Chapter 7
Discharge Arrangement

7-1. General

The method and structures required to transport pumping station discharge are determined largely by the type of protection works adjacent to the pumping station, the location of the station with relation to existing sewers, and the desirability of avoiding layouts involving pressure conduits, especially under levees on yielding foundations. Pressure conduits can be avoided by carrying the discharge over the levees by individual pipes. If the protection works consist of a floodwall, pressure conduits should be avoided by locating the pumping station on the protection line and making the discharge through the riverside wall of the pumping station into a gravity conduit or open discharge chamber. If the pumping station is offset from the floodwall, special arrangement of the discharge pipes may be required. The designer should review EM 1110-2-3104 and EM 1110-2-1913, Chapter 8, and coordinate the discharge arrangement with the structural and geotechnical engineers.

a. Pipe connected to pumps. In general, a single pipeline should be installed and direct-connected to each pump. In the case of pumping stations of small capacity (315 ℓ/sec (5,000 gpm) or less), two pumps may be connected to the same line. The connection should be made inside the pumping station or a valve vault outside of the pumping station by a fitting. Check valves and gate valves should be inserted in the connecting line between the fitting and the pump to prevent reverse flow through an idle pump when the other pump(s) are operating.

b. Number and location of flexible couplings. Flexible couplings should be used wherever the pipe runs into or out of concrete structures, at bends or miters, and at other points where differential settlement or normal expansion and contraction of the pipe are anticipated. Where the pipe leaves the station wall, the first flexible coupling shall be located not more than 1 m (3 ft) from the wall. A second flexible coupling should be located no further than 2 m (7 ft) from the first.

7-2. Discharge Over the Levee

Due to the large settlement which may occur, discharge over levees should be limited to metal pipes, preferably ductile iron or coated steel, suitable for use with flexible couplings. Concrete conduits and precast reinforced concrete or reinforced sewer pipe are not satisfactory. The invert of the highest point of the discharge line should be the same as the top of the protective works at the pump station site.

a. Siphonic discharge lines. Over-the-levee discharge lines should be studied to determine if their use as a siphon is economical. Usually a siphon can be justified on power saved due to the lower head when primed. Pumps should be selected to operate over the entire range of heads provided by siphon usage. The pumping unit shall be capable of self priming the discharge pipe. Two types of discharge pipe terminations are used for siphon systems: concrete structures with a weir to submerge the pipe end or a turned up end (saxophone) discharge pipe (Plates 10 and 11). Both types are acceptable, and selections can be based on costs of construction and operation. Valves on the end of the discharge pipe should not be used to hold a siphon in the pipe. Plates 4 and 5 show a plant built within a levee with a siphon discharge.

b. Air vents. All over-the-levee discharge lines should be provided with an unobstructed (free) air vent at the highest point. Suitable protection should be provided to prevent the vent being rendered inoperative by vandalism.

c. Pipe supports. Pipe may be supported on the surface of the levee and should be completely covered by mounding, except on the riverside of the levee where the pipe should be placed in a trench to avoid concentration of levee erosion by flood flows. Covering the pipe in this manner affords protection against displacement, facilitates maintenance of levee surfaces, and provides access over the pipe for pedestrian or vehicular traffic.

7-3. Pressure Discharge Lines

Installing pumping station discharge lines under or through levees or floodwalls and subjecting these lines to flow under pressure should be avoided whenever possible. It is realized, however, that conditions may exist which require or dictate their use. As an example, a large discharge line may be carried under a floodwall when right-of-way for a pumping station would necessitate several bends. When it is not practicable to avoid a pressure line under the levee or wall, the pipe will have ample strength and be provided with joints that will provide flexibility with restraint to limit axial movement. Whenever it is necessary to install discharge lines under or through levees or floodwalls, seepage protection should be provided as required in EM 1110-2-1913.

7-4. Backflow Prevention

The type of pumps usually used for flood control pumping stations provide practically no restrictions to backflow. A suitable means must be provided to prevent backflow in the pump discharge lines. In planning pumping installations, the practices outlined below should be followed.

a. General. The basic requirement for pump discharge lines, in which backflow can occur without siphon action, is to provide two means of preventing backflow--one means for normal use and the other for emergency use in the event of failure of the normal method. The emergency method may consist of either a means of bulkheading the end of the pipe, or, in special cases, a separate shutoff valve on the discharge line.

b. Discharge chamber. For discharge lines terminating in the discharge chamber adjacent to the station, flap valves alone may be considered adequate protection against backflow for normal operation. The design of the structure should afford access to the valves at all flood stages. The discharge chamber should have slots for bulkheads at the exit of the chamber and at each flap gate location. The walls of the discharge chamber should be constructed to at least the protection elevation. This will allow, in the event of the failure of a flap gate, bulkheads to be placed at the exit of the chamber and dry access to repair the disabled flap gate.

c. Over levee or floodwall. Discharge lines over the levee or floodwall should have the invert of the high point of such discharge lines at or above the design protection elevation, except where unusual conditions exist that would justify deviation. All such deviations must be approved by higher authority. All discharge lines of this type should be provided with an emergency means of stopping backflow if the river stage should exceed the invert elevation of the highest part of the discharge line. A means to allow application of compressed air, from an emergency source, to the high point of the discharge line would be an acceptable method. Discharge lines having the invert at a lower elevation than the design protection elevation must be provided with a valve located at the high point of the discharge lines. The valve should be accessible at all flood levels and may require motor operation if the discharge pipe size is greater than 450 mm (18 in.) in diameter. In addition to the motor-operated valve, a manual-operated valve of the same size is required.

d. Under protective works. When discharge lines running under protective works cannot be avoided and the pipes are terminated in a headwall, flap valves alone are considered inadequate. If flap gates are used, a separate well should be constructed to the protection elevation from which access to the flap valve, comparable to that described above for a discharge chamber, is possible. This structure should be located and designed such that during periods of idleness of the pump station the tendency for silt, loose rock, debris, and floatable material to collect in sufficient amount to interfere with gate operation is minimized. An alternate procedure would be to provide a shutoff valve in each discharge pipe in addition to the flap gate.

e. Underground discharge lines. Underground discharge lines in small pumping stations should have a check valve on each pump discharge line to prevent backflow. Gate valves should always be provided on the discharge side of such check valves to permit maintenance of the check valves. Where butterfly valves are installed in bypasses between river and sump, a slide gate or emergency bulkhead over the riverside orifice of the bypass, or a gate valve on the riverside of the butterfly valve, should be provided for emergency closure of the bypass.

f. Emergency closures. Emergency closures may require a removable bulkhead or stoplogs. These should be furnished where openings need to be closed in a short time period. In such cases, slots should be provided in the walls of the passage to be closed, with provisions made for placing and removing the closure parts. Stoplogs and bulkheads should be made of noncorrosive material of ample strength to sustain the imposed loads. They should be provided with hooks to permit handling by means of a lifting device. Bulkheads should be designed for placement under all operating conditions using a mobile crane if required by the weight of the bulkheads.

7-5. Outlet Structure

An outlet structure should be constructed at the end of the pipes in order to protect the levee from erosion due to the pump discharge and the river current. Typical outlet structure designs are contained in EM 1110-2-3104. Since in most instances the pump will be in operation only at times when the streamflow is above the discharge outlet, the effect of erosion from the discharge is minimized. In most instances a concrete structure consisting of headwall, wing walls, apron, and cutoff wall will suffice. Rip-rap protection of the bottom and side of the discharge channel should be provided to protect the levee against erosion. The pump discharge channel should be sloped to drain away from the discharge structure. A combination discharge and reverse flow shut off gatewell

located on the riverside of the levee may be an economical arrangement, and is desirable in view of the protection afforded the shutoff gates. Where structures are accessible to children or the general public, wall heights should be minimized or pipe railing or other barriers should be installed.