
Appendix F

Horizontal Directional Drilling Plan

ADMIRALTY INLET PILOT TIDAL PROJECT
FERC PROJECT NO. 12690

HORIZONTAL DIRECTIONAL DRILLING PLAN

(submitted with the Final Application for a New Pilot Project License)

Submitted by:
Public Utility District No. 1 of Snohomish County



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HORIZONTAL DIRECTIONAL DRILLING PLAN

for the Admiralty Inlet Pilot Tidal Project

1.0 OVERVIEW

The Horizontal Directional Drilling (HDD) Plan for the Admiralty Inlet Pilot Tidal Project, FERC No. 12690 (the Project), establishes procedures that Public Utility District No. 1 of Snohomish County (the District) will use to install the required submarine cable shore end conduit(s) for the Project, including the required support services for HDD operations such as diving, surveying, and vessel support. This plan was developed in consultation with the Marine Aquatic Resource Committee (MARC) and Project stakeholders.

The Project involves installation of two OpenHydro tidal in-stream energy conversion devices in Admiralty Inlet, as well as placement of two transmission cables to shore. The turbines will be installed in the northeastern portion of Admiralty Inlet, approximately 1 km west-southwest of Admiralty Head near latitude 48°09'03.24" N longitude 122°41'15.72" W latitude, in water depth of approximately 58 meters. Power generated by the Project will be transmitted via two subsea cables to a new control building proposed on a private parcel approximately 2,000 feet west of the ferry terminal. Grid compliant power from the control building would exit the property and connect to the local Puget Sound Energy infrastructure.

The HDD bore is 203 meters long with an exit on the sea floor at the 19 meter contour. The bore liner will be DR 9 or 11 high density polyethylene (HDPE) pipe. The HDPE is fused in sections on the beach and then subducts are installed prior to installing in the bore hole. Table 1 identifies the entry and exit points.

Table 1. Location of HDD Entry and Exit.

Position	Latitude	Longitude	Length of Conduit
HDD Entry Point	48.160396 N	122.664829 W	
Exit (19 meter contour)	48.158757 N	122.664936 W	203 meters

The HDD entry point is located on private property on Admiralty Bay as shown in Figure 1. The red dot represents the HDD entry point and the blue line represents the HDD bore. The black lines represent the cable route.

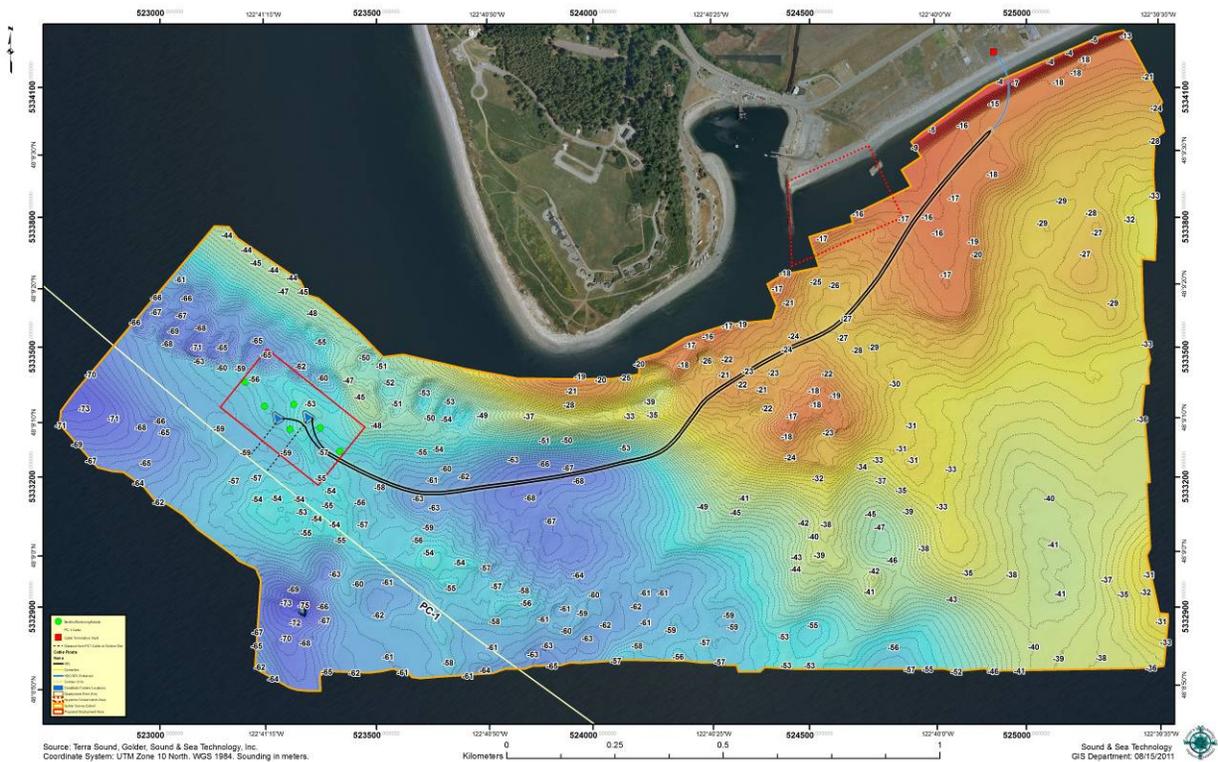


Figure 1. HDD and Project Location.

2.0 SITE SET UP

The HDD equipment arrives on site aboard multiple trucks. This can be as many as six eighteen wheel trucks along with support equipment such as cranes, back hoes or excavators, generators and water tanks (if a water supply is not available). The site is typically set up as shown in Figure 2. Major steps of the site set up and mobilization include but are not limited to:

1. Locate and identify any existing surface and/or buried utilities that might impact drilling operations
2. Set up all equipment and test
3. Anchor drill rig
4. Excavate pilot hole entry pit
5. Mobilize dive team and support vessels. At a minimum, the dive team needs to be able to do surface supplied diving with real time video and radio communication from a vessel that can be moored securely. Either the dive support vessel or another vessel (barge or boat) will need to be moored near the HDD exit point in order to disconnect the drilling head, attach the back reamer, connect the HDPE and handle the HDPE as it is pulled back through the pilot hole.
6. Assemble HDPE on beach, which involves fusion welding of sections
7. Hold final coordination and kick-off meeting with project team and interested stakeholders
8. Satisfy and meet all permitting and/or environmental requirements as required
9. Run survey wire for steering drilling tool

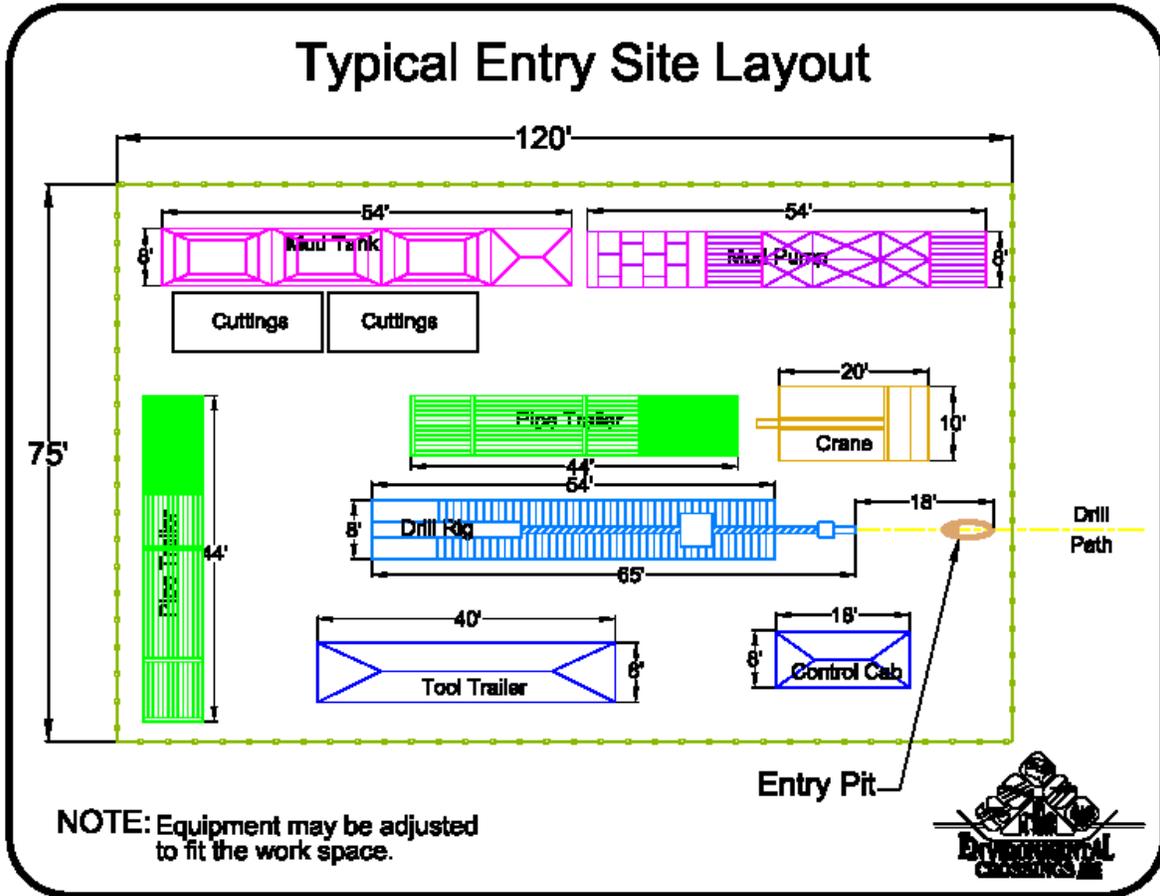


Figure 2. Typical Entry Site Layout.

3.0 SCHEDULE

For a drill of this length, with a pull back of 10 inch HDPE pipe, the anticipated schedule is set out in Table 2:

Table 2. Anticipated Schedule.

Day	Activities
Day 1	<ul style="list-style-type: none"> Equipment Arrives
Days 2-5	<ul style="list-style-type: none"> Locate and identify utilities as needed Mobilizing HDD equipment Fuse HDPE pipe Run tracking/survey wire Test systems Mobilize dive and support vessel crews
Day 6	<ul style="list-style-type: none"> Begin drilling – expected drilling time is 7 days
Day 13	<ul style="list-style-type: none"> Recover drilling head and tool Connect reamer Install (moor) offshore barge or vessel in position to support pullback of

	HDPE pipe
Day 14	• Pull back HDPE pipe into hole
Day 15	• Proof HDPE pipe with mandrill (pig) and install messenger wire
Day 16	• Begin demobilization on beach and install check valve on offshore end of pipe
Day 19	• Demobilization complete and site back to original condition

4.0 LAND SURVEY AND DRILL DESIGN FINALIZATION

During mobilization the driller, who is usually the site superintendent, the HDD project manager, and the drill crew, consisting of 8 to 9 people, will do a final review of the proposed drill site taking into account any abnormalities that could cause concern during the drilling procedure. The drill crew will be working seven 12-hour days per week while on site or as permitted by local noise ordinances. The HDD entry point and worksite workspace corners will be established and relative elevations and drill distances surveyed in and verified. During this operation, any existing subsurface obstructions in the area will be identified and staked. A profile of the ocean floor will be obtained by the diving support crew. This basic survey will verify the depths provided in the bidding documents are correct so as to establish a true running line and elevation for the drill path. The divers will assist the steering surveyor with obtaining a true shot at the exit point verifying the distance is correct. Should any conflict with a sea floor obstruction be encountered the drill path might need to be adjusted. Where possible a locating grid will be surveyed in along the entry portion of the drill path and a thin 8 ga. wire laid out on the perimeter. While drilling, a small DC current will be induced into the wire to create a magnetic field with known corner points that can be picked up by the sensors in the steering tool. This grid is used to verify the locating readings transmitted continuously through a wire in the drill stem to the drillers control cab. The steering tool, located behind the drill bit, keeps track of the azimuth and the inclination of the drill head (tool), giving the surveyor an accurate location of the bit at all times.

5.0 DRILL SITE PREPARATION AND SET-UP

The configuration of the drill rig, mud system, and support equipment will be done to maximize efficiency within the confines of the existing site work area as well as any rights-of-way or site specific requirements. The drill rig will need to be anchored with a temporary dead man. Typically this dead man consists of two driven steel piles located at the front of the drilling machine or a poured in place concrete footer. For this location and for the size and length of the drill planned it is anticipated that two steel piles will be driven approximately 6 feet into the ground. The piles vary from contractor to contractor but are usually reinforced standard steel shapes such as a W16x100 beam. A small sump pit usually 6 to 8 feet in diameter and 4 to 5 feet deep will be excavated at the bore entry; this sump pit allows for the recovery of the drilling fluid coming from the borehole back to the surface. The fluid is picked up by a sump pump and transferred to the solids control unit where the solids contained in the drilling fluid are mechanically separated allowing the mud to be re-circulated down hole and used again. The solids are discarded into dumpsters (hoppers) and transported to a local prearranged dump site.



Figure 3. Typical HDD Set-Up.

Figure 3 shows a typical HDD set-up. In this operation, the control cabin where driller and surveyor (steering hand) sit is to the right of the drill rig. An excavator is used to load pipe onto the drilling rig. The hose in the right forefront is pumping drill mud returns from return pit to mud separator units (not shown in this photo).



Figure 4. HDD Rig, View Two.

Figure 4 shows a side view of an HDD rig.



Figure 5. Mud Separator.

Figure 5 shows mud separator units and the plastic lined dumpsters or hoppers that the non toxic solids and drill tailings are disposed into. The hoppers are then trucked offsite to an approved dump site/landfill.

6.0 DRILLING PROCEDURES

The non-magnetic bottom hole assembly with the steering probe inside is attached to the drill string. The non-magnetic drill collar will serve as a buffer between the possibly magnetized drill string and the steering tool ensuring greater accuracy. The drill string is advanced along the pre-determined drill path while drilling fluid is pumped down the inside of the bore pipe and exits through the drill head. The fluid then returns to the entry pit through the annulus between the outside of the drill pipe and the formation being bored.

The drilling fluid is composed of naturally occurring bentonite clay and water. The clay is insoluble and made up of small particles that function as a lubricant for the drill head and pipe, a transport for the cuttings being removed from the hole, and as a sealant that fills the annulus space surrounding the drill hole. The drilling mud pressure and volume are monitored during drilling operations to assure there are no leakages due to fractures in the structure of the material being drilled through. If a fracture is present it is possible for drilling mud to escape onto the surface or into the water. This is called a “fracout”. While no fractures are expected in this glacially deposited substructure the driller is always monitoring for a fracout. By monitoring the pressure and volume, such fractures can be identified as they occur and steps can be taken to eliminate the problem. The driller can stop or slow down the operations to give the mud a chance to seal the fracout. If that is impractical or doesn’t work an alternative route can be taken.

During the drill, as each joint of pipe is set onto the drill rig, a visual inspection is done to make sure no debris is sent down the pipe that could cause a problem during cable installation (this is important for left in place steel drill pipe but not for this HDPE installation). Directional information is accumulated while drilling and survey shots are taken on 30-foot intervals. The data is calculated and plotted on a work plan and profile drawing so the true vertical depth and horizontal distance as well as the right and left bearing drift are always known throughout the entire drilling operation.

As soon as the pilot exits at the predetermined exit point, the contractor will connect a head on the rig side to blow air to aid the divers in locating the drill head. Once the divers get a fix on the bubbles, they will enter the water and locate the drill head. The divers will deploy a buoy or simply get a GPS fix directly in the center of the bubbles at the surface to confirm exit location acceptance. Once the exit location is accepted, the drilling rig will push pipe out of the hole until about 45 feet of drill pipe (not counting the monel or jetting assembly) are lying on the seabed. The divers will confirm the number of feet of drill pipe on the seabed. This technique aids in maintaining hole integrity at the point the pipe exits to the bottom. See Figure 6.

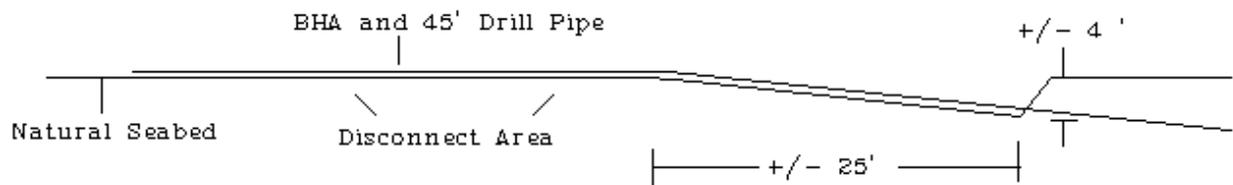


Figure 6. Drill Pipe Sketch.

7.0 DRILL EXIT

As the drill stem approaches the exit point on the ocean floor, the drilling conditions are carefully monitored. These conditions determine the time or distance from the exit when a shift from the bentonite drilling fluid to fresh water drilling is achieved. By flushing the drill string with fresh water, the drilling mud is circulated out of the system and a mud free exit is achieved. It must be reiterated that drilling conditions, not a pre-determined distance, will be the factor as to what point the change to water will occur. As a rule of thumb, 100 feet is the average distance at which a change to fresh water happens. The driller and surveyor will know when the bottom hole assembly exits the sea floor, not by a loss in pressure, but by watching the console inside the drill cab. When the bottom hole assembly is no longer supported by the soil, the angle of inclination will fall off dramatically thus signaling the bore exit. The marine support crew will be dispatched to dive on the exit and verify the exit point. Once the exit has been verified, the on-site inspector will be given the true offshore exit coordinate to approve. This approval must not be delayed if the crossing is not acceptable for any reason, as the drill string will need to be withdrawn as quickly as possible to avoid getting stuck in the hole. Due to exiting on fresh water, this timely approval is very important.



Figure 7. Drilling Head Exit.

Figure 7 shows a HDD drilling head exiting the seafloor.

8.0 REMOVE BOTTOM HOLE ASSEMBLY AND INSTALL CONDUIT

Once the exit has been approved, divers will jet down below the sea floor, if required, and remove the special bolt on the drill bit and affix a pull-head arrangement to mate up the HDPE conduit with the drill pipe. Figure 8 shows the Bolted Connection that will be unbolted and separated by the divers:



Figure 8. Bolted Connection.

The divers will find these two pieces bolted together. They must remove the twelve bolts and pull the two pieces apart. If they have difficulty separating the two pieces, there are two threaded bolt holes to re-insert two long bolts to drive the two pieces apart. Once the two pieces are separated, the approximate 40 foot Bottom Hole Assembly (BHA) section can be immediately recovered to the surface or put to the side for recovery after all reconnection operations are completed. The divers will then “choke” a snatch block to the drill pipe six to eight feet inshore of the one half of the bolt-on connection that remains on the end of the drill pipe. See Figure 9.

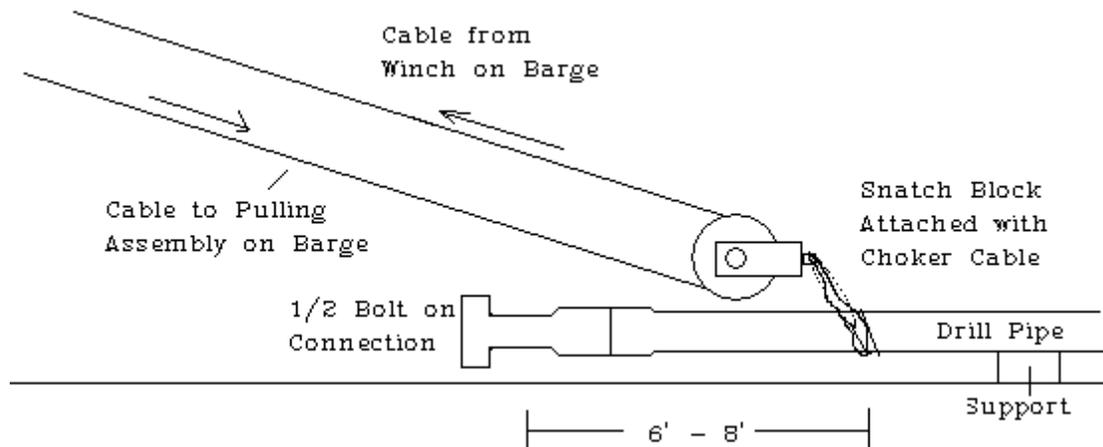


Figure 9. Snatch Block Choker Cable Sketch.

Once the snatch block has been secured to the drill pipe, the divers will pull a cable off the winch on the deck of the barge; pull it down to the snatch block shown above; run the cable through the sheave and back to the pullback assembly on the deck. During the drilling process a small crew on shore will be fusing the conduit together and preparing it to be towed off shore by the marine support crew. Once the drill bit is removed, a swivel will be attached to the drill pipe along with a pull head made specifically for this pipe.

The product pipe (conduit) will be attached to the swivel via the pull head. The drill pipe will be removed from the bored hole in turn pulling the conduit from sea to the on-shore worksite. After the conduit has been successfully pulled through the bored hole a pipe pig will be inserted at the entry with a 1/4" aircraft cable attached. This will be hydraulically pushed through the drill pipe with fresh water as the 1/4" cable trails the pig. This operation proofs the pipe as well as verifies a clean I.D. A check valve and surface buoy will be attached to seal the conduit for future location.

When the divers complete the open trench back to a depth of 4 feet, they will go offshore to the BHA and start the removal of the BHA.

The contractor, at this time, will have prepared the bottom hole assembly including a duplicate of the half of the bolt on connection that was previously removed from the drill pipe after punch out and also including a buoyancy device to float the weight of the pullback assembly as it is pulled down from the barge to the connection point on bottom. Once the two halves are close enough to connect (bolt up), the winch will slack the line and the divers will stab the half of the bolt on connection into the half that was left on the drill pipe and bolt up the connection in preparation

for pullback. The HDD Superintendent will go through a couple of rehearsals with the divers prior to this operation so the divers are familiar with the connection.

9.0 PULLBACK

The rig is now connected to the drill pipe running through the bore hole. The drill pipe is connected to the pullback assembly, which is connected to the first section of HDPE. The HDPE has been pulled from shore around the stern of the barge and back along the opposite side of the barge. While the first section is being pulled into the hole, the second section will be pulled from shore and alongside the barge. When the first section has been pulled sufficient length to place the rear of the section alongside the barge, the second section will be fused to the first section and pullback can recommence. The exact same operation will take place to fuse the third section to the second section. Pullback will continue until the pullback assembly surfaces at the drilling rig on land at entry and the pullback will be complete. The pilot hole BHA that was removed in preparation for pullback can now be recovered to the surface and shore if not previously accomplished.

There are many ways to install the HDPE conduit such as making one length and towing it offshore, using winches on a barge or assembling the HDPE in smaller lengths and making fuses at the offshore moored vessel. The actual methods used will be dependent on contractor selected, time of year, expected weather and tidal conditions, size and type of final conduit and length of drill.

10.0 PROOFING THE HDPE

Once the pullback is complete the contractor will blow a pig through the pipe from entry to exit to proof the conduit. While blowing the pig, a 5/16” stainless steel cable with a 3,000 lb. safe working load is attached to the shore side of the pig and pulled into the HDPE behind the pig during the proofing process. The divers will remove the 5/16” wire from the pig, install a TideFlex Coupling (one way valve) and secure the end of the wire around the end of the HDPE.

On the inshore end a flange will be installed to the HDPE pipe. The messenger line will be secured to the inside of the flange cap.

11.0 DEMOBILIZATION

The demobilization at the end of the HDD operations will include at a minimum:

1. All drilling equipment will be disassembled and trucked from site
2. The contractor will clean up any trash left on the site and backfill the entry pit
3. All signs of construction will be removed and site and vegetation returned to original condition
4. The contractor will get sign off from the District and all permitting authorities that installation has been in compliance with project specifications and environmental requirements
5. Any anchors used offshore or debris left on sea bottom will be removed.

12.0 MODIFICATIONS TO THE PLAN

The HDD Plan describes the equipment and procedures that the District currently expects will be used to install the required submarine cable shore end conduit(s). The actual equipment used and procedures employed may change depending in part upon further geotechnical data and other factors.

In the event that the equipment or procedures described in this Plan are materially modified, not less than thirty (30) days prior to initiating any ground disturbing activities required for installation of the required submarine cable shore end conduits, the Licensee shall file with the Commission, for approval, an updated HDD Plan that describes the changes to the Plan. The District shall develop these modifications in consultation with the MARC. The Licensee shall allow a minimum of thirty (30) days for members of the MARC to comment and make recommendations before submitting the updated HDD Plan to the Commission. When filing the updated HDD Plan with the Commission, the Licensee shall include documentation of consultation; copies of comments and recommendations; and specific descriptions of how comments and recommendations from the MARC are accommodated by the Licensee's plan. If the Licensee does not adopt a recommendation, the filing shall include the Licensee's reasons based upon Project-specific information.

Upon Commission approval, the Licensee shall implement the updated HDD Plan.

