Appendix M
Mechanical Engineering

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1. EXISTING CONDITIONS

Oakwood Bottoms currently has a total of eleven (11) deep-well pumps of various capacities ranging between 3-6 cfs that are utilized to fill particular units. These pumps are vertical turbine type pumps. They are equipped with three phase electrical pump motors of varying horse powers, electrical control boxes, and transformers. Nine of the pumps were installed by the U.S Forest Service in three phases. Phase I took place in 1964 and included Pumps #1-3, also known as the cluster, to fill units 1-10, and Pump #4 which fills units 11 and 12. Phase II occurred in 1976 and included the installation of three additional pumps, Pumps #5-7. The last phase took place sometime in the 1990’s and included Pumps #8 and #9. In 2017 Ducks Unlimited added a bi-directional well pump between units 20 and 21. In 2019 another pump was installed by Ducks Unlimited at the north end of the Green Tree Reservoir. Two pipeline systems run underground along the south ends of moist soil units. Pipeline #1 runs from Pump #5 to the beginning of existing unit 16MS W. The second pipeline begins at Pump #8 and runs to the end of existing unit 14MS. There are five valves associated with Pipeline #1, and ten valves associated with Pipeline #2.

Currently there are no existing pump stations at the project for flooding or drainage.

2. POTENTIAL MEASURES

2.1. Pump Station

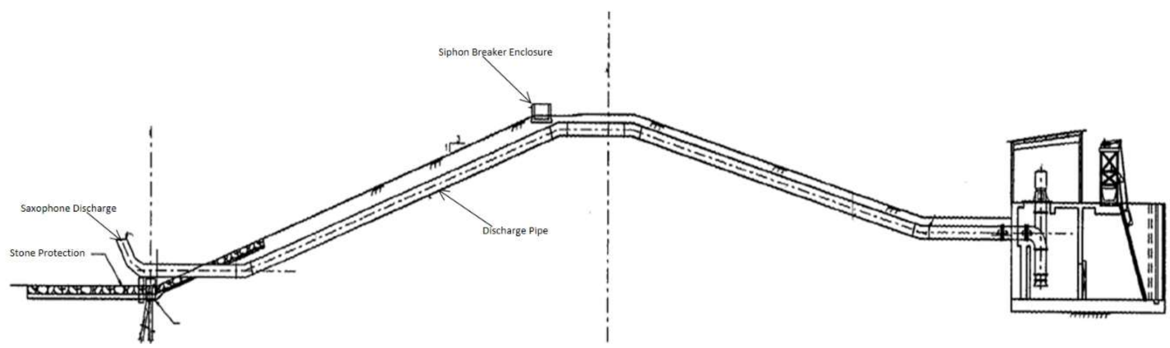

Figure 1- Pump Station with Over the Protection Discharge

The following proposed items are for the Forest Service Preferred (TSP) plan. Based off hydraulic modeling, Oakwood Bottoms will need one new pump station constructed at the southern unit, new unit F-6, in order to drain the area within a two week time period. This pump station will need a capacity of 30 cfs to meet the requirements of the project. Pump stations are comprised of pumps, motors, gates, and control systems. They are set up to provide a certain flow of liquid at a specific pressure to deliver fluid to and from targeted areas. Typically pump stations have a life pump stations can have various configurations that work effectively for the project. The recommended configuration for Oakwood Bottoms consist of two pumps at full capacity. The standby pump is recommended for redundancy. In the event that one of the pumps is down the pumping station will still be able to operate at full capacity. The pump motor could either be electric or diesel powered. This decision will depend on cost considerations, feasibility, and complexity of each system. A submersible pump is considered because it will be lower maintenance given that the pump station will only be ran approximately once a year. The discharge system is proposed to be an over the protection discharge as shown in Figure 1. The discharge pipe will run over the Big Muddy Levee and exit to the nearby channel.

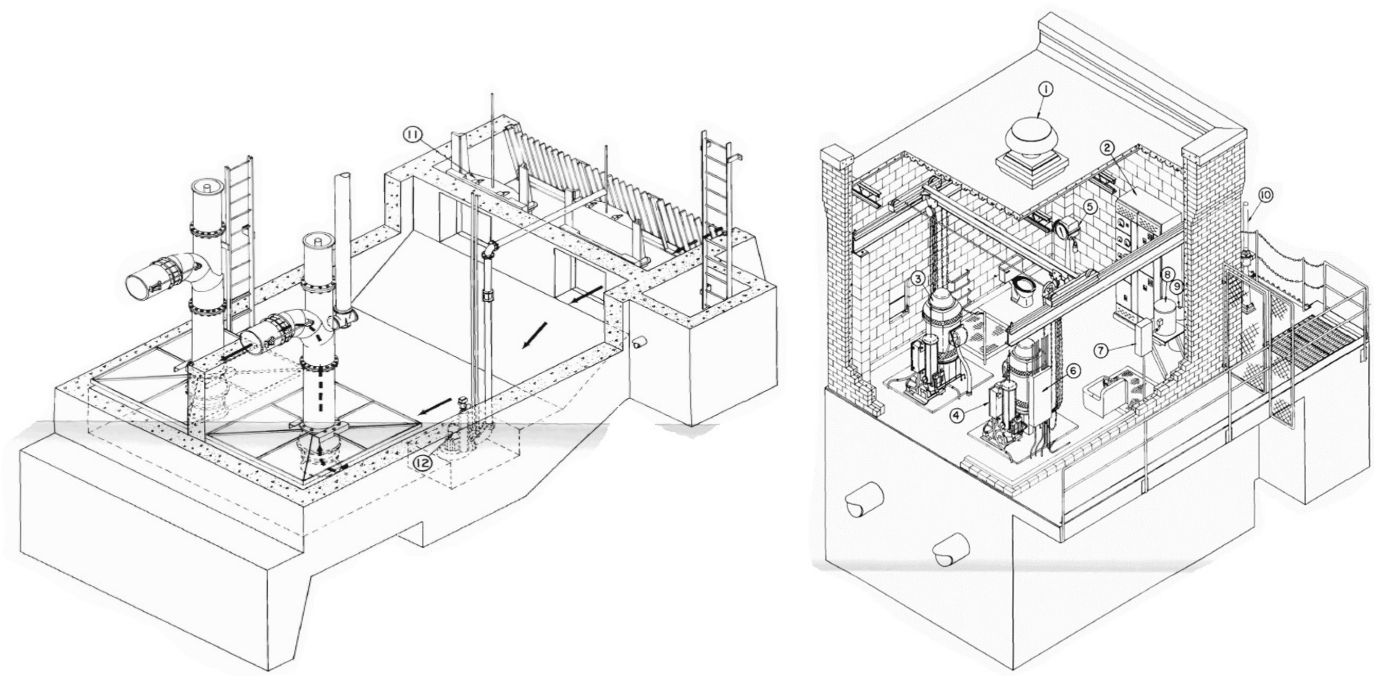

Figure 2 - Pump Station Layout (Franey Lake Pump Station)

2.1.1. Pumps

Submersible motor-driven wet pit pumps have an electric submersible motor close coupled to the impeller of the pump. Both the motor and pump are submerged. This arrangement is typically more compact and simplified than a conventional pump because the need for a long shaft to couple the motor to the pump is eliminated. The pump will be suspended above the sump floor inside of a vertical tube that extends to the operating floor. The tube allows placement and removal of the pump and forms part of the discharge piping.

Figure 3 - Submersible Pump and Pump Tube

2.1.2. Motors and Engines

2.1.2.1. Electric motors

Submersible motors have been used very effective in smaller stations where economy of design is significant. Thermal sensors should be provided to monitor the winding temperature for each stator phase winding. A leakage sensor should be provided to detect the presence of water in the stator chamber. If the possibility exists that rodents may enter the sump, special protection should be provided to protect the pump cable(s).

2.1.2.2. Diesel engines

Diesel engine drives can require more maintenance and be more complex to operate. The proposed pumping stations would use a vertical pump with a right-angle gear to transmit power from the horizontal engine shaft to the vertical pump shaft, as seen in Figure 4. A diesel engine system will also require additional equipment such as a radiator or heat exchanger for the cooling system, and fuel tanks for storage, as seen in Figure 5.

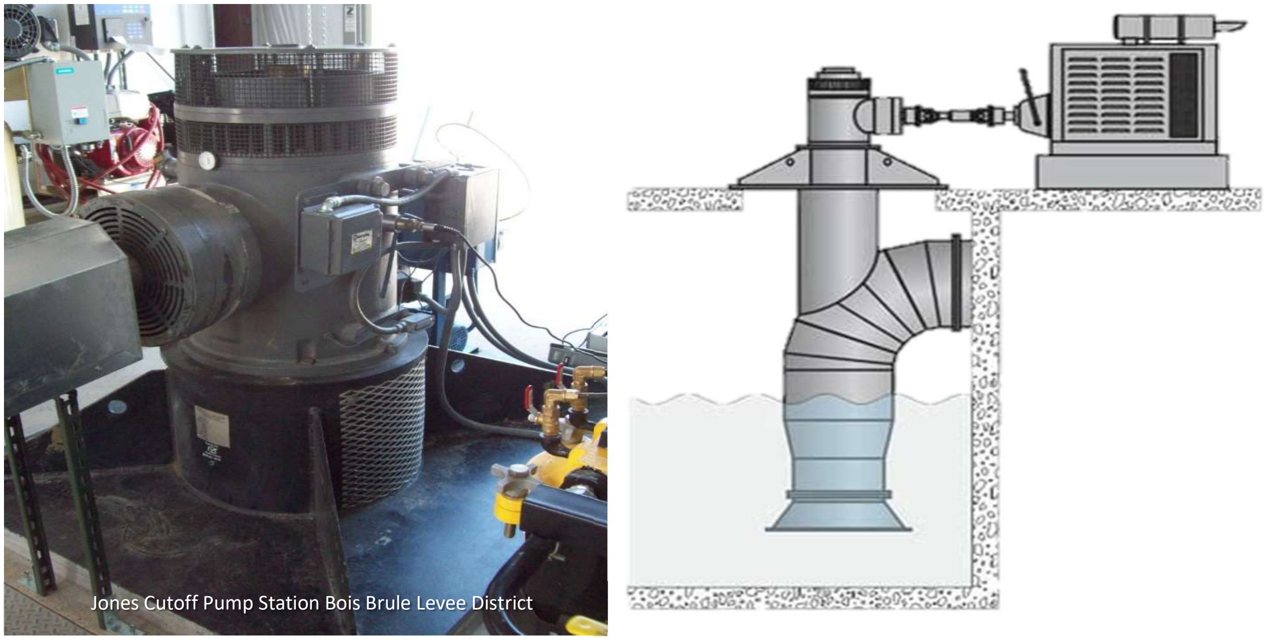

Figure 4 - Diesel Engine Powered Pump

Figure 5 - 2,000 gal Fuel Oil Storage Tank

2.1.3. Sluice Gates

Slide gates are located in the sump to control the flow of water to the pumps. Manual sluice gates are proposed for the Oakwood Bottoms pump station. Manual gates are considered over automatic to provide a less complex system because of the infrequent operation of the station. Once the water in the ponding area has increased, and the station is put into operation, the sluice gates can be manually operated to allow water into the sump. The sluice gates will need to be maintained in a condition wherein the full range of operation is insured. Maintenance will include lubrication, cleaning procedures, and cycling to insure optimal operation. It is standard to install trash racks between the inlet channel and the sluice gates to protect both the gates and the pumps from incoming debris. Cleaning of the trash racks will be required for maintenance.

Figure 7 - Inlet Section

Figure 6 - Cast Iron Sluice Gate

2.1.4. Controls

Float control devices can be included in the pump station for automatic start/stop of the pumps. The float switches are encapsulated in a polypropylene casing and are activated when the longitudinal axis of the float is horizontal, and is de-activated when the water level falls one inch below the activation level. The float switch, located in the sump, serve as an interlock that will stop the pump and/or prevent the pumps from operating if the water level in the sump falls below the pump low water cut-off elevation. This device is shown in Figure 8.

Figure 6- Low Water Cutoff Float Switch

2.2. Well Pumps

Four additional well pumps are proposed for Oakwood Bottoms. These pumps will be vertical centrifugal turbine pumps with an electric motor. They will pull water from underground aquifers and discharge them into the desired units. Figure 9 shows the configuration of a typical deep well pump, as well as an older, existing well pump that is reaching the end of its design life. It is proposed to replace these older well pumps because they are undersized and inefficient for the project. The design of the pumps will be standardized to allow for interchangeable parts. This can benefit maintenance and maintenance costs.

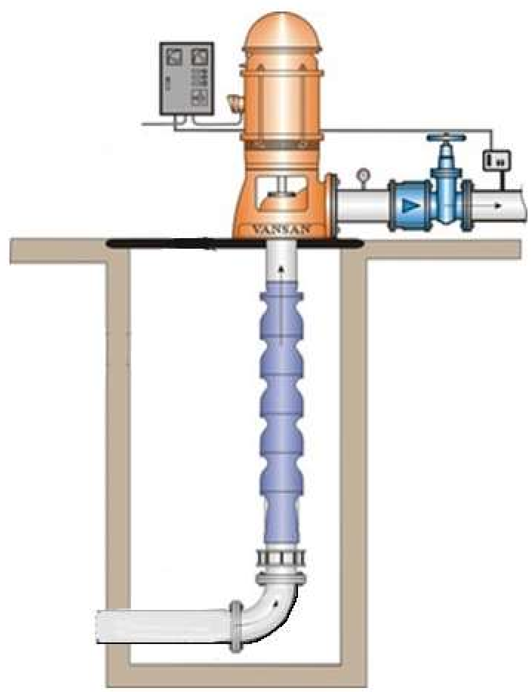

Figure 7- Well Pumps

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US Army Corps of Engineers. (1995, February). Engineer Manual 1110-2-3102. *General Principles of Pumping Station Design and Layout.*

US Army Corps of Engineers. (1999, November). Engineer Manual 1110-2-3105. *Mechanical and Electrical Design of Pumping Station.*