2.4S.8 Cooling Water Canals and Reservoirs

The following site-specific supplement addresses COL License Information Item 2.17.

A description of the site can be found in Subsection 2.4S.1.1. A topographic map and the locations of major structures of STP 3 & 4 can be found in Figures 2.4S.1-3 and 2.4S.2-4. Figure 2.4S.8-1 shows the aerial view of the site and the Main Cooling Reservoir (MCR). This section discusses the cooling water canals and reservoirs at the STP 3 & 4 site. Each unit uses an Ultimate Heat Sink (UHS) to remove heat load during normal operation, safe shutdown and design basis accident conditions. Each STP 3&4 unit has a counterflow mechanically induced draft cooling tower with six cooling tower cells, of which two cells are dedicated to each of the three RSW divisions. Each UHS consists of a dedicated mechanical draft cooling tower with three independent divisions. The UHS basin is sized for a water volume adequate for 30 days of cooling under design basis accident conditions. The primary source of makeup water to the UHS cooling towers are site wells and the backup source is the MCR. Further details on and the safety evaluation of the UHS are provided in Subsection 9.2.5. There are no safety-related canals or reservoirs associated with the operation of the UHS for STP 3 & 4. All of the facilities described in the following sections are part of the existing STP 1 & 2 (Reference 2.4S.8-1).

2.4S.8.1 Cooling Water Canals

2.4S.8.1.1 Main Cooling Reservoir Channels

The STP 3 & 4 Circulating Water Intake Structure is located in the north dike of the MCR on the south side of the STP 1 & 2 Circulating Water Intake Structure, while the STP 3 & 4 Circulating Water Discharge Structure is located on the west side of the STP 1 & 2 Circulating Water Discharge Structure (Figure 2.4S.8-1). The MCR has two existing nonsafety-related water channels, which were designed originally for four units: the circulating water intake channel and the discharge channel. Each channel leads to its respective structures for STP 1 & 2. The intake channel is locally modified to accommodate the approach channel to the STP 3 & 4 intake. No modification is made to the discharge channel for STP 3 & 4. Each of the existing channels have a bottom width of 1000 ft. The bottom of the intake channel varies between El. 20.5 ft MSL and 22.0 ft MSL. The bottom of the discharge channel is at El. 22.0 ft MSL. The side slope of both channels is 3:1 horizontal: vertical (H:V) (Reference 2.4S.8-1). These channels are not safety-related. Since these channels are normally submerged, they are not subjected to the direct effects of wind-wave activity (Reference 2.4S.8-1). The addition of the new intake and discharge structures for STP 3 & 4 does not affect the operation or design of the MCR channels.

2.4S.8.1.2 Main Cooling Reservoir Spillway Discharge Channel

The purpose of the MCR spillway discharge channel is to transfer the spillway releases from the MCR to the Colorado River. The channel has a bottom width of 150 ft and an average depth of 12 ft with side slopes of 5:1 H:V. It has a slope of about 0.2% along its length and an approximate length of 5220 ft (Reference 2.4S.8-1). The addition of STP 3 & 4 does not affect the operation or design of this nonsafety-related channel.

2.4S.8.1.3 Makeup Pump Station

The existing makeup intake structure, located by the Colorado River, is called Reservoir Make-up Pumping Facility (RMPF) and is a shared facility for STP 1 & 2 and STP 3 & 4. The RMPF was originally designed for four units, but was only equipped for STP 1 & 2. To facilitate the addition of the STP 3 & 4, the makeup intake structure is upgraded to include additional pumps, screens, and rakes in the spaces previously allocated. The makeup pump station's function is to provide makeup water to the MCR and is also nonsafety-related. The addition of STP 3 & 4 does not result in an increase in the original makeup intake design flow rate of 1200 cfs, which is for a four-unit operation. The intake channel provides a passage of water from the Colorado River to the makeup pump station and continues to the MCR by using the existing facilities. For STP 3 & 4, no modifications were necessary to the intake channel. Regular maintenance activities on the channel are performed, such as desilting to clear the flow path to the pumps.

2.4S.8.2 Reservoirs

There are two reservoirs at the STP site. One reservoir is a 46-acre Essential Cooling Pond (ECP) that serves as the UHS for STP 1 & 2, and it is not affected by the construction or operation of STP 3 & 4. A detailed description of the ECP is provided in Reference 2.4S.8-1. The second reservoir is a 7000-acre MCR that is shared by STP 1 & 2 and STP 3 & 4, and is a nonsafety-related facility. The MCR is part of the Circulating Water System (CWS) used by STP 3 & 4 to dissipate the heat rejected during normal plant operation. Make-up water from the Colorado River will be required to replace evaporative water losses, seepage loss, and blowdown discharge from the MCR. The embankment surrounding the MCR is constructed of compacted clay fill. The embankment has an exterior slope of 3:1 H:V and an interior slope of 2.5:1 H:V on the reservoir side. The top of embankment varies from elevation 65.8 ft MSL to 67.1 ft MSL (Reference 2.4S.8-1). To prevent the possibility of bypass of the cooling process, an interior dike was constructed of compacted clay fill with 2.5:1 H:V side slopes on both sides. The reservoir side of the peripheral embankment and both sides of the interior dike are lined with a 30-inch-thick layer of soil-cement to protect against erosion and it has a characteristic stepped surface that provides additional roughness. The outside of the peripheral embankment is sodded for erosion protection.

The normal maximum operating level within the MCR, the reservoir capacity, and the embankment height are unaffected by the CWS intake and discharge structures for STP 3 & 4 because the MCR design normal maximum operating level of 49.0 ft MSL is maintained. Based on the available historical data for the MCR water level elevation from February 1985 to July 2006, the minimum water level observed was 27.7 ft MSL on June 6, 1985 during the initial filling of the MCR. If the first year of observations that reflects the initial filling in of the MCR is excluded, then the minimum water level observed was 33.4 ft MSL on November 11, 1987. The maximum water level was observed as 47.6 ft MSL on July 3, 2003. Based on the historical data, the normal operating water level is 47.0 ft MSL for STP 1 & 2, which is less than the MCR design normal maximum operating level of 49 ft MSL. For STP 3 & 4 operation, the MCR normal maximum water level is maintained at 49.0 ft MSL. The minimum operating level is at 25.5 ft MSL (Reference 2.4S.8-1). The bed level of the MCR ranges approximately between El. 16.0 ft MSL at the southern end to El. 28.0 ft MSL at the northern end (Subsection 2.4S.4.2.2.2). Details about drought events resulting in low flows in the Colorado River, the source of makeup water for the MCR, are addressed in Subsection 2.4S.11.

2.4S.8.2.1 New CWS Intake and Discharge Structures

The new CWS intake structure for STP 3 & 4 is approximately 400 ft wide and 130 long and it is located on the east side of the interior dike, approximately 350 ft south east of the existing CWS intake structure. The new discharge structure for STP 3 & 4 is approximately 200 ft wide and 60 ft long, and it is located on the north embankment of the MCR, approximately 1000 ft west of the existing discharge structure (Figure 2.4S.8-1). Both the new intake and discharge structures are nonsafety-related structures.

2.4S.8.2.2 Spillway

A spillway is located on the southeast corner of the MCR embankment. Its purpose is to release water exceeding the normal maximum operating storage of the reservoir at an elevation of 49.5 ft MSL. The spillway is a gated concrete ogee overflow-type structure. The crest of the ogee is at elevation 40 ft MSL with four 6-foot wide by 9.5-foot high slide gates, constituting a total of 24 feet of spillway crest length. The spillway and blowdown discharge are described in Reference 2.4S.8-1. The spillway is a nonsafety-related structure and the addition of STP 3 & 4 has no effect on the operation or design of the spillway.

The maximum water surface elevation of the MCR is calculated by routing the Probable Maximum Precipitation (PMP) over the MCR through the reservoir. The procedures for developing the PMP are described in Reference 2.4S.8-2 (Subsection 2.4S.2). This storm will produce a total rainfall of 55.7 inches in 72 hours over the MCR, with a maximum hourly rainfall of 16.2 in. Other parameters taken into account for the storm routing are: area and capacity curves of the MCR, procedures for operating the flood gates of the spillway, initial water surface elevation in the MCR, which is set equal to the normal operating water level of 49 ft, and rating curve of the spillway. Details of these parameters are provided in Reference 2.4S.8-1. The addition of STP 3 & 4 has no effect on these parameters.

This analysis resulted in a maximum MCR water surface elevation of 52.6 ft MSL. With the lowest elevation of the top of the perimeter embankment at elevation 65.80 ft MSL, it is concluded that there is sufficient freeboard at the MCR. A discussion on the embankment freeboard is presented in the following subsection.

2.4S.8.2.3 Embankment Freeboard

The wind setup, wave height, and run-up elevation were determined for a 2-year wind speed with appropriately adjusted duration, in conjunction with the maximum still water level in the MCR. The wind setup elevation is estimated for a wind speed resulting from the Probable Maximum Hurricane (PMH) and the normal maximum operating level in the MCR. As shown in Figure 1 of ANSI 2.8-1992 (Reference 2.4S.8-3), the 2-year mean recurrence interval annual fastest mile wind speed measured 30 ft above ground at the STP site is 50 mph. From Subsection 2.4S.5, the overwater maximum wind speed of the PMH is estimated to be 137.5 knots or 158.2 mph. According to Reference 2.4S.8-4, page C-12, this value corresponds to the maximum 10-minute average wind speed measured at 32.8 ft (10 m) for a hurricane at rest. These values were adjusted for duration, wind speed above water, and fetch length, as applicable, before wave heights were determined.

The wind set-up, wave height, and run-up elevation were estimated at eight different locations along the MCR embankment. Six of the locations are similar to that considered in the STP 1 & 2 UFSAR (Reference 2.4S.8-1). These locations are: the STP 3 & 4 intake and discharge structures, the makeup outfall, the spillway, the southeast, south, southwest, and north embankments. Sketches of the fetch for each location are depicted in Figures 2.4S.8-2 to 2.4S.8-5.

Methodologies described in the U.S. Army Corps of Engineers, Coastal Engineering Manual (Reference 2.4S.8-5) and in Reference 2.4S.8-6 were used to determine the wave height, run-up, and wind setup elevation at the embankment of the MCR. Also, appropriate checks were made to examine if the waves are duration-limited or fetch-limited. Finally, the waves were not limited by water depth (Reference 2.4S.8-5).

To obtain the maximum wave run-up elevation for the 2-year wind conditions on the MCR embankment, the wave run-up values based on the 1% wave height, were added to the maximum still water elevation of the MCR of 52.6 ft MSL determined in Subsection 2.4S.8.2.2, as recommended by ANSI 2.8-1992 (Reference 2.4S.8-3, Section 10.2.3). For all cases, the maximum water level due to wave run-up calculated is El. 58.38 ft MSL, which is significantly below top of embankment elevation and therefore sufficient freeboard is provided.

The average wind set-up value of 1.6 ft for the PMH was added to the normal maximum operating water level of the MCR of 49 ft MSL. The resulting stillwater level of 50.6 ft MSL is lower than the water level used in the analysis of the embankment breaching in Subsection 2.4S.4. The MCR is a nonsafety-related structure and the impacts of its failure on STP 3 & 4 have been addressed in Section 2.4S.4. All the safety-related structures are designed to withstand the flood levels of the postulated failure of the MCR embankment.

2.4S.8.2.4 Seiche in Main Cooling Reservoir

A seiche is a standing wave in an enclosed or partially enclosed body of water and can be caused by changes in wind and/or barometric pressure. The passage of a hurricane over a water body can cause such an effect. Assuming that a hurricane will pass over the MCR, the change in wind and pressure fields will create waves on the water surface. When the forces causing the wind/pressure changes stop, seiche oscillations on the water surface might appear.

The frequency of oscillation is a function of the forcing, together with geometry and bathymetry, of the system. For the case of the MCR, it is assumed that the PMH passing over the site is the forcing mechanism of the seiche. The maximum significant wave height induced by the PMH wind is estimated close to 13.0 ft with a spectral wave period of 4.7 seconds. When the external force creating this wave ceases to act, the water surface will oscillate. The spectral period of this wave is significantly smaller than the natural frequency of the MCR, following Reference 2.4S.8-6, which is estimated approximately as 22 minutes. Therefore, due to frictional effects, the energy of the oscillation will disperse and the raised water surface will decrease after each oscillation (Reference 2.4S.8-5).

In conclusion, the amplitude of the seiche oscillation will not be significant because the maximum wave height that can trigger a seiche motion is below the top of the MCR embankment.

2.4S.8.3 References

2.4S.8-1 "STPEGS Updated Final Safety Analysis Report (UFSAR) for Units 1 & 2," Revision 13.

2.4S.8-2 "Probable Maximum Precipitation Estimates, United States, East of the 105th Meridian," Hydrometeorological Report No. 51, National Oceanic and Atmospheric Administration (NOAA), June 1978.

2.4S.8-3 "Determining Design Basis Flooding at Nuclear Power Reactor Sites," ANSI 2.8-1992, Historical Technical Reference, American Nuclear Society, July 1992.

2.4S.8-4 "Engineer Manual 1110-2-1412, Storm Surge Analysis and Design Water Level Considerations," U.S. Army Corps of Engineers, April 15, 1986.

2.4S.8-5 "Coastal Hydraulics Laboratory, EM1110-2-1100, Coastal Engineering Manual," U.S. Army Corps of Engineers, June 2006.

2.4S.8-6 "Advanced Series on Ocean Engineering – Volume 16, Introduction to Coastal Engineering and Management," J. William Kamphuis, World Scientific, 2000.

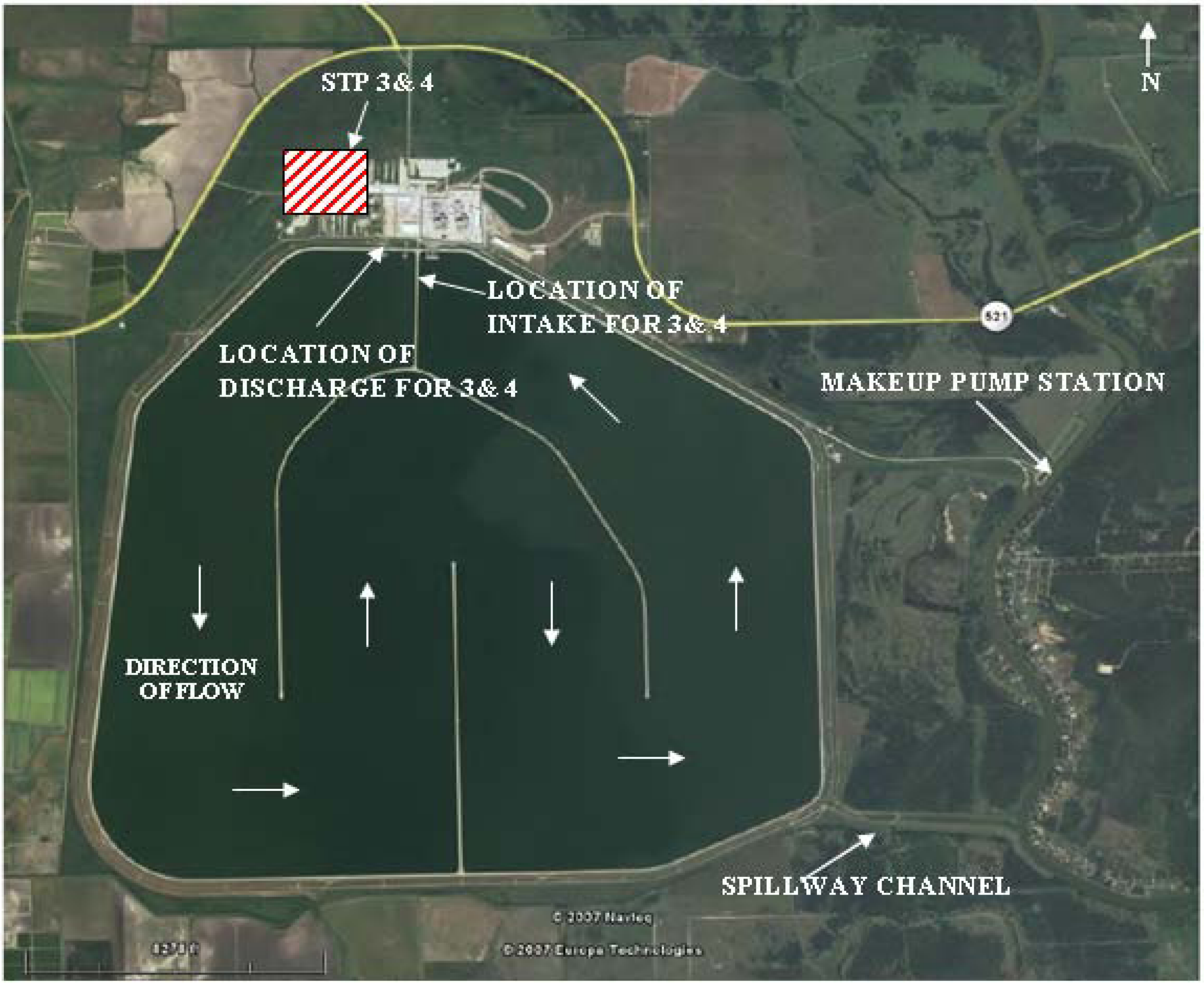

Figure 2.4S.8-1 Aerial View of the Site

Source: Google Earth® (v2007).

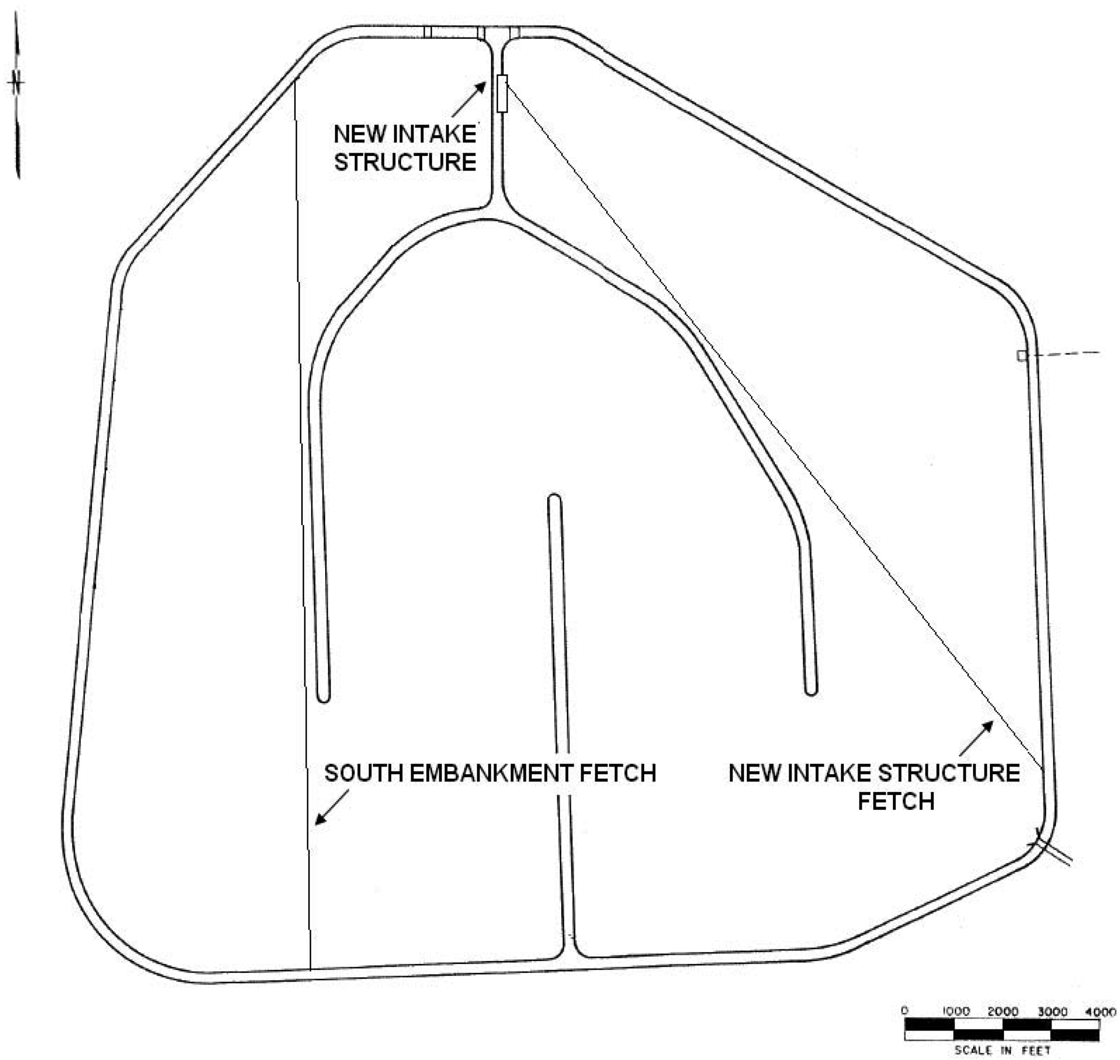

Figure 2.4S.8-2 Determination of Fetch at the New Intake Structure and at the South Embankment

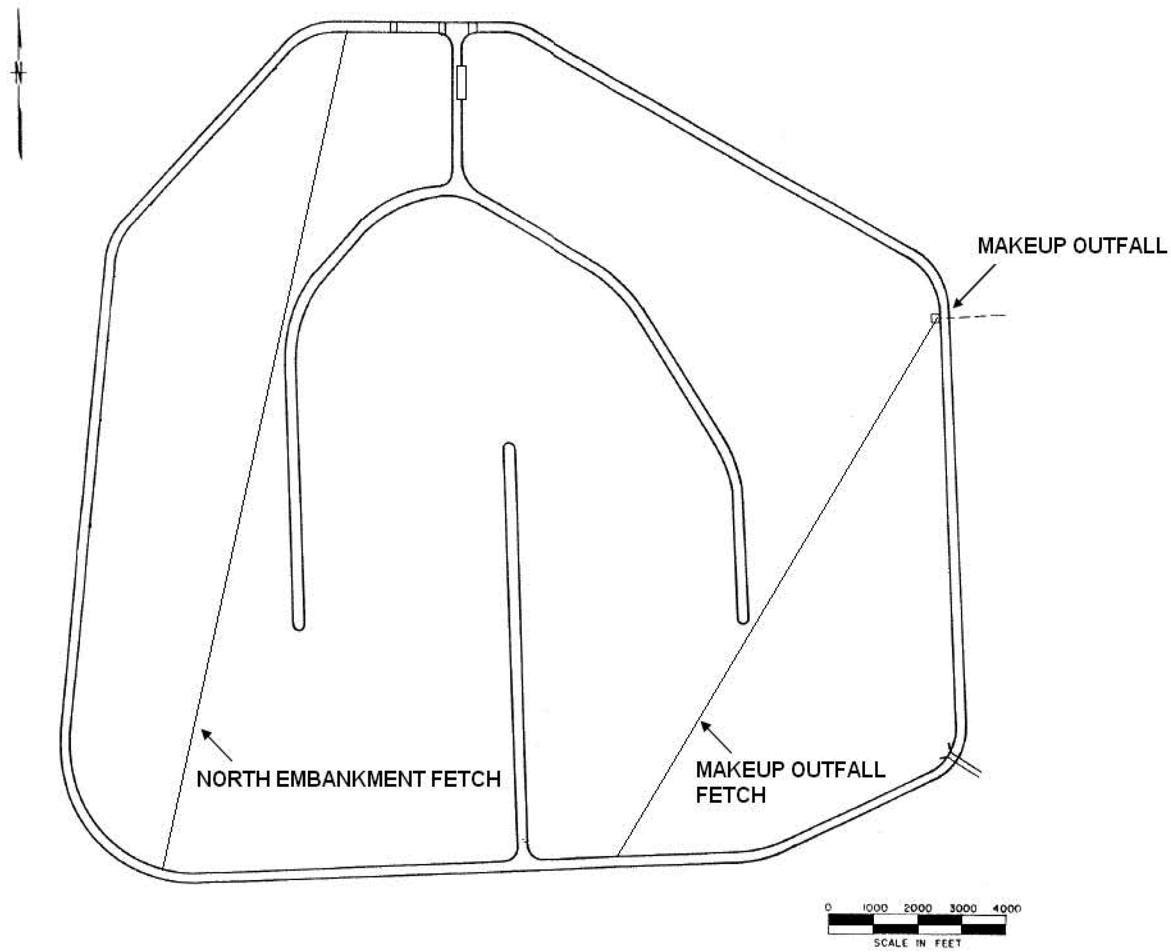

Figure 2.4S.8-3 Determination of Fetch at the Makeup Outfall and at the North Embankment

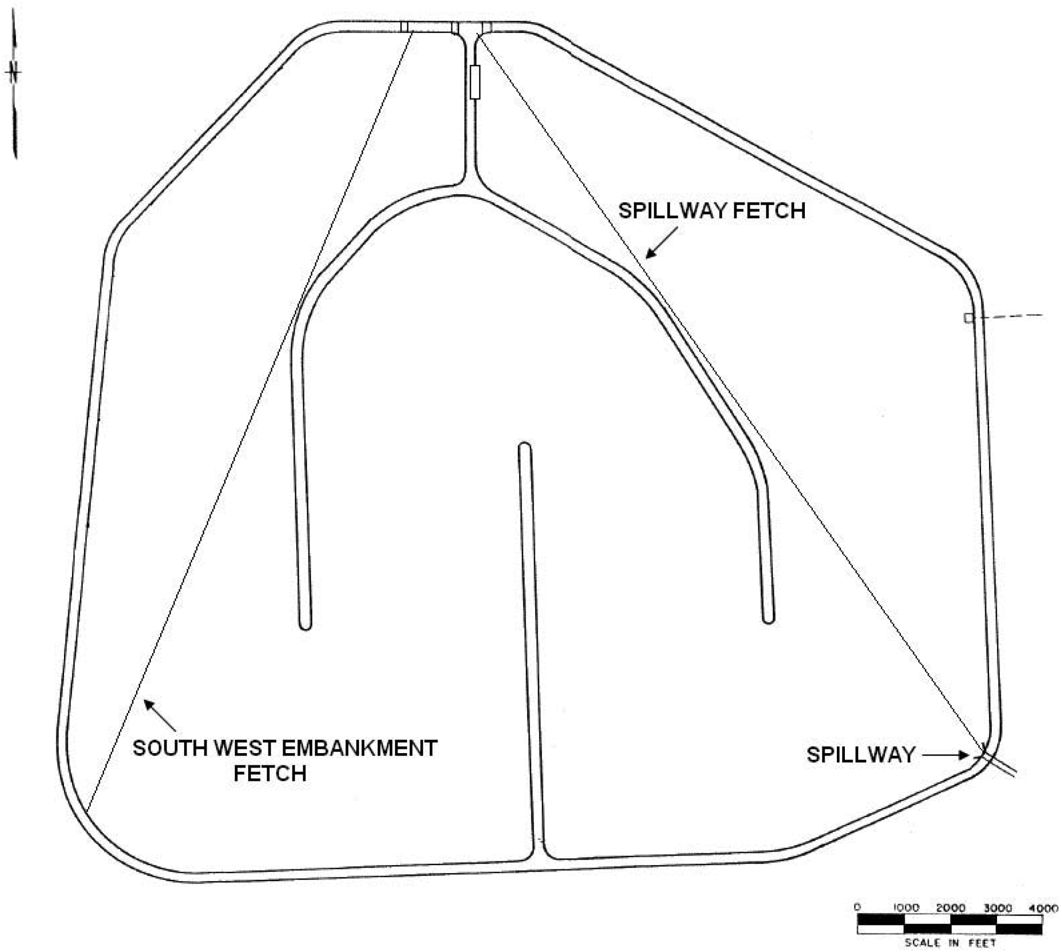

Figure 2.4S.8-4 Determination of Fetch at the Spillway and at the South West Embankment

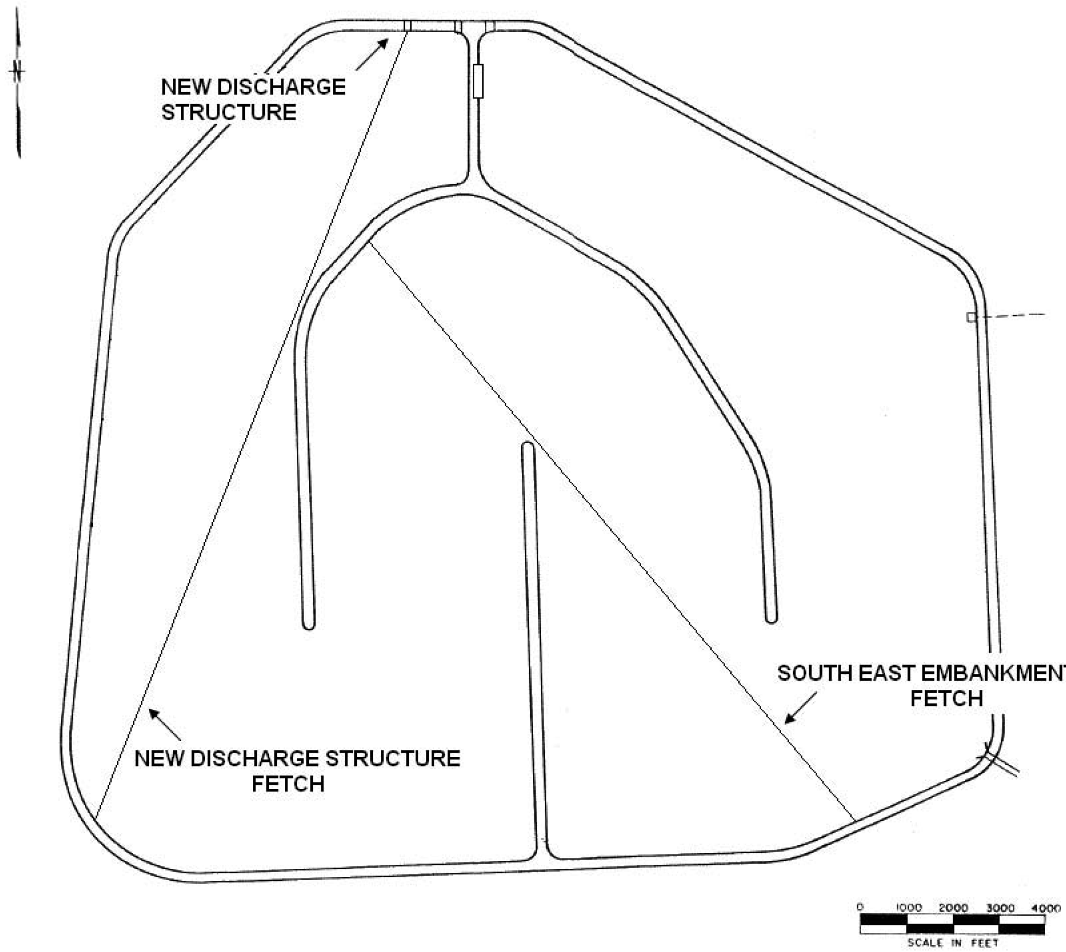

Figure 2.4S.8-5 Determination of Fetch at the Southeast Embankment and at the New Discharge Structure