VII - WATER CONTROL PLAN

7-01 **General Objectives**. The overall objectives of the Seven Oaks Dam Water Control Plan are 1) to provide flood control on the lower Santa Ana River below Prado Dam by reducing peak inflow and volume into Prado reservoir, and to communities between Seven Oaks and Prado, 2) to mitigate for project impacts upon downstream water users, 3) to support downstream environmental mitigation and enhancement and 4) to support the prototype testing program.

7-02 **Operation Constraints**. There are no major constraints on the operation of Seven Oaks Dam under the Water Control Plan. Mechanical problems and other minor deficiencies have been observed since the completion of the dam and during its initial operation. These observed problems and their repairs are discussed in detail in Section 3-07. Minor operation constraints that have developed as a result of these problems are discussed as follows:

a. Improper Seating of Outlet Gates. As discussed in Section 3-07.a., the low flow and RO gates need hydrostatic pressure upstream of the gates to seat properly against the frame seals for tight closure. As water initially enters the main tunnel, severe leakage will develop around the sides of the unseated gates. Once the pressure that develops from water filling the tunnel upstream exceeds the friction between the gate and invert seal, the gate can suddenly slip downstream along the invert babbit seal and slam against the gate frame. This results in a loud bang and could cause damage to the gate system. In order to prevent the gates from slamming against the frame during filling of the main tunnel, the gates need to be raised slightly to allow the upstream hydrostatic pressure to properly seat the gate onto the gate frame. This step to properly seat the outlet gates is part of the procedure to water up the tunnel prior to the operation of the sluice gate (Section 7-06.c).

b. Hydraulic Sluice Gate - Observed Drift. The sluice gate was designed to be in either a fully opened or fully closed position. Its installation therefore did not include a gate indicator. It was reported during initial operation that the gate had drifted downward from a fully open position after an extended period of time. However, this drift problem has not recurred. Without a gate indicator, it will be difficult to determine the extent of any future drift if this problem recurs. Periodic monitoring, through actual operation of the gate, is necessary to ensure that the gate is open to pass flows into the main wet well. Visual inspection of the gate position is not possible during real-time operation.

c. Outflow Limited to Leakage at Stoplogs. As part of the design for sedimentation allowance, stop logs will be placed along the upstream face of the multilevel withdrawal system wet well at the intake structure in order to minimize the amount of sediment entering the outlet works. The elevation range between the current reservoir invert to the top of the stop logs is called the "Sediment Pool". When the water surface elevation drops to within the sediment pool the outflow from the dam becomes limited to leakage through the stoplogs. At the time the project was turned over from the Corps of Engineers to the project sponsors, six stop logs were installed, blocking the lowest two rows of intake ports. The top of stop log, or the bottom of the lowest open port at turnover of this project is at elevation 2120.24 feet, NGVD.

d. Gate Chamber Fill Line Cavitation Noise. The fill line at Seven Oaks Dam was operated in November and December 2002. The first time was with a reservoir level of elevation 2160 feet and the second was at elevation 2131 feet. In both cases, the operators observed excessive noise with the opening and operation of the fill line valve. The operators also observed that the noise moved downstream along the fill line as the valve was opened. After a period of about 3 to 4 hours while filling the upstream (RO) conduit, the noise subsided and then became unnoticeable. After preliminary evaluation, the Corps identified the problem as cavitation. Currently, an interim procedure for operation of the fill line must be followed until the Corps completes the analysis of the problem and provides further recommendations. The interim operation procedure for the fill line is provided in section 7-06.b.

7-03 Overall Plan for Water Control. The primary objective of the Seven Oaks Dam Water Control Plan is flood control. There are elements in the flood control plan that address the needs of downstream water users. These mitigation features are contained in the debris pool portion of the operation plan. When conditions warrant, the plan also allows for the adjustment of releases above the debris pool to support downstream environmental mitigation and enhancement plans, and the prototype-testing program. The details of the overall Water Control Plan are provided in section 7-05.

7-04 Standing Instructions to Project Operator. Exhibit A contains the standing instructions to the project operator for regulation of Seven Oaks Dam and Reservoir. During periods of normal communications, the dam operators will receive operating instructions from the water control managers. In the event that communication with the water control managers is interrupted, the dam operators should follow the standing instructions. The numerical gate settings provided are based on gate rating curves as shown on Plates 7-02 to 7-06.

7-05 Water Control Plan. The Water Control Plan contained in this document was based on the flood control operation plan contained in the report entitled Phase II GDM on the Santa Ana River Mainstem including Santiago Creek, Volume 1- Seven Oaks Dam, dated August 1988, augmented to allow the modification of releases at water surface elevation ranges above the debris pool in order to operate for downstream environmental mitigation and enhancement plans when conditions warrant. In addition, when the opportunity exists, the regulation plan also allows minor modifications for the performance of the prototype-testing program. The Water Control plan is illustrated on Plate 7-01 and is described in detail as follows:

a. Sediment Pool. At the beginning of each flood season, stop logs will be added, as necessary, to block the lower inlet ports of the multilevel withdrawal system (MWS) wet well. This wet well leads to the minimum discharge line (MDL). Additional stop logs will be added as necessary to block the ports to a point about 20 to 30 feet above the active sediment level. This is done to prevent sediment from entering the intake structure and either blocking or damaging the MDL. The stop logs will form a "dead pool" and no operation will be possible, other than leakage through the stop logs when the water surface elevation is within the sediment pool. Additional stop logs may be installed during the flood season if sediment accumulation is greater than expected. During the initial years of operation, stop logs were installed to block the bottom two rows of intake ports at the MWS, making the invert elevation for the open row of ports 2120.24 feet, NGVD. As sediment accumulates and more stop logs are added, the Sediment Pool will shift upward. The elevation of the top of the sediment pool at turnover is shown also in Plate 7-01.

While the water surface is within the Sediment pool, outflow passes through the MDL. During the dry months, the minimum discharge extension line (MDLE) can be used to bypass the plunge pool. The MDLE is controlled by a 24-inch ball valve. This ball valve should not be used to regulate flows and must be either in a fully opened or fully closed position. Beginning 1 October of each year, releases from the dam within the sediment pool will be limited to a maximum of 3 cfs in order to allow the formation of the debris pool. Since this release rate can only be made through the MDL, the sluice gate is kept in a closed position in order to prevent sediment from entering the main tunnel.

b. Debris Pool. At the beginning of the project life, the design documents call for a debris pool up to elevation 2200 feet, NGVD. Throughout the project life, the allotted storage for sediment accumulation will be filled, new tops of debris pool elevation will be established. Towards the end of the project life, sediments will have accumulated up to the final invert elevation of the reservoir, which is 2265 feet, NGVD. The final top of debris pool elevation at the end of the project life will be the top of the trash rack structure elevation, which is at 2300 feet, NGVD. The adjustment of the debris pool during the project life is described in Section 7-06.a of this manual. Water stored within the debris pool is not available for environmental mitigation and enhancement plans.

As stated in the previous section, releases from the dam are reduced to a maximum of 3 cfs in order to form the debris pool starting 1 October of each year. This rate is to continue until the water surface elevation reaches the top of the debris pool elevation. During the first major storm of the year, if the water surface is expected to exceed the top elevation of the debris pool, preparation for releases through the main tunnel shall be made. This would entail equalizing the pressure between the main wet well and the MDL wet well, opening the sluice gate, and seating the RO and low flow gates. Procedures to perform these steps are outlined in Section 7-06.c. titled "Operating the Sluice Gate". Once opened, the sluice gate may remain open through the remainder of the flood season.

The debris pool is held until the end of the flood season, when it is drained on a schedule established in cooperation with the downstream water agencies during the development of the Phase II GDM. During the month of June, releases will equal inflow plus 10 cfs, and during the months of July and August, releases will equal inflow plus 20 cfs. The process of determining the proper release rate to drain the debris pool will involve trial and error, as the gates and valve settings will need to be constantly adjusted to release the calculated value. Also, these adjustments may be needed on a regular basis to accommodate varying inflow rates. By 1 September, the debris pool shall be completely drained, using higher than calculated release rates, if needed.

c. <u>The Intermediate Pool</u>. The intermediate pool elevations occur between the current top of the debris pool and the sill of the main intake, which is at elevation 2265 feet, NGVD. The Intermediate Pool is that portion of the flood control pool that lies below the sill of the main intake. The releases within this range should match inflow up to the maximum release capability of the project. The combined release capability of the low flow gate and the MDL in this range is approximately 400 to 500 cfs. Section 7-16 outlines the permissible rates of release change when increasing or decreasing outflow. If hydrologic conditions warrant (i.e., no forecasts indicating significant rainfall), releases can be modified/delayed in order to support operations for environmental mitigation and enhancement as discussed in section 7-05h.

d. <u>Main Trash Rack Pool (El. 2265 to 2299 feet, NGVD)</u>. The trash racks protecting the main intake are located between elevations 2265 and 2292.5 feet, NGVD. Within this range, releases are based only on the rising and falling pool elevations at Seven Oaks Dam. During the pool rising stages, releases, if required, will be cut back to a release that is considered to be the maximum safe rate through the MDL when the water surface elevation is between elevations 2265 and 2299 feet, NGVD. The reason for this is to avoid drawing floating debris into the trash racks and possibly rendering the main outlets inoperative. The 2299 elevation allows for sufficient submergence of the trash rack to avoid vortex formation. The maximum safe release rate, when the pool is rising, will be determined by project operating experience but is theoretically on the order of 50 cfs. During falling stages, releases will be made in accordance with the project design schedule as shown on Plate 7-01. These are theoretical maximum safe rates ranging up to 2000 cfs. If project experience indicates that floating debris is less of a problem than anticipated, the falling pool release rates may be increased. Conversely, if operational experience indicates that floating debris is more of a problem than anticipated then falling pool rates may be decreased. Section 7-16 outlines the permissible rates of release change when increasing or decreasing outflow. If hydrologic conditions warrant, releases can be modified/delayed in order to support operations for environmental mitigation and enhancement.

e. <u>Flood Control Pool (El 2299 to 2580 feet, NGVD)</u>. This is the pool between elevations 2299 feet, NGVD and the spillway crest at elevation 2580 feet, NGVD. Within the flood control pool, release rates from Seven Oaks Dam are based on concurrent conditions at Prado Dam. During flood events, Seven Oaks Dam will store water destined for Prado Dam as long as the reservoir pool at Prado reservoir is rising, and the pool at Seven Oaks Dam is not approaching the spillway. Once the reservoir water surface elevation at Prado Dam reaches its peak and starts to recede, Seven Oaks Dam releases will be made based upon the Seven Oaks Dam pool elevation, ranging from a minimum of 2,000 cfs at elevation 2299 feet, NGVD up to the maximum rate of 7,000 cfs at elevation 2580 feet, NGVD. Plate 7-01 contains the Water Control Diagram, which identifies the release schedule within this elevation range. Section 7-16 outlines the permissible rates of release change when increasing or decreasing outflow. It is important to note that within most of this range, the intake structure deck at elevation 2302 feet, NGVD, which is where the sluice gate control is located, will be submerged. If hydrologic conditions warrant, releases can be modified/delayed in order to support operations for environmental mitigation and enhancement.

f. Spillway Surcharge (El 2580 to 2604 feet, NGVD). Above elevation 2580 feet, NGVD uncontrolled releases over the spillway occur. During rising stages when uncontrolled releases are less than 7,000 cfs, releases from the outlet works will be adjusted so that the total project release (combination of spillway and outlet works releases) equals 7,000 cfs. When uncontrolled releases are greater than 7,000 cfs, no outlet works releases will be made. The spillway rating curve is shown on Plate 7-07. The maximum spillway design discharge is 180,000 cfs at elevation 2604.4 feet, NGVD, a surcharge depth of 24.4 feet. During falling stages, the outlet works gates can be adjusted to attempt to maintain the maximum spillway release rate resulting during the event, so as to assure the quickest evacuation of the remaining surcharge volume in anticipation of another significant flood.

g. Initial Reservoir Filling Plan. The Initial Reservoir Filling Plan is contained in a document entitled, "Initial Reservoir Filling Plan Seven Oaks Dam, San Bernardino County, California", dated July 2002. This plan presents a guide for surveillance of the Seven Oaks Dam project during periods of reservoir filling. It outlines inspection procedures, procedures for identifying warning signs of distress, actions to be taken, and data to be collected and analyzed. Visual inspections are required as new maximum reservoir water surface elevations or "critical elevations" are achieved. Geotechnical monitoring is then required to confirm the integrity of the embankment and the performance of the system of seepage monitors and controls. If these "critical elevations", which are determined prior to the start of each flood season, will be exceeded, the water control managers shall notify the personnel responsible for performing inspections as specified in the Initial Reservoir Filling Plan. A copy of the Initial Reservoir Filling Plan is included in this manual as Exhibit I.

h. Seven Oaks Dam Environmental Regulation. The construction, operation, and maintenance of Seven Oaks Dam required the determination of mitigation/enhancement for environmental impacts including those to endangered species. Due to limited knowledge of the habitat needs of endangered species downstream of the dam, and concerns related to what are the best measures to ensure survival of endangered species, Section 7 (of the Endangered Species Act) consultation with the USFWS resulted in a proposed array of alternative mitigation and enhancement measures. Therefore, operation of the dam includes mechanical movement of sediment deposited behind the dam to the downstream channel, physical measures in the downstream channel to generate periodic flooding of the overbank floodplain to mimic the pre-dam hydrologic processes (scour and deposition) upon which the endangered species are dependent, and monitoring of the ecological health of the endangered species.

A multi-agency steering committee such as the Woolly Star Preserve Area (WSPA) Steering Committee will use adaptive management techniques to annually determine and define for the project operator an environmental regulation to be followed should sufficient flood runoff occur. An example of this regulation may be that the pool within the reservoir will be held longer so that additional head will be available for releases greater than what is schedule in the water control plan. The WSPA, the Local Sponsors, and the U.S. Army Corps of Engineers will meet annually to adjust the environmental regulation plan as necessary. For instance, water might be retained during and immediately after a storm event for a period of several days, or a few weeks, while temporary diversion dikes are constructed downstream. Then, when the water is released, the temporary diversion dikes would direct flows onto specific areas of the WSPA or other target areas. Water may be stored behind the dam for a slightly longer period and, or at a higher elevation than would otherwise be required for flood control, to accomplish these mitigation aspects of the overall operation.

i. Prototype-Testing Program and Instrumentation. Because of the high head and complicated design of the structure, a model study was conducted at the U.S. Army Engineer Waterways Experiment Station (ERDC-WES) to evaluate the hydraulic design be measuring dynamic hydrostatic pressures in the outlet structure. In this study, zones of potential cavitation and air demand at the mid-tunnel were determined. At the same time, the adequacy of the intake tower, the outlet plunge pool, and the exit channel design was also evaluated. Also, the extent of scour and the need for protection downstream of the structure, and the discharge characteristics of the regulation outlet (RO) gates with various operating scenarios were determined from the model. As a result of this model study, a prototype testing program was developed.

Under the Water Control Plan, a prototype-testing program will be implemented, to gather data and verify actual performance of the outlet works with design parameters derived from the model study, once during a low reservoir condition as early in the project life as practical, and once during a high reservoir condition. The water control managers need to inform the Los Angeles District, Reservoir Regulation Section, so that coordination can be made with the Corps' Portland District Office in Portland, Oregon, in advance, every time that the opportunity for testing is expected to exist. The water control managers must maintain the Waterways Experiment Station (WES) POC's and telephone numbers each year prior to the start of the flood season. Exhibit F contains the details about the testing program and the instrumentation installed at the dam. A layout of the prototype hydraulic instrumentation is also on Plate 2-24.

7-06 **Other Operational Requirements**. The following are Seven Oaks Dam operational design criteria that need to be followed in the implementation of the Water Control plan in order to assure that the dam's safety is not jeopardized:

a. **Adjustment of the Debris Pool.** The debris pool was designed to accommodate estimated sediment accumulation, without the need for removal, through the 100-year service life of the project. According to the original design documents, the initial debris pool upper boundary is at elevation 2200 feet, NGVD, and the ultimate top elevation is at 2300 feet, NGVD. The design documents also show the initial debris pool to have a total storage volume of 2,968 acre-feet, and the ultimate debris pool to have a total storage volume of 839 acre-feet. During the life of the project, as the reservoir sediment level rises, stoplogs will be installed about 20 to 30 feet above the active invert. This will raise the elevation of the lower boundary of the debris pool. As a result, the top of the debris pool needs to be adjusted to maintain a storage volume between 839 and 2968 acre-feet until it reaches the ultimate elevation of 2300 feet, NGVD. At a minimum, the current top of debris pool elevation shall be adjusted whenever it is suspected that the current debris pool storage is reduced to near the ultimate storage value of 839 acre-feet. A reservoir survey should be conducted and the upper debris pool boundary shall be set to an elevation where the new debris pool storage will be approximately equal to the initial storage (2,968 acre-feet). Beyond the minimum, the debris pool may be adjusted as often as is desired by the water control managers in consultation with the Corps of Engineers, but shall in no case be less than 800 acre-feet nor exceed 3,000 acre-feet.

b. Procedures for Avoiding Cavitation at the 12-inch Recharge Line (Filling Line). As mentioned in section 7-02.d., a problem with noise in association with cavitation was discovered at the 12-inch recharge line when the water surface elevation within the MWS wet-well exceeded elevation 2130 feet, NGVD. An interim procedure, until the Corps completes the analysis of the problem and provides further recommendation, shall be followed to temporarily relieve this problem. The procedure is as follows:

1. Monitor the head in the MDL using either of the cone valve piezometers with all flows shut off.
2. As soon as there is sufficient head in the MDL for the filling line to operate (approximately 2095-2100 feet, NGVD), open the filling line to pressurize the upstream portion of the main tunnel. When the RO gates are sufficiently submerged, seat the RO and LF service gates by opening them one at a time to 0.1 ft for a few seconds then closing them.
3. Leave the filling line open for the remainder of the flood season. Keep the service gates closed for the remainder of the flood season except

when making releases when the pool is above 2130 feet, NGVD. The pool inside the main wet well should match the pool inside the MWS wet well fairly well even with the sluice gate closed. This should maintain sufficient back-pressure to avoid or minimize cavitation in the filling line. Releases from the cone valves will need to be adjusted in coordination with the downstream water users to compensate for leakage through the service gates.

4. When the MWS wet well water surface elevation is below elevation 2130, the sluice gate should be closed to avoid having sediment and floating debris enter the main tunnel.
5. When the MWS wet well water surface elevation is above 2130, the sluice gate should be open so that the outlet works will be capable of passing releases greater than 90 cfs. [Note: As a precaution, prior to opening the sluice gate, ensure that the heads between the MWS wet well and the main wet well are balanced. Refer to section 7-06.c.4.]
6. When emptying the debris pool after a flood event, as the pool drops below 2130, NGVD, make sure that the main gates are closed before closing the sluice gate. This will assure that there is sufficient pressure to seat the gates.
7. If cavitation in the fill line becomes significant even with the fill line valve open, the fill line valve should then be closed. If fill line valve is closed, it should be reopened as part of step 6, after closing the main gates and before closing the sluice gate. The dam tenders should keep detailed notes of any cavitation that occurs in the filling line, including the start times, stop times, readings from all the piezometers and a qualitative description of the cavitation (i.e., minor, severe, etc.). These notes should be entered into the operations report form (Figure 5-01) and also reported to the water control managers.

c. Operating the Sluice Gate. The procedure for operating the sluice gate can be found within the Seven Oaks Dam Operation, Maintenance, Repair, Replacement &

Rehabilitation (OMRR&R) Manual, Appendix C (Standard Operating Procedures), and also summarized within this section. The wet well sluice gate is located in the multi-level withdrawal system wet well at the entrance to a 6'x6' conduit that leads to the main wet well (Plate 2-08). During periods of low flow, the MDL is used to pass flows and the sluice gate is normally closed to prevent flow and damaging sediment from entering into the main wet well and the main tunnel. As inflow increases and the water surface elevation rises, the RO and LF gates in the main tunnel are needed to discharge at rates higher than the MDL alone can pass. In order to use the main tunnel when the water surface elevation is lower than 2265 feet, NGVD, the sluice gate needs to be opened. Prior to opening the sluice gate, however, a head differential of no more than 2.5 feet between the MWS wet well and the main wet well should exist[1]. If the 12-inch Recharge Line (filling line) has been closed, and the tunnel is dry, the following outlined procedures must be followed for operating the sluice gate prior to and after the use of the main tunnel for releases (as project experience is gained, this procedure shall be modified, if necessary):

1. Verify that the RO and LF gates are in a closed position. Cut off MDL releases using either the two cone valves located in the valve structure, or the 24-inch MDL ball valve located in the gate chamber. Normally the cone valves will be used as the ball valve is for emergency shut off only.
2. As soon as there is sufficient head in the MDL for the filling line to operate (approximately 2095-2100 feet, NGVD), open the filling line to pressurize the upstream portion of the main tunnel. When the RO gates are sufficiently submerged (approximately 2109.1 feet, NGVD), seat the RO and LF service gates by opening them one at a time to 0.1 ft for a few seconds then closing them.

---

[1] When balancing the head below elevation 2120 ft, NGVD, piezometers located just upstream of the MDL valves and the main tunnel outlet gates can be used to determine when the required head differential is achieved prior to operating the sluice gate, as described. Piezometers located within the main wet well and the MWS wet well can read the head differential starting at elevation 2120 ft, NGVD.

3. Allow the tunnel to fill completely and let the water surface elevation within the main wet well build in order to balance the head with the MWS wet well.
4. The dam tenders are able to determine water surface elevations within the main wet well and the MWS wet well through the digital readout of the transducers that sense the pressure in the piezometer tubes located just upstream of the MDL valves and the main tunnel outlet gates. *[Notes: 1) All gates must be closed in order to obtain proper digital readouts from the transducers that sense pressure from the piezometer tubes; 2) the piezometer lines need to be bled of air in order to obtain an accurate reading. Refer to Exhibit E for instructions on bleeding piezometer lines; 3) Refer to Table 2-1 for determining which operational piezometer can be used for taking readings.]*
5. Upon achieving a balanced head where the water surface differential does not exceed 2.5 feet between the main tunnel wet well and the MWS wet well, open the sluice gate completely.
6. The LF and/or the RO gates can now be used for discharging higher flows. The rate of release change restrictions and the minimum and maximum allowable gate opening restrictions described in sections 7-16 and 7-17 should be followed.

d. <u>Dewatering the Main Tunnel</u>. At the end of the flood season when it is expected that the RO and LF gates will no longer be needed, the sluice gate should be closed and the main tunnel drained. The following procedures shall be followed:

1. Close the MDL valves.
2. Close the RO and LF gates.
3. Close the sluice gate.
4. Close the filling line valve.
5. Open the LF or RO to drain the remaining water in the tunnel, at a rate that is as close as possible to the required release rate until the tunnel is drained.

6. Open the MDL valves to the required release rate.

There is a 12-inch diameter RO air vent pipe that serves as the vacuum breaker if the main tunnel is dewatered while the bulkhead is in place. The air vent pipe extends from the RO gate to the top of the intake structure. The air intake contains a float to prevent debris from plugging the air pipe when the intake structure is inundated. No operation is required for the air vent pipe function.

e. Dewatering the Downstream MDL Conduit. For maintenance, inspection and emergency purposes, dewatering of the MDL conduit downstream of the ball valve is accomplished as follows:

1. Shut off flow in the MDL using the two cone valves located in the valve structure.
2. Close the ball valve located in the gate chamber.
3. Open the two cone valves in the valve structure to dewater the downstream end of the MDL.

Note: A combination vacuum breaker/air release valve is located downstream of the ball valve to provide relief during emptying or filling of the downstream MDL conduit. The siphon breakers function automatically, allowing air to enter the MDL during closure of the ball valve to prevent collapse of the MDL pipe.

The 4-inch diameter embedded air vent pipe serves as the vacuum breaker if the MDL is dewatered while the MDL bulkhead is in place. The MDL air vent pipe extends from the upstream portion of the 3-foot diameter MDL pipe, and connects with the RO air pipe just below the top of the intake structure. No operation is required for the air vent pipe function.

f. Procedures for Installing and Removing the Bulkhead Gate for the Upstream Main Conduit. Outlet bulkhead guide slots are located in the wet well at the entrance to the main conduit. When not in use, a bulkhead is stored inside the storage slot on the intake structure. The bulkhead provides the capability to seal and drain the main tunnel to allow inspection or maintenance activities in the portion of the main tunnel upstream of the RO gates. The bulkhead is lowered into or raised from the bulkhead guide slots using a truck mounted mobile crane positioned on the deck of the intake structure. A balanced head condition must exist on either side of the bulkhead gate when installing or removing the bulkhead gate. The elevation of the deck of the intake structure is at 2302 feet NGVD, which is the highest water surface elevation at which the bulkhead can be installed or removed. The bulkhead has been designed to withstand a maximum of 202 feet of head behind the reservoir, however, if the bulkhead is in place and there is a possibility of the water surface exceeding elevation 2302, it should be removed immediately. If installation of the bulkhead gate is not possible, then the emergency gates (ROG3, ROG4, and LF2) can be lowered in order to inspect the service gates.

The following are steps to be followed for installing the RO maintenance bulkhead. Reference must be made to the Seven Oaks Dam Operation, Maintenance Repair, Replacement & Rehabilitation (OMRR&R) Manual, Appendix C-2, for detailed installation procedures.

1. If the sluice gate is open, close it in preparation for dewatering the main tunnel, as outlined in section 7-06.d.
2. If the reservoir water surface elevation is below elevation 2265 feet, NGVD, allow the main conduit to drain by opening either the RO or LF gates. If the reservoir water surface elevation is above elevation 2265 feet, NGVD, close the RO and LF gates to create a still water condition.
3. Once the conduit is empty or a still water condition exists, lower the bulkhead into the wet well using a truck mounted mobile crane positioned on the deck of the intake structure.

If there is water in the upstream conduit, drain the upstream portion of the tunnel. In order to do this, first check the vent line to make sure it is clear and then gradually open the RO and/or LF gates.

Once inspection or maintenance is complete and the bulkhead needs to be removed. The following are steps, depending on the conditions of the reservoir and the main wet well, to be followed for installing the RO maintenance bulkhead. Reference must be made to the Seven Oaks Dam Operation, Maintenance Repair, Replacement & Rehabilitation (OMRR&R) Manual, Appendix C-2, for detailed removal procedures:

Condition A – No Water in the Main Wet Well

1. If the main wet well is dry, remove the bulkhead using a truck mounted mobile crane positioned on the deck of the main intake structure.

Condition B – Water in the Main Wet Well – Pool above 2265 feet NGVD

1. If there is water in the main wet well close RO and LF gates. Make sure the sluice gate is open.
2. Cut off MDL releases using the cone valves located in the valve structure.
3. Fill the upstream tunnel using the 12-inch filling line (Refer to section 7-06.b.)
4. Pressure between the main wet well and the conduit downstream of the bulkhead gate will be equal when there is no more flow through the filling line and/or when the piezometer in the main wet well reads the same as the piezometer just upstream of the gates. The dam tenders are able to obtain readouts for these piezometers which are located at the gate chamber and at the control house downstream of the outlet tunnel.
5. When pressure is equal between the main wet well and the conduit downstream of the bulkhead gate, remove the bulkhead gate using a

truck mounted mobile crane positioned on the deck of the intake structure.

Condition C -- Water in the Main Wet Well - Pool below elevation 2265

There are two scenarios where this condition could occur: 1) The main wet well was initially drained but leakage has partially filled it, and 2) The main wet well water surface elevation has fallen below 2265 while the bulkhead has been in place. If the difference in elevation between the main wet well and the MWS wet well is less than 2.5 feet, then the sluice gate can be opened and the procedures for Condition B can be followed. If the difference is greater than 2.5 feet, then two further scenarios can occur: 1) the water surface in the main wet well is higher than in the MWS wet well and 2) the water surface in the main wet well is lower than in the MWS wet well.

It is possible, but unlikely that the water surface in the main wet well will be more than 2.5 feet higher than the water surface in the MWS. This scenario can be avoided if the valves in the MDL are closed and or the sluice gate is opened if the reservoir pool falls below 2265 feet, NGVD while the bulkhead is in place. If for some reason this scenario does occur, there is no direct way to balance the water surfaces in the main wet well and the MWS. The valves in the MDL should be closed and then water control managers will have to wait until leakage through the aggregate access bulkhead, the sluice gate and the bulkhead gate equalize the two water surfaces. If this doesn't work then other possible solutions would be: 1) to pump water out of the main wet well until the water surfaces come within 2.5 feet of each other and 2) use the filling line to fill the main tunnel, close the filling line valve, then pump additional water into the air vent line to increase the pressure in the upstream tunnel to match the main wet well. Then the bulkhead gate could be removed.

A more likely scenario would be that the water surface in the main wet well is more than 2.5 feet lower than that of the MWS. This could happen if the reservoir pool is below elevation 2265 and significant amounts of water leak from the sluice gate and the aggregate access bulkhead into the main wet well. In this case the following procedure should be used:

1. Close the MDL valves and the LF and RO service gates.
2. Open the filling line valve.
3. Carefully monitor the piezometers that measure the water surface elevation in the main tunnel (O-6, O-7, and O-8). Close the filling line valve when the head in the tunnel matches the water surface in the main wet well.
4. Use a truck mounted crane to remove the bulkhead gate.

g. <u>Procedures for Installing and Removing the Bulkhead Gate for the Upstream Conduit of the MDL</u>. The procedure for installing and removing the MDL bulkhead gate can be found within the Seven Oaks Dam Operation, Maintenance Repair, Replacement & Rehabilitation (OMRR&R) Manual, Appendix C-3, and also summarized within this section. Bulkhead guide slots are located in the MWS wet well at the entrance to MDL conduit in order to allow inspection and maintenance of the upstream portion of the MDL conduit. Since the elevation of the deck of the MWS is at 2276 feet NGVD, this is the highest water surface elevation at which the bulkhead can be installed or removed. The bulkhead has been designed to withstand a maximum 202 feet of head behind the reservoir should the water surface start to rise after it is in place. If there is a possibility of the water surface rising to elevation 2276 feet NGVD while the bulkhead is in place, it should be removed immediately. Additional information regarding the bulkhead is provided within the Seven Oaks Dam Operation and Maintenance Manual, dated August 2002.

1) <u>Installing the MDL Bulkhead</u>. When installing the bulkhead, a dry or still water condition must exist. If there is water in the reservoir a still water condition can be achieved by closing the cone valves controlling the MDL and by closing the RO and LF gates controlling the main conduit. <u>Note that the sluice gate must be open while the MWS bulkhead is in place.</u> If the sluice gate is not open it will not be possible to balance head between the two wet wells with the MDL out of service. If head between the wet wells cannot be balanced, then the sluice gate cannot be opened and the filling line cannot be used to balance heads upstream and downstream of the bulkhead. If these heads cannot be balanced, then it will not be possible to remove the bulkhead. Refer to Section 7-06.c. for procedures to open the sluice gate. Once a still water condition has been achieved and the sluice gate is open, the bulkhead can be installed in its guides just above the intake and can be lowered by a truck mounted crane positioned on the intake structure deck. The MDL can then be drained by opening one or more of the cone valves. A 3-inch-diameter vent line connects to the MDL conduit just downstream of the bulkhead for air to enter when emptying the MDL conduit.

2) Removing the MDL Bulkhead. In order to remove the MWS bulkhead, a balanced head condition must exist upstream and downstream of the bulkhead. This is achieved by watering up the MDL, and connecting it hydraulically with the MWS wet well. In order to do this, first the cone valves controlling the MDL and the LF and RO gates controlling the main conduit are closed. Then the butterfly valve controlling the 12-inch filling line is opened. When flow through the filling line ceases a balanced head condition will exist. A 3-inch-diameter vent line connects to the MDL conduit just downstream of the bulkhead to allow air to escape when filling the MDL conduit. If, for some reason it is not possible to water up the MDL with the filling line it can also be watered up by pumping water in through the air vent. If hydraulic communication cannot be achieved between the MWS wet well and the MDL, piezometers O-5, O-9 and O-10 can be used to determine when a balanced head condition has been achieved. Once a balanced head condition has been achieved, the bulkhead can be raised by a truck mounted crane positioned on the intake structure deck.

h. Operational Hydraulic Instrumentation. Table 2-1 and Plate 2-24 individually list and show, respectively, the operational hydraulic instruments, their locations, types, intake elevations, and elevations of the pressure transducers. These piezometers and pressure transducers can be utilized to verify reservoir water surface elevation, head differential between the wet well and the MWS wet well, check for trash blockage, among other uses. If the tap for a piezometer dries out between readings, air will enter the line and the piezometer will have to be "bled" before the next reading can be taken. Exhibit E contains the procedures for bleeding piezometer lines.

i. Channel Observation. Prior to making significant releases, the Seven Oaks Dam water control managers will notify the San Bernardino and Riverside Flood Control Districts. Each respective flood control districts will assign channel observers at their discretion. The downstream flood control districts will be asked to report any downstream problem areas, the available channel capacities, and other observed information that is vital to the operation of Seven Oaks Dam.

7-07 Recreation. The Water Control Plan does not include regulation of the dam for recreational purposes.

7-08 Water Quality. The Water Control Plan does not include operation for water quality. During emergencies, however, the water control manager can operate Seven Oaks Dam to contain pollution spills either in or dilute spills downstream of Seven Oaks Dam and reservoir. The local sponsors perform water quality monitoring in the reservoir as part of their operation and maintenance responsibilities. Details of this monitoring may be found in the Seven Oaks Dam Operations and Maintenance Manual. The U.S. Fish and Wildlife Service, the Santa Ana Watershed Project Authority (SAWPA), the California Regional Water Control Board, and local water agencies monitor the various aspects of water quality in the Santa Ana River basin.

7-09 Fish and Wildlife. The Water Control Plan includes provisions to allow operation above the debris pool for environmental mitigation and enhancement, specifically for the listed species downstream. The water used for this purpose would come from the flood flows stored in the intermediate, main trash rack, and the flood control pools. Details of this operation are contained in section 7-05h.

7-10 Water Supply. The operational objectives of the Seven Oaks Dam Water Control Plan include flood control, dam safety, mitigating for impacts to downstream water users and environmental mitigation and enhancement. Water supply is not an operational objective of the Seven Oaks Dam Water Control Plan. Details of how the water control plan mitigates impacts to downstream water users may be found in section 7-05.b.

7-11 Hydroelectric Power. Seven Oaks Dam is not operated for the generation of hydroelectric power.

7-12 Navigation. There is no navigation possible at Seven Oaks Dam reservoir or on the Santa Ana River.

7-13 Drought Contingency Plans. Seven Oaks Dam is a Section 7 project. It does not require a Drought Contingency Plan.

7-14 Emergency Action Plans. The Emergency Action Plan for Seven Oaks Dam is contained in a document entitled "Emergency Action Plan for Seven Oaks Dam, San Bernardino County, California", dated June 2001. The scenarios developed include a dam breach and spillway flow conditions. Flood inundation maps downstream of Seven Oaks Dam are included in the document. The plan also covers identification of impending and existing emergencies, notification of other parties about impending or existing emergencies, emergency operations and repairs, and post earthquake response procedures. Copies of this plan are maintained in the OCPF&RD Storm Operation Center and also in the Corps of Engineers, Reservoir Regulation Section, Reservoir Operation Center.

7-15 Deviation from Normal Regulation. Deviations from the approved Water Control Plan contained in this manual may be necessary at times because every possible circumstance cannot be anticipated by the plan. Deviations from the approved water control plan are allowed under some circumstances to address unforeseen and unique circumstances. They are not intended as a means for identifying or initiating new opportunities to re-operate or reallocate storage in response to new and changing public needs.

Because of the often competing goals and complex interactions of interested groups and agencies, even seemingly inconsequential deviations from an approved plan can lead to unforeseen environmental and legal complications. Therefore, except during emergencies, all deviations from this Water Control Plan require prior approval from the U.S. Army Corps of Engineers' South Pacific Division office in San Francisco, California (SPD). Requests for Deviations from the approved Water Control Plan will be submitted to SPD through the U.S. Army Corps of Engineers Los Angeles District office (SPL). The SPD regulation "Guidance on the Preparation of Deviations from Approved Water Control Plans" (CESPD R 1110-2-8) dated 12 September 2002 provides guidance for preparing deviation requests, and outlines a minimum set of considerations that need to be addressed when requesting a deviation from the approved plan contained in this manual. Exhibit G contains a copy of CESPD R 1110-2-8. This guidance defines two forms of deviations, namely, emergency deviations and planned deviations. These two types of deviations are summarized below.

a. Emergency Deviations. An emergency deviation from the approved Water Control Plan is one that is required due to an emergency situation. An emergency situation is defined in CESPD R 1110-2-8 as a situation in which there is a potential for injury, loss of life, threat to the project, or other serious hazards; but furthermore, also demanding immediate action, such that time constraints render impractical notification to the Corps. Depending upon the need for immediate action, an emergency situation could include: drowning and other accidents, assistance to local authorities responding to an emergency (e.g., police and fire departments), failure of operations facilities, chemical spills, treatment plant failures, and other temporary pollution or water quality problems. Since water control actions necessary to abate the problem are to be taken immediately, emergency deviations do not require prior approval from SPD. However even in an emergency situation, the Corps needs to be notified of the action as soon as possible, and the notification shall comply with all the applicable requirements as outlined in CESPD R 1110-2-8 (Exhibit G). Notifications shall be made by the Seven Oaks Dam water control managers to the SPL Reservoir Regulation Section, which will in turn notify SPD.

b. <u>Planned Deviations</u>. Planned deviations cover all other deviations not addressed by an emergency deviation. Planned deviations require prior approval from the Corps' Division Office. Deviation requests are to be made by the project owner through the SPL Reservoir Regulation Section. Costs incurred by the Corps of Engineers associated with the processing of a deviation request are the responsibility of the local sponsors. Information and analysis required in a deviation request package are outlined SPD R 1110-2-8 (Exhibit G).

7-16 <u>Rate of Release Change</u>. The maximum permissible rate of change in the release rate depends upon the magnitude of the current release. When increasing or decreasing the release, consideration shall be given to the possibility of downstream impacts such as structural damage to downstream improvements, levee or bank sloughing due to rapid bank de-watering and public safety. Furthermore, the water control managers, or project operators, prior to any significant changes in releases, must notify other government agencies, and affected parties (refer to sample notifications list in Exhibit H). Table 7-1 outlines the recommended maximum permissible rate based on SPL experience with similar projects having unimproved downstream channels. Note that conditions in the downstream channel (erosion, overbank flow, etc.) may require a slower rate of change of release. The project operators and/or channel observation teams may be directed by the water control managers to observe the effects of increased flows upon downstream channel conditions in order to determine if any adjustments are necessary in the rate at which releases are changed.

7-17 <u>Minimum and Maximum Gate Openings</u>. The minimum and maximum gate openings for both the RO and LF gates are shown on Table 7-2 below. A minimum gate opening is required to avoid gate vibration. Small gate openings coupled with high velocities can result in a water surface that remains close to the bottom surface of the gate lip. This flat water surface can intermittently contact the bottom of the gate lip causing the point of control to shift rapidly, resulting in vibration and damage to the gate. A maximum gate opening is required in order to minimize the possibility of pressurizing the downstream gate passage and losing control at the gates. If the downstream passage pressurizes it could result in zones of low pressure and interference with the aeration of the gate discharges. This would increase the risk of cavitation damage.

Table 7-1. Maximum Permissible Rate of Release Change at Seven Oaks Dam

Discharge (cfs)	To Increase Flow (cfs/hour)	To Decrease Flow (cfs/hour)
0 – 200	NO RESTRICTION	NO RESTRICTION
UP TO 500	250	250
500 - 4,000	500	500
4,000 - 8,000	1000	1000

Table 7-2. Minimum and Maximum Gate Openings Seven Oaks Dam

Gate Type	Minimum Gate Opening (ft)	Maximum Gate Opening (ft)
Main Regulation Outlet (RO)	0.75	6.8
Low Flow (LF)	0.5	2.8