Horizontal Directional Drilling: The Sustainable Solution for Crossing the Kissimmee

Dr. Maureen Carlin, Laney Directional Drilling, Spring, TX
Alan Snider, Laney Directional Drilling, Spring, TX
Dr. Jwala Swarma, Laney Directional Drilling, Spring, TX

1. ABSTRACT

Horizontal Directional Drilling has been identified as a preferred pipeline construction method in order to minimize environmental impacts associated with the upcoming Florida Southeast Connection Project. Nine (9) major HDD crossings have been identified along the 126-mile path of the natural gas transmission pipeline. Crossings included bypassing vast citrus groves, cattle grazing land, canals, creeks, rivers, lakes, and wetlands. The most challenging of these crossings, with regards to sustainability and ecological protection, is a major crossing beneath the Kissimmee River. The Kissimmee River Valley is essential to the overall health of one of the most unique and diverse ecological systems in the world: the Florida Everglades. Before construction begins, HDD Engineers and Contractors will contribute to avoid or mitigate environmental. Particular effort will be made to conserve Florida's diversity of wildlife, particularly all 60 recognized species, for future generations. This paper discusses ongoing efforts in the area of sustainability for Horizontal Directional Drilling as a part of the overall Florida Southeast Connection Project and its construction beneath the Kissimmee River.

2. INTRODUCTION

Sustainable practices for buried pipeline construction have been long overlooked by the vertical construction of buildings, roads, and bridges. Pipeline construction, however, has significant considerations with regards to sustainability as many projects are hundreds of miles in length and affect a variety of natural habitats, unique economic regions and contrasting communities. This paper highlights a uniquely valuable upcoming pipeline project, the Florida Southeast Connection Project (FSC), and how the Horizontal Directional Drilling Method (HDD) of construction is critical to the pipelines sustainable development.

The FSC is a 125-mile long pathway that will run predominantly through the naturally occurring Kissimmee River Valley (KRV). This region of lakes and rivers is the main tributary system that feeds the Florida Everglades, which is one of the most diverse natural habitats for fish, wildlife, and plant life in the world. Presently, the KRV is undergoing arguably the largest true ecosystem restoration project ever attempted, the Kissimmee River Valley Restoration Project (KRP), to restore habitats previously reduced by historically unsustainable measures. Thus, sustainable practices for all new construction in the area are of the highest importance.

The ultimate goal of the FSE is to provide safe, reliable, and adequate natural gas resources to millions of Floridians, while at all times mitigating the impact to environmentally susceptible areas of the Kissimmee along the path of the pipeline. HDD significantly reduces the project’s environmental impact by providing a trenchless construction method and eliminating the need for traditional open-cut installation. The purposes of this paper are to discuss the benefits of the Horizontal HDD method to sustainability pipeline development and to identify ways to
mitigate potential ecological risks associated with the future HDD construction beneath the environmentally sensitive Kissimmee River.

3. BACKGROUND

3.1. Engineering the Kissimmee River Valley (KRV)

Understanding the environment one is working in is the first step to identifying potential areas of environmental susceptibility for pipeline construction along the Kissimmee. The Kissimmee River Valley (KRV) is a region of lakes and rivers that feeds the Florida Everglades. The Everglades are considered the most diverse natural habitats for fish, wildlife, and plant life in the world. Currently, the KRV is undergoing the largest true ecosystem restoration project ever attempted. The Kissimmee River Valley Restoration Project (KRP) will restore habitats previously lost due to unsustainable engineering measures.

Historically, the river travelled along a meandering path through from Orlando, FL South through Central Florida. Annual rainfalls produced flooding, causing the natural ecosystem to thrive with native wetland wildlife & plant life. At times, heavy rainfall resulted produced flooding along the river, which allowed the natural ecosystem to thrive with native wetland wildlife and plant life.

This all changed after extended flooding during the particularly damaging hurricane season of 1947. In 1948, as an attempt to reduce property destruction due to flooding in the region, U.S. Army Corps of Engineers (Corp) began the Central and South Florida Project. The project involved the channelization of the river by deepening, straightening and widening the river’s natural pathway. The once 100 plus mile (160 km) pathway from Lake Kissimmee to Lake Okeechobee was reduced by half. Refer to Figure 1. Effects of Channelization of the Kissimmee River Valley.

Figure 1. Effects of Channelization of the Kissimmee River Valley
At the time, sustainability was a far consideration for the future effects of the project and ultimately, the results were ecologically devastating. Faster water flow contributed to major environmental problems in the Kissimmee Valley and Lake Okeechobee. Nearly 65 mile\(^2\) (160 km\(^2\)) disappeared, which reduced the natural wildlife habitats by nearly 90% for some species. Fish populations, particularly game fish such as largemouth bass, were considerably reduced. Local economies suffered due to poor sport fishing and bird watching and decreased lake and river recreation tourism.

Now, nearly 70 years later, civil engineers are reevaluating the effort, and are working to reverse the channelization to recreate natural changes in the pathway to reduce water flow. Upon completion, over 40 miles of the Kissimmee River will be restored. Refer to Figure 2. Effects of the Kissimmee River Restoration Efforts. While the project is far from completion, initial results indicate that wildlife is returning to the already restored sections of river. Increased water levels have flushed out smothering aquatic weed, reduced sediment, and allowed sandbars to reemerge. In addition, higher levels of dissolved oxygen in the water, has helped aquatic plant life and invertebrates such as insects, mollusks, and freshwater crustacean populations to flourish. Ultimately, the increased food source will continue to support fish, bird and alligator populations’ benefiting the overall food chain and natural ecosystem.

![Figure 2. Effects of the Kissimmee River Restoration Efforts](image)

#### 3.2. The Florida Southeast Connection (FSC)

Natural gas is largest fuel source consumed in the Sunshine State of Florida. Nearly 70 percent of the electricity Floridians use is generated by natural gas power plants. Natural gas is considered to be the cleanest fossil fuel. In addition, the United States has abundant natural gas resources which make it more affordable than imported oil and more environmentally responsible than foreign resources. Florida, however, has only minimal natural gas production and no natural gas storage capacity. Therefore, the state relies on interstate Gulfstream Natural Gas System and Florida Gas Transmission that service the state’s majority of its supply, however, both are nearing capacity.
To address this existing concern and to meet Florida’s future natural gas needs, a new pipeline project has been developed. The Florida Southeast Connection (FSC) project includes the construction of 126 miles of a combination 30” & 36” high pressure natural gas transmission pipeline. Refer to Figure 3. Florida Southeast Connection and Horizontal Directional Drill Crossing Locations. The proposed pipeline route originates in Osceola County, FL, travels south through the Kissimmee River Valley, and terminates at the Martin Power Plant in Indiantown, Florida. The Martin Country Power Plant is owned and operates by the Florida Power & Light Company (FPL). Figure 4. Arial View of Martin Power Plant, Indiantown, FL. The Martin Plant, which burns gas and oil, is currently the single largest fossil fuel burning power plant in the United States. In efforts to increase production and reduce greenhouse emissions, plant capacity expansion is focused on natural gas expansion.

Figure 3. Florida Southeast Connection and Horizontal Directional Drill Crossing Location
The FSC is currently in the design phase and pending regulatory approvals and permitting, construction of the pipeline will begin in 2016. Before construction begins, however, all environmental factors along the path of the pipeline are being thoroughly evaluated. Federal, state and local agencies are coordinating efforts to avoid and/or mitigate environmental impacts to wildlife or habitat, particularly because the pipeline crosses environmentally sensitive areas, most notably the Kissimmee River itself. To ensure that protection of the Kissimmee River as an environmentally sensitive area, the FSC has selected the well-established pipeline construction method of Horizontal Directional Drilling (HDD) to install the pipeline beneath the river.

3.3. **Horizontal Directional Drilling (HDD) and its Role Along the FSC**

Understanding the ongoing restoration efforts along the Kissimmee further emphasizes the need for the sustainable development of the Florida Southeast Connection. HDD has been selected as a trenchless method to install the pipeline in areas where traditional open cut excavations are not feasible for environmental or logistical explanations. Construction of the FSC pipeline using HDD will reduce field severing, soil degradation & erosion significantly compared to conventional open trench projects. In addition, HDD reduce the width of the right away needed for construction operations, eliminates the need for trenching, and has an overall reduction in environmental blueprint.

The process itself is simple. First of all, a “pilot” hole is drilled along a predetermined alignment to bypass the sensitive area, in this case the river itself. Typically, this pilot hole ranges in size from 6 5/8” to 12 ¾”. Next, the hole is “reamed” until the pilot hole is enlarged enough for the 36” product pipeline to be inserted. The last step is the “pullback” of the carrier pipe. Nine (9) major HDD crossings were identified along the path of the pipeline. Crossings included bypassing vast citrus groves, cattle grazing land, canals, creeks, rivers, lakes, retention basins, irrigation canals, wetlands, and highways. The most significant of these locations is a major 5,200 foot crossing beneath the Kissimmee River. Refer to Figure 5. HDD Crossing Profile of Lake Kissimmee and Table 1. Lake Kissimmee Crossing Parameters.
Table 1. Lake Kissimmee Crossing Parameters

<table>
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<tr>
<th>Product Pipe Specification</th>
<th>36.00” O.D. X 0.750” W.T., API-5L X-70 Pipe With 14-16 MILS of Fusion Bonded Epoxy &amp; 32-40 MILS ARO</th>
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<tr>
<td>Max Allowable Operating Pressure (MAOP)</td>
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<td>Entry Angle, Elevation (FT)</td>
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<td>Exit Angle, Elevation (FT)</td>
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<td>Directional Drill Pipe Length (FT)</td>
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<td>Design Radius (FT)</td>
<td>4,200.00FT</td>
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<tr>
<td>Max Depth From Entry (FT)</td>
<td>106.26FT</td>
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4. SUSTAINABLE CONSIDERATIONS FOR HDD OPERATIONS

4.1. Geotechnical Investigation

A comprehensive geotechnical investigation is essential for reliable evaluation of potential risks. Engineers must make certain assumptions regarding drilling practices and drilling fluid properties, however, understanding the geotechnical conditions at the Kissimmee River is the first step to reducing damage to the environment during construction. Using these conditions, in coordination with HDD installation length depth, and pipe size, engineers can identify locations along the bore path that are at risk for hydraulic fracture, allowing contractors to reduce the potential consequences of returns occurring at all. Refer to Figure 6. Geotechnical Investigation for HDD Crossing at the Kissimmee.

4.2. Drilling Fluid Considerations

Inadvertent drilling fluid returns or hydraulic fracturing are significant issue because of environmental concerns. Drilling fluid is comprised primarily of water & up to 3% bentonite, a naturally occurring, non-toxic clay
4.3. Construction Method Selection

Construction execution is critical to maintaining sustainable pipeline development. Contractors are typically given the flexibility to choose the means and methods by which the complete the pipeline construction. Additional construction techniques include relief wells, piezometers, conductor casings, and monitoring drilling fluid returns at the drill rig can be used to prevent returns. Ultimately, however, it is critical that the contractor performs construction with a sustainable state of mind in order to make sure construction is executed properly.

4.4. Wildlife and Habitat Considerations

Though the KRP is helping to boost indigenous wildlife, there are ongoing concerns for the area. In 2013, the Florida Wildlife Commission (FWC) introduced an Imperiled Species Management Plan that will be the blueprint for conserving 60 species on Florida’s Endangered and Threatened Species list. This includes birds, fish, frogs, invertebrates, mammals and reptiles contribute to keeping Florida’s natural areas functioning and alive. Natural predators such as alligators, black bears, and panthers are seeing reduced populations which are essential to the natural food chain. Bald eagles are of special significance, as Florida has one of the densest concentrations of nesting eagles in the lower 48 states, with over 1,000 nesting pairs. The protection of these animals and their habitats is a major concern for all construction efforts in the area. Refer to Figure 7: The Florida Alligator (LEFT) and the Florida Panther (RIGHT.) Thus, the pipeline construction must be designed, constructed, and operated with utmost awareness of challenges facing the local habitat.
4.5. Site Access Issues

Site Access can be challenging due to remote sites for entry & exit locations. Minimizing environmental impacts should be a main consideration in selecting appropriate access locations. In the case of the site access for the FSC HDD locations, there are several challenges that are present when accessing each drill entrance and exit locations, particularly at the Kissimmee River Crossing location. Preplanning is key to identify the most appropriate path to the jobsite without altering the natural environment. Specific access challenges include travelling through marsh like conditions, grazing fields, citrus orchards, and National Forest settings. Coordination among all parties is also important to making sure that all parties are aware of the natural habitats and are utilizing appropriate measures to reduce the overall impact of construction activities. Refer to Figure 8: Site Access through Grazing Field (LEFT) and Marsh (RIGHT.)

Figure 7: The Florida Alligator (LEFT) and the Florida Panther (RIGHT)

Figure 8: Site Access Through Grazing Field (LEFT) and Marsh (RIGHT)
5. CONCLUSIONS AND RECOMMENDATIONS

As Horizontal Directional Drilling operations are executed at the Kissimmee, the following considerations should be made with regard to both the HDD installation as well as overall pipeline construction with regards to sustainable pipeline development in the Kissimmee River Valle

- Conservation strategies with specific actions for each wildlife species including habitat conservation and wildlife preservation should be implemented at all levels of pipeline and HDD construction.

- The sustainable design, construction and operation of underground pipelines of the FSE is essential to Kissimmee Restoration Project as a whole.

- As the FSE project moves forward into design, construction, and operation, it is critical to continue ongoing collaboration between government entities, DOT representatives, land owners, environmental experts, and surrounding community members.

- It is critical to conserve Florida’s diversity of wildlife, particularly all 60 recognized species, for future generations.

- With advice and input from various stakeholders, including recreational user groups, business interests, environmental partners and residents, the construction for the FSE should address hydrologic management, water quality, fish and wildlife, water supply and recreation and public use. (Figure 9. Key Stakeholders for the FSC and KVR Projects)

Figure 9. Key Stakeholders for the FSC and KVR Projects

- The FSE project should provide support to enhance and sustain the health of the lake ecosystems by defining strategies to minimize the negative effects of human activities on natural systems.

- The ASCE Code of Ethics requires civil engineers to strive to comply with the principles of sustainable development in the performance of their professional duties. With this said, all parties working to complete the FSE should support this effort and continue to improve best management practices through sustainable state of mind.

Though the Kissimmee River Valley has long history of poor civil engineering decisions with regards to sustainability and ecological protection, civil engineers have the opportunity to learn from previous mistakes. It is important to understand to the long term effects of working in, and sometimes altering, natural habitats. In addition, it is critical that sustainable efforts are made at all levels of the construction and engineering process in order to support the Florida Southeast Connection as a landmark project for sustainable pipeline construction.
6. REFERENCES


