Chapter 7
Groundwater

7.1 Environmental Setting/Affected Environment

7.1.1 Potential Environmental Effects Area

The Delta, Suisun Marsh, and the Central Valley overlie parts of several extensive groundwater basins that play key roles in local and regional water supply. The groundwater basins are influenced to various degrees by complex physical relationships in the affected areas.

- Rivers draining the Coast Ranges and the Sierra Nevada convey water into the Central Valley and Suisun Marsh, interconnect with the underlying groundwater basins, and eventually flow into San Francisco Bay. The Sacramento River Hydrologic Region overlies the Sacramento Valley groundwater basin. The San Joaquin River and Tulare Lake hydrologic regions overlie the San Joaquin Valley groundwater basin, and the San Francisco Bay Hydrologic Region (including the Suisun Marsh) overlies the Suisun-Fairfield Valley groundwater basin.
- Private individual groundwater wells provide for the majority of the residential potable water source for~~Water is supplied to~~ several of the Delta communities ~~of~~ such as Clarksburg, Courtland, Freeport, Hood, Isleton, Rio Vista, Ryde, and Walnut Grove~~ by groundwater~~, and the largely agricultural San Joaquin Valley is dependent on groundwater to support agricultural and municipal demands (see Chapter 6, *Surface Water*).
- Some water flowing through the Delta is exported by the SWP/CVP to areas outside the Delta (see Chapter 5, *Water Supply*), and the availability of these water supplies influences the groundwater use and conditions of those areas. Groundwater basins in the Export Service Areas underlie several hydrologic regions in central and southern California, including parts of the San Joaquin, San Francisco Bay, Tulare Lake, Central Coast, Southern California, and Colorado River hydrologic regions.
- Throughout the potential effects area, geologic history and conditions strongly influence groundwater flow and aquifer recharge.
- Subsidence, such as peat soil compaction, can result from several mechanisms related to hydrogeologic conditions.

The existing groundwater conditions in the Delta Region, the Suisun Marsh, the Upstream of the Delta Region, and the SWP/CVP Export Service Areas are described to support discussions of environmental consequences (Section 7.3, *Environmental Consequences*) associated with potential changes resulting from the construction of project water conveyance and related facilities and implementation of CM2–CM~~22~~21 in the Delta Region, as well as other indirect effects on groundwater resources stemming from the long-term operations and existence of these facilities and restored areas.

7.2 Regulatory Setting

7.2.2 State Plans, Policies, and Regulations

7.2.2.4 Basin Adjudications

Table 7-5. Adjudicated Groundwater Basins in BDCP Project Area~~Southern California~~

Basin Name	Date of Final Court Decision	County	Hydrologic Region
Beaumont Basin	2004	Riverside	South Coast/ Colorado River
Brite Basin	1970	Kern	Tulare Lake
Central Basin	1965	Los Angeles	South Coast
Chino Basin	1978	San Bernardino	South Coast
Cucamonga Basin	1978	San Bernardino	South Coast
Cummings Basin	1972	Kern	Tulare Lake
Goleta Basin	1989	Santa Barbara	Central Coast
Main San Gabriel Basin: Puente Narrows	1973	Los Angeles	South Coast
Mojave Basin Area	1996	San Bernardino	South Lahontan
Puente Basin	1985	Los Angeles	South Coast
Raymond Basin	1944	Los Angeles	South Coast
Rialto-Colton	1961	San Bernardino	South Coast
Santa Margarita River Watershed	1966	San Diego	South Coast
Santa Maria Valley Basin	2008	Santa Barbara, San Luis Obispo	Central Coast
Santa Paula Basin	1996	Ventura	South Coast
Six Basins	1998	Los Angeles	South Coast
Tehachapi Basin	1973	Kern	Tulare Lake~~South Lahontan~~
Upper Los Angeles River Area (including San Fernando Basin)	1979	Los Angeles	South Coast
Warren Valley Basin	1977	San Bernardino	Colorado River
West Coast Basin	1961	Los Angeles	South Coast
Western San Bernardino	1969	San Bernardino	South Coast

Sources: California Department of Water Resources 2003, 201~~1b~~4.

7.3 Environmental Consequences

7.3.3 Effects and Mitigation Approaches

7.3.3.2 Alternative 1A—Dual Conveyance with Pipeline/Tunnel and Intakes 1–5 (15,000 cfs; Operational Scenario A)

Delta Region

Impact GW-1: During Construction, Deplete Groundwater Supplies or Interfere with Groundwater Recharge, Alter Local Groundwater Levels, or Reduce the Production Capacity of Preexisting Nearby Wells

Construction of the conveyance facilities would require dewatering operations. The dewatering wells would be generally 75 to 300 feet deep, placed every 50 to 75 feet apart along the construction perimeter as needed, and each would pump 30–100 gpm. Dewatering for the tunnel shaft constitutes the deeper dewatering (300 feet deep) while the shallow (75 feet deep) dewatering is reserved for open trench construction; no dewatering is required along the tunnel alignment; and the 50–75 feet dewatering wells frequency distance applies to the pipelines, intakes, widened levees, the perimeter of the forebay embankments, the perimeter of excavation for the pumping plants, and the perimeter of tunnel shafts. <u>Tunnel shafts are assumed to be constructed using slurry diaphragm walls, and therefore require only minimal dewatering, as necessary. Construction of the tunnel shafts is not anticipated to result in significant impacts to surrounding groundwater as the dewatered zone will be hydraulically isolated from the surrounding aquifer system.</u>

Dewatering would occur 24 hours per day and 7 days per week and would be initiated 1 to 4 weeks prior to excavation. Dewatering would continue until excavation is completed and the construction site is protected from higher groundwater levels. Dewatering requirements of <u>the intake construction and construction of other major features along this alignment are estimated to range from approximately 34 gpm to 1,360 gpm.</u> ~~features along this alignment are assumed to range from approximately 240 to 10,500 gpm~~ (California Department of Water Resources 2010b).

Groundwater removed with the dewatering system would be treated as necessary and discharged to surface waters under an NPDES permit. Velocity dissipation features, such as rock or grouted riprap, would be used to reduce velocity and energy and prevent scour. Dewatering facilities would be removed following construction activities.

NEPA Effects: Dewatering would temporarily lower groundwater levels in the vicinity of the dewatering sites. Two areas could be subject to substantial lowering of groundwater levels: (1) ~~In~~ <u>in</u> the vicinity of the intake pump stations along the Sacramento River; and (2) in the vicinity of the Byron Tract Forebay. Groundwater-level lowering from construction dewatering activities is forecasted to be less than 10 feet in the vicinity of the intakes and less than 20 feet in the vicinity of the forebay. The horizontal distance from the boundary of the excavation to locations where forecasted groundwater levels are 5 feet below the static groundwater level is defined as the "radius of influence" herein. The radius of influence is forecasted to extend approximately 2,600 feet from the Byron Tract Forebay excavation and from the intake excavations (Figure 7-7). Groundwater would return to pre-pumping levels over the course of several months. Simulation results suggest that 2 months after pumping ceases, water levels would recover to within 5 feet of pre-pumping water levels. The sustainable yield of some wells might temporarily be affected by the lowering of water levels such that they are not able to support existing land uses. The construction of conveyance features could result in an adverse effect on groundwater levels and associated well yields that would be temporary. It should be noted that the forecasted impacts described above reflect a worst-case scenario as the option of installing seepage cutoff walls during dewatering was not considered in the analysis.

CEQA Conclusion: Construction activities associated with conveyance facilities under CM1, including temporary dewatering and associated reduced groundwater levels, have the potential to temporarily affect the productivity of existing nearby water supply wells. Groundwater levels within 2,600 feet of the areas to be dewatered are anticipated to experience groundwater level reductions of up to 20 feet for the duration of the dewatering activities and up to 2 months after dewatering activities are completed. Nearby domestic and municipal wells could experience significant reductions in well yield, if they are shallow wells, and may not be able to support existing land uses. The temporary localized impact on groundwater levels and associated well yields is considered significant because construction-related dewatering might affect the amount of water supplied by shallow wells located near the CM1 construction sites. Mitigation Measure GW-1 identifies a monitoring procedure and options for maintaining an adequate water supply for land owners that experience a reduction in groundwater production from wells within 2,600 feet of construction-related dewatering activities. It should be noted that the forecasted impacts described above reflect a worst-case scenario as the option of installing seepage cutoff walls during dewatering was not considered in the analysis. Implementing Mitigation Measure GW-1 would help address these effects; however, the impact may remain significant because replacement water supplies may not meet the preexisting demands or planned land use demands of the affected party. In some cases this impact might temporarily be significant and unavoidable until groundwater elevations recover to preconstruction conditions, which could require several months after dewatering operations cease.

Mitigation Measure GW-1: Maintain Water Supplies in Areas Affected by Construction Dewatering

Prior to construction, BDCP proponents will determine the location of wells within the anticipated area of influence of construction sites at which dewatering would occur. Based on available information, the location of wells, depths of the wells and the depth to groundwater within these wells will be determined. During construction dewatering, monitoring wells should be installed sufficiently close to the groundwater dewatering sites, or if possible, water levels in existing wells will be monitored, in order to be able to detect changes in water levels attributable to dewatering activities. If monitoring data or other substantial evidence indicates that groundwater levels have declined in a manner that could adversely affect adjacent wells, temporarily rendering the wells unable to provide adequate supply to meet preexisting demands or planned land use demands, the BDCP proponents will implement one or more of the following measures:

- Offset domestic water supply losses attributable to construction dewatering activities. The BDCP proponents will ensure domestic water supplies provided by wells are maintained during construction. Potential actions to offset these losses include installing sheet piles to depths below groundwater elevations, deepening or modifying wells used for domestic purposes to maintain water supplies at preconstruction levels, or securing potable water supplies from offsite sources. Offsite sources could include potable water transported from a permitted source or providing a temporary connection to nearby wells not adversely affected by dewatering.

- Offset agricultural water supply losses attributable to construction dewatering activities. The BDCP proponents will ensure agricultural water supplies are maintained during construction or provide compensation to offset for crop production losses. If feasible, the BDCP proponents will install sheet piles to depths below groundwater elevations, or deepen or modify the wells to ensure agricultural production supported by water supplied by these wells is maintained. If deepening or modifying existing wells is not feasible, the BDCP proponents will secure a temporary alternative water supply or compensate farmers for production losses attributable to a reduction in available groundwater supplies.

The implementation of this mitigation measure will follow the steps below:

- BDCP proponents will be responsible for determining the area of influence of dewatering operations and the location of potentially affected existing wells, in addition to the installation of potential new monitoring wells and the monitoring of existing wells.
- Prior to commencement of construction activities the BDCP Proponents will determine the locations of existing wells which will require monitoring. In addition, shallow monitoring wells may be installed prior to construction dewatering operations. Monitoring of water levels in these wells will occur during construction. Implementation of measures necessary to offset domestic and agricultural water supply losses will occur during construction as necessary.
- Monitoring wells will be installed; or, if feasible, water levels in existing wells will be monitored, in order to detect changes in water levels attributable to dewatering activities. Water levels in the installed monitoring wells and existing wells will be measured by the BDCP Proponents and Construction Contractors prior to construction dewatering and on a weekly or daily basis, as needed, during the entire construction dewatering period. Upon completion of construction, the water levels in the monitoring wells will be measured and monitoring will continue for up to six months following termination of construction dewatering activities or less if groundwater levels reach pre-construction levels.
- All monitoring data will be reported on a monthly basis, and in an annual summary report prepared by the BDCP Proponents and Construction Contractors that will evaluate the impacts of the construction dewatering for that year. The monthly reports will contain tabular water level data as well as changes in water levels from the previous months. The annual report will summarize monthly data and show the most recent water level contour map as well as the pre-construction contour map. The final report will include water-level contour maps for the area of the groundwater aquifer that is affected by dewatering showing initial, pre-construction water levels and final, post-construction water levels.
- If water level data indicate that dewatering operations are responsible for reductions in well productivity such that water supplies are inadequate to meet existing or planned land use demands, mitigation will be required and implemented.
- If monitoring data or other substantial evidence indicates that groundwater levels have declined in a manner that could adversely affect adjacent wells, temporarily rendering the wells unable to provide adequate supply to meet preexisting demands or planned land use demands, the BDCP proponents will implement one or more of the measures described above.

Impact GW-5: During Operations of New Facilities, Interfere with Agricultural Drainage in the Delta

NEPA Effects: The Intermediate and Byron Tract Forebays would be constructed to comply with the requirements of the Division of Safety of Dams (DSD) which includes design provisions to minimize seepage under the embankments, such as cutoff walls. These design provisions would minimize seepage under the embankments and onto adjacent properties. Once constructed, the operation of the forebays would be monitored to ensure seepage does not exceed performance requirements. In the event seepage were to exceed these performance requirements, the BDCP proponents would modify the embankments or construct seepage collection systems that would ensure any seepage from the forebays would be collected and conveyed back to the forebay or other suitable disposal site.

However, operation of Alternative 1A would result in local changes in groundwater flow patterns adjacent to the Intermediate and Byron Tract forebays, where groundwater recharge from surface water would result in groundwater level increases. If agricultural drainage systems adjacent to these forebays are not adequate to accommodate the additional drainage requirements, operation of the forebays could interfere with agricultural drainage in the Delta.

CEQA Conclusion: The Intermediate and Byron Tract Forebay embankments would be constructed to DSD standards and the BDCP proponents would monitor the performance of the embankments to ensure seepage does not exceed performance requirements. In the event seepage would exceed DSD requirements, the BDCP proponents would modify the embankments or construct and operate seepage collection systems to ensure the performance of existing agricultural drainage systems would be maintained.

However, operation of Alternative 1A would result in local changes in shallow groundwater flow patterns in the vicinity of the Intermediate and Byron Tract forebays caused by recharge from surface water, and could cause significant impacts on agricultural drainage where existing systems are not adequate to accommodate the additional drainage requirements. Implementation of Mitigation Measure GW-5 is anticipated to reduce this impact to a less-than-significant level in most instances, though in some instances mitigation may be infeasible due to factors such as costs that would be imprudent to bear in light of the fair market value of the affected land. The impact is therefore significant and unavoidable as applied to such latter properties.

In addition, as described for Impact GW-2, groundwater levels are projected to increase in Suisun Marsh under Alternative 1A compared to Existing Conditions, primarily due to sea level rise and climate change conditions as simulated with the Alternative 1A CVHM-D run. These increases in groundwater levels could affect agricultural drainage in the Suisun Marsh area, but do not in and of themselves require mitigation.

Mitigation Measure GW-5: Agricultural Lands Seepage Minimization

Areas potentially subject to seepage caused by implementation of habitat restoration and enhancement actions or operation of water conveyance facilities shall be monitored and evaluated on a site-specific basis by BDCP proponents prior to the commencement of construction activities to identify baseline groundwater conditions. Restoration sites, along with the sites of water conveyance features that could result in seepage, shall be subsequently monitored once construction is completed. Monitoring shall include placement of piezometers and/or periodic field checks to assess local groundwater levels and salinity and associated impacts on agricultural field conditions. In areas where operation of water conveyance facilities or habitat restoration is determined to result in seepage impacts on adjacent parcels, potentially feasible additional mitigation measures will be developed in consultation with affected landowners. These measures may include installation or improvement of subsurface agricultural drainage or an equivalent drainage measure, as well as pumping to provide for suitable field conditions (groundwater levels near pre-project levels). Such measures shall ensure that the drainage characteristics of affected areas would be maintained to the level existing prior to project construction.

The implementation of this mitigation measure will follow the steps below:

- BDCP Proponents and Construction Contractors will be responsible for monitoring and evaluation to identify baseline groundwater conditions as well as monitoring after construction is complete.
- Monitoring will occur at areas adjacent to the expanded Clifton Court Forebay portion at Byron Tract, where groundwater recharge from surface water would result in groundwater level increases, and other potentially impacted areas affected by operation of the water conveyance facilities.
- Monitoring and evaluation shall occur prior to commencement of construction activities to identify baseline conditions and with sufficient time allotted to develop additional mitigation measures if needed. Monitoring of restoration sites, along with the sites of water conveyance features that could result in seepage will occur after construction is completed.
- Monitoring shall include placement of piezometers and/or periodic field checks to assess local shallow groundwater levels and salinity and associated impacts on agricultural field conditions.
- Monitoring will collect information on two thresholds:
    1. Water surface elevation (recorded as depth to water)
    2. Shallow groundwater salinity (measured as specific conductance)
- Monitoring of groundwater levels will occur on a daily basis to check real-time measured groundwater levels. This can be performed by equipping the piezometers with electronic water level probes which automatically record levels on a daily basis. Periodic field checks, including measurements of specific conductance will occur on a monthly basis and in the event groundwater levels are above identified thresholds.
- Baseline conditions of shallow groundwater levels and salinity will be determined prior to construction through water level measurements and water testing at the installed piezometers in proximity to restoration areas and conveyance features that might affect drainage on adjacent lands.
- Salinity will be determined by measuring specific conductance at the piezometers with a calibrated field probe before construction begins, and monthly during operation.
- Visual observations will also be used to monitor associated impacts on agricultural field conditions. Visual surveys will be conducted during periodic field checks as well as by local landowners on a continual basis.

- A seepage hotline will be established for landowners to report any visual observations of seepage or deteriorating crop health as a result of an excessive rise in the water table and/or increasing root-zone salinity due to deteriorating shallow groundwater quality.
- All monitoring data will be reported on a monthly basis, and in an annual summary report prepared by the BDCP Proponents that will evaluate the potential impacts of the operation of CMs for that year. The monthly reports will contain tabular water level and salinity data as well as compute changes in water levels and salinity from the previous months. The annual report will summarize monthly data and evaluate if impacts have occurred.
- Groundwater levels at the affected areas will be maintained to the level existing prior to project construction.
- Shallow groundwater salinity will be monitored prior to construction and a threshold will be determined in coordination with the local landowners, based on existing crop salinity tolerance (considerations will include both if shallow groundwater is used for irrigation or if shallow groundwater levels rise and encroach upon the root-zone area).

7.3.3.3 Alternative 1B—Dual Conveyance with East Alignment and Intakes 1–5 (15,000 cfs; Operational Scenario A)

Delta Region

Impact GW-1: During Construction, Deplete Groundwater Supplies or Interfere with Groundwater Recharge, Alter Local Groundwater Levels, or Reduce the Production Capacity of Preexisting Nearby Wells

Construction of the conveyance facilities would require dewatering operations. The dewatering wells would be generally 75 to 300 feet deep, placed every 50 to 75 feet apart along the construction perimeter as needed, and each would pump 30–100 gpm. Dewatering for the tunnel shaft constitutes the deeper dewatering (300 feet deep) while the shallow (75 feet deep) dewatering is reserved for open trench construction; no dewatering is required along the tunnel alignment; and the 50–75 feet dewatering wells frequency distance applies to the pipelines, intakes, widened levees, the perimeter of the forebay embankments, the perimeter of excavation for the pumping plants, and the perimeter of tunnel shafts. Tunnel shafts are assumed to be constructed using slurry diaphragm walls, and therefore require only minimal dewatering, as necessary. Construction of the tunnel shafts is not anticipated to result in significant impacts to surrounding groundwater as the dewatered zone will be hydraulically isolated from the surrounding aquifer system.

Dewatering would occur 24 hours per day and 7 days per week and would be initiated 1 to 4 weeks prior to excavation. Dewatering would continue until excavation is completed and the construction site is protected from higher groundwater levels. Dewatering requirements of the intake construction and construction of other major features along this alignment are estimated to range from approximately 34 gpm to 1,360 gpm ~~features along this alignment are assumed to range from approximately 24,500 to 360,000 gpm~~ (California Department of Water Resources 2010b).

Groundwater removed with the dewatering system would be treated as necessary and discharged to surface waters under an NPDES permit. Velocity dissipation features, such as rock or grouted riprap, would be used to reduce velocity and energy and prevent scour. Dewatering facilities would be removed following construction activities.

7.3.3.4 Alternative 1C—Dual Conveyance with West Alignment and Intakes W1–W5 (15,000 cfs; Operational Scenario A)

Delta Region

Impact GW-1: During Construction, Deplete Groundwater Supplies or Interfere with Groundwater Recharge, Alter Local Groundwater Levels, or Reduce the Production Capacity of Preexisting Nearby Wells

Construction of the conveyance facilities would require dewatering operations. The dewatering wells would be generally 75 to 300 feet deep, placed every 50 to 75 feet apart, and would each pump 30–100 gpm. Dewatering for the tunnel shaft constitutes the deeper dewatering (300 feet deep) while the shallow (75 feet deep) dewatering is reserved for open trench construction; no dewatering is required along the tunnel alignment; and the 50-75 feet dewatering wells frequency distance applies to the pipelines, intakes, widened levees, the perimeter of the forebay embankments, the perimeter of excavation for the pumping plants, and the perimeter of tunnel shafts. Tunnel shafts are assumed to be constructed using slurry diaphragm walls, and therefore require only minimal dewatering, as necessary. Construction of the tunnel shafts is not anticipated to result in significant impacts to surrounding groundwater as the dewatered zone will be hydraulically isolated from the surrounding aquifer system.

Dewatering would occur 24 hours per day and 7 days per week and would be initiated 1 to 4 weeks prior to excavation and continue until excavation is completed and the construction site is protected from higher groundwater. Dewatering requirements of the intake construction and construction of other major features along this alignment are estimated to range from approximately 34 gpm to 1,360 gpm ~~features along this alignment are assumed to range from approximately 49,000 to 313,000 gpm~~ (California Department of Water Resources 2010b).

Groundwater removed with the dewatering system would be treated as necessary and discharged to surface waters under an NPDES permit. Velocity dissipation features, such as rock or grouted riprap, would be used to reduce velocity and energy and prevent scour. Dewatering facilities would be removed following construction.

7.3.3.9 Alternative 4—Dual Conveyance with Modified Pipeline/Tunnel and Intakes 2, 3, and 5 (9,000 cfs; Operational Scenario H)

Facilities construction under Alternative 4 would be similar to those described for Alternative 1A with only three intakes. In addition, the Intermediate Forebay for Alternative 4 differs significantly from the one that would be constructed under Alternative 1A. The Alternative 4 Intermediate Forebay is reduced in size (from 720 acres to 40 acres in water surface area) and is located further away from the Sacramento River and further south from the intakes as compared to the Alternative 1A. This smaller forebay footprint would result in reduced effects on groundwater resources as compared to Alternative 1A. Alternative 4 will result in the modification and expansion of Clifton Court Forebay to include the Byron Tract area, while for Alternative 1A, Clifton Court Forebay would remain the same and the new Byron Tract Forebay would be constructed adjacent. The overall footprint of the forebay (or forebays) would be similar for both alternatives, resulting in similar effects on groundwater in the vicinity of Clifton Court Forebay.

Operations under Alternative 4 would be identical to those under Alternative ~~2~~1A except that there would be more reliance on the south Delta intakes due to less capacity provided by the north Delta intakes. Alternative 4 was simulated in CALSIM II with Scenario H, which included a decision tree analysis, as described in Chapter 3. Alternative 4 includes the following four sub-scenarios.

- Alternative 4 Scenario H1: low Delta outflow
- Alternative 4 Scenario H2: includes enhanced Spring Delta outflow, excludes Fall X2
- Alternative 4 Scenario H3: excludes enhanced Spring Delta outflow; includes Fall X2
- Alternative 4 Scenario H4: high Delta outflow

The discussion below presents a combination of simulated quantitative results and a qualitative approach, since the only scenario that was simulated with CVHM and CVHM-D is Scenario H3 due to the fact that it falls within the range of delivery resulting from the other scenarios and provides a realistic average.

Delta Region

Construction and operation of Alternative 4 facilities would be similar under each of the operational scenarios for the purposes of this analysis, since the footprint is the same. Therefore, the description of impacts that were simulated with CVHM-D for Scenario H3 below is applicable to each Alternative 4 scenario.

Impact GW-1: During Construction, Deplete Groundwater Supplies or Interfere with Groundwater Recharge, Alter Local Groundwater Levels, or Reduce the Production Capacity of Preexisting Nearby Wells

See Impact GW-1 under Alternative 1A; construction activities under Alternative 4 would generally be similar to those under Alternative 1A. The impacts on groundwater levels resulting from dewatering activities are dependent on the local hydrogeology and the depth and duration of dewatering required. Because all of ~~the pump stations associated with~~ the intakes are located in areas of similar geology and hydrogeology, and the dewatering configurations are identical for each of the facilities, it would be expected that the impacts of construction activities on local groundwater levels and associated well yields would be similar with respect to intake ~~and intake pumping plant~~ construction. The only difference would be associated with the number of intakes used. This alternative uses three intakes instead of five used in Alternative 1A. This would result in decreased dewatering effects and fewer wells being affected. One additional difference, is the dewatering requirements at the Intermediate Forebay, as further described below.

Geotechnical explorations including geophysical surveys, seismic profiling, pressuremeter and aquifer tests will be performed to collect data related to subsoil properties and the construction dewatering requirements in areas where deep excavation is anticipated (*CDWR 2014, Geotechnical Exploration Plan – Phase 2*).

Specific considerations for the construction of elements of Alternative 4 are as follows :

Levees

According to the MPTO CER, "a deep slurry cutoff wall will be installed to enhance future public protection from levee underseepage in accordance with USACE requirements and to reduce the groundwater inflow into deep excavations within the intake facility site pad".

Intake Pipelines

Pipeline dewatering with two dewatering schemes are being considered, pending more detailed geotechnical and groundwater quality investigations to assess the best methodology to be used. Where high groundwater is encountered along portions of the alignment, a groundwater collection and disposal system will be installed and operated continuously during the construction period while the excavation trench is open. Temporary localized impacts will be mitigated.

Clifton Court Pumping Plant Shafts

The pumping plant shafts are assumed to be constructed using slurry diaphragm walls. Dewatering inside the slurry wall enclosure will be conducted as necessary to support shaft excavation, but will likely be intermittent. No significant impacts due to shaft construction dewatering are anticipated as the dewatered zone will be hydraulically isolated from the surrounding aquifer system.

Tunnel Shafts

Tunnel shafts are assumed to be constructed using slurry diaphragm walls, and therefore require only minimal dewatering, as necessary. Construction of the tunnel shafts is not anticipated to result in significant impacts to surrounding groundwater as the dewatered zone will be hydraulically isolated from the surrounding aquifer system.

Intermediate Forebay

Dewatering is required for excavation operations at the Intermediate Forebay, notably to build the embankments. However, no site specific geotechnical or hydrogeologic information is available at this time, so conservative assumptions are made regarding construction dewatering requirements, as described in Appendix 7A.

Clifton Court Forebays

The new embankments for the NCCF and SCCF are constructed by installing a sheet pile cofferdam, dewatering, excavating the embankment foundations down to suitable material, and possibly installing a slurry cutoff wall. Due to these measures, these construction activities would not result in significant impacts to surrounding groundwater levels.

NEPA Effects: Dewatering would temporarily lower groundwater levels in the vicinity of the dewatering sites. Three~~wo~~ areas could be subject to substantial lowering of groundwater levels: (1) In the vicinity of intake pump stations 2, 3, and 5; (2) in the vicinity of the Intermediate Forebay; and (3~~2~~) in the vicinity of the expanded Clifton Court Forebay portion that includes the Byron Tract area. Groundwater-level lowering from construction dewatering activities is forecasted to be less than 10 feet in the vicinity of the intakes and the Intermediate Forebay and less than 20 feet in the vicinity of the Bryon Tract ~~f~~Forebay. The horizontal distance from the boundary of the excavation to locations where forecasted groundwater levels are 5 feet below the static groundwater level is defined as the "radius of influence" herein. The radius of influence is forecasted to extend approximately 2,600 feet from the Byron Tract Forebay excavation and from the intake 2, 3, and 5 excavations, and approximately 1,500 feet from the Intermediate Forebay (Figure 7-27). Groundwater would return to pre-pumping levels over the course of several months. Simulation results suggest that two months after pumping ceases, water levels would be within 5 feet of pre-pumping water levels. The sustainable yield of some wells might temporarily be affected by the lower water levels such that they are not able to support existing land uses. The construction of conveyance features would result in effects on groundwater levels and associated well yields that would be temporary. It should be noted that the forecasted impacts described above reflect a worst-case scenario as the option of installing seepage cutoff walls during dewatering was not considered in the analysis.

CEQA Conclusion: Construction activities associated with conveyance facilities under CM1 for Alternative 4 including temporary dewatering and associated reduced groundwater levels have the potential to temporarily affect the productivity of existing nearby water supply wells. Groundwater levels within 2,600 feet of the areas to be dewatered are anticipated to experience groundwater level reductions of less than 20 feet for the duration of the dewatering activities and up to 2 months after dewatering is completed. Nearby wells could experience significant reductions in well yield, if they are shallow wells and may not be able to support existing land uses. The temporary impact on groundwater levels and associated well yields is considered significant because construction-related dewatering might affect the amount of water supplied by shallow wells located near the CM1 construction sites. Mitigation Measure GW-1 identifies a monitoring procedure and options for maintaining an adequate water supply for land owners that experience a reduction in groundwater production from wells within 2,600 feet of construction-related dewatering activities. It should be noted that the forecasted impacts described above reflect a worst-case scenario as the option of installing seepage cutoff walls during dewatering was not considered in the analysis. Implementing Mitigation Measure GW-1 would help address these effects; however, the impact may remain significant because replacement water supplies may not meet the preexisting demands or planned land use demands of the affected party. In some cases this impact might temporarily be significant and unavoidable until groundwater elevations recover to pre-construction conditions which could require several months after dewatering operations cease.

Mitigation Measure GW-1: Maintain Water Supplies in Areas Affected by Construction Dewatering

See Mitigation Measure GW-1 under Impact GW-1 in the discussion of Alternative 1A.

Impact GW-2: During Operations, Deplete Groundwater Supplies or Interfere with Groundwater Recharge, Alter Local Groundwater Levels, or Reduce the Production Capacity of Preexisting Nearby Wells

NEPA Effects: The new Intermediate Forebay and the expanded Clifton Court Forebay would be constructed to comply with the requirements of the DSD which include design features intended to minimize seepage under the embankments. In addition, the forebays will include a seepage cutoff wall installed to the impervious layer and a toe drain around the forebay embankment, to capture water and pump it back into the forebay. Any potential vertical seepage under the smaller Intermediate Forebay would also be captured by the toe drain. However, operation of Alternative 4 would result in groundwater level increases in the vicinity of the expanded Clifton Court Forebay portion at Byron Tract due to groundwater recharge, similar to Alternative 1A.

Operation of the tunnel would have no impact on existing wells or yields given the facilities would be located more than 100 feet underground and would not substantially alter groundwater levels in the vicinity.

CEQA Conclusion: The new Intermediate Forebay and the expanded Clifton Court Forebay will include design features intended to minimize seepage under the embankments and a toe drain around the forebay embankment, to capture water and pump it back into the forebay. Any potential vertical seepage under the smaller Intermediate Forebay would also be captured by the toe drain.

However, operation of Alternative 4 would result in groundwater level increases in the vicinity of the expanded Clifton Court Forebay portion at Byron Tract due to groundwater recharge, similar to Alternative 1A, which would not reduce the yields of nearby wells.

Operation of the tunnel would have no impact on existing wells or yields given these facilities would be located over 100 feet underground and would not substantially alter groundwater levels in the vicinity.

Groundwater levels in the Suisun Marsh area under Alternative 4 are forecasted to rise by 1 to 5 feet compared with Existing Conditions, as described for Alternative 1A. This groundwater level rise is primarily attributable to sea level rise and climate change conditions in the Alternative 1A CVHM-D simulation. However, the anticipated effects of climate change and sea level rise are provided for information purposes only and do not lead to mitigation measures.

Therefore, this impact would be less than significant. No mitigation is required.

Impact GW-3: Degrade Groundwater Quality during Construction and Operation of Conveyance Facilities

See Impact GW-3 under Alternative 1A; construction and operations activities under Alternative 4 would be similar to those under Alternative 1A, but to a lesser magnitude, because only three intakes would be constructed.

Impact GW-4: During Construction of Conveyance Facilities, Interfere with Agricultural Drainage in the Delta

See Impact GW-4 under Alternative 1A; construction activities under Alternative 4 would be similar to those under Alternative 1A, but to a lesser magnitude, because only three intakes would be constructed.

Impact GW-5: During Operations of New Facilities, Interfere with Agricultural Drainage in the Delta

NEPA Effects: As described in Chapter 3 *Description of Alternatives*, under Alternative 4, the Intermediate Forebay and the expanded Clifton Court Forebay will include a seepage cutoff wall to the impervious layer and a toe drain around the forebay embankment, to capture water and pump it back into the forebay. These design measures will greatly reduce any potential for seepage onto adjacent lands and avoid interference with agricultural drainage in the vicinity of the Intermediate Forebay. Once constructed, the operation of the forebay would be monitored to ensure seepage does not exceed performance requirements.

However, operation of Alternative 4 would result in local changes in shallow groundwater flow patterns adjacent to the expanded Clifton Court Forebay portion at Byron Tract, where groundwater recharge from surface water would result in groundwater level increases, similar to Alternative 1A. If existing agricultural drainage systems adjacent to the forebay are not adequate to accommodate the additional drainage requirements, operation of the forebay could interfere with agricultural drainage in the Delta.

CEQA Conclusion: As described in Chapter 3 *Description of Alternatives*, under Alternative 4, the Intermediate Forebay and the expanded Clifton Court Forebay will include a seepage cutoff wall to the impervious layer and a toe drain around the forebay embankment, to capture water and pump it back into the forebay. These design measures will greatly reduce any potential for seepage onto adjacent lands and avoid interference with agricultural drainage in the vicinity of the Intermediate Forebay. Once constructed, the operation of the forebay would be monitored to ensure seepage does not exceed performance requirements.

However, operation of Alternative 4 would result in local changes in shallow groundwater flow patterns adjacent to the expanded Clifton Court Forebay portion at Byron Tract, caused by groundwater recharge from surface water, and could cause significant impacts to agricultural drainage where existing systems are not adequate to accommodate the additional drainage requirements, similar to Alternative 1A. Implementation of Mitigation Measure GW-5 is anticipated to reduce this impact to a less-than-significant level in most instances, though in some instances mitigation may be infeasible due to factors such as costs that would be imprudent to bear in light of the fair market value of the affected land. The impact is therefore significant and unavoidable as applied to such latter properties.

In addition, as described for Impact GW-2, groundwater levels are projected to increase in Suisun Marsh under Alternative 1A compared to Existing Conditions, primarily due to sea level rise and climate change conditions as simulated with the Alternative 1A CVHM-D run. These increases in groundwater levels could affect agricultural drainage in the Suisun Marsh area, but do not in and of themselves require mitigation.

Mitigation Measure GW-5: Agricultural Lands Seepage Minimization

Please see Mitigation Measure GW-5 under Impact GW-5 in the discussion of Alternative 1A.

Impact GW-6: Deplete Groundwater Supplies or Interfere with Groundwater Recharge, Alter Local Groundwater Levels, Reduce the Production Capacity of Preexisting Nearby Wells, or Interfere with Agricultural Drainage as a Result of Implementing CM2–CM~~22~~21

See Impact GW-6 under Alternative 1A; CM2–CM~~22~~21 under Alternative 4 would result in effects similar to those under Alternative 1A.

Impact GW-7: Degrade Groundwater Quality as a Result of Implementing CM2–CM~~22~~21

See Impact GW-7 under Alternative 1A; CM2–CM~~22~~21 under Alternative 4 would result in effects similar to those under Alternative 1A.

SWP/CVP Export Service Areas

Impact GW-8: During Operations, Deplete Groundwater Supplies or Interfere with Groundwater Recharge, Alter Groundwater Levels, or Reduce the Production Capacity of Preexisting Nearby Wells

NEPA Effects: Total long-term average annual water deliveries to the CVP and SWP Service Areas under Alternative 4 vary for each of the scenarios, compared to the No Action Alternative.

The four operational scenarios represent a range of surface water exports to the CVP and SWP Service Areas. In general, Scenario H1 includes the highest total long-term average annual water deliveries to the CVP and SWP Service Areas, while Scenario H4 includes the lowest total long-term average annual water deliveries to the CVP and SWP Service Areas. These two scenarios reflect the range of effects that would result from the four potential outcomes under Alternative 4, the effects associated with H2 and H3 fall within this range.

For the San Joaquin and Tulare export areas, each of the four potential outcomes provides higher surface water deliveries under Alternative 4, compared to the No Action Alternative. Alternative 4 Scenario H3 was simulated with CVHM, and was used to provide an example impacts analysis for an outcome that is between the highest and the lowest deliveries. The discussion below provides an impact discussion based on CVHM simulation results for Alternative 4 Scenario H3. The impacts of Scenarios H1, H2, and H4 will be similar to those under Scenario H3, but with the magnitude of the impacts proportional to the change in the quantity of CVP/SWP surface water supplies delivered to the SWP/CVP Export Service Areas under each scenario.

Total long-term average annual water deliveries to the CVP and SWP Service Areas under Alternative 4 Scenario H3 would be higher than under the No Action Alternative, as described in Chapter 5, *Water Supply*, and Table 7-7. Increases in surface water deliveries attributable to project operations from the implementation of Alternative 4 are anticipated to result in a corresponding decrease in groundwater use in the Export Service Areas, as compared with the No Action Alternative, as discussed in Section 7.3.3.2.

CVHM modeling results for groundwater under the Corcoran Clay layer show that levels would rise up to 10 feet in most areas in the western and southern portions of the Valley, but could increase by up to 250 feet under WBS 14 (i.e., Westside and Northern Pleasant Valley basins) as compared with the No Action Alternative. The forecasted maximum groundwater level changes occur in August because agricultural groundwater pumping is typically highest during this month.

The forecasted groundwater level rises across the Export Service Areas during a typical peak groundwater level change condition in August, as compared to the No Action Alternative are shown in Figure 7-28. These forecasted changes in groundwater levels result from decreased agricultural pumping during the irrigation season due to an increase in surface water deliveries from the Delta under Alternative 4 Scenario H3 in the western portion of the San Joaquin and Tulare Lake basins. Indirect effects of increased groundwater levels include a reduction in pumping costs due to reduced lift requirements, a reduced potential for the inducement of inelastic subsidence, and an increase in the available yields from pumping wells within the affected area.

The SWP deliveries to Southern California areas under Alternative 4 Scenarios H1, H2, and H3 would be greater than those under the No Action Alternative. Implementation of Alternative 4 with these scenarios would result in an overall decrease in groundwater pumping and a corresponding increase in groundwater levels.

The SWP deliveries to Southern California areas under Alternative 4 Scenario H4 would be less than those under the No Action Alternative. Implementation of Alternative 4 Scenario H4 may result in additional groundwater pumping and a potential corresponding decrease in groundwater levels. This could result in adverse effects associated with groundwater levels and recharge in Southern California areas. However, opportunities for additional pumping might be limited by basin adjudications and other groundwater management programs. Additionally, as discussed in Appendix 5B, *Responses to Reduced South of Delta Water Supplies*, adverse effects might be avoided due to the existence of various other water management options that could be undertaken in response to reduced exports from the Delta. These options include wastewater recycling and reuse, increased water conservation, water transfers, construction of new local reservoirs that could retain Southern California rainfall during wet years, and desalination.

Even if the effect is adverse, feasible mitigation would not be available to diminish this effect due to a number of factors. First, State Water Contractors currently and traditionally have received variable water supplies under their contracts with DWR due to variations in hydrology and regulatory constraints and are accustomed to responding accordingly. Any reductions associated with this impact would be subject to these contractual limitations. Under standard state water contracts, the risk of shortfalls in exports is borne by the contractors rather than DWR. As a result of this variability, many Southern California water districts have complex water management strategies that include numerous options, as described above, to supplement SWP surface water supplies. These water districts are in the best position to determine the appropriate response to reduced imports from the Delta. Second, as noted above, it may be legally impossible to extract additional groundwater in adjudicated basins without gaining the permission of watermasters and accounting for groundwater pumping entitlements and various parties under their adjudicated rights. Finally, in many groundwater basins, additional groundwater pumping might exacerbate existing overdraft and subsidence conditions, even if such pumping is legally permissible because the affected basin has not been adjudicated or no other groundwater management program is in place.

CEQA Conclusion: For the San Joaquin and Tulare export areas, each of the four potential outcomes provides lower surface water deliveries under Alternative 4, compared to Existing Conditions, largely because of effects due to climate change, sea level rise, and increased water demand north of the Delta. Alternative 4 Scenario H3 was simulated with CVHM, and was used to provide an example impacts analysis for an outcome that is between the highest and the lowest deliveries. Modeling predicts that groundwater pumping under Alternative 4 Scenario H3 would be greater than under Existing Conditions, and that groundwater levels in some areas would be lower than under Existing Conditions.

CVHM modeling results of groundwater under the Corcoran Clay layer show that levels would decrease by up to 250 feet under WBS14 (i.e., Westside and Northern Pleasant Valley basins) as compared with Existing Conditions. The forecasted groundwater level changes across the Export Service Areas during a typical peak groundwater level change condition in August as compared to Existing Conditions are shown in Figure 7-29. These forecasted changes in groundwater levels under Alternative 4 result from increased agricultural pumping during the irrigation season due to a decrease in surface water deliveries from the Delta to the western portion of the San Joaquin and Tulare Lake basins. On the eastern side of the San Joaquin and Tulare Lake basins, climate change impacts on stream flows could result in a decline in groundwater levels of up to 50 feet. In addition, if reduced stream flows are not adequate to meet the surface water diversion requirements, groundwater pumping could increase, resulting in a further decline in groundwater levels.

As shown above in the NEPA analysis, SWP and CVP deliveries would either not change or would increase under Alternative 4 for all scenarios as compared to deliveries under conditions in 2060 without Alternative 4 if sea level rise and climate change conditions are considered the same under both scenarios. For reasons discussed in Section 7.3.1, *Methods for Analysis*, DWR has identified effects of action alternatives under CEQA separately from the effects of increased water demands, sea level rise, and climate change, which would occur without and independent of the BDCP. Absent these factors, the impacts of Alternative 4 for each of the four scenarios with respect to groundwater levels are considered to be less than significant.

Unlike the NEPA analysis where scenarios H1 and H4 bounded the range of anticipated impacts, the impacts relative to the Existing Conditions baseline are more variable. The SWP deliveries to Southern California areas under Alternative 4 Scenarios H1 and H3 would be greater than those under Existing Conditions. This would result in beneficial impacts associated with groundwater levels and recharge in Southern California areas. However, the SWP deliveries to Southern California areas under Alternative 4 Scenarios H2 and H4 would be less than those under Existing Conditions. For Scenario H2, the reduced surface water deliveries would be largely due to the effects of climate change, sea level rise, and increased water demand north of the Delta, and, as described above for the Tulare and San Joaquin areas, absent these factors, the impacts of Scenario H2 on groundwater levels would be less than significant. For Scenario H4, reduced surface water deliveries could result in significant impacts associated with groundwater levels and recharge in Southern California areas.

As discussed above in the NEPA conclusion, Southern California water districts may be able to avoid this impact due to various water management options. For reasons also discussed above, no feasible mitigation would be available to mitigate this impact if it is significant. Due to these uncertainties, the overall impact for Alternative 4 (Scenarios H1–H4) is considered significant and unavoidable.

Impact GW-9: Degrade Groundwater Quality

NEPA Effects: As discussed under Impact GW-8, surface water deliveries to the CVP and SWP Export Service Areas in the San Joaquin Valley and Tulare Basin under all Alternative 4 scenarios (H1–H4) outcomes are expected to increase as compared to the No Action Alternative. Increased surface water deliveries could result in a decrease in groundwater use. The decreased groundwater use is not anticipated to alter regional patterns of groundwater flow in these service areas. Therefore, it is not anticipated this would result in an adverse effect on groundwater quality in these areas.

In contrast, under Scenario H4 there would be reduced SWP supplies in Southern California. It is unclear, however, whether such reductions would lead to increased groundwater pumping for reasons discussed in connection to Impact GW-8. If groundwater pumping is increased, there could be resulting changes in regional patterns of groundwater flow and a change in groundwater quality. Due to the uncertainty associated with these effects, this effect is considered adverse. For the same reasons discussed earlier in connection with the possibility of increased groundwater pumping in Southern California, there is no feasible mitigation available to mitigate any changes in regional groundwater quality.

CEQA Conclusion: As discussed under Impact GW-8 above, the impacts of Alternative 4 under all scenarios with respect to groundwater levels are considered to be less than significant in the CVP and SWP Export Service Areas in the San Joaquin Valley and Tulare Basin. Therefore, no significant groundwater quality impacts are anticipated in these areas during the implementation of Alternative 4 because it is not anticipated to alter regional groundwater flow patterns. Therefore, this impact is considered less than significant with respect to these areas. The same is true for Scenarios H1-H3 for the Southern California SWP Export Service Areas.

However, implementation of Alternative 4 Scenarios H4 could degrade groundwater quality in portions of the Southern California SWP Export Service Areas; this impact is considered significant due to the possibility of increased groundwater pumping and the resulting effects on regional groundwater flow patterns. As discussed above, there is no feasible mitigation available to address this significant impact. The impact would be considered significant and unavoidable in these areas.

Due to the uncertainties identified in connection with the potential response to Impact GW-8 under Scenario H4 in Southern California, the overall impact for Impact GW-9 Alternative 4 (Scenarios H1–H4) is considered significant and unavoidable.

Impact GW-10: Result in Groundwater Level–Induced Land Subsidence

The potential for groundwater level–induced land subsidence under Alternative 4 would be similar to that under Alternative 1A. See Impact GW-10 under Alternative 1A.

7.4 References

7.4.1 Printed Communications

California Department of Water Resources. 2014. *List of Adjudicated Basins and Subbasins*. Originally developed for the California Water Plan Update 2013—Updated January 1, 2014. Available: http://www.water.ca.gov/groundwater/docs/List%20of%20adjudicated%20basins%20and%20subbasins_01012014.pdf. Accessed May 20, 2015.