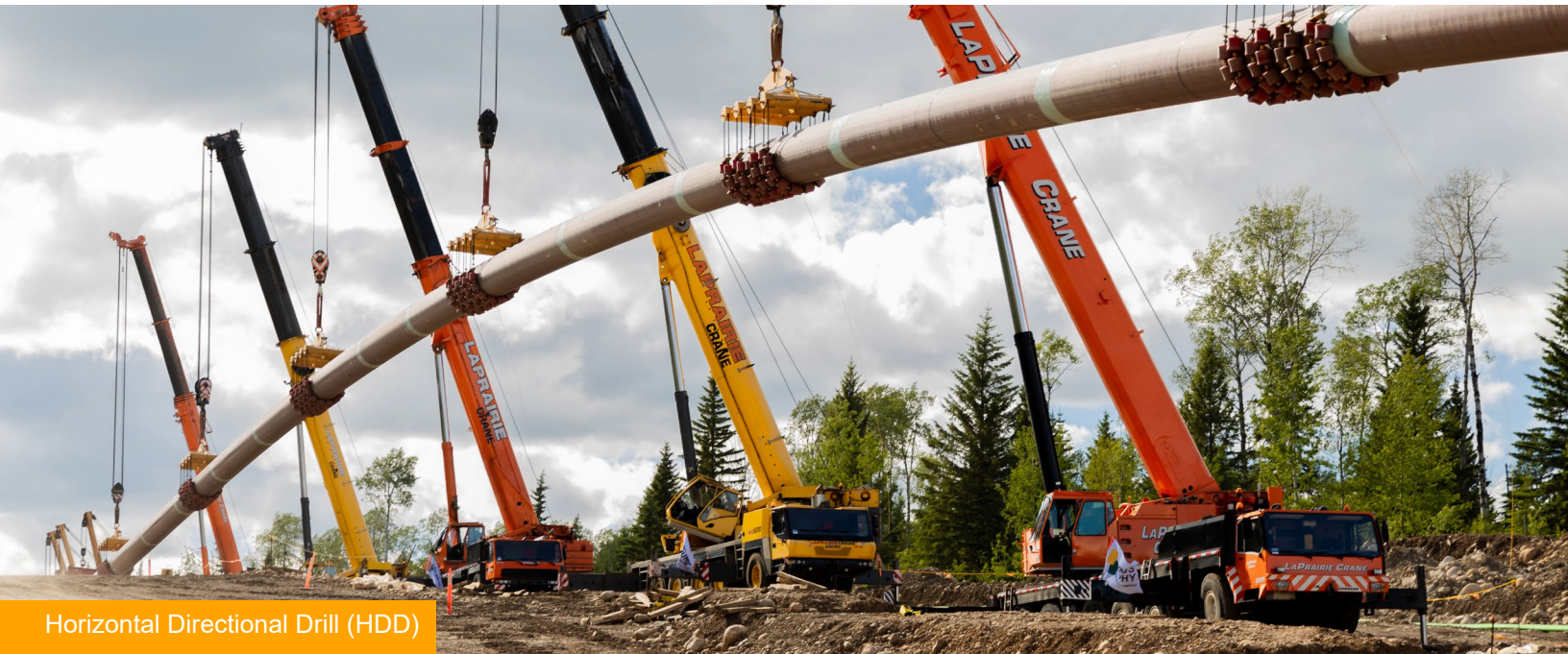
Major crossings, such as Horizontal Directional Drilling (HDD), Direct Pipe Installation (DPI), Down the Hole Hammer (DTH) and tunnelling and/or micro tunnelling require significant geotechnical investigation and design to be completed prior to construction.

Surerus Murphy has in-house engineering and construction expertise to support the information gathering methods (e.g., geotechnical & topographical) crossing design development and production of execution plans required to successfully deliver these crossings.

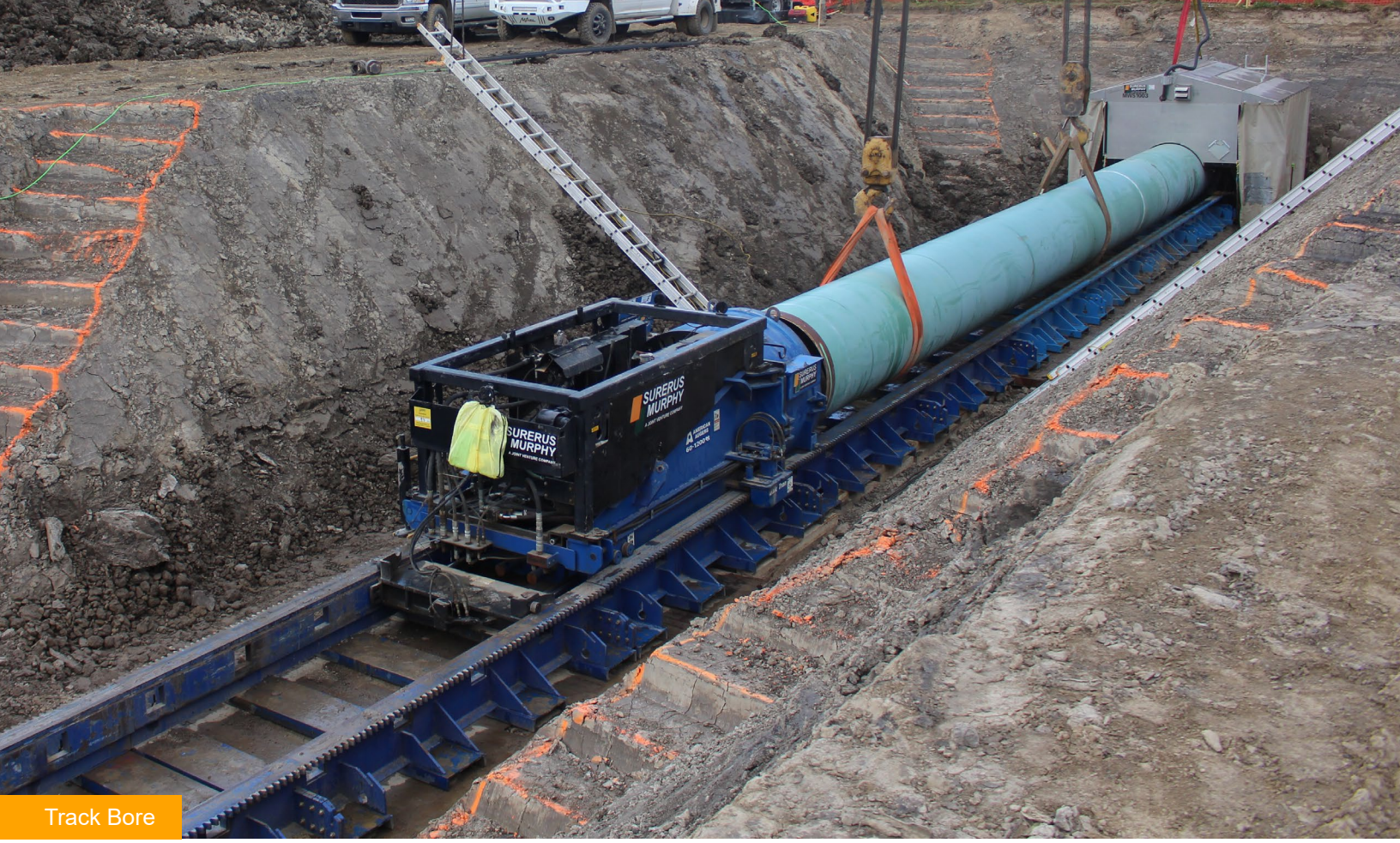
Our experience with tools, technologies and our ability to understand data to make construction decisions, helps our clients pick the best pipeline route and construction method for their project:

We have experience working with geotechnical investigation consultants to support conventional ground investigation programs as well as non-intrusive geotechnical techniques, such as Electrical Resistivity Tomography (ERT), Ground Penetrating Radar (GPR) and seismic and acoustic methods. The information we gather from these techniques informs if and what type of trenchless crossing we might recommend.

All this information informs the final design and selection of trenchless crossing technology used. Ultimately, our goal is to provide our client with a construction solution that minimizes risk through design and optimizes efficiency while respecting the constraints of a situation.



Horizontal Directional Drill (HDD)



Track Bore

MINOR TRENCHLESS CROSSINGS

Conventional Boring, or Auger Boring

Surerus Murphy's knowledge of auger boring technology and its limitations due to ground conditions, pipe diameter, alignment and length allows us to optimize crossing design, equipment selection and schedule while minimizing the risk of failure.

"Auger Bore" is a catch-all term for a bored crossing where a length of sacrificial pipe, generally the same or slightly larger diameter as the product pipe is pushed into the ground from one excavation or bore pit to another. Soil is removed from within the pipe using an auger that is rotated by an Auger Bore Machine (ABM). Once the sacrificial pipe has been installed through the crossing and has been cleaned out of all soil, the product pipe is pushed or pulled through the crossing, replacing the sacrificial pipe.

While all ABMs use a bore machine in one form or another, how the hole is created from one side of the crossing to the other and subsequently how the pipe is inserted into the ground depends on the type of bore.

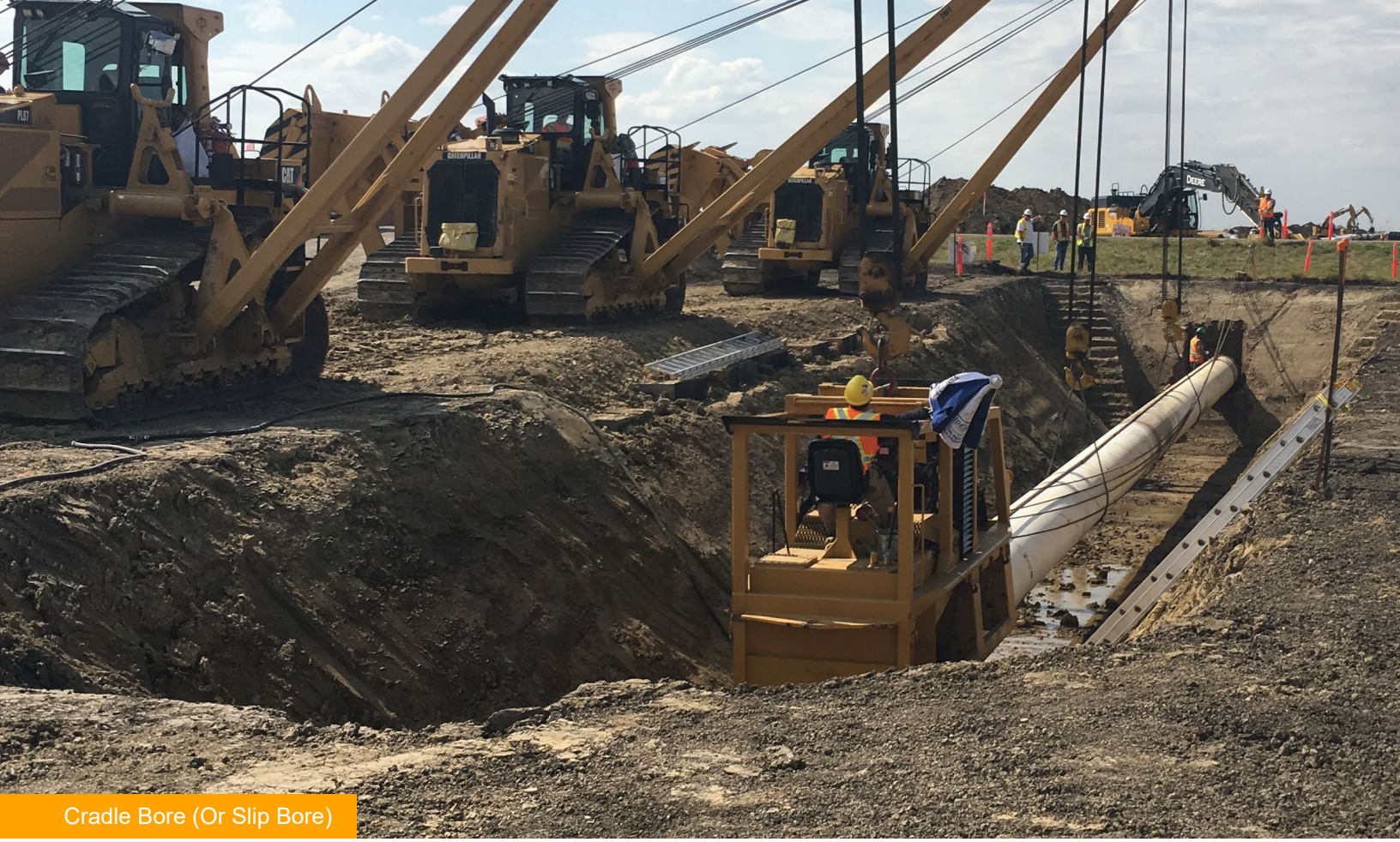
AUGER BORING TECHNIQUES:

Track Boring

Arguably the most common type of auger bore in current use is a track bore as it has the benefit of providing a stable platform for setting the line and grade of the pipe. As the bore machine pushes on the ground, it can provide a great deal of thrust and can use a wide assortment of tooling to cut through the ground and has the option to utilize steering heads to maintain line and level throughout the crossing.

Track Bores use ABMs that are mounted on track assemblies within the drive pit which are in turn anchored at the back to allow the machine to thrust on them. The bore machine sits in and pushes on these tracks to push the pipe through the ground at the same time as it spins augers inside the pipe to remove soil. The ABM rotates along the track until it inserts a piece of pipe of that length, then it is returned to its starting place on the track and another pipe is inserted between the ABM and the pipe installed. The process is repeated until the pipe is installed and the sacrificial pipe is pushed through and replaced with the product pipe.

This style of crossing is common for installations between 25 m and 125 m in length, though longer crossings using this technology have been completed, sometimes using steered or guided methods.



Cradle Bore (Or Slip Bore)

Cradle Boring or Slip Boring

Cradle Boring is a similar process to auger boring in that a large screw (auger) displaces soil as the pipe is installed, but it is vastly different in terms of design, application, and productivity. While standard auger boring requires a launch and exit pit, in Cradle Boring, a Cradle Bore Machine (CBM) is suspended from multiple side booms during the boring process. An onboard winch is used to pull itself toward the crossing to advance the sacrificial pipe. This can be an extremely quick and efficient way to complete short crossings limited to between 15 m and 50 m in length, though longer crossings using this technology have been completed. Cradle bores use a wide array of tooling. However, as the alignment of the bore is supported by side booms, setting, and maintaining line and grade for longer crossings can prove challenging.

Guided Auger Boring

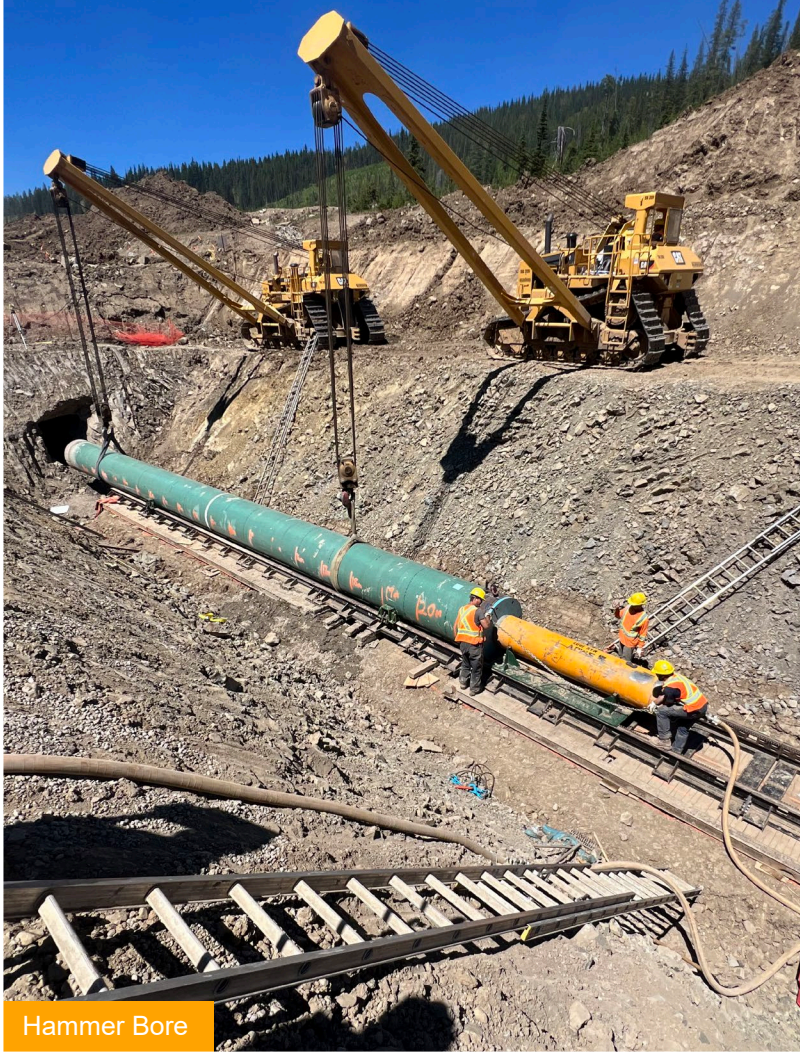
Guided Auger Bores are similar to track bores, with the difference being that with a guided bore, a pilot tube that is 2- to 6-inches in diameter is drilled on a centerline in advance of the casing. The pilot tube is steered to maintain grade and alignment, and acts as a centralizer to the casing pipe that follows. This allows the bore to be installed with a higher level of accuracy for both line and level. Additionally, geotechnical conditions and potential obstructions can be confirmed during its installation. After the install of the pilot tube, the sacrificial pipe is connected to the end of the tube on the drive side. An ABM is used to thrust the sacrificial pipe forward, augering out the additional material as it travels.

On the exit side of the crossing, the pilot tubes are removed as the sacrificial pipe travels forward and follows the alignment of the previously installed pilot tube. This process is repeated until all the pilot tubes have been removed and the hole contains only sacrificial pipe, following which the product pipe is installed as outlined above with regular track bores. The pilot tube method has the added advantage of permitting soil conditioning fluids to be pumped back into the bore path and aid the soil retrieval.

Hammer Boring or Pipe Ramming

Hammer Bores use a sacrificial pipe that is advanced into the ground using a pneumatic hammer usually between 18 – 30 inches in diameter to break ground. The hammer is used to install a length of pipe (e.g., 12m) after which the hammer is removed and an ABM, as used on the track bore, rotates the augers into the pipe to remove soil. This process is repeated until the sacrificial pipe is through the crossing. The same process as used in auger boring is then utilized to install the product pipe and remove the sacrificial pipe. As soil is removed from the pipe separately from the pipe being installed, the hammer bores offer a precise solution to removing material. Hammer Boring is used in situations where there may be a risk of over excavation, such as with soft sand or muskeg, and under features sensitive to surface settlement such as highways and railways.

Surerus Murphy can self deliver auger bores, track bores, guided bores, cradle bores and hammer bores and has strong relationships with some of the best subcontractor providers for this service to provide a cost effective and flexible approach to these crossings.

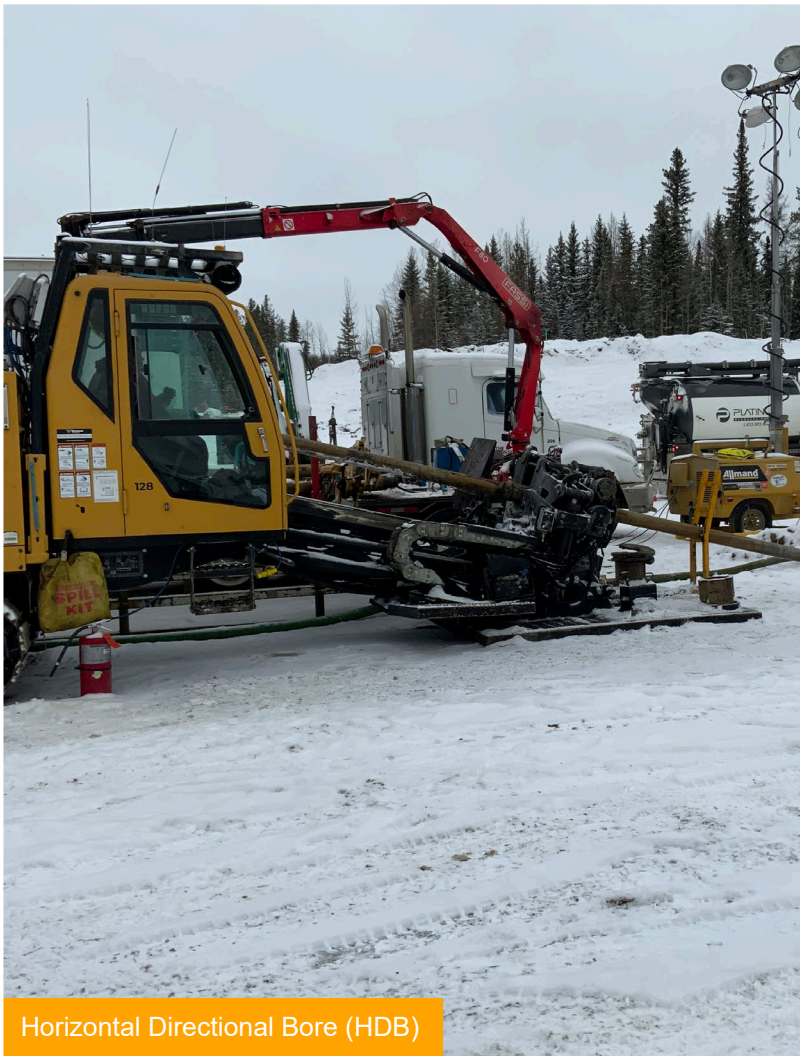


Hammer Bore

Horizontal Directional Bores (HDB)

Horizontal Directional Bores use Horizontal Directional Drilling (HDD) technology with the notable difference in HDB being no curvature in the bore. To complete a HDB, a drill rig is set up on one side of the crossing and advances lengths of drill rod through the crossing to create a small borehole (pilot shot). Reamers are inserted into the borehole to gradually increase its size until the hole is the desired diameter generally pipe diameter plus 6 inches at which point the crossing pipe is pulled through.

Surerus Murphy plans, manages, and executes HDB's on our projects alongside the subcontracted drilling contractor. Surerus Murphy also plans the pullback operations, including pipe stringing, welding, coating, crane allocations and lift plans to ensure safe and successful pipe installation.



Horizontal Directional Bore (HDB)

Horizontal Directional Drill (HDD)

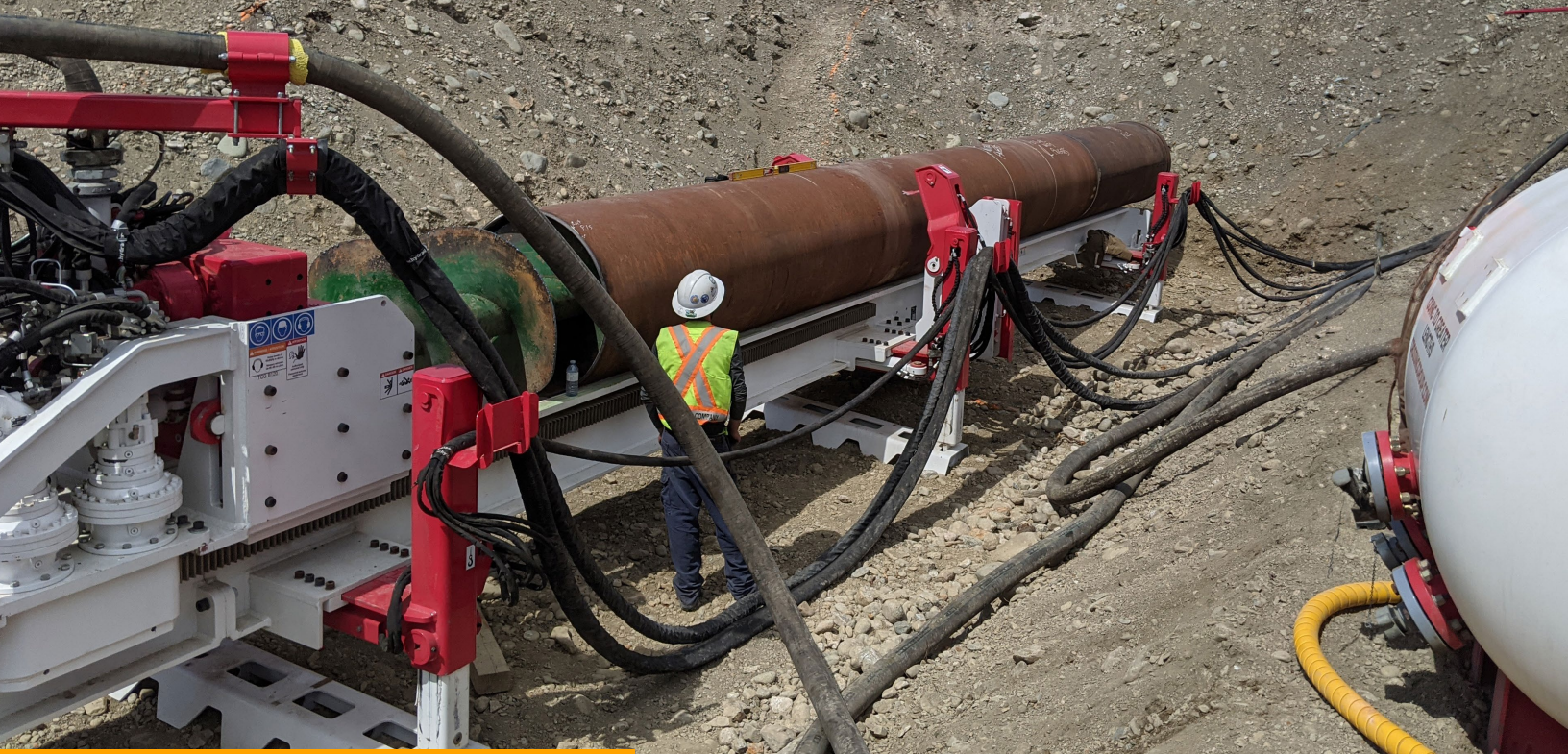
MAJOR TRENCHLESS CROSSINGS

Horizontal Directional Drilling (HDD)

Horizontal Directional Drilling (HDD) is a process used to construct a hole under the required obstacle to a suitable size to allow the product pipe to be pulled back into the hole. Depending on length of crossing, pipe diameter and planned radius, the final hole size could be 20 per cent to 50 per cent larger than the pipe diameter.

A pilot hole is constructed from entry to exit for a conventional HDD, although sometimes two HDD rigs are used for longer crossings of larger diameter where the pilot hole intersects in the middle of the crossing. After the pilot hole is completed, a series of reaming passes are completed to construct the hole to the required diameter. Throughout the drilling process, the borehole is conditioned with drilling fluid, generally a bentonite-based fluid, to reinforce the wall of the borehole, control hole stability and remove cuttings. Once the hole is completed, the pipeline is pulled in. This method is often the preferred choice for crossing under sensitive features such as large rivers.

Surerus Murphy has a successful history of managing HDD projects and has completed some of the longest large diameter HDD's in North America. Surerus Murphy understands the HDD process and can manage key subcontract partners to successfully plan and execute challenging crossings.



Down-the-Hole Hammer (DTH) before installation

Direct Pipe Installation (DPI)

Direct Pipe™ Installations or DPIs combine the soil excavation equipment of a micro tunnel with the pipe alignment geometry of an HDD. Unlike an HDD that drills a curved hole and then pulls the pipe back in, the DPI process uses a Micro Tunnel Boring Machine (MTBM) attached to the front of the pipe string. The pipe is then pushed through the curved crossing with drilling fluid and cuttings being pumped through lines within the pipe. Compared to HDD's, DPIs cannot generally reach the same lengths, but require smaller surface footprint, and do not require the additional depth typically required of an HDD under a given crossing.

While Surerus Murphy does not complete DPIs in-house, we support our clients with selection of appropriate locations, design, and support for execution and have completed multiple DPI crossings in North America with our partners.

Down-the-Hole Hammer (DTH)

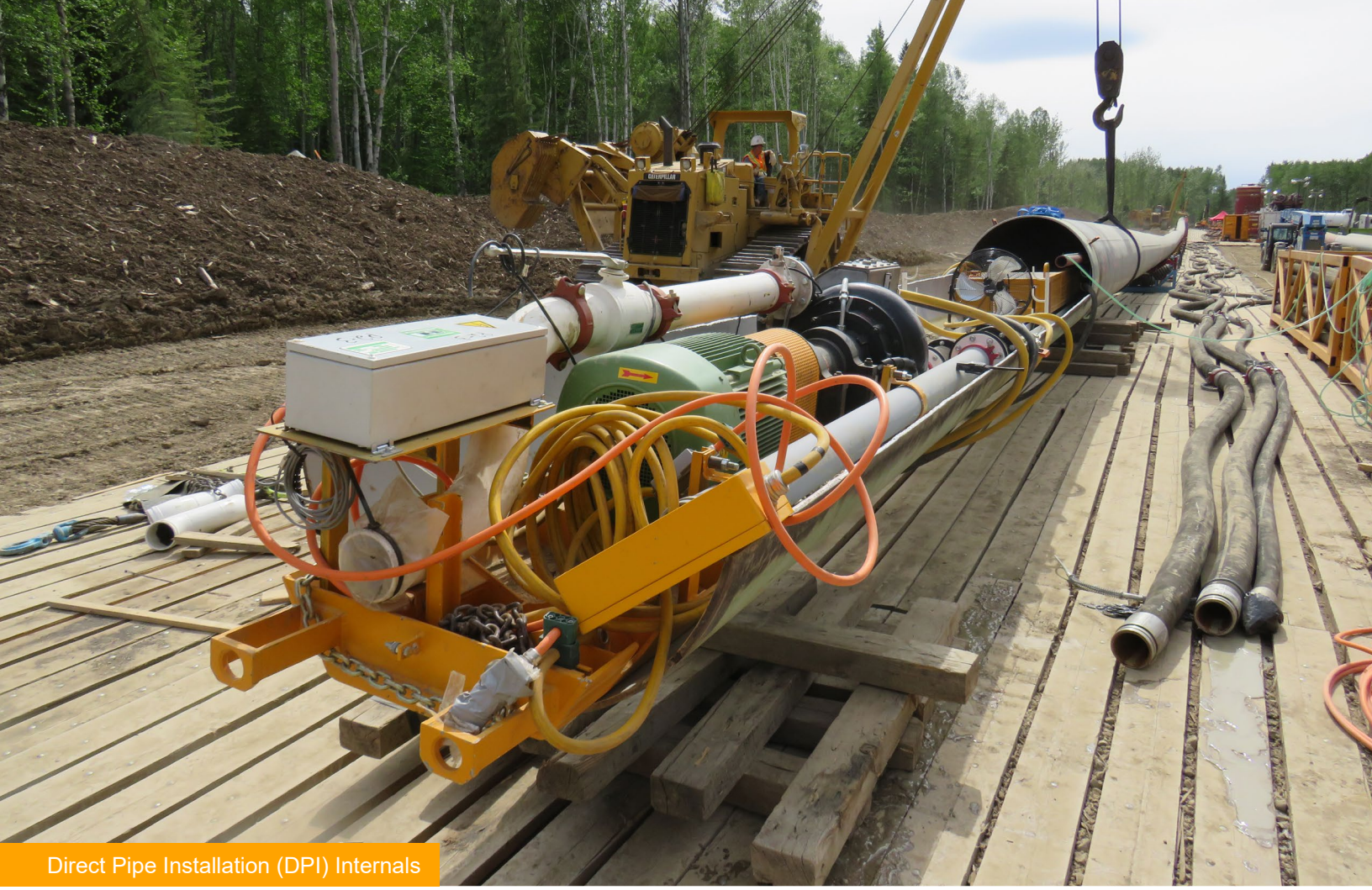
Like a Hammer Bore, a Down-the-Hole Hammer system uses a pneumatic hammer to advance the casing pipe. However, unlike a hammer bore, the DTH hammer is located at the leading edge of the casing pipe and is connected to a cutting head that reciprocates and rotates to pulverize rock in its path. Compressed air blows the pulverized rock chips and dust away from the cutting face of the bore and back to the removal augers as the pipe progresses. If a sacrificial pipe is used for the initial install, the same process as auger boring is repeated to switch out the sacrificial pipe with the product pipe.

Tunnelling and Micro Tunnelling

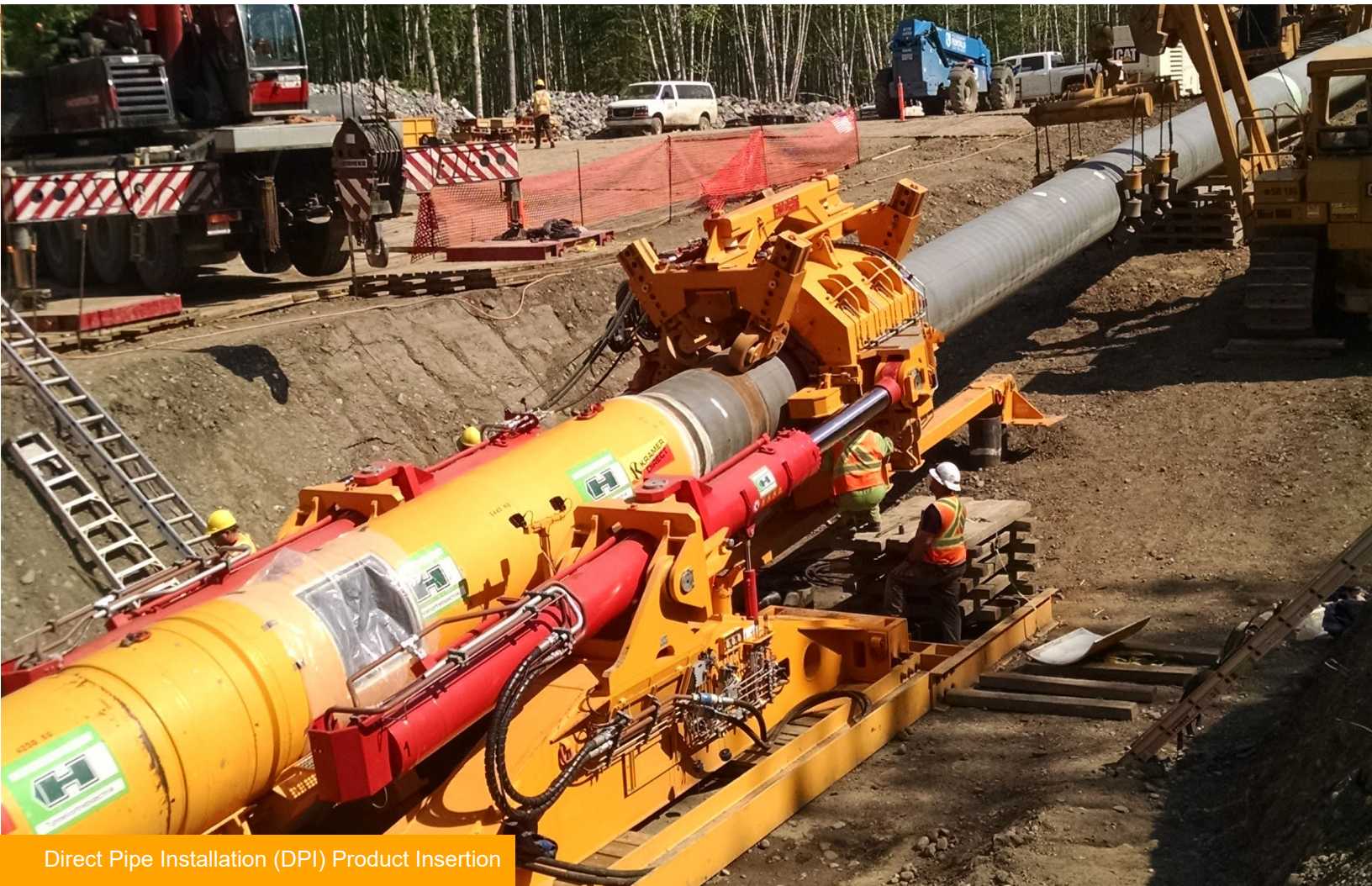
Tunnelling and Micro Tunnelling are specialized crossing operations that use a Tunnel Boring Machine (TBM or MTBM) to cut away soil as the tunnel is constructed. Typically, in pipeline operations, a tunnel will be completed prior to the product pipe being installed within it.

The difference between a tunnel and a micro tunnel is scale, with tunnels being significantly larger than micro tunnels. Each tunnel or micro-tunnel is unique and requires planning and design prior to construction. Surerus Murphy's value includes supporting our clients to determine tunnel route selection, geotechnical investigation requirements, tunnel construction methodology, and equipment selection and installation methods for the product pipe within the completed tunnel.

Having recently completed some of the longest tunnels on Canadian pipelines on the Trans Mountain Expansion Project and with a 60-year history of tunneling through our parent companies, Surerus Murphy understands what is needed to plan and execute a successful tunnel.



Direct Pipe Installation (DPI) Internals



Direct Pipe Installation (DPI) Product Insertion

For more information email:

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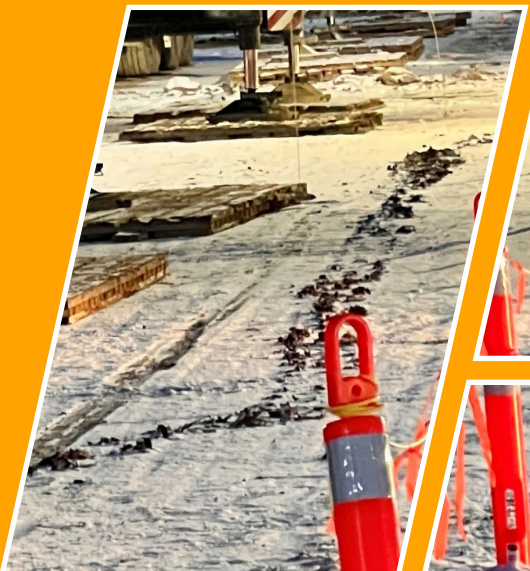

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