3.8 Hydrology and Water Resources

Since publication of the Palmdale to Burbank Project Section Draft Environmental Impact Report/Environmental Impact Statement (EIR/EIS), the following substantive changes have been made to this section:

- Discussion of impacts to federal U.S. Army Corps of Engineers (USACE) Civil Works projects requiring Section 408 review was added in Section 3.8.2.1, under Impact HWR #3 Changes in Flood Risks Associated with Temporary Construction Activities and Permanent Structures Required for the Build Alternatives and Impact HWR #6 Project Operation Effects on Water.
- Section 3.8.2.1, Federal, was revised to note there are no navigable waters of the United States (WOTUS) present within the Palmdale to Burbank Project Section resource study area (RSA), under Section 9 of the Rivers and Harbors Act.
- Section 3.8.2.2, State, was revised for clarity regarding the Cobey-Alquist Floodplain Management Act (California Water Code Section 8400 et seq.).
- Section 3.8.2.3, Regional and Local, was revised to change the "City of Santa Clarita" to "Upper Santa Clara River" and to clarify the discussion and Los Angeles County's Capital Flood.
- Section 3.8.2.3, Regional and Local, was revised to add discussion of Upper Los Angeles River Area Watermaster.
- Section 3.8.2.3, Regional and Local, was revised to include the new subsection "County Floodplains and Floodways," which discusses Los Angeles County's Capital Flood.
- Section 3.8.4.2, Impact Avoidance and Minimization Features, was revised to note both storm and groundwater management would apply for HYD-IAMF#1.
- Section 3.8.4.4, Methods for Evaluating Impacts under NEPA, was revised to clarify Federal Emergency Management Agency (FEMA) and local agency requirements regarding floodplain encroachment.
- Table 3.8-1, Hydrology and Water Resources Information Sources, was updated to include Los Angeles County Floodway maps.
- Section 3.8.5.3, Floodplains, was revised to clarify Los Angeles County Public Works stream crossing design requirements.
- Table 3.8-5, Groundwater Basins, was updated and revised to depict the various groundwater basins within the Palmdale to Burbank Project Section.
- Impact HWR#4, Changes in Groundwater Recharge Associated with Temporary Construction Activities and Permanent Structures Required for the Build Alternatives, its associated CEQA Conclusion, and HWR-MM#3, Compensation for Impacts on Hansen Spreading Grounds, were revised to delete references to modifying operations.
- Impact HWR#4, Changes in Groundwater Recharge Associated with Temporary Construction Activities and Permanent Structures Required for the Build Alternatives, was strengthened to more clearly state the potential for direct impacts to private water supply wells from tunnel construction.
- The discussion of ephemeral stream locations in risk areas has been removed because ephemeral streams are not fed by groundwater and therefore would not be potentially affected by any seepage into tunnels constructed within the Angeles National Forest (ANF).
- In Section 3.8.5.7, Hydrogeological Conditions, the hydraulic conductivity value range was clarified to align with the data presented in Table 3.8-7.
- Section 3.8.6.3, Build Alternatives, was revised to incorporate a global revision correcting USACE facilities to USACE projects.

- HWR-MM#1 was revised to specify sampling collection that would occur for affected well owners.
- HWR-MM#2 was revised to specify the reduction in the Hansen Spreading Grounds would be mitigated through replacement groundwater recharge areas to ensure for no net loss in recharge area or capacity.
- HWR-MM#4 was revised to specify the reports for state and federal resource agencies regarding groundwater and surface water conditions before, during, and after construction would be generated quarterly and annually.
- HYD-IAMF#8 has been added which addresses effects on private wells.
- Section 3.8.8.4, Groundwater Depletion, was revised to clarify that HWR-MM#3 requires the Authority to provide replacement groundwater recharge area.
- Section 3.8.8.6, Hydrology and Hydrogeology in the ANF, was revised under the Conductivity heading to add information regarding predominant lithologies.
- References to "LADWP" with respect to the Hansen Spreading Grounds were revised to Los Angeles County Flood Control District (LACFCD) throughout this section.

The revisions and clarifications provided in this section of the Final EIR/EIS do not change the impact conclusions pertaining to hydrology and water resources presented in the Draft EIR/EIS.

Hydrology and Water Resources

Surface water features provide wildlife habitat and serve as indicators of the environmental health of resources within the surface hydrology and water quality Resource Study Area. Water resources also provide both domestic water supply and recreational opportunities. Groundwater aquifers serve important functions, including as a source of domestic and agricultural water supply. Water quality is highly regulated in accordance with the federal Clean Water Act and the state Porter-Cologne Act.

3.8.1 Introduction

This section describes the regulatory setting associated with hydrology and water resources, the affected environment for hydrology and water resources, the impacts on hydrology and water resources that may result from each of the six Build Alternatives, and design features and mitigation measures that would be implemented to reduce these impacts. This section addresses a range of topics related to water resources, including surface water hydrology, water quality, groundwater, and floodplains. Surface water resources are important for fish and wildlife habitat, urban and agricultural water supply, and stormwater conveyance. Groundwater is also an important source of urban and agricultural water supply.

The following resource sections in this Palmdale to Burbank Project Section Final EIR/EIS provide additional information and analysis related to hydrology and water resources:

- Section 3.6, Public Utilities and Energy—includes an evaluation of the effects of the Build Alternatives on water resources and supply.
- Section 3.7, Biological and Aquatic Resources—includes an evaluation of impacts on wetlands and other aquatic resources.
- Section 3.14, Agricultural Lands—includes an evaluation of impacts to agriculture associated with water supply.

In addition, the following appendices and technical reports provide additional information regarding hydrology and water resources within the Palmdale to Burbank Project Section:

- *Palmdale to Burbank Project Section: Hydrology and Water Resources Technical Report* (Authority 2017a) provides detailed information on hydrology and water resources.
- *Preliminary Geotechnical Data Report for Tunnel Feasibility, Angeles National Forest* (Authority 2019a)

- *Geotechnical Tunnel Feasibility Evaluation for High-Speed Rail Tunnels Beneath the Angeles National Forest* (Authority 2019b)
- Appendix 2-E, Impact Avoidance and Minimization Features (IAMF), lists IAMFs incorporated into the project.
- Appendix 2-H, Regional and Local Policy Consistency Analysis, provides a Regional and Local Policy Consistency Table, which lists the hydrology and water resources goals and policies applicable to the Palmdale to Burbank Project Section and notes the Build Alternatives' consistency or inconsistency with each.
- Appendix 3.1-B, United States Forest Service (USFS) Policy Consistency Analysis, provides an analysis of the consistency of the six Build Alternatives with these laws, regulations, policies, plans, and orders.
- Appendix 3.8-A, Hydrology and Water Resources Figures, includes all figures referenced herein.
- Appendix 3.8-B, Major Waterbodies Crossed Table, lists all major waterbodies crossed by the Palmdale to Burbank Project Section Build Alternatives.
- Appendix 3.8-C, Adaptive Management and Monitoring Plan for Potential Hydrologic Effects in the Angeles National Forest (ANF), outlines the California High-Speed Rail Authority's (Authority) plan to detect and remediate impacts resulting from potential hydrogeological changes associated with tunnel construction beneath the ANF.
- Appendix 3.8-D, Supplemental Water Demand Analysis for Impacts on the ANF, including the San Gabriel Mountains National Monument (SGMNM), evaluates the feasibility of proposed remedial activities set out in the Adaptive Management and Monitoring Plan (AMMP).

During stakeholder outreach efforts, commenters expressed concern about issues pertaining to hydrology and water resources, including impacts on streams and groundwater. Impacts to streams and groundwater are addressed in Section 3.8.6.3.

3.8.2 Laws, Regulations, and Orders

Federal and state regulations and orders applicable to hydrology and water resources affected by the project are presented below. The Authority would implement the high-speed rail (HSR) project, including the project extent, in compliance with all federal and state regulations. Regional and local plans and policies relevant to hydrology and water resources considered in the preparation of this analysis are provided in Appendix 2-H.

3.8.2.1 Federal

Federal Railroad Administration Procedures for Considering Environmental Impacts (64 Federal Register [Fed. Reg.] 28545)

Federal Railroad Administration (FRA) procedures direct that an EIS should consider possible impacts on water quality and flood hazards and floodplains.

Clean Water Act (33 United States Code [U.S.C.] Section 1251 et seq.)

The Clean Water Act (CWA) is the primary federal law protecting the quality of the nation's surface waters, including lakes, rivers, and coastal wetlands. The CWA prohibits any discharge of pollutants into the nation's waters unless specifically authorized by permit. The sections of the CWA applicable to the Palmdale to Burbank Project Section are discussed below.

- **Basin Planning (33 U.S.C. 1289):** CWA Section 102 requires the planning agency of each state (in California, the State Water Resources Control Board [SWRCB]) to prepare a basin plan that sets out regulatory requirements for protection of surface water quality, which include designated beneficial uses for surface waterbodies as well as specified water quality objectives to protect those uses. The following basin plans are applicable to the project:

  – The Los Angeles Regional Board's Basin Plan
  – Water Quality Control Plan for the Central Coastal Basin

- **Water Quality Impairments (33 U.S.C. 1313(d)):** CWA Section 303(d) requires each state to develop a list of impaired surface waters that do not meet or that the State expects would not meet state water quality standards as defined by that section. It also requires each state to develop total maximum daily loads (TMDL) of pollutants for impaired waterbodies. The TMDL must account for the pollution sources causing the water to be listed by the State.
- **Water Quality Certification (33 U.S.C. 1341):** Under CWA Section 401, applicants for a federal license or permit to conduct activities that may result in a discharge into WOTUS must obtain certification that the discharge would not violate water quality standards, including water quality objectives and beneficial uses. The state in which the discharge would originate or the interstate water pollution control agency with jurisdiction over affected waters issues the certification. The SWRCB issues the Section 401 certification for the project.
- **National Pollutant Discharge Elimination System Program (33 U.S.C.1342):** Under Section 402, the National Pollutant Discharge Elimination System (NPDES) program regulates all point-source discharges, including but not limited to construction-related runoff discharges to surface waters and some post-development discharges. In California, project sponsors must obtain an NPDES permit from the SWRCB.
- **Stormwater Discharges: Municipal Separate Storm Sewer System NPDES Permits:** The SWRCB and Regional Water Quality Control Boards (RWQCB) issue Municipal Separate Storm Sewer System (MS4) permits in two phases. Phase I MS4 permits are issued to a group of co-permittees encompassing an entire metropolitan area. The Phase II MS4 General Permit (SWRCB Water Quality Order No. 2013- 0001-DWQ, NPDES No. CAS000004) (SWRCB 2013) was adopted by the SWRCB to provide NPDES permit coverage to municipalities not covered under the NPDES Phase I Rule (i.e., small MS4 permits generally for fewer than 100,000 people). The MS4 permits require the discharger to develop and implement a stormwater management plan or program. Stormwater management programs limit, to the maximum extent practicable, the discharge of pollutants from storm sewer systems. A single state agency or a coalition, often consisting of more than one municipality (such as cities and counties), may implement these programs. Each program includes best management practices (BMP) designed to reduce the quantity and improve the quality of stormwater discharged to the stormwater system. Discharges to storm sewer systems must comply with the stormwater management program requirements.
- **Permit for the Discharge of Dredged or Fill Material in Wetlands and Other Waters (33 U.S.C. 1344):** Under CWA Section 404, USACE and the United States Environmental Protection Agency (USEPA) regulate the discharge of dredged or fill material into WOTUS. Project sponsors must obtain a permit from USACE for proposed discharges of dredged or fill materials into waters over which USACE has jurisdiction. The Authority manages compliance with the USACE permitting process required for an individual permit under Section 404 through a memorandum of understanding (MOU) that establishes three checkpoint reports: one defines project purpose and need, another establishes the range of alternatives for environmental review, and the last identifies a preliminary least environmentally damaging practicable alternative (LEDPA) (FRA et al. 2010)

Rivers and Harbors Act of 1899 (33 U.S.C. Section 401 et seq.)

The Rivers and Harbors Act is the primary federal law regulating activities that may affect navigation on the nation's waterways. The sections of the act that are relevant to the Palmdale to Burbank Project Section include the following:

- **Section 9 of the Rivers and Harbors Act and Section 9 of the General Bridge Act** require a United States Coast Guard permit for the construction of bridges and causeways over certain navigable WOTUS to avoid adverse effects on marine traffic. Section 9 bridge permits are only required for waters that are currently or potentially navigable for commerce; general recreational boating is typically not sufficient to establish jurisdiction. Navigable waters are defined as those waterbodies subject to the ebb and flow of the tide or that are used currently, potentially, or historically in their natural condition or by reasonable improvements, to transport interstate or foreign commerce. No navigable WOTUS are present within the Palmdale to Burbank Project Section RSA.

- **Section 14 of the Rivers and Harbors Act** (33 U.S.C. Section 408) requires USACE permission for the use, including modifications or alterations, of any flood control project built by the United States to prevent the impairment of the usefulness of the federal project. The Authority manages Section 408 compliance through an MOU among the Authority, FRA, USEPA, and USACE (FRA et al. 2010). The MOU provides a process for the Authority to submit information early in the design process to confirm that the project as designed can feasibly achieve Section 408 compliance. The following USACE projects are within the Palmdale to Burbank Project Section RSA: Lopez Dam, Hansen Dam, and Tujunga Channel.

Floodplain Management (USEO 11988) and United States Department of Transportation Order 5650.2 (Floodplain Management and Protection)

United States Presidential Executive Order (USEO) 11988 directs that federal agency construction, permitting, or funding of a project must avoid inconsistent floodplain development, be consistent with the standards and criteria of the National Flood Insurance Program, and restore and preserve natural and beneficial floodplain values. United States Department of Transportation Order 5650.2 contains policies and procedures for transportation agencies to implement USEO 11988 on transportation projects.

Protection of Wetlands (USEO 11990)

USEO 11990 aims to avoid direct or indirect impacts on wetlands from federal or federally-approved projects when a practicable alternative is available. If wetland impacts cannot be avoided, all practicable measures to minimize harm must be included.

National Flood Insurance Act (42 U.S.C. Section 4001 et seq.)

The purpose of the National Flood Insurance Act is to identify flood-prone areas and provide insurance. The act requires insurance to be purchased for buildings in SFHAs. The act is applicable to federally-assisted acquisitions or construction projects in an area identified as having special flood hazards. Projects should avoid construction in, or develop a design to be consistent with, FEMA-identified flood hazard areas.

Safe Drinking Water Act (42 U.S.C. Section 300 et seq.)

The Safe Drinking Water Act was originally passed by Congress in 1974 to protect public health by regulating the nation's public drinking water supply. The act authorizes the USEPA to set national health-based standards for drinking water to protect against both naturally occurring and human-produced contaminants that may be found in drinking water. The Safe Drinking Water Act applies to every public water system in the United States.

The Sole Source Aquifer Protection Program is authorized by Section 1424(e) of the Safe Water Drinking Act. The sole source aquifer designation is used to protect drinking water supplies where there are few or no alternative sources and where, if contamination occurred, use of an alternative source would be extremely expensive. All proposed projects to receive federal funds are subject to USEPA review to ensure that they do not endanger the water source.

United States Forest Service Authorities

Activities that potentially affect hydrology and water resources in the ANF, including the SGMNM, are subject to the requirements of several USFS-related laws, and their implementing regulations, as well as agency policies, plans, and orders. The primary laws governing activities in the ANF are the Federal Land Policy and Management Act and the National Forest Management Act. In addition, the Antiquities Act of 1906 and the presidential proclamation creating the SGMNM govern activities proposed in the monument. Appendix 3.1-B, USFS Policy Consistency Analysis, provides an analysis of the consistency of the six Build Alternatives with these laws, regulations, policies, plans, and orders. Refer to Section 3.8.3, Consistency with Plans and Laws and Appendix 3.8-C for a discussion of specific standards that would apply to the tunneling activities associated with each of the six Build Alternatives in the ANF. To construct the Build Alternatives in the ANF, the Authority would need to obtain a Special Use Authorization from the USFS, which would require the Authority to, among other things, demonstrate that the proposed use would be consistent with USFS laws, regulations, plans, and policies pertaining to the protection of existing hydrologic conditions and water resources.

Specific policies have been adopted by the USFS to protect hydrologic conditions and water resources in the ANF (see Appendix 3.1-B). Three such policies (termed "standards") would apply to tunneling activities required for all six Build Alternatives. To ensure consistency with these standards, the Authority would adopt engineering and design approaches described in HYD-IAMF#5 through HYD-IMAF#7 requiring the use of state-of-the-art tunneling techniques to avoid and minimize tunneling impacts on groundwater. Furthermore, the Authority will implement an AMMP. The AMMP will require the implementation of a comprehensive monitoring program to establish baseline conditions regarding surface and subsurface water resources in the ANF and to allow for the detection of changes in groundwater and surface water conditions related to tunnel construction to ensure timely implementation of remedial measures (See Appendix 3.8-C and Section 3.8.7, Mitigation Measures). The applicable standards are as follows:

- **USFS Soil, Water, Riparian and Heritage Standard 45**—This standard requires that "all construction, reconstruction, operation, and maintenance of tunnels on National Forest System lands shall use practices that minimize adverse effects on groundwater aquifers and their surface expressions."
- **USFS Soil, Water, Riparian and Heritage Standard 47**—This standard requires the application of a screening process to projects that could impact riparian areas, including such areas that are dependent on groundwater aquifers.
- **USFS Fish and Wildlife Standard 11**—This standard requires the protection of the habitat of special-status species in the National Forest System. As such, surface habitat could be impacted by subsurface changes in hydrogeologic conditions. This standard would apply to tunnels required for each of the six Build Alternatives.

3.8.2.2 State

Porter-Cologne Water Quality Control Act (California Water Code Section 13000 et seq.)

The Porter-Cologne Water Quality Control Act provides for the regulation of all pollutant discharges, including wastes in project runoff and the placement of fill in waters of the state. Any entity proposing to discharge waste must file a Report of Waste Discharge with the appropriate RWQCB or the SWRCB. The RWQCBs are responsible for implementing CWA Sections 401, 402, and 303(d). Because the California HSR System is a project of statewide importance, any Reports of Waste Discharge would be filed with the SWRCB. The Porter-Cologne Water Quality Control Act also provides for the development and periodic reviews of basin plans that designate beneficial uses of California's major rivers and groundwater basins and establish water quality objectives for those waters.

Statewide Stormwater Permits

In California, the NPDES program is administered by the SWRCB, with implementation and enforcement by the RWQCBs. The NPDES program, which was designed to protect surface water quality, applies to discharges to WOTUS, including stormwater discharges associated with construction activities, industrial operations, municipal drainage systems, and point sources. In general, the NPDES permit program is designed to control, minimize, or reduce surface water impacts.

Construction Activities, National Pollutant Discharge Elimination System Construction General Permit

Under the CWA, discharge of stormwater from construction sites must comply with the conditions of an NPDES permit. The SWRCB is the permitting authority in California and has adopted the statewide General Permit for Stormwater Discharges Associated with Construction Activity that applies to projects resulting in one or more acres of soil disturbance. For projects disturbing more than 1 acre of soil, a SWPPP is required that specifies site management activities to be implemented during site development. These activities include construction stormwater BMP, erosion and sedimentation controls, dewatering (nuisance water removal), runoff controls, and construction equipment maintenance, as described in Section 3.8.4.2.

On July 1, 2010, the statewide General Permit for Stormwater Discharges Associated with Construction and Land Disturbance Activities (SWRCB Water Quality Order No. 2009-0009-DWQ, NPDES No. CAS000002) superseded the previous statewide General Permit. This permit was later revised by Order No. 2010-0014-DWQ and Order No. 2012-006-DWQ. The new statewide permit implements a risk-based permitting approach, specifies minimum BMP requirements, and requires stormwater monitoring and reporting.

National Pollutant Discharge Elimination System Industrial General Permit

Another required permit is the statewide General Permit for Discharges of Stormwater Associated with Industrial Activities (SWRCB Water Quality Order No. 2014-0057-DWQ, NPDES No. CAS000001). Qualifying industrial sites are required to prepare SWPPPs describing BMPs that will be employed to protect water quality. Industrial facilities are required to use best conventional pollutant control technology for control of conventional pollutants and best available technology economically achievable for toxic and non-conventional pollutants. Monitoring of runoff leaving the site is also required. For transportation facilities, this permit applies only to vehicle maintenance shops and equipment cleaning operations.

Caltrans National Pollutant Discharge Elimination System Statewide Stormwater Permit

The California Department of Transportation (Caltrans) operates under a permit (Order No. 2012-0011-DWQ, NPDES No. CAS000003) that regulates stormwater discharge from Caltrans properties, facilities, and activities and requires that the Caltrans construction program comply with the adopted statewide General Permit for Stormwater Discharges Associated with Construction Activity (described above). The permit requires Caltrans to implement a year-round program in the state to effectively control stormwater and non-stormwater discharges. The Caltrans permit is applicable to portions of the California HSR System that involve modifications to state highways.

Cobey-Alquist Floodplain Management Act (California Water Code Section 8400 et seq.)

The Cobey-Alquist Floodplain Management Act and California Executive Order B-39-77 support the National Flood Insurance Program. The act encourages local governments to plan, adopt, and enforce land use regulations for floodplain management, to protect people and property from flooding hazards. The act also provides State financial assistance for flood control. Executive Order B-39-77 requires state agency compliance with good floodplain management practices.

Streambed Alteration Agreement (Sections 1601 to 1603) of the California Fish and Game Code

The California Fish and Game Code requires agencies to notify the California Department of Fish and Wildlife prior to implementing a project that would divert, obstruct, or change the natural flow or bed, channel, or bank of any river, stream (including intermittent streams), or lake.

Sustainable Groundwater Management Act

The Sustainable Groundwater Management Act of 2014 requires water agencies managing medium- and high-priority basins to halt overdraft of groundwater and maintain a balance between withdrawal and recharge of groundwater. The act also requires local agencies to form Groundwater Sustainability Agencies tasked with establishing sustainable groundwater management plans for medium- and high-priority groundwater basins. The groundwater basins traversed by all six Build Alternatives are classified as very-low-priority basins, except for the Santa Clara River Valley basin, which is classified as high priority (Los Angeles County 2019). However, a sustainable groundwater management plan has not been drafted for this groundwater basin (Santa Clarita Valley Groundwater Sustainability Agency 2019).

Basin Prioritization

Groundwater basins are assigned a priority rating based on a point system that considers factors affecting a basin's capacity, such as population, public well supply, and acreage of irrigated land. The basin priority classifications are listed below:

- Very Low (less than or equal to 7 points)
- Low (8 to 14 points)
- Medium (15 to 21 points)
- High (more than 21 points)

Source: Los Angeles County, 2019

3.8.2.3 Regional and Local

This section discusses local and regional regulations, as well as permitting requirements. Cities within the hydrology and water RSA, Los Angeles County, and regional agencies have developed ordinances, policies, and other regulatory mechanisms to minimize negative hydrological and water quality effects of projects such as the Palmdale to Burbank Project Section. The regional and local policies discussed in this section govern a variety of activities that could impact hydrology and water quality, including activities within flood control channels, dewatering activities, and stormwater management.

Los Angeles County Flood Control Act

The Los Angeles County Flood Control Act was adopted by the State Legislature in 1915, after a regional flood resulted in significant loss of lives and property. This act established the LACFCD with a directive to provide flood protection, water conservation, recreation, and aesthetic enhancement within its boundaries. In 1984, LACFCD was transferred to Los Angeles County Public Works, who assumed the responsibilities and authority vested in the LACFCD. The LACFCD owns and maintains a broad network of flood control facilities, such as channels and spreading grounds, which convey stormwater to local rivers and ultimately to the ocean as well as groundwater reservoirs. This vast network of regional flood control channels is interconnected with local flood control facilities owned and maintained by both LACFCD and the incorporated municipalities within Los Angeles County.

Regional Water Quality Control Boards

RWQCBs were established in the Porter-Cologne Act to oversee water quality on a day-to-day basis at the local and regional level. RWQCBs are responsible for ensuring implementation and compliance with the provisions of the CWA and Porter-Cologne Act by setting water quality standards for surface waters and groundwater, implementing the NPDES program, issuing waste discharge requirements, determining compliance with those requirements, and taking appropriate enforcement actions. The Palmdale to Burbank Project Section is primarily located in Region 4, which is overseen by the Los Angeles RWQCB. The northernmost portion of the Palmdale to Burbank Project Section is located in Region 6, which is overseen by the Lahontan RWQCB.

Dewatering Activities

Care is required when nuisance water is removed from a construction site (known as dewatering) because of high turbidity and other pollutants potentially associated with this activity. Discharges to surface water from activities such as dewatering are covered by the following permits: Lahontan RWQCB's Renewal of WDRs, NPDES General Permit for Limited Threat Discharges to Surface Waters, and the Los Angeles RWQCB's WDRs for Discharges of Groundwater from Construction and Project Dewatering to Surface Waters. These permits allow discharges to surface water provided that the discharges do not violate applicable water quality objectives, exceed effluent limitations or discharge specifications, or cause acute or chronic toxicity in receiving waters.

Discharges to land from dewatering activities are covered under Order No. 2003-0003- DWQ, Statewide General WDRs for Discharges to Land with a Low Threat to Water Quality (SWRCB 2003).

Lahontan Regional Water Quality Control Board Dewatering Permits

The Lahontan RWQCB has a general permit for low-threat water discharges to surface waters. The general permit is Order No. R6T-2014-0049, NPDES No. CAG996001, *Renewal of Waste Discharge Requirements and NPDES General Permit for Limited Threat Discharges to Surface Waters.* The Lahontan RWQCB encourages the disposal of wastewater on land, where practicable, and requires applicants for the general permit to evaluate land disposal as the first alternative. The general permit covers the following discharges, provided that the discharge does not contain significant quantities of pollutants that could adversely affect designated beneficial uses, including:

- Diverted stream flows
- Construction dewatering
- Dredge spoils dewatering
- Subterranean seepage dewatering
- Well construction and pump testing of potable aquifer supplies

The Lahontan RWQCB also has a general permit for the discharge of water from a groundwater treatment unit to surface waters. This permit is Order No. R6T-2010-0024, NPDES No. CAG916001, *Waste Discharge Requirements for Surface Water Disposal of Treated Groundwater.* Its provisions cover the discharge of treated groundwater from cleanups of pollution, other than through a community wastewater collection and treatment facility, to surface waters.

Los Angeles Regional Water Quality Control Board Dewatering Permits

The Los Angeles RWQCB has a similar general permit for discharges of groundwater from construction and project dewatering to surface waters in coastal watersheds of Los Angeles and Ventura Counties. The general permit is Order No. R4-2013-0095, NPDES No. CAG994004, *Waste Discharge Requirements for Discharges of Groundwater from Construction and Project Dewatering to Surface Waters in Coastal Watersheds of Los Angeles and Ventura Counties.*

Discharges covered under the general permit include groundwater generated from permanent or temporary dewatering operations or other appropriate wastewater discharge not specifically covered in other general or individual NPDES permits. In addition, the general permit covers discharges from cleanup of contaminated sites where other project-specific general permits may not be appropriate, such as groundwater affected by metals and/or other toxic compounds. This general permit also covers discharges from dewatering operations in the vicinity of creeks where surface waters and groundwaters are hydrologically connected and have similar water chemistry.

SWRCB Order No. 2003-0003-DWQ, Statewide General WDRs for Discharges to Land with a Low Threat to Water Quality

Section 13260(a) of the California Water Code requires that any person discharging waste or proposing to discharge waste within any region, other than to a community sewer system, and which could affect the quality of the Waters of the United States, file a report of waste discharge.

Discharges to land with a low threat to water quality are defined as low volume discharges with minimal pollutant concentrations. These discharges are disposed of by similar means and are appropriately regulated under the General WDR and include well/boring waste, clear water discharges, small dewatering projects, and other miscellaneous discharges. All General WDRs must implement RWQCB Water Quality Control Plan (Basin Plan) for the Region affected by the discharge. These General WDRs require dischargers to comply with all applicable Basin Plan provisions, including any prohibitions and water quality objectives governing the discharge.

Basin Plans, Water Quality Objectives, and Beneficial Uses

Each RWQCB develops and periodically updates the water quality control plan (also known as a *basin plan*) for its respective region. Basin plans designate beneficial uses for specific surface water and groundwater resources, establish water quality objectives to protect those uses, and establish policies to guide the implementation of programs to attain the objectives. Two RWQCB basin plans are applicable for the groundwater RSA: *Water Quality Control Plan: Los Angeles Region* (RWQCB Los Angeles Region 1994), and *Water Quality Control Plan for the Lahontan Region* (RWQCB Lahontan Region 1995).

Section 303(d) of the CWA requires that states list waters that are not in attainment with water quality standards. The RWQCB establishes TMDLs for State waters and a program of implementation to meet the TMDLs. A TMDL must account for the pollution sources that cause the water to be listed.

Stormwater Management Programs

Stormwater discharges are regulated under the NPDES program. LACFCD, Los Angeles County, and 84 incorporated cities in Los Angeles County (collectively referred to as *permittees*) are covered under an MS4 permit for the discharge of urban runoff to WOTUS. The purpose of the MS4 permit is to ensure that permittees are not causing or contributing to exceedances of water quality objectives or impairments of beneficial uses in the receiving waters of the Los Angeles region. Municipal MS4 permits require municipalities to develop and implement stormwater management plans.

Los Angeles County Standard Urban Stormwater Mitigation Plan

The Standard Urban Stormwater Mitigation Plan is part of the Development Planning Program of the NPDES, Phase I, Stormwater Permit for Los Angeles County. The Standard Urban Stormwater Mitigation Plan applies to development and redevelopment projects in the county that fall into specific categories. Los Angeles County has developed a Standard Urban Stormwater Mitigation Plan manual that includes the permitting and inspection process for projects required to meet Standard Urban Stormwater Mitigation Plan regulations. The objective of the Standard Urban Stormwater Mitigation Plan is to effectively prohibit non-stormwater discharges and reduce the discharge of pollutants from stormwater conveyance systems to the maximum-extent-practicable statutory standard. The Standard Urban Stormwater Mitigation Plan defines hydrology standards for designing volumetric and flowrate-based BMPs (Los Angeles County 2006).

City of Palmdale Stormwater Management Plan

The City of Palmdale Department of Public Works is responsible for maintaining public improvements, including stormwater conveyances, within the city boundaries. The majority of stormwater in the city is directed to the Amargosa and Anaverde dry creek systems, which originate from the Sierra Pelona Mountains. The department submitted a stormwater management plan to the Lahontan RWQCB in August 2003 (City of Palmdale 2003). The SWRCB designated the Palmdale MS4 as a “Small MS4” because it is located in an urbanized area, as defined by the United States Bureau of the Census (City of Palmdale 2003). Small MS4s have three permitting options for stormwater discharges: individual permits, general permits, or inclusion in the existing Phase I permit. The City of Palmdale requested, and was allowed by the RWQCB to submit, an individual application for a general permit. In January 2005, the RWQCB informed the City of Palmdale that the Lahontan RWQCB does not intend to regulate the City of Palmdale under the General Permit because stormwater discharges within the Amargosa Creek watershed do not constitute discharges to WOTUS (RWQCB 2011).

City of Los Angeles Water Quality Compliance Master Plan

In 2009, the City of Los Angeles adopted the Water Quality Compliance Master Plan, a 20-year strategy for clean stormwater and urban runoff to reduce the pollution flowing into local waterbodies (City of Los Angeles 2009). The master plan describes the existing conditions for runoff management, identifies key issues for future stormwater management, provides strategic guidelines for improving the quality of Los Angeles' waterbodies, identifies opportunities for inter-agency and nongovernmental coordination, and describes how rainwater may be used to augment the city's water supply.

Upper Santa Clara River Enhanced Watershed Management Program

The Upper Santa Clara River Enhanced Watershed Management Program was developed for a portion of the Upper Santa Clara River watershed in Los Angeles County to comply with requirements in their MS4 permit (City of Santa Clarita 2014). The Upper Santa Clara River Watershed Group consists of Los Angeles County, Los Angeles County Flood Control District, and the City of Santa Clarita. The intent of the plan is to retain both non-stormwater and stormwater runoff as well as to facilitate flood control and water supply reliability.

Watermaster Service in the Upper Los Angeles River Area

The Upper Los Angeles River Area (ULARA) encompasses all the watershed and tributaries of the Los Angeles River and four groundwater basins above a point in the river designated by Los Angeles County Public Works. The intent of the ULARA Watermaster is to assist the Court in its administration and enforcement of the provisions of the judgement in the case of the *City of Los Angeles vs. City of San Fernando, et al*., (Case No. 650079), and in any subsequent orders of the Court pursuant to the Court's continuing jurisdiction. The ULARA group approved the ULARA Enhanced Watershed Management Plan in 2016 (Los Angeles Regional Water Quality Control Board 2016).

Los Angeles County Floodplains and Floodways

Los Angeles County's Capital Flood Control Act was adopted by State Legislature in 1915, after regional flooding occurred within the county. The Act established the Los Angeles County Flood Control District, which provides flood protection, water conservation, recreation, and aesthetic enhancement within its boundaries.

The Capital Flood is the runoff produced by a 50-year frequency design storm falling on a saturated watershed, where the watershed is undeveloped and the effect of burned conditions is factored in. The County considers floodplains and floodways associated with the County's Capital Flood to be areas of potential severe flood hazard in which development is regulated.

The County floodway is an area immediately adjacent to a water course where floodwaters during a Capital Flood are deepest and fastest moving. Its hazardous nature requires that development in this area be carefully managed. The floodway should remain free of obstruction and construction unless engineering analysis demonstrates that the flood hazard on adjoining properties would not be increased. Ideally, development in the floodway would be restricted to uses that do not interrupt or excessively accelerate the natural flow of the water (tennis courts, swimming pools, etc.). The limits of the County floodway are defined as the point where the velocity of flood flow is 10 feet per second, or the water surface elevation is 1 foot above the Capital floodplain water surface elevation. The first of either criteria reached controls the floodway width. Where the flow velocity exceeds 10 feet per second for the entire width of the floodplain, the floodplain lines and floodway lines are the same. Los Angeles County Public Works' Capital Flood Protection requirements apply to all unincorporated areas mapped as County floodways (Los Angeles County 2021).

City and County Policies and Regulations

Appendix 2-H identifies water resources policies and regulations from cities and counties traversed by all six Build Alternatives. The policies pertain to water quality, floodplain and groundwater protection, and grading. These local plans, policies, and regulations were identified and considered in the preparation of this analysis.

3.8.3 Consistency with Plans and Laws

As indicated in Section 3.1.4.3, Consistency with Plans and Laws, the California Environmental Quality Act (CEQA) and the Council on Environmental Quality (CEQ) regulations require a discussion of inconsistencies or conflicts between a proposed undertaking and federal, state, regional, or local plans and laws to provide planning context.

The Authority, as the lead state and federal agency proposing to construct and operate the California HSR System, is required to comply with all federal and state laws and regulations and to secure all applicable federal and state permits prior to initiating construction on the selected Build Alternative. Therefore, there would be no inconsistencies between the six Build Alternatives and these federal and state laws and regulations.

The Authority is a state agency and therefore is not required to comply with local land use and zoning regulations; however, it has endeavored to design and construct the California HSR System so that it is consistent with land use and zoning regulations. For example, the proposed Build Alternatives will incorporate IAMFs that require the contractor to prepare a stormwater pollution prevention plan to demonstrate how construction impacts will be maintained below applicable standards.

Appendix 2-H provides a Regional and Local Policy Consistency Table, which lists the hydrology and water resources goals and policies applicable to the Palmdale to Burbank Project Section and notes the consistency or inconsistency of each of the six Build Alternatives. The Authority reviewed seven plans and several policies. Each of the six Build Alternatives are consistent with the majority of policies reviewed but are potentially inconsistent with 2 policies. These are Policy S 2.2 of the Los Angeles County General Plan, which discourages development from locating downslope from aqueducts, and Policy LU 3.3 of the Los Angeles County Ordinances, which limits the amount of development in Flood Zones designated by FEMA. Both policies can be found in Appendix 2-H.

3.8.4 Methods for Evaluating Impacts

The evaluation of impacts on hydrology and water resources is a requirement of the National Environmental Policy Act (NEPA) and CEQA. The following sections describe the RSAs, and the methods used to analyze impacts associated with the Build Alternatives on hydrology and water resources.

3.8.4.1 Definition of Resource Study Areas

As defined in Section 3.1, Introduction, RSAs are the geographic boundaries in which the environmental investigations specific to each resource topic were conducted. In general, the boundaries of the RSAs pertaining to hydrology and water resources extend beyond all six Build Alternative footprints and include tributary and receiving watercourses that are connected to resources within the Build Alternative footprints. For the Palmdale to Burbank Project Section, RSAs are defined as follows:

- **Surface Hydrology and Water Quality RSA**—The RSA is defined as the Build Alternative footprint for each of the six Build Alternatives (e.g., stations, track, equipment storage areas, substations, temporary construction areas, and easements) and the areas encompassing receiving waters of runoff from the Build Alternatives.
- **Flooding RSA**—The RSA is defined as the FEMA-designated and DWR-designated flood-hazard areas located within each of the six Build Alternative’s footprint as well as any areas where flood frequency, extent, and duration could be affected by the Build Alternatives.
- **Tunnel Construction RSA**—The Tunnel Construction RSA is defined as the area within 1 mile of the centerline of each of the six Build Alternatives in the ANF. This RSA was delineated to analyze potential indirect hydrologic effects in the ANF, including the SGMNM, associated with changes in hydrogeologic conditions caused by tunnel construction required by each of the Build Alternatives. Figure 3.8-A-1 through Figure 3.8-A-15 illustrate the alignments for the Build Alternatives and the tunnel construction RSA. The RSA consists of a

tectonically elevated terrain that extends from Soledad Canyon on the north to the Santa Clarita and San Fernando Valleys on the west, Tujunga Wash (i.e., Tujunga Valley) on the south and Big Tujunga Canyon to the east.

- **Groundwater RSA**—The RSA is defined as the Build Alternative footprint for each of the six Build Alternatives and the underlying groundwater, including aquifers, perched groundwater, seeps, and springs.

3.8.4.2 Impact Avoidance and Minimization Features

IAMFs are project features that the Authority has incorporated into each of the six Build Alternatives for purposes of the environmental impact analysis. The full text of the IAMFs that are applicable to the Palmdale to Burbank Project Section is provided in Volume 2, Appendix 2-E, Project Impact Avoidance and Minimization Features.

The following is a list of IAMFs that were incorporated into the hydrology and water resources analysis:

- **HYD-IAMF#1:** Stormwater and Groundwater Management—This IAMF describes the Authority's commitment to coordinate with the contractor to prepare a stormwater and groundwater management and treatment plan, prior to construction.
- **HYD-IAMF#2:** Flood Protection—This IAMF describes the Authority's commitment to coordinate with the contractor to prepare a Flood Protection Plan, prior to construction.
- **HYD-IAMF#3:** Prepare and Implement a Construction Stormwater Pollution Prevention Plan—This IAMF describes the Authority's commitment to coordinate with the contractor to comply with the SWRCB Construction General Permit requiring preparation and implementation of a SWPPP, prior to construction (ground disturbing activities).
- **HYD-IAMF#4:** Prepare and Implement an Industrial Stormwater Pollution Prevention Plan—This IAMF describes the Authority's commitment to coordinate with the contractor to comply with existing water quality regulations, prior to construction of any facility classified as an industrial facility.
- **HYD-IAMF#5:** Tunnel Boring Machine Design Features—This IAMF describes the Authority's commitment to employ types and specifications of Tunnel Boring Machines (TBMs) to minimize seepage into tunnel cavities, and to be designed to operate in either an open hard rock tunneling mode (open mode) or a pressurized tunneling mode (closed mode).
- **HYD-IAMF#6:** Tunnel Lining Systems—This IAMF describes the Authority's commitment to employ different types of tunnel system lining that would be used under varying circumstances, including circumstances where risk of seepage into tunnel cavities is moderate or high.
- **HYD-IAMF#7:** Grouting—This IAMF describes the Authority's commitment to employ various methods and approaches to grouting that would be used to avoid and minimize seepage into tunnel cavities. A multi-phase grouting program would be implemented during the construction of the tunnels. A primary objective of the grouting program would be to reduce or prevent potential groundwater flows into the tunnels during construction. This IAMF also describes the network of piezometers that would detect any changes in groundwater elevations during construction. Within Section 3.8-36, each impact narrative describes how these project features are applicable and, where appropriate, effective at avoiding or minimizing impacts.
- **HYD-IAMF#8:** Private Well Monitoring and Minimizing Access Disruptions for Private Water Supply Wells Outside of the ANF—Prior to tunnel construction, the Authority will identify all private water supply wells within the tunnel alignment outside of the ANF that may be rendered unusable due to tunnel construction. Baseline conditions prior to construction start, including pumping capacity and water quality, will be recorded for each well. Per the Authority's Right-of-Way Manual, if the project's tunneling intersects with a private well, the

replacement of an affected private water supply well is among the options that the Authority will consider. Any final measures that the Authority undertakes will be determined only after consultation with the affected property owner.

Other resource IAMFs applicable to impacts on hydrological and water resources include:

- **HMW-IAMF#9**: Environmental Management System
- **HMW-IAMF#10**: Hazardous Materials Plans

3.8.4.3 Methods for NEPA and CEQA Impact Analysis

Overview of Impact Analysis

This section describes the sources and methods the Authority used to analyze project impacts to hydrology and water resources associated with the six Build Alternatives. These methods apply to both NEPA and CEQA analyses unless otherwise indicated. Refer to Section 3.17.5, for a description of the general framework for evaluating impacts under NEPA and CEQA.

3.8.4.4 Methods for Evaluating Impacts under NEPA

The CEQ NEPA regulations (40 C.F.R. Parts 1500–1508) provide the basis for evaluating project effects (Section 3.1.5.4).

As described in Section 1508.27 of these regulations, the criteria of context and intensity are considered together when determining the severity of the change introduced by the project. “Context” is defined as the affected environment in which a proposed project occurs. “Intensity” refers to the severity of the effect, which is examined in terms of the type, quality, and sensitivity of the resource involved; location and extent of the effect; duration of the effect (short- or long-term); and other considerations of context. Beneficial effects are also considered. When no measurable effect exists, no impact is found to occur. For the purposes of NEPA compliance, the same methods used to identify and evaluate impacts under CEQA are applied here.

3.8.4.5 Method for Determining Significance under CEQA

The Authority used the following thresholds to determine if a significant impact on hydrology and water resources would occur as a result of the construction or operation of any of the Build Alternatives. A significant impact is one that would:

- Violate water quality standards or WDRs, or otherwise substantially degrade surface or groundwater quality
- Substantially decrease groundwater supplies or interfere substantially with groundwater recharge such that the project may impede sustainable groundwater management of the basin
- Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, or through the addition of impervious surface in a manner which would:
  - Result in substantial erosion or siltation on- or off-site
  - Substantially increase the rate or amount of surface runoff in a manner that would result in flooding on- or off-site
  - Create or contribute runoff water that would exceed the capacity of existing or planned stormwater drainage systems or provide substantial additional sources of polluted runoff or impede or redirect flood flows
- Risk release of pollutants due to project inundation in flood hazard, tsunami, or seiche zones
- Conflict with or obstruct the implementation of a water quality control plan or a sustainable groundwater management plan

Impacts related to dam inundation and similar type hazards are discussed in Section 3.9, Geology, Soils, Seismicity, and Paleontological Resources.

As discussed above, state and federal agencies, including the U.S. Environmental Protection Agency, SWRCB, and the RWQCBs, have established water quality standards that are relevant to the Palmdale to Burbank Project Section. These standards and requirements have been developed to prevent the degradation of water quality and thus serve as appropriate thresholds for determining the significance of water quality impacts.

For impacts related to flood-related hazards, the analysis relies on standards established by FEMA and local agencies. FEMA oversees federal floodplain management policies and runs the National Flood Insurance Program adopted under the National Flood Insurance Act of 1968. FEMA prepares flood insurance rate maps that delineate the floodplain to assist local governments with land use and floodplain management decisions to avoid flood-related hazards. To avoid impacts related to flooding, FEMA and the local agencies require that an encroachment into a floodplain not increase the water surface elevation of the 100-year flood by more than 1 foot in FEMA mapped floodplains. However, if there is a FEMA-designated "regulatory floodway," no increase in water surface elevation is permitted. If the Authority later determines that a FEMA regulatory floodway may be affected by the Project, it would conduct additional hydraulic modeling to confirm that there would be no (0.00 foot) increase in the base flood elevation, as indicated in HYD-IAMF#2, which requires compliance with local agency requirements for development within the floodplain. If the Authority is unable to meet these requirements, and the base flood elevation exceeds the NFIP regulations, the Authority would seek approval of the LAFCD to apply to FEMA for a Conditional Letter of Map Revision (CLOMR), as indicated in HYD-IAMF#2.

3.8.4.6 Hydrology and Water Resources Methodology

This section explains the data sources and methodology used in the hydrology and water resources evaluation. The analysis draws from a variety of sources of information, as summarized in Table 3.8-1. Information sources and methodology specific to each resource topic are specified under the subheadings below. To date, limited site-specific investigations and field work were conducted for the hydrogeological evaluation.[1]

Table 3.8-1 Hydrology and Water Resources Information Sources

Topic Area	Information Source
Climate, Precipitation, and Topography	▪ California Data Exchange Center ▪ Western Regional Climate Center ▪ USGS topographic maps ▪ USGS National Hydrography Dataset ▪ National Elevation Dataset ▪ Project description and conceptual design ▪ Plans

[1] Hydrologic features are also identified in the aquatic delineation for the Palmdale to Burbank Project Section (Authority 2016), which focused on biological parameters and included fieldwork studies to map and evaluate potential aquatic features that are regulated under Section 404 of the CWA. Refer to Section 3.7, Biological and Aquatic Resources, for additional information on this delineation effort.

Topic Area	Information Source
Regional and Local Hydrology and Water Quality	▪ USGS topographic maps ▪ Department of Water Resource aerial and infrared imagery ▪ California Interagency Watershed Map of 1999 (updated May 2004) ▪ FEMA Flood Insurance Rate Maps ▪ RWQCB beneficial uses ▪ CWA Section 303(d) lists of water quality-impaired reaches
Impacts on Hydrology and Water Resources	▪ Conceptual-level reports ▪ Draft drainage, floodplain, hydrology and hydraulics, and stormwater reports ▪ Federal and state statutes regulating water resources ▪ FEMA floodplain and floodway maps ▪ *Preliminary Floodplain Impacts Assessment Report* (Authority 2020a) ▪ Los Angeles County Floodway maps
Hydrogeologic Impacts	▪ *Preliminary Geotechnical Data Report for Tunnel Feasibility, Angeles National Forest* (Authority 2019a) ▪ *Geotechnical Tunnel Feasibility Evaluation for High-Speed Rail Tunnels Beneath the Angeles National Forest* (Authority 2019b)

Source: Authority, 2017a
CWA = Clean Water Act; FEMA = Federal Emergency Management Agency; RWQCB = Regional Water Quality Control Board; USGS = United States Geological Survey

Surface Water Hydrology

Surface water refers to aboveground waterbodies found in the surface hydrology and water quality RSA, such as natural or artificial streams, creeks, rivers, springs, ponds, lakes, and reservoirs. Because of the dry climate in Los Angeles County, many waters in the surface hydrology and water quality RSA flow only during wet seasons (intermittent) or flow only for a short time immediately following rainfall (ephemeral). In developed areas, impervious surfaces (e.g., pavement and buildings) affect the flow of stormwater by preventing infiltration into groundwater, which can change water quality.

Floodplains – Key Definitions

Floodplain—An area susceptible to inundation by floodwaters from any source

Floodway—The channel of a river or other watercourse and the adjacent land areas that must be reserved to discharge the base flood without cumulatively increasing the water surface elevation more than a designated height

Special Flood Hazard Area (SFHA)—The land area covered by the floodwaters of the base flood, as defined by the National Flood Insurance Program

Zone A—FEMA flood zone designation corresponding to an area with a 1 percent annual chance of flooding

100-year flood (base flood)—A flood with 1 percent chance of being equaled or exceeded in any given year

Source: FEMA, 2017

For the purposes of this analysis, the Authority evaluated surface water impacts from each of the six Build Alternatives by overlaying geographic information system datasets for the HSR footprint on the United States Geological Survey (USGS) National Hydrography for surface waters. The Authority then used these GIS layers to identify additional potential encroachments and new crossings of watercourses throughout the surface hydrology and water quality RSA. Then, the amount of impervious area that would prevent infiltration into the groundwater table created by the Build Alternatives was estimated.

Impacts associated with the construction and operations of the six Build Alternatives on surface waters could result from the physical impact on the landscape of facilities, such as tracks, stations, parking structures/lots, or support facilities, which create new barriers to surface water flows. Impacts on surface waters could also result from tunneling, as discussed in Section 3.8.5.6. New impervious surfaces could increase the timing and volume of stormwater runoff. In addition, the Build Alternatives may change or otherwise impede local drainage infrastructure, which could lead to localized or regional drainage impacts. For example, increased rates and amounts of stormwater runoff could cause erosion, thereby altering existing drainage channels.

Floodplains

Facilities within floodplains could be at risk of inundation, and new development within a floodplain could create new flood risks by changing the location, direction, or elevation of flood flows. Railroad tracks, bridges, and culverts that cross a designated floodplain may potentially affect the hydraulics of the waterbody associated with the floodplain.

For the purposes of this analysis, the Authority evaluated impacts based on SFHA Zone A, which corresponds to the 100-year flood hazard area. Under FEMA requirements, the channel of a watercourse designated as a floodway by FEMA must be kept free of encroachment so that the 100-year flood flow can be conveyed without increasing the water surface elevation. Within the portion of the floodplain located outside of the floodway, referred to as the floodway fringe, development and other forms of encroachment are permitted and small increases in water surface elevation could result. A substantial encroachment on the 100-year floodplain would be one that increases the base flood elevation by 1 foot, consistent with FEMA guidance.

This analysis quantified the SFHAs and regulated floodways within each of the six Build Alternative footprints and evaluated the potential for the Build Alternatives to increase flood height and/or divert flood flows.

In addition, USFS requested additional information on new drainage crossings to determine the capacity of the drainage systems to accommodate higher stormwater runoff flows and mudflows in areas denuded by wildfires. Data from wildfire impacts on watersheds show elevated flood flows and sediment delivery after a wildfire, which could exceed typical FEMA 100-year flood events. Furthermore, wildfires could create extensive debris that could cause culverts and drainage systems to become overwhelmed during a flood event, possibly causing road and property damage. New drainage structures in and adjacent to ANF were evaluated based on the size of the watershed and the watershed’s potential wildfire rating to determine whether said drainage structures would have adequate capacity for flood flows and sediments in the event of a FEMA 100-year flood event. This analysis predicted and identified which structures may need to be reevaluated during the detailed design phase for flows greater than the 100-year flood event and mud flows. This analysis did not include flow calculations.

Surface Water Quality

Human and natural communities depend upon safe surface waters for consumption and recreational, agricultural, industrial, and commercial uses. The analysis of impacts on surface water quality included identifying watercourse segments with impaired water quality, evaluating construction activities for their effects on surface water quality, and reviewing operations and maintenance activities required for all six Build Alternatives for their potential to introduce pollutants into the environment.

Groundwater

Groundwater is found in subsurface water-bearing formations. A groundwater basin is defined as a hydrogeologic unit containing one large aquifer or several connected and interrelated aquifers within a sedimentary basin. Groundwater basins are confined by surface features and/or subsurface geological features such as faults, impermeable layers, and natural or artificial divides in the water table. An example of a natural divide is the San Gabriel Mountains separating the San Fernando groundwater basin from the Santa Clarita groundwater basin. Groundwater basins may be recharged naturally as precipitation infiltrates through permeable surfaces such as undeveloped land and/or artificially with imported or reclaimed water. The amount of impermeable surface in an area negatively affects a groundwater basin’s ability to recharge naturally, thereby increasing the need for artificial recharge.

Especially in Los Angeles County, where many rivers are channelized (e.g., paved) as a flood control measure, spreading grounds are a common way to increase the amount of natural recharge. Spreading grounds are undeveloped areas adjacent to a river or other waterbody into which stormwater can be diverted and retained long enough for percolation into groundwater basins to occur.

Groundwater also occurs within the natural divides between groundwater basins but to a very limited extent compared to the basins. Generally, natural divides between groundwater basins consist of nearly impermeable bedrock. Groundwater in the bedrock is stored and transmitted through fracture systems in the rock.

The analysis of impacts on groundwater from all six Build Alternatives included estimates of the length and acreage of groundwater basins beneath each of the six Build Alternatives footprints, as well as the depth to groundwater in these areas. To evaluate construction impacts, the Authority examined contaminated site runoff, excavation, tunnel boring, and dewatering activities' effects on groundwater resources. Effects on groundwater related to operations may be associated with increases in impervious surfaces and introduction of pollutants.

Hydrologic Impacts Related to Hydrogeologic Changes

Hydrologic effects associated with changes to hydrogeologic conditions were evaluated in the tunnel construction RSA associated with the ANF, in addition to tunnels in other areas. Tunnel construction in the ANF presents conditions such as high mountains, faulting, hard rock formations and potentially high water pressures. These conditions are substantially different than those that would be encountered in areas outside the ANF, which are primarily characterized by alluvial soils and low groundwater pressures.

The general approach to evaluating impacts on subsurface (e.g., groundwater, including domestic water wells) and surface (springs, seeps, and streams) water resources in the San Gabriel Mountains due to tunneling is based on an assessment of known hydrogeologic and hydrologic conditions of the western San Gabriel Mountains; the professional judgment of experts in the field of hydrogeology, hydrology, and tunnel construction; as well as in case studies of similar types of tunnel construction projects. The information and data are derived in part from preliminary geotechnical investigations conducted by the Authority (Authority 2019a and 2019b). Case studies of tunnel construction occurring under similar type conditions were used to inform the analysis, including documented effects on surface water and other water resources associated with those tunnels. The case studies include tunnels located in Southern California (Authority 2020c). The analysis is focused on the number and location of known mapped faults intersected by the alignments of the six Build Alternatives, the groundwater pressures associated with the tunnel alignments, and the evidence of surface water manifesting as springs or seeps and streams in proximity to the alignments.[2]

The interpretation of hydrogeologic conditions for the three tunnel alignments associated with the six Build Alternatives is informed by information available from six core holes completed in the RSA, published geologic maps and studies, and previous experience with projects encountering the same or similar lithologies. Since the existing core holes are not located directly on any alternative alignment, the six core holes serve as analogs to represent the general rock conditions where the tunnel alignments are located. The geologic units, lithologies, geologic structures, geologic hazards, and other key features are summarized in the following Authority reports:

- *Preliminary Geotechnical Data Report for Tunnel Feasibility, Angeles National Forest*, (Authority 2019a)
- *Geotechnical Tunnel Feasibility Evaluation for High-Speed Rail Tunnels Beneath the Angeles National Forest* (Authority 2019b)

[2] During the summer months, the flows of many of the monitored springs substantially decrease, reducing the spring to a seep or wet area. Therefore, this analysis uses the term springs to refer to both springs and seeps.

Monitoring of known springs was conducted in the vicinity of the three tunnel alignments associated with the Build Alternatives beneath the ANF over an approximate 25-square-mile area in support of tunnel feasibility field studies (Authority 2019a and 2019b). The monitoring program encompassed 20 known springs at various locations in the ANF. Of the 20 springs, four were in private, in-holding properties. Sixteen springs were ultimately selected for the monitoring program (Figure 3.8-A-16). The first monitoring cycle was completed during the end of the summer season on September 16, 2016, with subsequent cycles continuing on a quarterly basis.

As discussed below, the following general assumptions form the basis of the evaluation of impacts to subsurface, surface, and other water resources in the ANF, including areas within the SGMNM, due to tunnel construction[3]:

- The greatest potential for groundwater to flow into tunnels exists at locations where tunnel construction intersects faults and fractures in the bedrock.
- The potential for water to flow into tunnels during construction, as well as the rate and volume of any such flows, is greatest in areas of high water pressure, assumed for purposes of this analysis to be greater than 25 bar.
- Proximity of the tunnel construction to water resources influences the severity of the water loss. Closer proximity of a water resource to the tunnel excavation may result in greater impact.
- Springs, intermittent and perennial streams, and water supply wells along, or in proximity to, faults are most vulnerable to impacts when tunnel construction intersects faults, areas of high water pressure, and water within fractures that seeps into the tunnel excavation.

With respect to the first assumption, hydrologic impacts are most likely to occur where the tunnel alignments for the Build Alternatives intersect fault zones in the bedrock. This is because faults and associated fractures act as areas of water storage and as flow paths for groundwater. Rock void of fractures or faults (intact rock) is virtually impermeable to water and does not store water or transmit water flow. Case studies confirm that highest levels of groundwater inflows into tunnels occur where a fault is encountered during tunnel construction (USFS 2012). The intersection of a fault and associated fracturing with the tunnel is assumed to make a direct connection of the fault and associated groundwater flow with the tunnel excavation, resulting in the potential discharge of water into the tunnel opening. As a result, subsurface and surface water resources impacts, where present, are most likely to occur in these areas. This analysis includes mapping of known faults along the alignments of the tunnel Build Alternatives, geologic maps, and older aerial photographs to identify those areas at risk of hydrologic impacts. However, it is likely that not all faults in the ANF have been mapped because of limited surface evidence and the inherent limitations of surface geologic investigations. Additional geological investigation would occur before final design and construction.

Groundwater pressure is also assumed to have a direct influence on potential groundwater flow rates and volumes as well as the capacity of tunnel boring methods and technologies to control flows into the tunnel. As pressures increase, the driving force to push groundwater through fractured ground increases. This results in higher potential flow rates at greater depths. Areas of pressure above 25 bar were mapped based on the depth of the tunnel below the ground surface using data derived from the geotechnical investigations, which roughly correlate pressure versus depth data in the six completed exploratory bore holes (Authority 2019a). The higher pressures occur where a greater thickness of rock above the tunnel is saturated (i.e., greater depth below the groundwater table).

A 25 bar groundwater pressure was selected as a cut-off to represent the maximum pressure that gaskets used for construction of one-pass water-tight tunnels are designed to withstand over time (Swartz et al. 2002). Two-pass lining systems would be installed to resist over the long-term

[3] Construction of adits for the tunnels would be conducted using conventional mining methods, which would include pre-exploratory grouting, tunnel liners, and check grouting such that effects on groundwater would be minimized.

groundwater pressures above 25 bar and ensure that the tunnels remain water-tight throughout the life of the project. The second lining would consist of a monolithic reinforced concrete lining and would be put in place after the TBM has finalized the excavation and the first lining has been installed. During the tunnel construction, groundwater inflow risk mainly occurs between boring and installation of the first pass lining. Excavation and installation of the first lining precast segments are concurrent operations with the erection of the precast segments taking place in the space behind the cutterhead and inside the TBM shield.

Pre-excavation grouting would provide further reinforcement against tunnel seepage. Grouting would be applied to form a permanent strengthened very low permeability circular crown around the TBM that, in conjunction with the first-pass tunnel lining, would take on the high-water pressures until a second lining is installed (Maidl et al. 2012). If any water flow is detected during the construction period after the installation of the first lining and before the second lining deployment, additional check grouting would be implemented as needed.

Groundwater Pressure

Groundwater pressure, or hydraulic head, is a function of how deep into the groundwater system a measurement of pressure is made. The pressure increases with increasing depth of submergence at a constant rate. The rate of pressure increase is independent of whether pressure is measured in an open body of water or along fractures in bedrock.

This analysis assumes that areas where tunnel Build Alternatives intersect faults and are subject to water pressures greater than 25 bar present conditions that pose a greater risk of inflow during tunnel construction compared to areas subject to 25 bar or less. Such groundwater flows into the tunnel, while not anticipated to be substantial, could reduce groundwater levels and result in adverse effects to surface water resources.

Based on the general observations of groundwater occurrence and flow behavior described above, potential risk areas were identified and mapped in the tunnel construction RSA in the ANF, with relative rankings of High Risk, Moderate Risk, and Low/No Risk of impacts to subsurface, surface, and other water resources (Table 3.8-2). These risk rankings are generally based on occurrences where tunnel alignments intersect with faults, the expected groundwater pressures at the tunnel depth at those points of intersection, and the proximity of subsurface and surface water resources to these intersections. In a limited number of cases, the presence of springs in proximity to a tunnel Build Alternative, considered along with groundwater pressures above 25 bar but independent of the presence of mapped faulting, was used to define a Moderate Risk area.

The risk areas have been delineated based on the general criteria presented in Table 3.8-2.

Table 3.8-2 Definition of Risk Areas

Risk Area Designation	Description of Risk Designation
High Risk Area	▪ Tunnel Build Alternative intersects a fault where groundwater pressures are estimated to be above 25 bar at the tunnel depth. ▪ The lateral extent of surface and groundwater impacts for a High Risk Area is defined as the length of the fault out to 1 mile from where the tunnels intersect the fault and the area that encompasses the approximate width of the fault zone and associated fractured rock.
Moderate Risk Area	▪ Tunnel Build Alternative intersects a fault where groundwater pressures are estimated to be equal or below 25 bar at the tunnel depth. ▪ Areas with no mapped faults, but with known springs within 0.5 mile of the tunnel alignment where groundwater pressures are estimated to be above 25 bar at the tunnel depth. ▪ The lateral extent of surface and groundwater impacts for a Moderate Risk Area is defined as the length of the fault out to 0.5 mile from where the tunnels intersect the fault and the area that encompasses the approximate width of the fault zone and associated fractured rock.

Risk Area Designation	Description of Risk Designation
Low Risk/No Risk Area	▪ All other areas within 1 mile of the centerline of the tunnel alignments on each side of the alignment.

The Risk Areas are depicted on maps in Appendix 3.8-A (Figures 3.8-A-21 through 3.8-A-23). These maps illustrate the location and spatial relationships of known faults, known springs, and topography, and indicate estimated groundwater pressures at the estimated tunnel depths along the alignments of each of the Build Alternatives. Base maps were created depicting the topography, fault traces, spring locations, active/inactive wells, and estimated areas with groundwater pressures above 25 bar in the tunnel construction RSA. The tunnel construction RSA, which extends 1 mile from the alignment, was sized to capture the totality of hydrological effects that may occur as a result of tunneling activities, informed by an assessment of case studies, particularly the Inland Feeder Arrowhead Tunnels case study (USFS 2012).

The locations of fault zones, streams (Campbell et al. 2014), and springs (USGS 2016) were mapped using available GIS databases. The areas of pressure above 25 bar were mapped based on the depth of the tunnel below the ground surface using data derived from the geotechnical investigations, which roughly correlate pressure versus depth data in the six completed exploratory bore holes (Authority 2019a). The higher pressures occur where a greater thickness of rock above the tunnel is saturated (i.e., greater depth below the groundwater table).

As shown in Table 3.8-2, the length of High Risk areas, which were delineated in the tunnel construction RSA, extends 1 mile from the point of intersection with the tunnel Build Alternatives along the fault trend. The 1 mile distance from the tunnel alignment that makes up the tunnel construction RSA was selected based on the general limit of observed impacts on groundwater from past tunnel projects (Authority 2019b). The Moderate Risk areas extend 0.5 mile from the tunnel Build Alternative also parallel to the fault zone. The Moderate Risk Areas extend less distance from the tunnel Build Alternatives fault interface than the High Risk areas because tunnel seepage would be more readily controlled and hydrological impacts in the absence of design features and construction methods would be more localized. Where Moderate Risk areas are identified based solely on the proximity of tunnel Build Alternatives to mapped springs where groundwater pressures would be above 25 bar, the Risk Areas are delineated within 0.5 mile of the alignment.

The width of the Risk Areas shown on the maps were drawn to encompass mapped locations of individual faults or groups of faults intersecting the tunnel Build Alternatives, or to encircle the mapped occurrence of springs or streams within 0.5 mile of the tunnel Build Alternatives where pressures exceed 25 bar. Since water flows most freely through interconnected fracture systems surrounding and along faults (e.g., as planar conduits of groundwater flow radiating from the tunnel cavity), the area of hydrological effect is anticipated to cover the width of shearing and fractured rock extending outward from the fault and parallel to the trend of the fault as mapped. This width could be tens to hundreds of feet depending on the individual fault zone effects on the rock mass. These at-risk areas were demarcated on base maps that capture both the point of intersection and additional areas that may be affected by hydrogeological changes, the distance of which is based on professional judgement and informed by the relevant case studies (Authority 2019b).

3.8.5 Affected Environment

The six Build Alternatives cross over or through a variety of hydrologic and water resources, including watersheds, floodplains, watercourses, springs, and groundwater basins. These resources are discussed below.

3.8.5.1 Regional Setting and Physiography

The Palmdale to Burbank Project Section stretches from the city of Palmdale in the north to the city of Burbank in the south. The city of Palmdale is a developing urban center in the Antelope

Valley, which is a broad, closed basin bordered on the north by the Garlock Fault and on the south by the San Andreas Fault. The topography of the Antelope Valley is generally level with isolated hills rising abruptly from the desert floor. Regionally, the desert floor slopes toward the center of the Antelope Valley from an elevation of about 4,400 feet above mean sea level near the Garlock Fault to about 2,300 feet above mean sea level along Amargosa Creek, which passes through the city of Palmdale. Thus, Palmdale is located in a relatively lower elevation within the Antelope Valley basin. The existing drainage features in the Antelope Valley are small ephemeral washes that experience flash floods during substantial rainfall events and do not outlet to the Pacific Ocean. Because it lacks defined channels outside of the foothills, the valley is subject to unpredictable sheet flow during periods of heavy rain.

Continuing south, after passing through the Mojave Desert Geomorphic Province, the Palmdale to Burbank Project Section enters the Transverse Ranges geomorphic province, an east-west trending series of steep mountain ranges and valleys. Its eastern edge near the San Bernardino Mountains has been displaced to the south along the San Andreas Fault due to fault activity. This geomorphic province is one of the most rapidly rising regions on earth due to intense north-south tectonic compression. As a result of stress directed towards the center of mass, thick petroleum-rich sedimentary rocks have created an important oil-producing region. This area includes the rural residential neighborhoods of Acton and Agua Dulce as well as the ANF. Topography throughout this area is variable but could reach elevations of more than 10,000 feet above mean sea level. South of the ANF, the Palmdale to Burbank Project Section enters the cities of Los Angeles and Burbank, which are fully developed with commercial, industrial and a mix of urban and suburban residential uses. This region is physiographically defined by a lowland plain in the San Fernando Valley crossed by multiple fault systems. For more information on regional geology, refer to Section 3.9, Geology, Soils, Seismicity, and Paleontological Resources.

Climate

The climate in the region varies greatly from north to south because of the presence of the San Gabriel Mountains. The mountains create a rain shadow, causing a desert climate in the Antelope Valley, which contrasts with the moister climate on the coastal side of this mountain chain. Palmdale experiences hot, dry summers and cool to cold winters, characteristic of the Mojave Desert. The average annual precipitation observed in Burbank was more than 200 percent greater than that of Palmdale. Detailed temperature and precipitation data for the surface hydrology and water quality RSA is included in the *Palmdale to Burbank Hydrology and Water Quality Technical Report* (Authority 2017a).

Watersheds

A watershed is a network of waterbodies that share a common outlet or exist within a closed topographic basin. The surface hydrology and water quality RSA encompasses three watersheds, described below and mapped on Figure 3.8-A-18.

Antelope Valley Watershed

The Antelope Valley Watershed encompasses 1,220 square miles within Los Angeles County, 2,006 square miles within Kern County, and 143 square miles within San Bernardino County. This watershed is a closed topographic basin with no outlet to the Pacific Ocean. Streams originating in the mountains and foothills flow across the valley floor and eventually pond in the dry lakes adjacent to the northern Los Angeles County line. The Antelope Valley lacks defined natural and improved channels outside of the foothills and is subject to unpredictable sheet flow patterns (Los Angeles County 2017). Approximately 10 percent of lands within the Antelope Valley Watershed are developed. Historically, water supplies in the Antelope Valley Watershed have been used primarily for agriculture; however, as a result of population growth, water demands from residential and business uses have increased significantly and this trend is expected to continue.

Santa Clara River Watershed

The Santa Clara River Watershed encompasses 786 square miles within Los Angeles County, 243 square miles within Ventura County, and 1 square mile within Kern County. Approximately

43 percent of lands within the Santa Clara River Watershed are developed (Los Angeles County 2017). This watershed contains the Santa Clara River, the largest natural river remaining in Southern California. The river originates in the northern slopes of the San Gabriel Mountains inside the western part of the ANF, near the community of Acton. The river and its tributaries flow in a westerly direction for approximately 84 miles through Tick Canyon, Aliso Canyon, Soledad Canyon, the Santa Clarita Valley, the Santa Clara River Valley, and the Oxnard Plain before discharging to the Pacific Ocean in Ventura County. The headwaters take drainage from the northern slopes of the San Gabriel Mountains inside the western part of the ANF.

Los Angeles River Watershed

The Los Angeles River Watershed encompasses 834 square miles within Los Angeles County. Approximately 56 percent of lands within the Los Angeles River Watershed are developed (Los Angeles County 2017). The Los Angeles River Watershed spans from the Santa Monica Mountains to the Simi Hills in the east and from the Santa Susana Mountains to the San Gabriel Mountains in the west. Particularly in the San Fernando Valley and southward, the Los Angeles River Watershed consists of many paved and channelized waterbodies. From the 1930s through the 1960s, USACE lined the Los Angeles River with concrete along almost its entire length to provide flood control for the increasingly developed region. Pollutants from dense clusters of residential, industrial, and other urban development have impaired water quality in the middle and lower portions of the watershed.

3.8.5.2 Surface Waters

The surface hydrology and water quality RSA is characterized by a tectonically elevated terrain that extends from Soledad Canyon on the north to the Santa Clarita and San Fernando Valleys on the west, Tujunga Wash (i.e., Tujunga Valley) on the south and Big Tujunga Canyon to the east (Figure 3.8-A-17). The tunnel construction RSA also includes surface waters for the purposes of analyzing potential indirect effects of hydrogeologic changes caused by tunneling on surface waters. The methodology for evaluating hydrogeologic effects from tunnel construction is discussed further in Section 3.8.5.7. The steep topographic relief of the San Gabriel Mountains is illustrated in Figure 3.8-A-17. The surface drainage pattern is governed by two approximately east-west trending drainage divides, the Santa Clara Divide, and the Mendenhall Divide (Mendenhall Ridge Road) (Figure 3.8-A-17). The Santa Clara Divide extends from the Little Tujunga Canyon Road-Sand Canyon Road transition eastward to Mendenhall Ridge Road. The Mendenhall Divide extends from Little Tujunga Canyon Road at Pacoima Road north-northeasterly where it joins Santa Clara Divide. The Little Tujunga Canyon and Gold Creek drainage system captures the surface runoff in the RSA south of Mendenhall Divide. Big Tujunga Canyon is the next drainage system east of Little Tujunga Canyon-Gold Creek drainage that is south of Mendenhall Divide. Both Big Tujunga and Little Tujunga canyons drain southward into Tujunga Wash. Pacoima Canyon and its tributaries drain westward between the Santa Clara Divide and Mendenhall Divide to discharge along the northeast edge of San Fernando Valley. Numerous smaller canyons drain northward from the Santa Clara Divide into the Santa Clara River and Soledad Canyon. The smaller canyons include Sand Canyon, Iron Canyon, Pole Canyon, and Arrastre Canyon. The many small tributary canyons capture the mountain runoff and feed into the larger canyons, which discharge most of rainfall and snowmelt into the valleys (i.e., groundwater basins) flanking the mountains as surface runoff.

Surface water features in surface hydrology and water quality RSAs:

Refined SR14 Build Alternative—47 surface water features

SR14A Build Alternative—60 surface water features

E1 Build Alternative—38 surface water features

E1A Build Alternative—23 surface water features

E2 Build Alternative—29 surface water features

E2A Build Alternative—25 surface water features

Stream flows in the local canyons vary depending on seasonal trends in precipitation and with the topography, vegetation, and geology of the drainages. No field data have been collected for the streams in the RSA. However, the USGS has designated intermittent (i.e., ceases flow during dry season) and ephemeral (i.e., flows only during and shortly after precipitation) and perennial streams as indicated on the base map used for displaying the Risk Areas along each of the alignments (Table 3.8-3 and Figures 3.8-A-25 through 3.8-A-96). The flow of springs in the area appears to vary with seasonal precipitation; however, the current database is not sufficient to quantify the amount of water discharge from springs in the study area and how those springs are maintained. Major waterbodies crossed by each Build Alternative are listed in Appendix 3.8-B.

Table 3.8-3 Surface Water Resources along the Build Alternative Alignments in the ANF

Build Alternative Alignment	Length of Tunnel in ANF (feet)	Streams and Tributaries (number)	Springs within 1 mile of Alignment (number)	Active Wells Present (number)
Refined SR14	38,450	13	0	0
SR14A	38,450	13	0	0
E1	94,300	37	3	1
E1A	94,300	37	3	1
E2	94,500	37	9	1
E2A	94,500	37	9	1

Sources: Authority, 2017a; Los Angeles County, 2017, 2015; USGS, 1978

Una Lake

Una Lake is a sag pond formed from the collection of surface runoff within a depression in the fault zone associated with the San Andreas Fault. A sag pond is a waterbody that collects in the lowest parts of a depression formed between two faults of an active strike-slip fault zone. The Refined SR14, E1, and E2 Build Alternatives would cross Una Lake on an embankment, as shown in Figure 3.8-A-26, Figure 3.8-A-56, and Figure 3.8-A-78. In contrast, the SR14A, E1A, and E2A Build Alternatives would avoid Una Lake, pursuing a more easterly course approximately 300 feet east of Una Lake, as shown in Figure 3.8-A-41, Figure 3.8-A-67, and Figure 3.8-A-88.

Governor Edmund G. Brown East Branch California Aqueduct

The Governor Edmund G. Brown East Branch California Aqueduct (California Aqueduct) is operated by the California Department of Water Resources and is the principal feature of the California State Water Project. The aqueduct comprises 400 miles of canals, tunnels, and pipelines that carry water from northern and central California to southern California. Water flows both by gravity and interspersed pumping stations. The Refined SR14 Build Alternative would be built beneath the California Aqueduct, and the E1 and E2 Build Alternatives would cross over this feature. The SR14A, E1A, and E2A Build Alternatives would progress through more easterly routes, crossing over the California Aqueduct where the California Aqueduct enters a siphon to go under Sierra Highway and the existing Metrolink railroad tracks.

Santa Clara River System

The Santa Clara River originates in Los Angeles County in the San Gabriel Mountains and flows approximately 100 miles to discharge to the Pacific Ocean in Oxnard (Ventura County). The entire Santa Clara River drains approximately 1,200 square miles and is the receiving watercourse for numerous ephemeral streams and rivers draining rainwater in canyons throughout the San Gabriel Mountains. The Refined SR14 Build Alternative would cross over the Santa Clara River on a bridge in Soledad Canyon and proposes numerous other fills, embankment, and viaduct crossings of ephemeral tributaries to the Santa Clara River. The E1 and E2 Build Alternatives would cross under the Santa Clara River (i.e., Upper Soledad Canyon) in a bored tunnel. The SR14A, E1A, and E2A Build Alternatives would also cross the Santa Clara

River. Such Crossings would be identical to those required for the Refined SR14, E1, and E2 Build Alternatives, respectively.

Pacoima Wash

Pacoima Wash is a major tributary to Tujunga Wash with headwaters in the San Gabriel Mountains. Pacoima Wash is the receiving waterbody for numerous ephemeral streams draining rainwater in canyons throughout the ANF. The Refined SR14 and E1 Build Alternative alignments would cross under Pacoima Wash in a bored tunnel. The E2 Build Alternative surface hydrology and water quality RSA would not encompass this feature. The SR14A and E1A Build Alternatives would also cross under Pacoima Wash in a bored tunnel, while the E2A Build Alternative surface hydrology and water quality RSA would not encompass this feature.

Tujunga Wash

Tujunga Wash is a major tributary to the Los Angeles River and is the receiving waterbody for Pacoima Wash. The waterbody is regulated by the Hansen Dam, built for flood control by USACE in 1940 in response to the Los Angeles Flood of 1938. USACE water releases at Hansen Dam are dependent on several factors, including low and high surface water elevations within the Hansen Dam basin and the needs of Los Angeles County Public Works and USACE in operating the Hansen Spreading Grounds. The portion of Tujunga Wash below the Hansen Dam has been channelized into a concrete channel until its confluence with the Los Angeles River approximately 9.8 miles south of the dam although a portion of Tujunga Wash approximately 3.3 miles downstream of the proposed Refined SR14 Build Alternative crossing has undergone restoration as part of the Tujunga Wash Ecosystem Restoration Project. The E2 Build Alternative would cross Tujunga Wash above Hansen Dam on an elevated viaduct. The Refined SR14 and E1 Build Alternatives would cross Tujunga Wash below Hansen Dam where it is a concrete channel. The SR14A, E1A, and E2A Build Alternatives would also cross Tujunga Wash. Such crossings would be identical to those required for the Refined SR14, E1, and E2 Build Alternatives, respectively.

Big Tujunga Creek System

The Big Tujunga Creek system includes Alder Creek, Big Tujunga Creek, and Gold Creek. Gold Creek and its tributary Alder Creek are located within the ANF and are tributaries to Little Tujunga Creek, which in turn contributes to Big Tujunga Creek at the Hansen Flood Control Basin. While both Gold and Alder Creeks are classified as intermittent by USGS where they would be crossed by the E2 Build Alternative, a perennial section of Alder Creek is located 150 feet upstream of a proposed E2 construction staging area (CSA). Alder Creek is not located in the surface hydrology and water quality RSAs of the Refined SR14 and E1 Build Alternatives. The E2A Build Alternative would also cross Gold and Alder Creeks while requiring a CSA in the same location in relation to Alder Creek as required for the E2 Build Alternative. Alder Creek is not located in the surface hydrology and water quality RSAs of the Refined SR14A and E1A Build Alternatives.

3.8.5.3 Floodplains

Floodplains provide floodwater storage, which reduces the risk of downstream flooding, as well as habitat for native species. Floodplains also improve water quality by allowing sediments and other contaminants to filtrate, and they can provide locations for groundwater recharge. In most urban areas, levees and upstream dams control floods. In addition to showing the locations of surface waters, Figure 3.8-A-25 through Figure

Floodplains – Key Definitions

Floodplain—an area susceptible to inundation by floodwaters from any source

Special Flood Hazard Area (SFHA)—the land area covered by the floodwaters of the base flood, as defined by the National Flood Insurance Program

Zone A—FEMA flood zone designation corresponding with an area with a 1 percent annual chance of flooding determined without detailed hydraulic modeling

Zone AE—FEMA flood zone designation corresponding with an area with a 1 percent annual chance of flooding determined by detailed predictive hydraulic modeling

Zone AO—FEMA flood zone designation corresponding with an area with a 1 percent annual chance of shallow flooding with average depths between 1 and 3 feet, determined by detailed predictive hydraulic modeling

Source: FEMA, 2017

3.8-A-27 depict the floodplains located in the six Build Alternatives. Information on floodplains for the Palmdale Subsection and Maintenance Facility are provided in this section to provide a conservative analysis for context; however, effects regarding floodplains for the Palmdale Subsection and Maintenance Facility are discussed in the Bakersfield to Palmdale Project Section EIR/EIS.

Within the city of Palmdale, the six Build Alternative flooding RSAs encompass a Zone AO SFHA between Technology Drive and Avenue O (depicted on Figure 3.8-A-26).

The Refined SR14 Build Alternative would diverge from the E1 and E2 Build Alternatives near the California Aqueduct and would follow the State Route (SR) 14 corridor to the south until crossing the main stem of the Santa Clara River. The Refined SR14 Build Alternative's trackway and ancillary features would cross Zone A and Zone AO floodplains associated with ephemeral and intermittent tributaries of the Santa Clara River (depicted in Figure 3.8-A-25 through Figure 3.8-A-33). South of the ANF, the Refined SR14 adit options SR14-A2 and SR14-A3 could encroach on the Zone A and Zone AO floodplains associated with the Pacoima Wash (Figure 3.8-A-27 and Figure 3.8-A-39). In the city of Burbank, the Refined SR14 Build Alternative's trackway and ancillary footprint would cross Zone AE floodplains between Sheldon Street and Tuxford Street (Figure 3.8-A-37 and Figure 3.8-A-39).

The E1 and E2 Build Alterative corridors would diverge from the Refined SR14 Build Alternative corridor near the California Aqueduct and would continue south and east of the SR 14 corridor. The E1 and E2 Build Alternatives' viaducts and ancillary facilities would cross two Zone A SFHAs associated with intermittent tributaries of the Santa Clara River (Figure 3.8-A-62 and Figure 3.8-A-77). Continuing south, the E1 and E2 Build Alternatives' viaduct and ancillary facilities would cross Zone A SFHAs associated with watercourses in Aliso Canyon and Arrastre Canyon (Figure 3.8-A-63 and Figure 3.8-A-78). The E1 and E2 Build Alternative corridors would diverge south of Arrastre Canyon. The only other SFHA in the E1 Build Alternative's flooding RSA is the Zone AE between Sheldon Street and Tuxford Street. Floodplain crossings in this area would be identical to those described for the Refined SR14 Build Alternative.

South of the ANF, the E2 Build Alternative viaduct would cross Zone A and Zone AO SFHAs associated with the Big Tujunga Creek, the Hansen Dam, and the Hansen Spreading Grounds (Figure 3.8-A-80 and Figure 3.8-A-82). The E2 Build Alternative's trackway and ancillary facilities (CSA, utility lines, and roadway realignments) would also cross Zone AE in the San Fernando Valley (Figure 3.8-A-83 and Figure 3.8-A-84).

The SR14A, E1A, and E2A Build Alternatives would also traverse floodplains. Their alignments would be identical to those resulting from the implementation of the Refined SR14, E1, and E2 Build Alternatives, respectively, with one exception. The SR14A Build Alternative would not cross a Zone AO area east of the intersection of Davenport and Agua Dulce Canyon Road.

Changes in resource conditions caused by increased fire occurrences in the ANF could alter storm flows, resulting in flows potentially exceeding typical FEMA 100-year flood events. Wildfires could alter plant cover and soils, affecting runoff patterns. Data from wildfire impacts on watersheds show elevated flows and sediment delivery compared to normal conditions could occur during a 2-year interval event. Post-fire increases compared to pre-fire conditions are between 2 and 5.5 times for flow and up to 20 times for sediment yield with a 2-year return interval storm (Authority 2017a). This could cause culverts and drainage systems to become overwhelmed with debris, possibly causing road and property damage. Additionally, Los Angeles County Public Works requires stream crossings to be designed for the Capital Flood, which is larger than the 100-year flood event. The Los Angeles County Hydrology Manual and Sedimentation Manual provides methodology for burning and bulking peak flows to account for wildfire potential and debris production.

Although the alignments for all six Build Alternatives would be in a tunnel beneath the ANF, each Build Alternative would include tunnel portals, trackway, and access roads in fire-prone areas and areas adjacent to ANF. The Refined SR14 and E1 Build Alternatives have at grade footprints within three drainage areas adjacent to the ANF, and the E2 Build Alternative has an at grade footprint within four drainage areas adjacent to the ANF within potential wildfire hazard areas. Thus, the Build Alternatives’ flooding RSAs would include areas in which fire occurrences could increase flood hazards. The SR14A, E1A, and E2A Build Alternatives would require drainage areas and other features adjacent to the ANF. Such drainage areas and their associated impacts would be identical to those resulting from the implementation of the Refined SR14, E1, and E2 Build Alternatives, respectively.

3.8.5.4 Surface Water Quality

The Lahontan and Los Angeles RWQCBs maintain water quality control plans designating beneficial uses for water resources in the surface hydrology and water quality RSA. Waterbodies in the jurisdiction of the Lahontan RWQCB are generally approved for municipal and domestic supply, agricultural supply, commercial and sport fishing, contact and noncontact water recreation, cold freshwater habitat, wildlife habitat, and groundwater recharge. The SWRCB developed a list (known as 303[d]) of water quality limited waterbodies that do not meet water quality objectives. TMDLs were developed to restore the quality of these impaired waterbodies. As shown in Table 3.8-4, portions of the Santa Clara River, Tujunga Wash, and Burbank Western Channel have established water quality impairments. Portions of these watercourses are located in the surface hydrology and water quality RSA

Table 3.8-4 summarizes the beneficial uses for major waterbodies in the jurisdiction of the Los Angeles RWQCB. Tributaries generally retain the designated beneficial uses of their receiving waters.

Table 3.8-4 Surface Water Quality — Beneficial Uses

Surface Water	Los Angeles RWQCB Water Quality Control Plan Beneficial Uses														303(d) Contaminants
	MUN	IND	PROC	AGR	GWR	FRSH	WARM	COLD	WILD	RARE	WET	REC-1	REC-2	SPWN	
Santa Clara River (Reach 7)[1]	P	E	E	E	E	E	E	-	E	E		E	E	-	Coliform Bacteria
Santa Clara River (Reach 8)[1]	E	E	E	E	E	E	E	-	E	E	E	E	E	-	None Specified
Pacoima Wash	P	-	-	-	E		E	-	E		E	P	E	-	None
Big Tujunga Creek	P	-	-	-	E		E	E	E	E	E	E	E	E	None
Tujunga Wash	P	-	-	-	I		P	P	-	-	P	P	I	-	Ammonia
Burbank Western Channel	P	-	-	-	I		P	-	P	-	-	P	I	-	Ammonia

Source: Authority, 2017a

[1] Reaches 7 and 8 are the two easternmost reaches of the Santa Clara River.

AGR = agricultural supply; COLD = cold freshwater habitat; E = existing beneficial use; FRSH = freshwater replenishment; GWR = groundwater recharge; I = intermittent beneficial use; IND = Industrial Service Supply (for processes not dependent on water quality); MUN = municipal and domestic supply; P = potential beneficial use; PROC = Industrial Service Supply (for processes dependent on water quality); RARE = rare, threatened, or endangered species; REC-1 = water contact recreation; REC-2 = noncontact water recreation; RWQCB = Regional Water Quality Control Board; SPWN = spawning, reproduction, and development; WARM = warm freshwater habitat; WET = wetland; WILD = wildlife habitat

3.8.5.5 Groundwater

As summarized in Table 3.8-5, the Palmdale to Burbank Project Section would be located within four groundwater basins: Antelope Valley, Santa Clara River Valley East Sub-basin, Acton Valley, and San Fernando Valley. Figure 3.8-A-21 through Figure 3.8-A-23 depict groundwater basins in relation to the six Build Alternatives (Los Angeles County 2019).

Table 3.8-5 Groundwater Basins

Groundwater Basin	Total Area	Storage Capacity	Approximate Depth to Groundwater	Beneficial Uses	Basin Priority	Build Alternative RSA					
						Refined SR14	SR14A	E1	E1A	E2	E2A
Antelope Valley	1,010,000 acres	68,000,000 acre-feet	40–435 feet below-ground surface	Municipal, agricultural, industrial, freshwater replenishment	Very Low	X	X-	X	X-	X	X-
Santa Clara River Valley, East Sub-basin	66,200 acres	1,890,000 acre-feet	15 feet below-ground surface	Municipal, agricultural, industrial	High	X	X	-	-	-	-
Acton Valley	8,270 acres	40,000 acre-feet	20 feet below-ground surface	Municipal, agricultural, industrial	Very Low	X	X	-	-	-	-
San Fernando Valley	145,000 acres	3,670,000 acre-feet	250 feet below-ground surface	Municipal, agricultural, industrial	Very Low	X	X	X	X	X-	X-

Sources: Authority, 2017a; Los Angeles County, 2019
RSA = resource study area

These four groundwater basins underlie the valleys adjacent to the bedrock highlands bordering the basins. Groundwater basins may be recharged naturally as precipitation infiltrates or artificially with imported or reclaimed water. In the Antelope Valley Groundwater Basin, recharge primarily occurs through the alluvial fans located at the foot of the mountains and hills. Recharge in the Acton Valley Basin occurs by percolation of precipitation and by infiltration of runoff in the Santa Clara River and its tributaries. The Santa Clara River Valley East Sub-basin is also recharged by infiltration of runoff waters in the Santa Clara River and its tributaries, with additional natural recharge from percolation of rainfall to the valley floor, subsurface inflow, percolation of excess irrigation water applied to urban landscaping, and reclaimed water discharged into the Santa Clara River channel (California Department of Water Resources 2003). The Los Angeles County Flood Control District maintains spreading grounds to percolate water into groundwater basins for later pumping. These spreading grounds are located adjacent to watercourse channels and in soft-bottom (i.e., not concrete) channels where underlying soils are permeable and in hydraulic connection with the underlying aquifer. The Hansen, Lopez, Tujunga, and Headworks Spreading Grounds provide recharge for the San Fernando Valley Basin.

As shown in Table 3.8-5, subsurface elevation to groundwater basins varies throughout the RSA because of regional physiography and hydrogeology. Elevation to groundwater also varies with the amount of withdrawal and the amount of recharge to the groundwater basin. Highland areas, such as the San Gabriel Mountains and lower hills, collect and direct rainwater runoff into stream channels that carry it to the edge of the valley groundwater basins, where the runoff percolates into the basins. The bedrock highlands do not comprise groundwater basins but do contain limited quantities of groundwater stored in rock fractures. In some cases, the water table intersects with the ground surface to form springs or seeps. These features are concentrated in the ANF and adjacent highlands.

In addition, there are multiple active water supply wells within 1 mile of the centerlines of each of the six Build Alternatives. Figure 3.8-A-21 through Figure 3.8-A-23 depict the water supply wells within the groundwater RSA.

Water Supply wells in the RSA:

Refined SR14 Build Alternative—30 active wells

SR14A Build Alternative—30 active wells

E1/E1A Build Alternatives—24 active wells

E2/E2A Build Alternatives—22 active wells

Groundwater resources monitoring was conducted in in the general vicinity of the six Build Alternatives' tunnel corridors beneath the ANF, which included six piezometers installed at various locations within the tunnel construction RSA. Monitoring of groundwater levels through the automated measurement of groundwater pressure allows tracking of variation due to precipitation infiltrating to the various groundwater aquifers. With a total of 25 pressure transducers installed at varying depths in the six borings, measurements of potentiometric water elevations indicate that some pressure readings closely reflect groundwater changes by tracking closely with the rainfall records each year. Readings from other transducers at greater depths do not respond to rainfall records. This suggests some depths below-ground receive recharge from precipitation and others do not. The data are collected on data recorders every six hours and reveal a complex groundwater regime within the tunnel construction RSA.

3.8.5.6 Other Hydrologic Resources

For the analysis of impacts on water resources, the term *hydrogeological impacts* refers to below-ground impacts related to conditions such as geology, structural geology, and the groundwater system (i.e., groundwater storage, hydraulic conductivity, and flow through the rock/soil). The term *hydrologic impact* applies to effects on subsurface and surface water resources, which include impacts on streams and springs, some of which may be caused by hydrogeologic changes. The term *springs* refers to surface waters that flow from the ground, where the groundwater table intersects the ground surface and is expressed either as flowing water (i.e., spring) or as a seep where the surface water flow is not measurable.

Springs occur at various locations within the San Gabriel Mountains, many of them associated with mapped fault traces. A *seep*, as used in this document, refers to a spring where there is no measurable water flow at the ground surface. The extensive shearing of the crystalline rocks in the mountains along faults provides localized infiltration and storage of water and pathways for water to flow in the sheared and jointed rock. Where the flow gradient of water in the rock intersects the ground surface, springs occur as shown on Figure 3.8-A-20. Water wells within 1 mile of the alignments and springs and seeps within 2 miles of the alignments were mapped using datasets from Los Angeles County 2015, Authority 2016, and Integrated Water Resources Information Systems 2015. Not all springs are mapped along faults; some springs appear to be controlled by other local geologic conditions such as the general physical characteristics of the underlying rocks in the area of the springs or by local precipitation infiltration and shallow subsurface flow allowing water flow in the local bedrock. Groundwater chemistry data derived during the geotechnical investigation (Authority 2020b) indicates that the near surface groundwater that feeds the springs has a different source area than the deep water sampled at tunnel depths in the geotechnical investigations. Most of the spring water appears to derive from precipitation that seeps into fractures, weathered rock, and faults and then surfaces as springs downgradient. Water content, quality, and flow characteristics are controlled by fracture patterns in the bedrock. During the geotechnical investigation, various water chemistry parameters were measured, such as dissolved metals, radionuclides, and tritium in water (Authority 2020b).

Monitoring the flow of sixteen selected springs covering approximately 20 square miles in the general vicinity of the six Build Alternatives on a quarterly basis by the Authority has demonstrated that the flows vary with seasonal precipitation. One monitoring cycle was completed during the end of the summer season, on September 16, 2016, to assess access to the sites and make initial observations of spring conditions. The first monitoring cycle revealed that the long preceding dry years had resulted in mostly dry springs (i.e., only wet soil or greener vegetation where a spring had been identified). Based on this monitoring of the ANF springs, it was observed that protracted droughts cause these springs to dry up by late summer, indicating that the springs may not be fed by deep sustained water resources and are dependent on seasonal wet cycles to maintain flow. Water resources monitoring during subsequent rainy seasons (winter 2016, 2017, 2018, 2019, and 2020) verified that some of the springs exhibited flow again.

Based on the monitoring data, it is evident that normal dry seasons could result in springs ceasing to flow during late summer. Based on these flow data, and the differences in groundwater chemistry between water in the springs and groundwater sampled during the geotechnical investigation, it is assumed that the springs are not fed primarily by deep sustained water resources but that the springs are dependent on seasonal wet cycles to maintain their flow. Of the sixteen springs monitored, measurable spring flow was present at five to eight springs on average, during each monitoring event. In many cases, a spring was observed to have later ceased flowing, thus being more accurately classified as a seep or simply moist soil without measurable flow.

3.8.5.7 Hydrogeological Conditions

General Hydrologic Conditions within the Western San Gabriel Mountains

The general geologic, geotechnical, and surface water resources of the ANF were investigated by the Authority for a feasibility study of tunneling (Figure 3.8-A-17) (Authority 2019a). As noted previously, tunneling in the ANF was subject to more focused analysis in part because the conditions in the ANF are substantially different than those outside the ANF. The local geology of the tunnel construction RSA is complex due to multiple stages of metamorphism, igneous intrusion, tectonic rotation, and subsequent uplift and faulting of the area over the past 1.7 billion years. The geology of the San Gabriel Mountains has been mapped by the California Geological Survey (Campbell et al. 2014) and the USGS (Yerkes and Campbell 2005). Data collected during the geotechnical investigations (Authority 2019a) provide supporting evidence of the trends believed to characterize the groundwater system(s) where the tunnel alignments are located.

The data collected during these investigations indicate that the rock is much more weathered, oxidized, fragmented, sheared, and pulverized near fault zones. Away from faults, the condition of the rock improves with larger areas of more intact rock. The patterns of discontinuities show telltale signs of stresses in the mountain. These stresses have generated joints with fairly regular spacing and orientations. Numerous sets of intersecting joints, shears, and foliation have been identified in the rock core samples. The core samples illustrate broadly differing zones of fracturing, some with high density of fractures and other zones with virtually no fracturing. The wide variation of fracturing and the intersecting patterns of fracturing govern the direction and quantity of groundwater that is able to flow through the rock at those points. Generally, with greater and greater displacement along a fault, the fractured rock adjacent to a fault becomes a preferred path of groundwater flow. Away from faults, the rock quality improves, but groundwater flow remains dependent on the condition of the surrounding rock. For example, zones of completely intact rock could prevent groundwater flow, forming an impermeable barrier in the rock mass, whereas zones of more fractured rock facilitate storage and movement of groundwater.

The results of the geotechnical investigation show a broad range of groundwater flow rates ranging from 5x10-3 centimeters/second (cm/sec) to 5x10-7 cm/sec., high to low, respectively (Authority 2019b). Given that these investigations only examined conditions near faults, groundwater flow rates may be lower in areas without faults. The wide range of recorded values indicates that the characteristics of the aquifer vary depending on the type of fracturing and interconnection between fractures. This indicates that in some areas only a very small quantity of water is able to flow through the rock mass at very slow rates, whereas other areas may allow high rates of water flow. Packer test locations were selected in highly fractured zones, adjacent to faults and where discontinuities seemed to be stained by water flow. The low effective hydraulic conductivity values indicate that there is very little potential for the rock mass to yield large quantities of water. The higher effective hydraulic conductivity values indicate that there is also potential for large volume flows in some of the tested zones. The higher effective hydraulic conductivity values indicate that there is also potential for large volume flows in some of the tested zones. The rate of flow is also dependent on the locations and frequencies of discontinuities in the rock. The results from the core hole monitoring also show natural variations in groundwater elevations coinciding with the seasonal rainfall in southern California.

The data from core holes crossing faults indicate that water pressure increases with depth at a fairly constant rate, with a constantly increasing direct head of water from the shallowest to the deepest pressure measurements. The data also indicate that there are several zones or compartments of isolated groundwater in the rock mass that have lower pressures than expected such that water zones encountered in the bedrock are not connected or are poorly interconnected. Because of this, draining water from one compartment would have minimal impact on the water in an adjacent compartment. The data also imply that a tunnel driven through intact bedrock at depth may not have an influence on the shallow groundwater. However, the constant hydraulic head increase with depth near the fault zones explored suggests that the faults provide an open, vertical path for groundwater to flow from shallow to deeper zones.

Geologic Structure and the Role of Faults

Faults are structural discontinuities in rock that occur commonly as a result of tectonic forces squeezing and uplifting the earth’s crust until the earth’s crust breaks or shears causing physical displacement or separation of once adjacent rocks. Faults can be small or large depending on the length of time that rock masses are subject to tectonic forces and the total amount of slip that occurs along the fault. Faults tend to shear and fracture otherwise intact rock creating increased porosity and allowing water to flow through the rock mass along the fractures.

Faults have the potential to act both as groundwater conduits and as barriers that often result in substantial variations in groundwater pressures from one side of the fault to the other. These variations in groundwater pressures are especially critical when unexpectedly encountered during tunnel mining.

Exploratory Borings Investigating Faults

Three fault zones intersect the tunnel alignments—the San Gabriel, the Sierra Madre fault (to the north), and the Sierra Madre (to the south). Many secondary or smaller faults also intersect the alignment passing through the rock masses making up the San Gabriel Mountains. These include the Transmission Line fault, Lonetree fault, Magic Mountain fault, Pole Canyon fault, and other unnamed faults. Each fault is surrounded by a fault gouge zone which includes other smaller faults (i.e., traces) and areas of clay and silt gouge, rock flour, and crushed rock. Adjacent to the fault gouge zones are areas of crushed and sheared rock, weathered rock, and highly fractured and jointed rock. Generally, these conditions decrease within several hundred feet where solid intact rock mass is found.

Examination of core recovered from the San Gabriel and Transmission Line faults indicated extreme fracturing of the rock, abundant shearing, and clay gouge zones.

Hydrogeologic Conditions Along the Tunnel Alignments

The tunnels associated with the six Build Alternatives would intersect crystalline (metamorphic and igneous) rocks in varying amounts and varying degrees of alteration due to weathering, jointing, foliation, and shearing due to faulting. Most of rock removed to construct tunnels in each of the alignments would be crystalline rock. However, both Refined SR14/SR14A and E2/E2A tunnel alignments would encounter substantial reaches of sedimentary rock. Table 3.8-6 summarizes the general hydrogeological conditions for each of the tunnel Build Alternatives in the ANF.

Table 3.8-6 Hydrogeologic Conditions along Tunnel alignments within the San Gabriel Mountains

Tunneling Condition Description	Refined SR14	SR14A	E1	E1A	E2	E2A
Total Alignment Length (feet)	38,450	38,450	91,900	91,900	92,100	92,100
ANF including the SGMNM Lengths (miles)	7.3	7.3	17.9	17.9	17.9	17.9
Sedimentary Rock (feet)	16,600	16,600	0	0	13,200	13,200
Crystalline Rock (feet)	20,670	20,670	91,040	91,040	76,080	76,080
Number of Mapped Faults	15	15	7	7	20	20
Total Width of Gouge, Crushed and Sheared Rock Zones (ANF including the SGMNM) Subject to Squeezing Ground and Greater Groundwater Flows (feet)	1,180	1,180	860	860	2,820	2,820

Tunneling Condition Description	Refined SR14	SR14A	E1	E1A	E2	E2A
Approximate Overburden at San Gabriel Fault (feet)	1,600	1,600	700	700	1,700	1,700
Maximum Overburden (feet)	2,060	2,060	2,060	2,060	2,700	2,700

Source: Authority, 2017a

Each of the tunnel alignments intersect the same fault zones cutting nearly east-west through the San Gabriel Mountains. These include many branches of the San Gabriel fault and Sierra Madre fault zones.

The exploratory core holes and pressure readings at different locations along the inclined core holes through faults indicated that water pressures were almost the same on either side of the faults explored. However, the general hydraulic conductivity measurements indicate higher conductivity potential—and therefore greater potential to encounter groundwater flows during tunneling—in the rock surrounding the fault zone with very low conductivities closest to or within the clayey fault gouge zone. The presence of the shears and fractured rock associated with faults are indicators of higher potential groundwater flows into tunnels.

Hydraulic Conductivity

The hydraulic conductivity of the various geologic units and the groundwater pressures anticipated in the tunnel envelope are interpreted from in-situ testing and instrumentation data obtained from the six core holes in the ANF, published information for similar geologic conditions, and professional experience with other tunneling projects. Hydraulic conductivity is a measure of the ability of rock or sediment to transmit water under a constant head of water (i.e., pressure). As the pressure increases, the flow of water increases while maintaining the same hydraulic conductivity. The hydraulic conductivity of the geologic units interacting with the tunnels is important because conductivity affects both the potential for inflows into the tunnels to occur during and after construction and the effectiveness of measures to control such seepage.

Table 3.8-7 summarizes the typical ranges of hydraulic conductivity in published literature and estimated lengths of those ranges for tunnels (miles) along each alignment proportional to the frequency of occurrence for measured ranges of hydraulic conductivity.[4] Figure 3.8-A-19 illustrates the 96 data points and the frequency of occurrence of hydraulic conductivities that were measured during the preliminary field geotechnical investigations.

Table 3.8-7 Estimated Hydraulic Conductivity beneath the Angeles National Forest

Hydraulic Conductivity Classification	Hydraulic Conductivity (cm/sec)	Estimated Length of Tunnels (miles) for Corresponding Range of Hydraulic Conductivity Values from the ANF in Test Data					
		Refined SR14	SR14A	E1	E1A	E2	E2A
Very High	$10 – 10^{-1}$	0.0	0.0	0.0	0.0	0.0	0.0
High	$10^{-1} – 10^{-3}$	0.0	0.0	0.0	0.0	0.0	0.0
Moderate	10^{-3} - 10^{-5}	0.8	0.8	2.4	2.4	2.4	2.4
Low	10^{-5} - 10^{-7}	5.4	5.4	16.4	16.4	16.4	16.4
Very Low	$<10^{-7}$	0.0	0.0	0.0	0.0	0.0	0.0

Sources: USBR, 1998; Authority, 2019b

4 The table uses data from packer testing using 96 ANF data points collected during geotechnical investigations conducted by the Authority (2019a and 2019b).

ANF = Angeles National Forest; cm = centimeters; sec = seconds

Based on the rock types cored for the geotechnical feasibility study, the six Build Alternatives are anticipated to encounter areas with a hydraulic conductivity value ranging from Low to Moderate.

Groundwater Pressures

The tunnel alignments for each of the Build Alternatives would pass through areas with varying levels of groundwater pressure. Groundwater pressure is important to tunneling for two reasons: (1) pressure controls flow rates of water through the rock (i.e., increased pressure results in greater flow potential) and (2) there are levels of high pressure that make tunnel construction more difficult and increase the risk of water inflows into tunnel cavities that potentially result in impacts on groundwater and surface water resources.

Groundwater pressure is the pressure exerted by the weight of the water on a submerged object. As pressures rise with deeper submergence of the tunnel below the water table, the increased pressure increases the potential risk of inflow of water from the surrounding rock into the tunnel. Higher ranges of pressure require special designs of tunnel lining to control water flows into the tunnel during both construction and operation.

Groundwater pressures along each of the alignments have been estimated from instrumentation data available for the six core holes in the ANF, published data of groundwater resources in the ANF (i.e., as shown in Appendix A.9 in the PGDR [Authority 2019b]), and topographic and hydrogeologic trends observed during the geotechnical investigations (Authority 2019b). Based on the geotechnical investigation, groundwater was detected in the upper 100 to 250 feet below-ground surface. Based on the range of observed groundwater depths in the core holes in the ANF, the depth of submergence of the tunnel below the groundwater table and resulting pressure has been estimated using geologic profiles along each of the tunnel alignments (Authority 2019b) and direct pressure readings made in each of the core holes equipped with pressure transducers. The data of pressure readings in some of the deeper core holes indicate that a straight-line increase in pressure versus depth does not always hold at the greater depths (i.e., below 1,200 or 1,500 feet deep). At those depths, the pressures are often less than predicted by a constant pressure increase with depth. This indicates that when the rock becomes less permeable with depth, pockets or zones of lower-than-expected pressure exists in the subsurface. Table 3.8-8 summarizes the anticipated lengths of groundwater pressure conditions for the ANF tunnel alignments. Lower than expected pressures are also documented in some of the piezometer pressure readings from the ANF (Authority 2019a and 2019b).[5] As indicated earlier, faults are expected to behave like a continuous column of water, because they are accompanied by interconnected shears and fractures that penetrate from the depth of the tunnel to the ground surface and are expected to have associated groundwater pressures conforming to a constant pressure increase with depth.

Table 3.8-8 Estimated Groundwater Pressures beneath the Angeles National Forest

Estimated Depth of Tunnel Below-ground Surface (feet)	Estimated Groundwater Pressure (psi)	Equivalent Pressure (bar)	Approximate Length of Tunnel Segments (miles) with Estimated Groundwater Pressure Ranges at Depth					
			Refined SR14	SR14A	E1	E1A	E2	E2A
<275	<75	<5	1.8	1.8	6.3	6.3	4.9	4.9
275-450	75-150	5-10	2.4	2.4	2.9	2.9	2.9	2.9
450-850	150-370	10-25	2.2	2.2	4.7	4.7	5.7	5.7
950-1,275	370-510	25-35	0.6	0.6	2.6	2.6	2.1	2.1

5 Under actual tunneling conditions, there would likely be several zones encountered during construction of a tunnel alignment with lower-than-expected pressure where the tunnel penetrates from one zone of fractures into another.

Estimated Depth of Tunnel Below-ground Surface (feet)	Estimated Groundwater Pressure (psi)	Equivalent Pressure (bar)	Approximate Length of Tunnel Segments (miles) with Estimated Groundwater Pressure Ranges at Depth					
			Refined SR14	SR14A	E1	E1A	E2	E2A
>1,275	>510	>35	1.0	1.0	4.3	4.3	4.5	4.5

Source: Authority, 2019b
psi = pounds per square inch

Figure 3.8-A-24 presents a summary of the anticipated groundwater pressures. Based on the limited data and professional judgement, the E1 and E1A, and the E2 and E2A Build Alternative alignments have three to five times the lengths of tunnel where the groundwater pressures are anticipated to exceed 25 bar, compared to the Refined SR14 and SR14A Build Alternative alignments. The highest anticipated groundwater pressures for portions of the Refined SR14, SR14A, E1, E1A, E2, and E2A alignments are anticipated to be as high as 50 bar for Refined SR14, SR14A, E1, and E1A, and greater than 60 bar for E2 and E2A.

3.8.6 Environmental Consequences

3.8.6.1 Overview

This section evaluates hydrology and water resources impacts for the No Project and Build Alternatives. The Build Alternatives would generally result in similar types of impacts (listed below), but those impacts would vary in the location, degree, extent, intensity, and likelihood of effects.

- **Construction Impacts**
  - Impact HWR#1: Permanent Alteration of Surface Drainage Patterns from Aboveground Temporary Construction Activities and Permanent Structures Required for the Build Alternatives.
  - Impact HWR#2: Construction Activities Required for the Build Alternatives.
  - Impact HWR#3: Changes in Flood Risks Associated with Temporary Construction Activities and Permanent Structures Required for the Build Alternatives.
  - Impact HWR#4: Changes in Groundwater Recharge Associated with Temporary Construction Activities and Permanent Structures Required for the Build Alternatives.
  - Impact HWR#5: Changes in Hydrogeologic Conditions Associated with Tunnel Construction Beneath the ANF which May Affect Surface and Subsurface Water Resources.
- **Operations Impacts**
  - Impact HWR#6: Project Operation Effects on Water.

3.8.6.2 No Project Alternative

The No Project Alternative assumes that the population in the surface hydrology and water quality RSA would continue to moderately grow, and changes and improvements to transportation infrastructure in and near the Palmdale to Burbank area would be implemented by agencies other than the Authority. Overall, development would be focused within the urbanized portions of the Antelope Valley and San Fernando Valley. Between these urban centers, vast areas of the San Gabriel Mountains would likely remain intact and undisturbed because of their protected status as part of the National Forest System.

Construction projects could alter surface water drainage patterns, modify watercourse capacity and water-flow height, increase erosion and sedimentation, degrade surface water or groundwater quality, and increase flood risks by altering flood hazard areas. Long-term effects associated with these projects could include increases in stormwater runoff speed and rates, permanent alterations of watercourse hydraulic capacity, degradation of surface water or groundwater quality, increased flood heights, or decreased groundwater recharge. However, new development projects would be subject to federal, State, and local regulations designed to control stormwater runoff, which require construction-period pollution controls, prevent floodplain development, provide for adequate groundwater recharge, and otherwise protect hydrologic resources and water quality. Adherence to these regulations would avoid and minimize hydrology and water resource impacts under No Project Alternative conditions.

It is reasonable to assume that foreseeable development associated with the No Project Alternative would not entail the construction of tunnels in the tunnel construction RSA. Such construction, which is unique to the Build Alternatives, could affect groundwater hydrology, as further detailed below. The No Project Alternative would avoid such effects.

3.8.6.3 Build Alternatives

Construction Impacts

Impact HWR#1: *Permanent Alteration of Surface Drainage Patterns from Aboveground Temporary Construction Activities and Permanent Structures Required for the Build Alternatives.*

The presence of infrastructure, including the discharge of fill associated with the construction of the Build Alternatives, in surface waterbodies could permanently alter waterbody capacity and drainage patterns. Project features of the Build Alternatives that are located within surface water channels could also increase erosion and siltation through scour, wherein water flow would be redirected causing the erosion of banks and beds of watercourses. The six Build Alternatives would require trackway and ancillary features constructed within or immediately adjacent to existing surface waterbodies.

Refined SR14 Build Alternative

Aggregately, the Refined SR14 Build Alternative would involve 48 surface water crossings at grade, 12 viaduct surface water crossings, and tunnels beneath 29 surface water features. However, tunnels would not directly affect surface water features (Figure 3.8-A-25 through Figure 3.8-A-39). Several major surface waters, including Una Lake, the Santa Clara River and its tributaries, Pacoima Wash, and Hansen Spreading Grounds, would be crossed at grade. The Refined SR14 Build Alternative would also include the placement of a variety of ancillary features near or crossing existing watercourses. CSAs and utility lines would be removed following construction, resulting in no impacts during operations.

Between Avenue L and the California Aqueduct, the Refined SR14 Build Alternative would cross one unnamed ephemeral watercourse, one canal, and seven stationary waterbodies (including Una Lake) at grade. The Refined SR14 Build Alternative would also cross one canal and one ephemeral watercourse on viaduct structures. An embankment structure within Una Lake would require substantial fill of this waterbody, which could continue to exist at a much smaller size. The Refined SR14 Build Alternative would tunnel beneath the California Aqueduct. Under the Refined SR14A Build Alternative, roads used for aqueduct maintenance that intersect with the Refined SR14 Build Alternative alignment would continue to be accessible.

Between the California Aqueduct and the Santa Clara River crossing in Soledad Canyon, the Refined SR14 Build Alternative would tunnel beneath 13 unnamed ephemeral watercourses, cross 16 unnamed ephemeral watercourses at grade, and cross 6 unnamed ephemeral watercourses on viaduct. These unnamed surface waters are tributaries of the Santa Clara River.

The Refined SR14 Build Alternative would cross the main channel of the Santa Clara River in Soledad Canyon on viaduct. The Authority proposes a no-water-contact approach to construction of temporary and permanent structures within the Santa Clara River. The approach would use conventional construction techniques and limit most construction activities both spatially and temporally. Construction activities would be restricted to the dry season (i.e., June 1 to

September 30), when flow is minimal, and the channel is confined. Activities would be restricted spatially to keep permanent structures out of the 25-year flood limits.

South of the Santa Clara River crossing, the Refined SR14 Build Alternative would cross two ephemeral watercourses, two artificial paths (including Tujunga Wash), one intermittent watercourse, and four stationary waterbodies (including the Hansen Spreading Grounds) at grade. In this area, the Refined SR14 Build Alternative would also tunnel beneath 10 ephemeral watercourses and one intermittent watercourse at grade.

SR14A Build Alternative

Aggregately, the SR14A Build Alternative would result in 43 surface water crossings at grade (including on fill, embankment, and cut-and-cover profiles), 3 viaduct surface water crossings, and tunnels beneath 32 surface water features (Figure 3.8-A-40 through Figure 3.8-A-54). Crossings of major waterbodies required for the SR14A Build Alternative would be identical to those crossings required for the Refined SR14 Build Alternative, except for Una Lake and the California Aqueduct. The SR14A Build Alternative would not cross Una Lake and would cross over the California Aqueduct where the California Aqueduct enters a siphon to go under Sierra Highway and the existing Metrolink railroad tracks. Roads used for aqueduct maintenance that intersect with the SR14A Build Alternative alignment would continue to be accessible. Between the California Aqueduct and the Santa Clara River crossing in Soledad Canyon, the SR14A Build Alternative would cross one canal and 10 ephemeral watercourses at grade. During construction and operations, private roads used to maintain the canal and crossed under the SR14A Build Alternative would remain accessible. The SR14A Build Alternative would also cross three ephemeral watercourses on viaducts, while tunneling beneath 17 ephemeral watercourses. After the crossing at the Santa Clara River, the SR14A Build Alternative would require identical crossings compared to the Refined SR14 Build Alternative.

E1 Build Alternative

Aggregately, the E1 Build Alternative would result in 43 surface water crossings at grade, 7 viaduct surface water crossings, and tunnels beneath 43 surface water features that would remain unaffected due to the tunneling (Figure 3.8-A-55 through Figure 3.8-A-65). Several major surface waters, including Una Lake, tributaries of the Santa Clara River, Pacoima Wash, and Hansen Spreading Grounds, would be crossed at grade. [6] The E1 Build Alternative would also include a variety of ancillary features near or crossing existing watercourses. CSAs and utility lines would be removed following construction, resulting in no impacts during operations.

E1 Build Alternative surface water crossings between Avenue L and the California Aqueduct would be identical to those described above for the Refined SR14 Build Alternative. The E1 Build Alternative would cross the California Aqueduct. Roads used for aqueduct maintenance that intersect with the E1 Build Alternative alignment would continue to be accessible.

South of the California Aqueduct, the E1 Build Alternative would be built at grade through three ephemeral watercourses and on viaduct over two ephemeral watercourses before entering a tunnel south of the Vincent Substation. South of Vincent Substation, the E1 Build Alternative would be constructed beneath 40 ephemeral watercourses, two intermittent watercourses, and one stationary waterbody. The E1 Build Alternative would also cross 20 ephemeral watercourses,

> **Number of HSR surface water crossings:**
>
> SR14 Build Alternative—48 at grade, 12 on viaduct
>
> SR14A Build Alternatives—43 at grade, 3 on viaduct
>
> E1 Build Alternative—43 at grade, 7 on viaduct
>
> E1A Build Alternative—42 at grade, 3 on viaduct
>
> E2 Build Alternative—34 at grade, 8 on viaduct
>
> E2A Build Alternative—39 at grade, 3 on viaduct
>
> Many of these crossings are also associated with aboveground ancillary facilities, described in Section 3.8.5.2

[6] An embankment structure in Una Lake would require substantial fill of this waterbody, which could continue to exist at a much smaller size.

two intermittent watercourses, two artificial paths (including Tujunga wash), two stationary waterbodies (including the Hansen Spreading Grounds), and one perennial watercourse at grade south of Vincent Substation. The E1 Build Alternative would cross two ephemeral watercourses on viaduct in this area.

E1A Build Alternative

> *Sedimentation*
>
> *Sedimentation* refers to the settling out of soil particles suspended within a water column. Sediment can accumulate, fill, or modify water channels, increasing potential erosion or flood hazards.

The E1A Build Alternative would result in 42 surface water crossings at grade, 3 viaduct surface water crossings, and tunnels beneath 44 surface water features. Crossings of major waterbodies required for the E1A Build Alternative would be identical to crossings required for the E1 Build Alternative, with the exception of Una Lake and the California Aqueduct. The E1A Build Alternative would not cross Una Lake, although it would cross over the California Aqueduct where the California Aqueduct enters a siphon to go under Sierra Highway and the existing Metrolink railroad tracks. Roads used for aqueduct maintenance that intersect with the E1A Build Alternative alignment would continue to be accessible.

South of the California Aqueduct, the E1A Build Alternative would cross one ephemeral watercourse at grade, and one such feature on viaduct. The E1A Build Alternative would also tunnel beneath one ephemeral watercourse in this area. After passing the Vincent Substation, the water crossings of the E1A Build Alternative would be identical to those required for the E1 Build Alternative.

E2 Build Alternative

The E2 Build Alternative would include 34 surface water crossings at grade, 8 viaduct surface water crossings, and tunnels beneath 44 surface water features (Figure 3.8-77 through Figure 3.8-86). Several major surface waters, including Una Lake and tributaries of the Santa Clara River, would be crossed at grade.[7] The E2 Build Alternative would also include a variety of ancillary features near or crossing existing watercourses. CSAs and utility lines would be removed following construction, resulting in no impacts during the operations period.

E2 Build Alternative surface water crossings between Avenue L and Vincent Substation would be identical to those required for the E1 Build Alternative. South of Vincent Substation, the E2 Build Alternative would cross 24 ephemeral watercourses, and the Santa Clara River at grade. The E2 Build Alternative would also be constructed beneath one stationary waterbody and 38 watercourses, and cross one perennial watercourse (Big Tujunga Wash) on a viaduct in this area.

E2A Build Alternative

The E2A Build Alternative would result in 39 surface water crossings at grade, 3 viaduct surface water crossings, and tunnels beneath 40 surface water features (Figure 3.8-A-87 through Figure 3.8-A-96). Crossings of major waterbodies required for the E1A Build Alternative would be identical to crossings required for the E2 Build Alternative, with the exception of Una Lake and the California Aqueduct. The E2A Build Alternative would not cross Una Lake and would cross over the California Aqueduct where the California Aqueduct enters a siphon to go under Sierra Highway and the existing Metrolink railroad tracks. Roads used for aqueduct maintenance that intersect with the E2A Build Alternative alignment would continue to be accessible. Between Avenue L and Aliso Canyon, the surface water crossings required for the E2A Build Alternative would be identical to those required for the E1A Build Alternative.

Impact Summary

Although many surface waters throughout the surface hydrology and water quality RSA are ephemeral or intermittent, in-channel construction activities proposed during wet seasons or in perennial waterbodies could require water diversion or dewatering, which would temporarily impact surface water hydrology. The placement of fill or removal of material in surface water

[7] The E2 Build Alternative's crossing of Una Lake would be identical to that of the E1 Build Alternative.

channels during construction would permanently modify channel capacity and water flow height and increase erosion and sedimentation potential by redirecting water flow. Grading and earthmoving would alter upland topography, which could directly influence the direction and timing of stormwater flow toward receiving waters. Construction-induced erosion could also redistribute soil in a water system, temporarily increasing sedimentation throughout the construction period.

All six Build Alternatives' trackway, viaduct piers and abutments, traction power substations, roadway/railway modifications, access roads, station areas, CSAs, and drainage facilities would require construction activities within surface water channels. Water diversion or dewatering could be required to install these facilities, representing a direct temporary impact on surface water hydrology during the construction period. Some ancillary features, such as power and utility lines, would not require water diversion or dewatering. Power lines would be strung from utility poles that could be located outside of surface water features and utility lines would be collocated within existing roadway rights-of-way. Because power and utility lines do not require disturbance in flowing or open water, these features would not result in impacts related to water diversion or dewatering.

Site preparation for trackway and ancillary features could also require the placement of fill or dredging or excavation of material, within or immediately adjacent to surface waters, to elevate Build Alternatives infrastructure above the water level and minimize the risk of inundation. As described above, fill placement or removal of material within surface water channels could modify channel capacity and water-flow height and could increase erosion and sedimentation potential by redirecting water flow. Trackway, viaduct piers and abutments, traction power substations, roadway/railway modifications, access roads, station areas, drainage facilities, could require fill placement or removal of material within surface water channels, which would result in permanent hydrological impacts. CSAs would cause similar hydrological impacts related to fill placements, but these impacts would be temporary because these CSAs would be restored to preconstruction topography upon completion of construction activities. As described above, installation of power and utility lines would be unlikely to cause disturbance within water channels.

Aboveground trackway and ancillary features may also require grading in upland areas surrounding surface water resources. Alterations to local topography may change drainage patterns by redistributing stormwater flow patterns to affected waterbodies. Earthmoving during construction could also increase erosion potential as a result of grading, vegetation removal, grubbing, and other site preparation activities that expose or disturb soils. Trackway, viaduct abutments, traction power substations, roadway/railway modifications, access roads, station areas, CSAs, utility lines, power lines, and drainage facilities would require grading adjacent to surface waters, which would temporarily increase erosion impacts and permanently modify stormwater drainage. Impacts related to CSAs would be temporary because these areas would be restored to preconstruction topography following construction activities. Drainage facilities would be specifically designed to convey stormwater runoff, which would result in minimal direct drainage impacts related to these facilities.

All six Build Alternatives' viaducts could require permanent piers or abutments within surface waterbodies, which could reduce stream capacity and/or result in localized scour. The preliminary design of viaducts avoids placing piers or abutments within the low-flow channel of major water courses such as the Santa Clara River for the Refined SR14 Build Alternative, Aliso Canyon for the E1 and E2 Build Alternatives, and Big Tujunga Wash for the E2 Build Alternative. Trackway, access roads, tunnel portals, and roadway/railroad modifications could also require infrastructure or fill directly within surface water channels. Where feasible, these facilities would be collocated with existing or proposed crossing configurations (e.g., the roadway right-of-way or viaduct crossings) to minimize new obstructions to surface water flows. Utility poles for power lines would be located outside of water features wherever feasible. Drainage facilities within existing water facilities would be specifically designed to convey stormwater runoff throughout operations of the Build Alternatives. The SR14A, E1A, and E2A Build Alternatives would not differ substantially from those resulting from the implementation of the Refined SR14, E1, and E2 Build Alternatives, respectively. Required surface water crossings among the SR14A, E1A, and E2A Build Alternatives would only differ from the Refined SR14, E1, and E2 Build Alternatives, respectively, in the northern area of the Central Subsection. Other crossings would be identical.

Permanent HSR infrastructure located within existing surface water drainages could impede or alter existing stormwater patterns. For example, the new Build Alternative footprint could obstruct stormwater runoff, creating local ponding or drainage issues while reducing the amount of water in the receiving waterbody. New impervious surfaces could also alter the quantity and timing of stormwater runoff during operations of the Build Alternatives, which would result in changes to surface water hydrology. HSR alignment and ancillary features would result in a new permanent footprint and new areas of impervious surface throughout the surface hydrology and water quality RSA. Without adequate drainage facilities, stormwater runoff may be permanently altered.

In the urban areas of Palmdale and Burbank, streets, parking lots, and other paved surfaces compose a majority of the total surface coverage and typically drain stormwater to conveyance systems. New impervious surfaces associated with all six Build Alternative trackways, ancillary features, and station areas would not result in considerable quantities of new impervious surface in these urban areas. Between the urban areas of Palmdale and Burbank, a majority of the each of the six Build Alternatives would be tunneled using boring methodologies that would result in no impervious surface increase in those areas. Trackway ballast and sub-ballast would use permeable materials.

Depending on the alternative, the Vulcan Mine (Refined SR14, SR14A), Boulevard Mine (Refined SR14, SR14A, E1, E1A), or CalMat Mine (E2, E2A) would be filled with spoil materials from excavation and tunnel boring activities. The deposition and compaction of fill would result in changing topography in these areas. Fill at the Boulevard Mine and CalMat Mine deposition sites would not affect surface waters, because there are no existing surface water features in the mines, respectively. Following deposition of spoil materials, these mine sites would be graded to match the surrounding topography and reclaimed. Therefore, new impervious surfaces associated with the Build Alternatives would be associated with viaducts, access roads, roadway and railway relocations, tunnel portals, adits, and power facilities.

Within the Vulcan Mine site, three perennial ponds and two ephemeral streams are present. Construction of the Refined SR14 and SR14A Build Alternatives would likely require the removal of water from water features within and immediately adjacent to the deposition sites and would cause ongoing changes to drainage patterns in and around the site. Redirecting the flow in a watercourse would alter drainage patterns and increase the potential for erosion along new drainage paths. Increased erosion would lead to siltation in the flow channel and degradation of water quality at and downstream of altered locations. However, construction of the Refined SR14 and SR14A Build Alternatives, which would use the Vulcan Mine site for disposal of spoils material, would result in restoring a more natural overland flow pattern to the area. Furthermore, as specified by HYD-IAMF#1, the project will be designed and constructed to capture runoff and provide treatment prior to discharge of pollutant-generating surfaces which would result in minimal direct drainage impacts related to these facilities.

Spoils

Spoils are the earth and rock materials excavated during major earthwork activities, such as trenching and tunneling. As discussed in Chapter 2, Section 2.11.5, spoils generated during Project construction would be reused on the Project, disposed of within the Build Alternative footprint, or permanently disposed of at a designated site as appropriate. The Build Alternatives would dispose of the spoils at the following sites:

- Vulcan Mine (Refined SR14 and SR14A Build Alternatives)
- Boulevard Mine (Refined SR14 and E1 Build Alternatives)
- CalMat Mine (E2 Build Alternative)

HYD-IAMF#1 and HYD-IAMF#2 will require that surface water crossings maintain preconstruction hydraulic capacity through the implementation of on-site stormwater management BMPs to provide runoff dispersion, infiltration, detention, and evaporation. The incorporation of these IAMFs into project design will ensure that impacts on hydraulic capacity would be reduced by minimizing alterations to watercourses, implementing erosion control BMPs, and maintaining existing stormwater patterns.

HYD-IAMF#3, which involves the preparation and implementation of a SWPPP, would avoid or minimize changes to drainage, stormwater, and erosion patterns during construction. Hydromodification management procedures would include steps to maintain preconstruction hydrology by emphasizing on-site retention of stormwater runoff using measures such as flow dispersion, infiltration, and evaporation (supplemented by detention where required). In addition, BMPs would ensure that stormwater runoff was retained on-site per the stormwater management and treatment plan, as outlined in HYD-IAMF#1.

CEQA Conclusion

The construction-period SWPPP (HYD-IAMF#3) will incorporate BMPs to reduce short-term increases in construction-site runoff, and the stormwater management and treatment plan (HYD-IAMF#1) will address stormwater runoff and system capacity. HYD-IAMF#2 will require water crossings to maintain preconstruction hydraulic capacity. With implementation of HYD-IAMF#1 and HYD-IAMF#3, construction of the Build Alternatives would not substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, or through the addition of impervious surface, in a manner that would:

- Result in substantial erosion or siltation on- or off-site
- Substantially increase the rate or amount of surface runoff in a manner that would result in flooding on- or off-site
- Create or contribute runoff water that would exceed the capacity of existing or planned stormwater drainage systems
- This impact would be less than significant for the Refined SR14, SR14A, E1, E1A, E2, and E2A Build Alternatives. Therefore, CEQA does not require mitigation.

Impact HWR#2: *Construction Activities Required for the Build Alternatives.*

Construction of the Palmdale to Burbank Project Section Build Alternatives could result in the contamination or pollution of surface waters within or adjacent to the construction area. Surface waters that occur along the six Build Alternatives are depicted in Figure 3.8-A-25 through Figure 3.8-A-96 (Appendix 3.8-A).

Construction-related chemicals could be handled and applied within or immediately adjacent to surface waters. An uncontrolled chemical release (through spill, over-application, etc.) would directly affect surface water quality by introducing hazardous materials into the water column. Construction equipment or washing stations could introduce fuel, lubricant, oil, or other contaminants that would also directly affect nearby surface water quality. If unmanaged, stormwater could disperse these construction-related pollutants, along with trash and debris, from the worksite and into adjacent surface waters. This represents a potential temporary water quality impact that could occur during the construction period. As discussed in HYD-IAMF#3, a SWPPP will be prepared to outline BMPs for spill prevention and would provide procedures and responsibilities for addressing accidental releases. Furthermore, as discussed in Section 3.10, Hazards and Hazardous Materials, HMW-IAMF#5 through HMW-IAMF#9 would reduce the risks associated with use, transportation, storage, and disposal of hazardous materials.

Erosion is another principal contributor to water quality degradation. In this context, erosion refers to mobilization of soil particles within a surface water system. Soils at undisturbed sites experience natural erosion rates affected by climate, topography, and rainfall. Vegetation also protects soils from heavy rainfall, slows stormwater runoff, and stabilizes soils to decrease wind and water erosion potential. However, soils in construction sites could experience high erosion rates resulting from disturbance and exposure from grubbing, vegetation removal, grading, and stockpiling activities. Erosion into watercourses could result in a variety of localized and downstream water quality impacts, including sedimentation and increased turbidity. Sediment-borne pollutants could also become suspended in the water column, further degrading water quality.

Construction of trackway, bridges, and aboveground ancillary features would result in ground disturbance throughout the construction period. As described above, soils exposed through ground-disturbing activities like grubbing, vegetation removal, and grading could temporarily affect surface water quality during the construction period. Furthermore, as described above, portions of trackway, viaduct piers and abutments, traction power substations, roadway/railway modifications, access roads, station areas, CSAs, and drainage facilities would require construction activities within surface water channels. Should in-watercourse construction require dewatering or diversion, disruption of streambed sediments could increase turbidity within the watercourse. In light of these activities, construction of the Build Alternatives would result in erosion and sedimentation that would cause temporary direct impacts on water quality.

Turbidity

Turbidity is the measurement of particles suspended within a water column. Soil and clay particles are common causes of turbidity, which can degrade habitat, diminish recreational value, and increase costs of water treatment.

Tsunamis, seiches, and floods could introduce new conditions that could increase the risk of water pollution as a result of the Palmdale to Burbank Project Section. As described in Section 3.9, Geology, Soils, Seismicity, and Paleontological Resources, the Build Alternatives would not traverse tsunami or seiche zones. However, the Build Alternatives would include areas in flood hazard zones. HSR infrastructure in flood hazard zones would consist of passive features and would not include storage of hazardous chemicals. Thus, these features would not result in the release of pollutants if inundated.

Construction of any of the six Build Alternatives would introduce new sources of pollutants that could contaminate groundwater within the groundwater basins which they overlay. The Refined SR14 Build Alternative would require footprint within four groundwater basins: the Antelope Valley, the Santa Clara River Valley East Sub-basin, the Acton Valley, and the San Fernando Valley. The E1 and E2 Build Alternatives would require footprint within Antelope Valley and San Fernando Valley groundwater basins. One optional adit (E1-A2) for the E1 Build Alternative would require the construction of a utility easement within the Santa Clara River Valley East Sub-basin.

Construction activities, such as trenching and installation of bridge piers, could require dewatering to remove groundwater from the construction site. Dewatering activities could degrade groundwater through the introduction of sediment or the potential release of contaminated groundwater, particularly where groundwater is shallow. In the Antelope Valley Groundwater Basin, tunneling activities required for each of the six Build Alternatives could encounter shallow groundwater south of the California Aqueduct and north of the ANF. However, insufficient groundwater information is available at this time to identify the extent to which the tunnels may be below the water table. Therefore, the analysis assumes that tunnels are below the water table in this area. Where each of the six Build Alternative alignments would pass through foothills of the San Gabriel Mountains, tunnels would likely be constructed above the groundwater table. However, available information indicates the possible presence of perched groundwater or seasonal springs in the vicinity of these tunnels (Figure 3.8-A-17). Therefore, local water inflows during portal and tunnel excavations are anticipated in this area. In the ANF, the tunnels would pass through

Acres of construction-period ground disturbance footprint

Refined SR14—3,409 to 3,492 acres

SR14A— 3,144 to 3,232 acres

E1—2,249 to 2,263 acres

E1A—2,022 to 2,159 acres

E2—2,093 to 2,094 acres

E2A—1,963 to 1,964 acres

Acres of permanent footprint

Refined SR14—2,490 to 2,565 acres

SR14A—2,164 to 2,238 acres

E1—2,156 acres

E1A—1,898 2,021 acres

E2—1,994 to 2,006 acres

E2A—1,835 to 1,847 acres

Acres of new impervious surface

Refined SR14—787 acres

SR14A—752 acres

E1—742 acres

E1A—700 acres

E2—650 acres

E2A—607 acres

areas where groundwater is present. Groundwater would likely flow into the tunnels, particularly where the groundwater head is high and during the period between the tunnel boring machine (TBM) cutterhead encounter with groundwater and the installation of the first-pass lining system. Disposal of water flow into the tunnel could release water contaminated with drilling muds, sediments, and lubricants used during the tunneling activities.

South of the ANF, tunnels would likely be constructed above the groundwater table of the San Fernando Valley Groundwater Basin. However, tunnels could also encounter perched groundwater or seasonal springs in the vicinity of these tunnels (Figure 3.8-A-22 and Figure 3.8-A-23). Therefore, local water inflows during portal and tunnel excavations are also anticipated in this area.

Construction of tunnels could also cause the disruption and spreading of existing soil that would result in groundwater contamination from the disrupted soils. Tunneling activities have a high probability of encountering fractures containing groundwater that may be of varying water quality. However, the risk of encountering water that is contaminated by natural or anthropogenic chemical and mineral substances that could result in release of toxic or contaminated water to the surface and to surface waters is not known. As previously mentioned, disposal of water flow into the tunnel could release water contaminated with drilling muds, sediments, and lubricants used during the tunneling activities. Water quality may be affected by the construction method. Blasting on rock fractures and joints may impact groundwater flow and quality. For tunnels dug with TBMs, tunnel grouting, operation and maintenance of the machine, shaft excavation, and dewatering associated with shaft excavation could potentially affect groundwater quality. For sequential excavation method tunnels, grouting, and dewatering could also affect groundwater quality.

The SR14A, E1A, and E2A Build Alternatives would also introduce new sources of pollutants that could contaminate underlying groundwater basins. Compared to the Refined SR14, E1, and E2 Build Alternatives, respectively, the SR14A, E1A, and E2A Build Alternatives would result in slightly greater impacts on groundwater because they require more tunneled alignment through the Antelope Valley Groundwater Basin (3.89 miles more tunneled alignment for the SR14A Build Alternative and 1.32 miles more tunneled alignment for the E1A and E2A Build Alternatives). However, with respect to the pollutants reported in the 303(d)-listed waterbodies, construction of the six Build Alternatives would not contribute coliform bacteria or ammonia because neither pollutant is associated with construction activities.

The SWPPP (HYD-IAMF#3) will establish BMPs to minimize water quality impacts caused by short-term sedimentation throughout construction. BMPs would include erosion control requirements, stormwater management, and channel dewatering for affected stream crossings. Stormwater discharges would comply with the CWA and other applicable state and local stormwater regulations, as described in Section 3.8.2.1, Section 3.8.2.2, and Section 3.8.2.3. These regulations and associated permits include, but are not limited to, the SWRCB's NPDES General Permit for Stormwater Discharges Associated with Construction Activities, the use of a SWPPP, conditions of approval from USFS, and stormwater and grading permits obtained from Los Angeles County and the Cities of Palmdale, Los Angeles, Santa Clarita, and Burbank. These permits would establish water quality parameters and monitoring requirements to protect water quality during construction.

Tunnel construction outside the ANF is not anticipated to adversely affect the groundwater quality in the existing private water wells within the tunnel construction RSA. Nevertheless, the Authority will implement measures (HWR-MM#1) to continuously monitor groundwater quality or condition in private water wells before, during, and after tunnel construction. This mitigation measure would provide for timely detection of changes in the geochemistry of the groundwater and, if necessary, appropriate remediation.

CEQA Conclusion

The SWPPP (HYD-IAMF#3) will implement erosion-control BMPs during construction. In addition, the Palmdale to Burbank Project Section would comply with water quality parameters and monitoring required by applicable regulations and permitting conditions during construction of the tunnels. Therefore, the Build Alternatives would not:

- Violate water quality standards or WDRs
- Create or contribute runoff water that would provide substantial additional sources of polluted runoff
- Otherwise substantially degrade surface water quality.

Also, HMW-IAMF#5 through HMW-IAMF#9 would minimize risks associated with use, transportation, storage, and disposal of hazardous materials. Although these measures and the construction-related SWPPP (HYD-IAMF#3) would minimize water quality impacts related to channel dewatering, the Refined SR14, SR14A, E1, E1A, E2, and E2A Build Alternatives could still substantially degrade groundwater quality during tunnel construction and, therefore, result in a significant impact. As discussed in Section 3.8.8, HWR-MM#1 will require the Authority to treat potential groundwater contamination pursuant to RWQCB permit requirements. Through treatment of groundwater and installation of groundwater barriers (where necessary), application of this mitigation measure would prevent degradation of groundwater quality. Treatment methods for groundwater would include constructed wetland systems, biofiltration and bioretention systems, wet ponds, organic mulch layers, planting soil beds, and vegetated systems (biofilters), such as vegetated swales and grass filter strips. Therefore, with HWR-MM#1, the impact associated with contaminated groundwater resources during construction activities would be less than significant.

With implementation of HWR-MM#1, the Build Alternatives would not violate standards for groundwater quality or otherwise substantially degrade groundwater quality, and this impact would be less than significant for the Refined SR14, SR14A, E1, E1A, E2, and E2A Build Alternatives.

Impact HWR#3: *Changes in Flood Risks Associated with Temporary Construction Activities and Permanent Structures Required for the Build Alternatives.*

All six Build Alternatives would create permanent footprints within Special Flood Hazard Area (SFHA); these footprints would be associated with HSR tracks, roadway and railroad relocations, drainage basins, tunnel portals, bridge pillars and abutments, and power facilities. A permanent footprint within SFHAs could change location, direction, and elevation of flood flows, permanently increasing flood risks to HSR facilities and nearby communities over the lifetime of the Palmdale to Burbank Project Section. Portions of all six Build Alternatives built within FEMA-designated SFHAs could also impede, channelize, or redirect flood flows as a result of the presence of construction equipment, materials, and staging/laydown areas. Construction within SFHAs could also remove stabilizing vegetation and disturb or compact soils, which would directly affect flood patterns. Temporary impacts would include risks to construction facilities, workers, and communities located in flood-prone areas.

Redirected flood flows also have the potential to affect other floodplain values, such as those associated with existing flora and fauna, archaeological sites, natural beauty, and open space. Construction in a floodplain could temporarily impede or redirect flood flows because of the presence of construction equipment and materials in the floodplain, depending on the activity occurring in a specific area. Additionally, construction activities would increase the risk of release of sediment or construction pollutants during a storm event by increasing potential for erosion and thorough the presence of construction materials and equipment in the floodplain.

Refined SR14 Build Alternative

The Refined SR14 Build Alternative would result in 294 to 295 acres of temporary disturbance in SFHAs and 292 to 293 acres of permanent disturbance in SFHAs (discussed in Section 3.8.5.3, and mapped on Figure 3.8-A-25 through Figure 3.8-A-39). The Refined SR14 Build Alternative would also cross five SFHAs in tunnels; underground construction activities would not result in surface disturbance.

The Refined SR14 Build Alternative proposes construction activities within one large Zone AO floodplain in the city of Palmdale to install trackway, construct the Palmdale Station, and relocate the Sierra Highway and the Metrolink line. A new drainage basin is also proposed within this SFHA to alleviate flooding risks and poor drainage that currently exists in Palmdale. This drainage basin would occupy approximately 251 acres of land and include drainage features at Avenue M 12 to the east of existing Metrolink tracks, paralleling the Build Alternative alignment south toward Avenue R. Approximately 87 acres of the basin would occupy an undeveloped area at the intersection of Avenue R and Division Street.

Between Palmdale and the San Fernando Valley, the Refined SR14 Build Alternative proposes four viaduct crossings of SFHAs associated with the Santa Clara River and its tributaries. These crossings would be built between the SR 14 crossing and Vulcan Mine. Viaduct construction could require piers or bridge abutments within the SFHAs. Ancillary facilities associated with these SFHA crossings include utility lines, traction power facilities, power lines, CSAs, and a tunnel portal.

South of the Pacoima Reservoir, adit options SR14-A2 and SR14-A3 would require a CSA footprint within a Zone AO floodplain. Utility lines associated with adit option SR14-A3 would also cross the Zone AO.

Within the San Fernando Valley, the Refined SR14 Build Alternative would encounter one SFHA located in Sun Valley along the Metrolink rail line between Sheldon Street and Interstate (I) 5. This floodplain is adjacent to the Metrolink rail line and is part of a larger network of floodplains that inundates adjacent quarry pits and a number of surface streets. Trackway, viaduct piers and abutments, roadway relocations, Metrolink relocation, and utility easements would be installed within this floodplain.

SR14A Build Alternative

The SR14A Build Alternative would result in approximately 280 to 281 acres of temporary and permanent disturbance in SFHAs (discussed in Section 3.8.5.3 and mapped on Figure 3.8-A-40 through Figure 3.8-A-54). The SR14A Build Alternative would result in slightly lesser impacts when compared to the Refined SR14 Build Alternative, given its smaller footprint within SFHAs. This would result in less removal of stabilizing vegetation, a lesser amount of disturbance and compaction of soils during construction, and fewer permanent structures that would block or channelize flood flows.

Within San Fernando Valley, the SR14A Build Alternative's impacts on SFHAs would be the same as the Refined SR14 Build Alternative.

E1 Build Alternative

The E1 Build Alternative would result in 306 acres of temporary and permanent disturbance in SFHAs (discussed in Section 3.8.5.3, and mapped on Figure 3.8-A-55 through Figure 3.8-A-65).

Within the city of Palmdale, E1 Build Alternative construction activity disturbances to SFHAs would be identical to those described above for the Refined SR14 Build Alternative. Between the Palmdale Station and the San Fernando Valley, the E1 Build Alternative would cross three SFHAs on a viaduct. Bridge pylons and surface-level ancillary features at these SFHA crossings, including utility lines, drainage facilities, power facilities, and access roads, could result in new floodplain disturbance.

Within the San Fernando Valley, construction disturbances would be identical to those described above for the Refined SR14 Build Alternative.

E1A Build Alternative

The E1A Build Alternative would result in 306 acres of temporary and permanent disturbance in SFHAs (discussed in Section 3.8.6.3 and mapped on Figure 3.8-A-66 through Figure 3.8-A-76). Thus, the E1A Build Alternative would result in slightly lesser impacts on floodplains than the E1 Build Alternative.

E2 Build Alternative

The E2 Build Alternative would result in 422 acres of temporary and permanent disturbance in SFHAs (discussed in Section 3.8.5.3, and mapped on Figure 3.8-A-77 through Figure 3.8-A-86).

Between the city of Palmdale and the San Fernando Valley, E2 Build Alternative construction disturbances to SFHAs would be identical to those described above for the E1 Build Alternative.

Within the San Fernando Valley, the E2 Build Alternative would cross the Big Tujunga Wash on a viaduct. This crossing also proposes a number of ancillary features within the SFHA, including access roads, a tunnel portal, power facilities, utility lines, and a CSA.

South of the Tujunga Wash crossing, the E2 Build Alternative would enter a tunnel and continue underground until reaching the Burbank Airport Station. This tunnel would be built beneath several SFHAs within the Sun Valley neighborhood of Los Angeles, using a mix of subsurface mining and cut-and-cover. Mined tunnel portions would have no impact on the SFHAs but cut-and-cover tunnel areas would result in surface disturbance to SFHAs during construction. In addition, roadway relocations, utility easements, and CSAs would be located within the Sun Valley SFHAs.

E2A Build Alternative

The E2A Build Alternative would result in 421 acres of temporary and permanent disturbance in SFHAs (discussed in Section 3.8.5.3 and mapped on Figure 3.8-A-87 through Figure 3.8-A-96). The E2A Build Alternative would result in slightly lesser impacts on floodplains as the E2 Build Alternative (both cross 0.99 linear mile of SFHA).

This would result in less removal of stabilizing vegetation, less disturbance and compaction of soils during construction, and fewer permanent structures that would block or channelize flood flows.

Within the San Fernando Valley, the E2A Build Alternative’s impacts on SFHAs would be the same as the E2 Build Alternative.

Increased Flood Risks Downstream of Wildfire Areas within ANF

None of the Build Alternatives would create a permanent surface footprint in FEMA SFHAs within ANF. However, USFS requested information on proposed drainage crossings within and adjacent to ANF to determine the number of HSR structures that could experience increased flow/debris rates downstream of areas burned by wildfires. Increased flooding could persist in an area for several years after a wildfire, although it usually abates after the second rainy season after the fire event (USGS 2018). Each Build Alternative would be located in areas that would require several crossings of existing drainage within or adjacent to ANF that could be susceptible to increased flow/debris rates after a wildfire:

- **Refined SR14**—The alignment and ancillary facilities would cross existing drainages downstream of potential wildfire areas at three locations within or adjacent to ANF: the at grade covered tunnel in Vulcan Mine (Figure 3.8-A-33), the viaduct over the Santa Clara River (Figure 3.8-A-33), and a CSA/utility line crossing associated with SR14-A1 (Figure 3.8-A-35).
- **SR14A Build Alternative**—Impacts would be identical to those resulting from implementation of the Refined SR14 Build Alternative.
- **E1 Build Alternative**—This Build Alternative would include viaduct alignment and grading improvements near existing culverts in the Aliso Canyon area (Figure 3.8-A-58). In addition, CSAs and ancillary facilities associated with the E1-A1 and E1-A2 adit options would include existing surface drainage crossings in the ANF along Little Tujunga Road (Figure 3.8-A-61).
- **E1A Build Alternative**—Impacts would be identical to those resulting from the implementation of the E1 Build Alternative.

- **E2 Build Alternative**—The alignment and ancillary facilities would cross existing drainages downstream of potential wildfire areas within or adjacent to ANF at the following locations:
  - Viaducts and grading improvements in Aliso Canyon (Figure 3.8-A-69)
  - CSAs and ancillary facilities associated with the E2-A1 and E2-A2 adit options (Figure 3.8-A-83)
  - The tunnel portal at the southern perimeter of ANF, immediately north of the Big Tujunga Creek crossing (Figure 3.8-A-84)
- **E2A Build Alternative**—Impacts would be identical to those resulting from implementation of the E2 Build Alternative.

Impact Summary

All six Build Alternatives would require surface disturbance within several SFHAs throughout the RSA. Trackway, viaduct piers and abutments, traction power facilities, CSAs, and roadway/railway relocations could require ground disturbance, construction laydown areas, and fill placement within floodplain areas. In many instances, floodplain crossings by proposed utilities, such as power and water lines, would be co-located with existing utility corridors, roadways, and on existing utility poles, resulting in no new floodplain disturbance in those areas.

Wildfire conditions in the ANF may result in stormwater flows potentially exceeding typical FEMA 100-year flood events. Data from wildfire impacts on watersheds show elevated flows and sediment delivery of up to 5.5 and up to 20 times greater than pre-wildfire conditions, respectively (Authority 2017a). This could cause culverts and drainage systems to become overwhelmed with debris, possibly causing road and property damage. Areas of the HSR footprint that cross existing drainages within or downstream of potential wildfire hazard areas could experience heightened flood risks from post-wildfire storm flows.

As established by HYD-IAMF#2, Build Alternative infrastructure will be designed and constructed to avoid areas within floodplains wherever feasible. Where the Build Alternatives would cross major surface waters and be permanently located within SFHAs, the Authority conducted hydraulic modeling and confirmed that increases in floodplain elevations resulting from Build Alternative features would not exceed 1 foot, consistent with FEMA criteria (Authority 2020a).[8]

The National Flood Insurance Program introduced the concept of floodways and floodplains to assist local communities in floodplain management. The floodway is the channel of a watercourse, including any adjacent floodplain areas that must be generally kept free of encroachment so that the 100-year flood can be carried without substantial increases to flood heights. According to guidelines established by FEMA, increase in flood height in the floodway due to any encroachment in the floodway fringe areas may not exceed 12 inches, if hazardous velocities are not produced in the waterbody. Constructing levees, rail and road embankments, buildings, etc., that encroach on floodplains may reduce the flood-carrying capacity and increase flood elevations. No floodways would be crossed by any of the Build Alternatives.

As established by HYD-IAMF#2, infrastructure will be designed and constructed to avoid areas within floodplains wherever feasible. Where infrastructure would be permanently located within floodplains, the Authority conducted hydraulic modeling and confirmed that increases in flood plain elevations resulting from the Project would not exceed 1 foot in FEMA designated floodplains. However, none of the Build alternative footprints overlap with a FEMA regulatory footprint. If the Authority later determines that a FEMA regulatory floodway may be affected by the Project, it would conduct additional hydraulic modeling to confirm that there would be no (0.00 foot) increase in the base flood elevation, as indicated in HYD-IAMF#2, which requires compliance with local agency requirements for development within the floodplain. If the Authority is unable to meet these requirements, and the base flood elevation exceeds the NFIP regulations,

[8] FEMA criteria require existing and future development in the floodplain combined with the proposed project improvements to create less than 1 foot of cumulative rise in the base flood elevation (Authority 2020a).

the Authority would seek approval of the LAFCD to apply to FEMA for a CLOMR, as indicated in HYD-IAMF#2.

Additionally, the design of drainage basins would recognize existing floodplains and incorporate features to maintain existing flow patterns. This would allow flood flows during operations of the Build Alternatives to remain consistent with preconstruction flow conditions and would not raise the existing surface elevation levels.

The BMPs included within HYD-IAMF# 1 and implemented during construction would minimize floodplain impacts. HYD-IAMF#1 will implement stormwater management facilities to convey and detain runoff from new impervious surfaces, thus reducing the Palmdale to Burbank Project Section's contribution of runoff during flood events. The flood protection plan required by HYD-IAMF#2 will allow the Build Alternatives to remain operational during flood events and would minimize increases in 100-year or 200-year flood elevations. HYD-IAMF#2 will also incorporate USFS hydraulic modeling specific to post-wildfire conditions to provide for appropriately sizing HSR structures within and adjacent to the ANF to accommodate increased flood/debris flows after a wildfire.

Section 408 U.S. Army Corps of Engineers Federal Flood Control Projects

The project would require permission from USACE under Section 408 in the event that a Build Alternative would occupy, alter, or use any federal civil works project. Lopez Dam, Hansen Dam, and Tujunga Channel, which are located within the project study area, are USACE projects regulated under Section 14 of the Rivers and Harbors Act of 1899, as amended and codified in 33 U.S. Code 408 (Section 408). Section 408 provides that USACE may grant permission to a party to alter a USACE project upon a determination that the alteration proposed would not be injurious to the public interest and would not impair the usefulness of the project. Pursuant to *Memorandum of Understanding - National Environmental Policy Act (42 U.S.C. 4321 et seq) and Clean Water Act Section 404 (33 U.S.C. 1344) and Rivers and Harbors Act Section 14 (33 U.S.C. 408) - Integration Process for the California High-Speed Train Program* (NEPA/404/408 MOU) in November 2010, the Authority and USACE have been in discussions regarding the potential effects of the Build Alternatives on these USACE projects. The closest Build Alternative to Lopez Dam would be located 650 feet to the west. At that location, the alternative would consist of tunnels 450 feet underground. With respect to Hansen Dam, the closest Build Alternative would be located over 2,000 feet to the east and consist of tunnels 290 feet underground.

The Authority evaluated the potential for construction or operation of the HSR Build Alternatives to result in adverse effects to the federal projects, including the potential for ground settlement and vibration effects, and determined that these projects are located in areas outside the potential zone of influence of the HSR Build Alternatives.[9] Specifically, the Build Alternatives would not directly or indirectly alter, occupy, or use either Lopez Dam or Hansen Dam. With respect to Tujunga Channel, the Build Alternatives (Refined SR14, SR14A, E1 and E1A) would clear span the channel on viaduct. Abutments supporting the viaduct would be outside of the existing concrete U-box structure that makes up the Tujunga Channel, on property owned by the Los Angeles County Flood Control District. The design also preserves existing maintenance access along the channel.

The operation of the flood control features of the Hansen Spreading Grounds, including the outfall structures connected to Tujunga Wash, would not be adversely affected by the Build Alternatives. Preliminary engineering project design drawings include culverts that would be placed under the HSR embankment that would be located within the Hansen Spreading Grounds, which would allow for water to flow under the embankment and between ponds. These culverts would ensure that flows through the Hansen Spreading Grounds to the existing outfall structure would remain uninterrupted. With implementation of HWR-MM#3, the groundwater recharge function, operation

[9] Construction of tunnels may lead to settlement, the downward displacement of the surface, during tunnel construction. Settlement occurs directly over the tunnel. The Tunnel Influence Zone for potential ground settlement is a surface strip whose width is defined by an angle not greater than 45 degrees on both sides of the tunnel axis, according to the recommendations from the International Tunneling Association.

and capacity of the spreading grounds would not substantially change as a result of the project. USACE intends to use the Final EIR/EIS to fulfill its NEPA compliance responsibilities associated with Section 408 permission and Section 404 of the CWA permit decision-making including a determination about the Authority's compliance with the USEPA's Section 404(b)(1) Guidelines. A meeting was held with USACE and the Authority on April 6, 2023, and technical work has been prepared, to support the coordination under the NEPA/404/408 MOU. USACE provided concurrence on January 5, 2024, regarding the Checkpoint C Report, and USEPA provided its concurrence on January 9, 2024. As such, both agencies have indicated preliminary agreement on the least environmentally damaging practicable alternative pursuant to Section 404 of the CWA. Additionally, the USACE has provided a preliminary recommendation aligned with Checkpoint C regarding compliance with the requirements of Section 14 of the Rivers and Harbors Act ("Section 408").

CEQA Conclusion

HYD-IAMF#1 will require stormwater management facilities to reduce the Build Alternative's contribution of runoff to existing drainage systems during flood events, and the flood protection plan (HYD-IAMF#2) would minimize increases in flood elevations to existing surface elevation levels. However, construction within SFHAs could still impede or redirect flood flows, thereby substantially increasing the rate or amount of surface runoff in a manner that would result in flooding on- or off-site, such outcomes would result in a significant impact.

As discussed in Section 3.8.7, Mitigation Measures, HWR-MM#2 will require the Authority to avoid placing permanent facilities within floodplains and minimize encroachment during construction into surface water resources to the extent feasible. If such encroachments during construction are necessary, HWR-MM#2 will require restoration of temporarily affected floodplains after construction, by regrading to mimic contours and revegetating where necessary. Where placement of facilities in floodplains cannot be avoided, HWR-MM#2 will require the use of fill to raise infrastructure above the base flood elevation.

As discussed in Section 3.8.7, Mitigation Measures, HWR-MM#3 requires the Authority to provide replacement groundwater recharge areas in the vicinity of existing recharge ponds within the Hansen Spreading Grounds and to compensate for loss in recharge and capacity. With implementation of HWR-MM#3, floodways within the floodplain elevations would not increase as a result of any of the six Build Alternatives. The Build Alternatives would not substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, or through the addition of impervious surface, in a manner which would impede or redirect flood flows or exceed the capacity of existing or planned drainage systems. The Build Alternatives would not substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, or through the addition of impervious surface, in a manner which would impede or redirect flood flows or exceed the capacity of existing or planned drainage systems.

As discussed above, increases in both floodways within the floodplain elevations and floodplain elevations resulting from the Build Alternatives would not exceed 1 foot, consistent with FEMA criteria. However, none of the Build alternative footprints overlap with a FEMA regulatory footprint. If the Authority later determines that a FEMA regulatory floodway may be affected by the Project, it would conduct additional hydraulic modeling to confirm that there would be no (0.00 foot) increase in the base flood elevation, as indicated in HYD-IAMF#2, which requires compliance with local agency requirements for development within the floodplain. Therefore, with implementation of HYD-IAMF#2 and HWR-MM#2, construction activities and permanent structures would not substantially increase flood risks, and the impact would be less than significant for the Refined SR14, SR14A, E1, E1A, E2, and E2A Build Alternatives.

Impact HWR#4: ***Changes in Groundwater Recharge Associated with Temporary Construction Activities and Permanent Structures Required for the Build Alternatives.***

Groundwater Recharge Impacts from New Impermeable Surfaces

Impermeable surfaces created by the Build Alternatives would disrupt the infiltration of water from the surface to groundwater basins, permanently affecting groundwater recharge. Reducing groundwater recharge could lead to groundwater reduction. Nearby water supply wells could be affected by a reduction in groundwater availability. Groundwater basins underlaying all six Build Alternatives are depicted on Figure 3.8-A-21 through Figure 3.8-A-23. The Build Alternatives would not cross medium- or high-priority groundwater basins and no applicable groundwater sustainability plans have been adopted for these basins. All six Build Alternatives include construction of pairs of bored and mined tunnels, which would not directly impact surface conditions but in certain conditions may result in hydrogeological changes that may cause groundwater depletion. Impacts on groundwater conditions associated with the construction of tunnels in the ANF are discussed in Impact HWR#5. Such groundwater impacts caused by the construction of tunnels outside of the ANF are discussed below.

Permeable ballast and sub-ballast materials for aboveground, at grade alignment profiles would allow stormwater to percolate through the trackway into the groundwater basin. Other Build Alternative-related impediments to groundwater recharge would include impervious surfaces associated with viaducts, cut-and-cover tunnels, ancillary facilities, and station areas. New impervious surfaces would include drainage infrastructure designed to redirect upstream runoff and capture stormwater for local discharge, thus minimizing permanent impacts on groundwater recharge. Reduction of groundwater as a result of reduced recharge could occur in the groundwater basins listed below.

- **Antelope Valley Groundwater Basin**—Each of the Build Alternative footprints in the Antelope Valley Groundwater Basin are within developed suburban land uses and infrastructure. Because these areas are developed, the net increase in impervious surfaces would be relatively low. Stormwater retention and detention BMPs would be implemented to control stormwater runoff while also increasing groundwater recharge. The Refined SR14, E1, and E2 Build Alternatives would cross Una Lake on an embankment, which would reduce the potential for groundwater recharge in this waterbody. In contrast, the SR14A, E1A, and E2A Build Alternatives would not cross or require features within Una Lake. Because the Antelope Valley Groundwater Basin covers more than 1 million acres, and each of the six Build Alternatives would not require more than 1,623 acres, or less than 0.1 percent, of this groundwater basin, groundwater recharge reduction at Una Lake would be relatively small within the total size of the basin and thus would not affect the overall Antelope Valley Groundwater Basin recharge.
- **Acton Valley Groundwater Basin**—The Refined SR14 Build Alternative proposes utility lines in the Acton Valley Groundwater Basin boundaries and does not propose new impervious surfaces over this groundwater basin. Utility lines would be installed within existing roadway right-of-way, so the Acton Valley Groundwater Basin would not experience changes in groundwater recharge. The Refined SR14 Build Alternative would require 13 acres of footprint within the Acton Valley Groundwater Basin. The E1/E2 Build Alternatives would require footprint in the Acton Valley Groundwater Basin. The SR14A Build Alternative would also require utility lines within the Acton Valley Groundwater Basin boundaries; such impacts would be reduced due to the SR14A Build Alternative requiring only 6 acres of footprint in the Acton Valley Groundwater Basin. The E1A and E2A Build Alternatives would not require footprint in the Acton Valley Groundwater Basin.
- **Santa Clara River Groundwater Basin East Sub-Basin**—The Refined SR14 and SR14A Build Alternatives would cross the easternmost edge of the Santa Clara River East Sub-basin in three locations. Two of these proposed crossings would be underground and would not reduce groundwater recharge. The third crossing of the Santa Clara River East Sub-basin would be in the vicinity of Soledad Canyon and Lang Station Mine. Alignment and ancillary features overlying this groundwater basin would include ballast material, viaduct trackway,

access roads, power facilities, and drainage facilities. This basin is classified as a high-priority basin, but the aboveground features of the Refined SR14 and SR14A Build Alternatives would be minimal within this basin relative to the 66,200-acre total area of the basin. As the Refined SR14 and SR14A Build Alternatives would require 128 acres of footprint within this basin, it would only require the use of less than 0.2 percent of the basins total area (Los Angeles County 2019). Also, drainage facilities would be designed to capture upstream stormwater runoff and direct it into the Santa Clara River channel, which provides the primary groundwater recharge for this groundwater basin. One optional adit (E1-A2) for the E1 and E1A Build Alternatives would require the construction of a utility easement within the Santa Clara River Valley East Sub-basin. This feature would be minimal (2.1 acres) in nature and be unlikely to substantially impact groundwater resources. Both the E2 and E2A Build Alternatives would not require footprint in the Santa Clara River Groundwater Basin East Sub-basin.

- **San Fernando Groundwater Basin**—Similar to the Antelope Valley Groundwater Basin, most of the proposed six Build Alternatives’ surface footprints overlying the San Fernando Groundwater Basin would be located within urbanized areas. However, the Refined SR14 and SR14A, and E1 and E1A Build Alternatives would cross the Hansen Spreading Grounds on fill or embankment. New impervious surfaces within the spreading ground could reduce its capacity for groundwater recharge. The E2 and E2A Build Alternatives footprint would not substantially increase the amount of new impervious surfaces overlying the San Fernando Groundwater Basin because of its location within heavily urbanized areas.

Impervious surfaces would be utilized in the design of both the Palmdale and Burbank Stations. However, impacts on groundwater recharge would be minimal at these station sites because they would be located in urbanized areas and the net increase of impervious surfaces would be minimal.

Groundwater Recharge Impacts from Tunnel Construction

Tunnel construction could impact groundwater levels and surface water features during construction of all six Build Alternatives, due to groundwater seepage into tunnels. This section analyzes impacts from each of the six Build Alternatives from tunnels located outside of the ANF. The analysis of the potential hydrologic effects of tunnel construction in the ANF requires a different approach than the analysis related to tunnel construction outside of the ANF. Outside the ANF, tunnel depths would be shallower than in the ANF and the tunnels would not encounter high water pressures during construction. The primary issues associated with tunneling outside the ANF is the tunnel depth relative to the groundwater table and tunneling through alluvial soils. When tunnel depths are above the known groundwater table, effects on groundwater and groundwater dependent resources would be minimal to none. Where tunnel depths may coincide with the groundwater table, there could be impacts as described below. However, because of the shallow depth of the tunnels, and the correspondingly relative low water pressures at those depths, effects on groundwater would be avoided through tunnel design and construction methods outlined in the IAMFs.

Within the Antelope Valley Groundwater Basin, tunneling activities required for each of the six Build Alternatives could encounter shallow groundwater south of the California Aqueduct and north of the ANF. Where each of the Build Alternative alignments passes through foothills of the San Gabriel Mountains, tunnels would likely be constructed above the groundwater table. However, not enough groundwater information is available at this time to identify the extent to which the tunnels may be below the water table. There may be perched groundwater or seasonal springs in the vicinity of these tunnels (Figure 3.8-A-21).

South of the ANF, tunnels would likely be constructed above the groundwater table of the San Fernando Valley Groundwater Basin. However, tunnels could also encounter perched groundwater or seasonal springs in the vicinity of these tunnels (Figure 3.8-A-21 and Figure 3.8-A-23). In these areas outside of the ANF, groundwater pressures are expected to be less than 25 bar. In such conditions, the implementation of IAMFs as described below is expected to be adequate to control water inflow into the tunnels.

Tunnel construction outside the ANF would be constructed using one or more of four excavation methods: (1) the sequential excavation method, (2) the drill and blast excavation method, (3) the mechanized open-face or closed-face TBM excavation method, and (4) the cut-and-cover method.[10] Because of the presence of groundwater, perched groundwater, and seasonal springs, tunneling could provide a conduit for groundwater to drain into the excavation as the advancing tunnel intersects fractures and faults within bedrock or saturated alluvium in groundwater basins. For all excavation methods, excessive groundwater pressures might generate some seepage into the tunnel during construction, but additional measures implemented during construction, such as pre-grouting, would help to avoid or reduce the flow to manageable values. A network of piezometers, as described in HYD-IAMF#7, would be used to monitor the effectiveness of the construction methods in preventing a decline in groundwater levels. Design features such as the mining methods to be employed, the specific type of TBM to be used when construction by TBM is selected, the type of grouting approaches to be implemented to control water flows, and the appropriate lining systems to be installed would be further refined during the pre-construction phase of the selected Preferred Alternative after detailed field investigations are completed and would be implemented during construction.

Potential for Direct Impacts to Private Water Supply Wells from Tunnel Construction

Based on available information, there are 30 active water supply wells within 1 mile of the Refined SR14 and SR14A Build Alternatives, 24 active water supply wells for the E1 and E1A Build Alternatives, and 22 active water supply wells for the E2 and E2A Build Alternatives. These wells are depicted in Figure 3.8-A-21 through Figure 3.8-A-23 in Appendix 3.8-A, Hydrology and Water Resources Figures Part 1. Although the general locations of these wells have been identified, due to the wide variability and lack of precision in location reporting, it is not possible to determine if any of these wells would be physically affected by tunnel construction, or the extent of any such impacts.

Because only limited information is available regarding the location of private wells, there is the potential that tunnel construction could result in the destruction of private water supply wells, including wells that have not been identified, if any wells are located directly in the path of the tunnels. Pursuant to HYD-IAMF#8, private water supply wells that would be directly affected by tunnel construction would be identified and relocated prior to construction to the extent feasible. The Authority will not cut off access until a replacement well has been provided and is fully operational. It is anticipated that any replacement wells would be relocated as close as reasonably possible to the existing well. The relocated well would be functionally equivalent to the well being replaced and would not reduce the pumping capacity or diminish the water quality compared to the existing well. Any replacement wells would also be constructed in compliance with applicable regulations, including regulations by the Department of Water Resources, the State Water Resources Control Board, and the Department of Toxic Substances Control. Pursuant to HYD-IAMF#8, if replacing a well is not feasible, the Authority will identify an alternative water source for the affected property, which may include water supply wells on other properties or connecting to other water providers, to provide a water supply that is equivalent in quantity and quality to pre-existing conditions, to the extent feasible. The Authority will not cut off access until a replacement water source has been provided and is fully operational. If it is not feasible to provide a replacement well or alternative water source that is of equivalent quality and quantity, impacts to water supply wells may necessitate acquisition of the property, in which case the acquisition will occur in compliance with the Authority's Right-of-Way Manual and Uniform Relocation Assistance and Real Property Acquisition Policies Act.

CEQA Conclusion

Where the Refined SR14, SR14A, E1, and E1A Build Alternatives would cross the Hansen Spreading Grounds, new impervious surfaces within the spreading ground would potentially interfere substantially with groundwater recharge within the San Fernando Groundwater Basin. Impacts on groundwater recharge would lead to the reduction of groundwater resources over

[10] The drill and blast excavation method is one way of performing a sequential excavation method.

time. This impact would be significant for the Refined SR14, SR14A, E1, and E1A Build Alternatives. As discussed in Section 3.8.7, Mitigation Measures, HWR-MM#3 requires the Authority to provide replacement groundwater recharge areas in the vicinity of existing recharge ponds within the Hansen Spreading Grounds and to provide for no net loss in recharge area or capacity. With implementation of HWR-MM#3, rates of groundwater losses would not increase as a result of any of the six Build Alternatives. Each of the six Build Alternatives would not substantially decrease groundwater supplies or interfere substantially with groundwater recharge in a way that could impede sustainable groundwater management of the basin. Also, the six Build Alternatives would not conflict with or obstruct the implementation of a sustainable groundwater management plan. While there is no 'sustainable groundwater management plan' for ULARA, groundwater within ULARA is adjudicated, and groundwater is managed in accordance with ULARA judgement. The ULARA judgement requires safe yield operations for the ULARA groundwater basins to help ensure groundwater extractions over the long-term do not create a condition of overdraft. Basin management in ULARA is achieved by collective efforts between Court-appointed ULARA Watermaster and an Administrative Committee consisting of representatives from the Parties to the ULARA Judgment.

The Refined SR14 and SR14A Build Alternatives would include minimal surface features in a high-priority basin, the Santa Clara River Groundwater Basin East Sub-basin, but would include drainage facilities to prevent impacts on groundwater recharge. One optional adit (E1-A2) for the E1 and E1A Build Alternatives would require the construction of a utility easement within the Santa Clara River Valley East Sub-basin. Impacts from this easement would be minimal given its limited scope. Therefore, with implementation of HWR-MM#3, this impact would be less than significant with mitigation for the Refined SR14, SR14A, E1, E1A, E2, and E2A Build Alternatives.

Tunnel construction outside the ANF could result in the inflow of groundwater into tunnels where the tunnel depth may encounter the groundwater table or perched groundwater. This could lower groundwater levels locally in proximity to the tunnel alignment of each of the six Build Alternatives, which could adversely affect groundwater and wells if present nearby. HYD-IAMF#5, HYD-IAMF#6, and HYD-IAMF#7 require design features and construction methods that will address potential groundwater seepage, including the installation of tunnel linings. Because of the low-water pressures expected to be encountered, these measures would be sufficient to effectively avoid and minimize inflows into the tunnels. As such, groundwater inflow during construction, if any, would be minimal and temporary, and would not cause a substantial decrease in groundwater supplies or interfere substantially with groundwater recharge such that the Build Alternatives may impede sustainable groundwater management. Accordingly, with implementation of HWR-MM#4, this impact would be less than significant for the Refined SR14, SR14A, E1, E1A, E2, and E2A Build Alternatives.

Based on available information, it is unknown whether tunnel construction would directly impact private water supply wells, or the extend of any such impacts. However, there is the potential that tunnel construction could result in the destruction of private water supply wells if any wells are located directly in the path of the tunnels. Pursuant to HYD-IAMF#8 such impacts would be addressed, including replacement wells and other potential options to effectively minimize and avoid impacts if they occur. Accordingly, this impact would be less than significant for the Refined SR14, SR14A, E1, E1A, E2, and E2A Build Alternatives.

Impact HWR#5: ***Changes in Hydrogeologic Conditions Associated with Tunnel Construction Beneath the ANF which May Affect Surface and Subsurface Water Resources.***

This analysis evaluates the potential effects on hydrologic resources related to changes in hydrogeologic conditions caused by tunnel construction beneath the ANF. Potential effects caused by tunnel constriction outside of the ANF are analyzed in Impact HWR#4, above. Refer to Section 3.7, Biological and Aquatic Resources, for the analysis of potential effects on riparian and aquatic habitat associated with potential hydrologic changes caused by tunnel construction.

All six Build Alternatives include construction of twin side-by-side tunnels. Tunnels could provide a conduit for groundwater to seep into excavated areas as the advancing tunnel construction

All six Build Alternatives include construction of twin side-by-side tunnels. Tunnels could provide a conduit for groundwater to seep into excavated areas as the advancing tunnel construction intersects subsurface fractures and faults in bedrock that contain water. Where groundwater is present, it may under certain circumstances leak from the rock mass into the tunnels. In such cases, groundwater inflows may temporarily affect the hydrology of streams, springs, water supply wells, and other waterbodies.

The amount and duration of groundwater loss would depend on the geotechnical and hydrogeological conditions along the tunnel alignment, the tunnel construction methods used, and design features adopted to avoid and minimize inflows. Under certain conditions, temporary inflows into the tunnel during construction are likely unavoidable. Thus, temporary effects on surface and groundwater conditions are foreseeable even with the incorporation of design features and employment of construction methods intended to avoid and minimize the effects. Mitigation measures to control these effects would be implemented in response to monitoring information indicating that groundwater levels are declining (See HWR-MM#4).

The hydrogeological changes that may occur during tunnel construction would be primarily influenced by a combination of risk factors that may be encountered along the proposed tunnel alignments. As discussed in Section 3.8.5, Affected Environment, a comparative assessment between the six Build Alternatives of tunnel-related hydrologic impacts is based on a methodology that focuses on two primary risk factors: (1) the intersection of tunnels with mapped faults and (2) the groundwater pressures encountered at the depths of tunnel construction. Under the geologic conditions of the San Gabriel Mountains, the groundwater system is one of secondary porosity in the form of fractures and shears that allow storage and transmission of water through otherwise almost impermeable bedrock. Where high-pressure conditions are present in areas with sheared and fractured rock, inflow of water into the tunnels would likely be substantially more challenging to control during construction. In circumstances where water flows into the tunnel excavation, water pressures outside the tunnel would decrease and, consequently, shallower water would tend to flow downward from shallower aquifers toward the tunnel potentially affecting both water chemistry of the deeper groundwater and surface water resources connected to groundwater because of corresponding declines in groundwater pressures in the vicinity of the tunnel. As such, changes to hydrogeological conditions at depth may propagate upward and result in impacts to subsurface and surface hydrologic resources. The surface impacts may include loss or reduction in water available to streams, springs, and water supply wells. Under this analysis, the geographic relationship between surface water features to risk areas, as well as the identified level of risk for the area—No/Low Risk, Moderate Risk, or High Risk—provides the basis for comparing alignments based on areas with the likelihood that water resources would be affected by tunnel construction.

The Authority will utilize state-of-the-art design features and construction methods to avoid and minimize impacts on hydrologic resources, including through the use of TBMs equipped with specific features designed to reduce or prevent inflows and grouting and tunnel-lining approaches that have been proven effective at controlling water seepage. These measures are identified in HYD-IAMF#5, HYD-IAMF#6, and HYD-IAMF#7. In most cases, TBMs would be used to mine the tunnels. Mining of the tunnels may also include conventional mining methods, which would involve the installation of a preliminary lining concurrent with the excavation process in combination with grouting. Under the conventional approach, and as set out in HYD-IAMF#5, HYD-IAMF#6, and HYD-IAMF#7, various measures will be implemented to avoid and minimize tunnel inflows. As mentioned in Impact HWR#4, the tunnel lining system would also be important in controlling water flows both during and after construction and will consist of either a single-pass or two-pass lining system, depending on groundwater pressures. For proper implementation of this approach, a detailed site-specific geotechnical and hydrogeological characterization would be carried out for the selected preferred alternative to ensure effective control of water flow into the tunnels.

The circumstances under which these approaches would be employed would be guided by detailed site-specific geotechnical and hydrogeological characterizations that would be developed during the preconstruction phase of the project. Such studies would include geotechnical investigations along the tunnel alignment for the preferred alternative to characterize the differing rock types (strength, fracturing, in-situ stresses, etc.), groundwater pressures at tunnel depth, potential flow quantities, and structural geology, including faults and gouge zones. Additional geotechnical borings would be converted to piezometers or fitted with vibrating pressure transducers for measuring water pressure changes along the alignment to establish seasonal baseline conditions for deep groundwater and near surface water. Such instrumentation would also be used as the early warning system for pressure changes occurring in the subsurface along the alignment during tunnel construction.

Notwithstanding these measures, in High Risk Areas, which are zones associated with tunnels intersecting areas with faults and high hydrostatic pressure, groundwater inflow into the tunnels would likely occur during construction. To address this, the Authority would implement an AMMP (See HWR-MM#4). The AMMP would be implemented throughout the tunnel construction RSA. As described in Section 3.8.7, HWR-MM#4 requires that the AMMP include monitoring protocols to establish baseline conditions of surface water resources and to detect changes in groundwater conditions related to tunnel construction to ensure timely implementation of remedial measures.

The methodology adopted for this analysis reflects the challenges of assessing impacts that are likely to occur in a highly complex and mostly unknown physical setting. Under the methodology developed to assess the environmental consequences associated with tunnel construction and hydrologic resources, the extent of impacts is likely overstated for several reasons:

- Most of the Risk Areas have no documented springs or seeps within them. Some springs also occur outside of the Risk Areas and appear unrelated to the factors defining the Risk Areas.
- It is assumed in the analysis that springs occurring in the Moderate and High Risk Areas are dependent on groundwater and could be affected by tunnel construction based on their proximity to mapped faults and high groundwater pressure at the tunnel elevation. Available monitoring data suggest that all of the springs, regardless of whether they are in a Risk Area, respond seasonally to precipitation suggesting they are not sufficiently dependent on subsurface groundwater to result in impacts at the surface as a result of tunnel construction.
- For two Moderate Risk Areas (Risk Area 3 for E1/E1A and Risk Area 3 for E2/E2A), one of the primary risk factors, the presence of faults, appears to be absent from those areas. Nonetheless, under the methodology, the areas have been designated as Moderate Risk because springs are present. It is likely, however, that these springs are fed primarily by precipitation and are unlikely to have a connection to deep groundwater. Whether the springs have a connection to the deep groundwater would be determined prior to construction through monitoring and studies.

The primary risk factors and the assumptions described above, which are based on information and data regarding the hydrogeological and hydrologic conditions of the western San Gabriel Mountains developed during preliminary geotechnical investigations, professional judgement of experts in the field of hydrogeology, hydrology and tunnel construction, and case studies of tunnel construction projects, are used to evaluate the likelihood of this impact occurring in the three types of Risk Areas (see below and Table 3.8-2).

No/Low Risk Areas

No/Low Risk Areas cover all areas within 1 mile of each side of the tunnel alignments where primary factors used to designate Moderate and High Risk Areas are not present. In the absence of faults and high groundwater pressure, the implementation of HYD-IAMF#5, HYD-IAMF#6, and HYD-IAMF#7 would further ensure that impacts would be avoided.

Moderate Risk Areas

Moderate Risk Areas are within 0.5 mile of the alignment, which case studies indicate is the extent to which effects are likely to occur to subsurface and surface resources as a result of tunnel construction. The probability of groundwater depletion occurring in Moderate Risk Areas, however, would be much less than for High Risk Areas because the groundwater pressures in such areas would be at or below 25 bar or there is no fault intersecting the alignment at pressures above 25 bar. In areas where there are no mapped faults, but known springs occur within 0.5 miles of the tunnel alignment, ground pressures would have to be above 25 bar to have a moderate risk of surface impacts occurring due to inflow during tunnel construction. In addition, the design features and construction techniques described in HYD-IAMF#5, HYD-IAMF#6, and HYD-IAMF#7 that would be employed to avoid and minimize impacts are expected to be very effective because groundwater pressures in Moderate Risk Areas would be at or less than 25 bar or the tunnel alignment would not be in proximity to known faults. In particular under existing technologies, the lower hydrostatic pressure Moderate Risk Areas would allow the tunnels to be constructed using a TBM in closed face (provided pressures are 17 bar or less) and to be sealed with a single-pass liner instead of a two-pass liner. The use of a single-pass liner in areas under 25 bar of pressure would be sufficient to effectively control inflows into the tunnel excavation. For Moderate Risk Areas, the single-pass liner would establish a watertight seal as tunneling progressed such that groundwater inflow during and after construction would be *de minimis*.

High Risk Areas

High Risk Areas are designated as such because of the presence of known faults and groundwater pressures above 25 bar. Based on case studies, areas along the tunnel alignments where faults are present and under groundwater pressure above 25 bar have the highest probability for groundwater inflows into the tunnel excavations during construction, consequently potentially affecting hydrologic resources. In addition, areas with these higher groundwater pressures present technological challenges that limit the effectiveness of implementation of HYD-IAMF#5, HYD-IAMF#6, and HYD-IAMF#7 such that effects would be minimized but may not be fully avoided. For instance, because of high pressures, such areas would necessitate installation of a two-pass lining system where the capacity of the waterproofing gaskets in the first-pass lining cannot guarantee a watertight lining over the long term. During tunnel construction, groundwater inflow risk mainly occurs between boring and installation of the first pass lining. Excavation and installation of the first lining precast segments are concurrent operations with the erection of the precast segments taking place behind the cutterhead inside the TBM shield. In sections where groundwater pressures are above 25 bar, a second tunnel lining would be installed to ensure water tight tunnels over the long-term. Re-excavation grouting would provide further reinforcement against tunnel seepage. Grouting would be applied to form a permanent strengthened very low permeability circular crown around the TBM that, in conjunction with the first-pass tunnel lining, would take on the high-water pressures until a second lining is installed.

This analysis assumes that areas where each of the Build Alternative tunnel alignments intersect faults and are subject to water pressures greater than 25 bar present a considerably greater risk of water flows into the tunnel during tunnel construction compared to areas subject to 25 bar or less. Such groundwater flows into the tunnel, while not anticipated to be substantial, could reduce groundwater levels and result in adverse effects to surface water resources.

Risk Areas Refined SR14 and SR14A Build Alternatives

Four Risk Areas were identified for the Refined SR14 and SR14A tunnel alignment within the ANF. Three of the Risk Areas are Moderate Risk Areas, and one is designated as a High Risk Area. The Risk Areas are depicted in Figure 3.8-A-1 through Figure 3.8-A-2 and further described in Table 3.8-9.

- **Risk Area 1**—Risk Area 1 is a Moderate Risk Area that encompasses a zone of small faults including the Pole Canyon fault, which the alignment intersects approximately 250 feet below some branching canyons. Notwithstanding the presence of faults, because expected water pressures would be below 25 bar and no groundwater dependent resources are known within the risk area, the probability would be minimal to none that hydrologic resources would be affected.
- **Risk Area 2**—Risk Area 2 is a Moderate Risk Area. It is delineated along several unnamed faults trending subparallel and intersecting the alignment. If groundwater drained into the

tunnel, it could cause water flow parallel to the tunnel and impact local groundwater levels. The tunnels would be approximately 400 feet below-ground in Risk Area 2. Notwithstanding the presence of faults, because expected water pressures would be below 25 bar and no groundwater dependent resources are known within the Risk Area, the probability would be minimal to none that hydrologic resources would be affected.

- **Risk Area 3**—Risk Area 3 is a Moderate Risk Area that is in an area that intersects at an oblique angle with at least two faults near Sand Canyon Road. These faults are mapped as the Magic Mountain fault, possibly being a minor branch of the San Gabriel fault system. Within this Risk Area, the tunnels would be approximately 500 feet below-ground. Notwithstanding the presence of faults, because expected water pressures would be below 25 bar and no groundwater dependent resources are known within the risk area, the probability would be minimal to none that hydrologic resources would be affected.
- **Risk Area 4**—Risk Area 4 is a High Risk Area that is mapped parallel to the San Gabriel Fault zone, the alignment intersects at an oblique angle. Based on the Authority's field investigations and subsurface exploratory drilling, the main trace of the San Gabriel fault forms a gouge and crushed rock zone that is several hundred feet wide near the alignment (Authority 2019b). The depth of the tunnels below-ground ranges from approximately 1,300 to 1,500 feet. The Risk Area is approximately 0.4 miles wide to encompass subparallel fault traces of the San Gabriel fault zone as mapped. The length of this Risk Area extends to the edges of the 2-mile wide RSA. Considering the presence of faults and expected water pressures to be above 25 bar, the probability would be minimal to none that hydrologic resources would be affected because there are no known groundwater dependent water features mapped.

Table 3.8-9 Refined SR14 and SR14A Build Alternatives Risk Areas Summary

Refined SR14 Risk Areas	SR14A Risk Areas	Risk Area Rating	Groundwater Pressure Rating	Streams Present[1]	Springs Present	Known Wells Present	Alignment Length in Risk Area (mi)	Comments
Refined SR14/SR14A-1	Refined SR14/SR14A-1	Moderate	≤25 bar	0	0	0	0.4	Overlaps several small, mapped faults. Within SGMNM
Refined SR14/SR14A-2	Refined SR14/SR14A-2	Moderate	≤25 bar	0	0	0	0.3	Overlaps several small, mapped faults. Within SGMNM
Refined SR14/SR14A-3	Refined SR14/SR14A-3	Moderate	≤25 bar	0	0	0	0.5	Overlaps two branches of the Magic Mountain fault.
Refined SR14/SR14A-4	Refined SR14/SR14A-4	High	>25 bar	0	0	0	0.4	Overlaps San Gabriel fault zone including several branches.

Notes: [1] Ephemeral streams are dry stream beds that flow after periods of rainfall and as defined are not connected to groundwater resources. For the purposes of this analysis, ephemeral streams were not included in risk areas.

The Refined SR14 and SR14A alignments would cross the fewest identified risk areas compared to the other two alignments. Within those risk areas, no known seeps, springs, intermittent or perennial streams are present. As such, the Refined SR14 and SR14A Alternatives pose the least risk of hydrologic impacts occurring among the Build Alternatives. Moreover, to the extent such impacts may occur, they would likely be of less severity than the other Build Alternatives. If through further investigation additional seeps, spring, intermittent or perennial streams are discovered within the tunnel construction RSA, the risk of hydrologic impacts may increase accordingly. As noted above, implementation of HYD-IAMF#5, HYD-IAMF#6, and HYD-IAMF#7 would minimize the severity and duration of groundwater inflow during tunnel construction, but groundwater inflow into the tunnel excavations may still occur. Implementation of the Water Resources AMMP set forth in HWR-MM#4 would minimize impacts that occur and, if necessary, provide compensatory mitigation for unavoidable impacts to surface aquatic resources.

Risk Areas E1 and E1A Build Alternatives

Two High Risk and four Moderate Risk Areas are delineated along the E1/E1A alignment and summarized in Table 3.8-10. These are numbered on Figure 3.8-A-4 through Figure 3.8-A-9 from 1 through 6. Risk Area E1/E1A/E2/E2A-1 is common for the E1, E1A, E2, and E2A alignments because the alignments converge under this Risk Area. The other Risk Areas along the E1 and E1A alignments are designated as E1/E1A-2 through 6 from north to south.

- **Risk Area 1**—Risk Area 1 is a Moderate Risk Area that is along an unnamed fault that the alignment intersects at an acute angle. The Risk Area is shown to extend sub parallel along the alignment between two canyons. The tunnels would be approximately 250 feet below-ground. Notwithstanding the presence of faults, because expected water pressures would be below 25 bar and no groundwater dependent resources are known within the risk area, the probability would be minimal to none that hydrologic resources would be affected.
- **Risk Area 2**—Risk Area 2 is a High Risk Area that intersects the Lonetree fault at an acute angle to the alignment and extends for approximately 1 mile in either direction away from the alignment. The tunnels vary in depth below-ground from 1,400 feet to 1,700 feet. The fault traverses four large drainages that drain into Pacoima Canyon. The hydrologic feature that is known to be present in Risk Area 2 is one intermittent stream (Spring Creek). Because of the presence of a fault and water pressures likely to be above 25 bar, there is a high probability that surface and subsurface hydrologic resources within this risk area would be adversely affected.
- **Risk Area 3**—Risk Area 3 is a Moderate Risk Area that encompasses two mapped hydrologic features (spring #27685584 and well #27688594) in Pacoima Canyon and one of its tributaries. There is no apparent geologic cause for the features to be where they are, but both are within 0.5 mile of the tunnel alignment. Hydraulic feature #27688594 is a well rather than a spring. Spring #276885584 is used as one of the springs currently in the monitoring network. The proximity of the spring and well to the planned tunnel is the basis for the Moderate Risk Area designation. Without a mapped fault, the hydraulic connection of the spring and well to deep groundwater where the tunnel is planned, 600 to 800 below the spring elevations, is uncertain. If impacts on groundwater at the tunnel elevation could propagate to the ground surface, the spring flows and well could be impacted. The hydrologic features present in Risk Area 3 are one spring, one inactive well, and one intermittent stream. Notwithstanding the absence of mapped faults in this area, because water pressures are anticipated to be above 25 bar and a spring is present within this risk area, there is a moderate probability that impacts on hydrologic resources would occur.
- **Risk Area 4**—Risk Area 4 is a High Risk Area that is associated with the San Gabriel fault zone, which is composed of many individual fault traces. Risk Area 4 encompasses the main trace of the San Gabriel fault zone, which the alignment intersects approximately 500 feet below-ground where Pacoima Canyon crosses over the alignment. Although water pressures are not expected to be in the range of 25 bar at Pacoima Canyon, the terrain rises rapidly and water pressures above 25 bar are expected to be present along Risk Area 4 away from the canyon. The extensive shearing and fracturing of rock along the San Gabriel fault are

expected to have the potential to yield large volumes of water when encountered by the tunnels, which could substantially affect the groundwater levels above the tunnel. The length of Risk Area 4 extends to the edges of the 2-mile-wide RSA. The hydrologic feature present in Risk Area 4 is one intermittent/perennial stream (Little Tujunga Canyon). Because of the presence of a fault, water pressures are likely to be above 25 bar, and the presence of an intermittent/perennial stream, there is a high probability that surface and subsurface hydrologic resources within this risk area would be adversely affected.

- **Risk Area 5**—Risk Area 5 is a Moderate Risk Area that is adjacent to and trends into Risk Area 4 before intersecting the tunnels. This area is expected to be secondary to Risk Area 4 along the main San Gabriel fault. The known hydrologic feature present in Risk Area 5 is one perennial stream. Notwithstanding that water pressures are likely to be above 25 bar within this risk area, with Risk Area 5 not intersecting the tunnel alignment, there is a moderate probability that the perennial stream and subsurface hydrologic resources would be adversely affected.
- **Risk Area 6**—Risk Area 6 is a Moderate Risk Area that includes the area where the alignment intersects the Sierra Madre fault zone at the south edge of the San Gabriel Mountains. The intersection of the fault zone with the alignment is in an area of relatively low topography outside of the zone with greater than 25 bar pressure. Notwithstanding the presence of faults in the risk area, because expected water pressures would be at or below 25 bar where the fault intersects the alignment and no groundwater dependent resources are known within the risk area, the probability would be minimal to none that hydrologic resources would be affected.

Table 3.8-10 E1 and E1A Build Alternatives Risk Areas Summary

E1 Risk Areas	E1A Risk Areas	Risk Area Rating	Groundwater Pressure Rating	Streams Present[2]	Springs Present	Known Wells Present	Alignment Length in Risk Area (mi)	Comments
E1/E1A/E2/E2A-1[1]	E1/E1A/E2/E2A-1[1]	Moderate	≤25 bar	0	0	0	0.8	Overlaps one mapped fault intersecting tunnel. Within SGMNM
E1/E1A-2	E1/E1A-2	High	>25 bar	1 Intermittent	0	0	1.0	Overlaps Lonetree fault intersecting tunnels.
E1/E1A-3	E1/E1A-3	Moderate	>25 bar	1 Intermittent	1	1	0.25	Overlaps two springs within one-0.5 mile of tunnel. One spring is along Pacoima Canyon and the second is in a tributary. One active well is associated with the spring in the tributary.
E1/E1A-4	E1/E1A-4	High	>25 bar	1 Intermittent/ Perennial	0	0	0.25	Overlaps San Gabriel fault zone including several branches.
E1/E1A-5	E1/E1A-5	Moderate	≤25 bar	1 Perennial	0	0	0.0	Overlaps several branches of San Gabriel fault zone that do not directly intersect the tunnel.
E1/E1A-6	E1/E1A-6	Moderate	≤25 bar	0	0	0	0.0	Overlaps northern branch of the Sierra Madre fault that intersect the tunnels in the less than 25 bar pressure zone.

Notes: [1] At this location, E1 and E1A, and E2 and E2A share the same Risk Area so the numbering lists both alignment designations.
[2] Ephemeral streams are dry stream beds that flow after periods of rainfall and as defined are not connected to groundwater resources. For the purposes of this analysis, ephemeral streams were not included in risk areas.

The E1 and E1A Build Alternatives would traverse two High Risk and four Moderate Risk areas. There are six springs located within 1 mile of the tunnel alignment. As such the E1 and E1A alternatives would pose substantially higher risk of hydrologic impacts occurring when compared to the Refined SR14 and SR14A alternatives and similar risk of hydrologic impacts occurring when compared to the E2 and E2A alternatives. Moreover, to the extent such impacts may occur, they would likely be more severe than the Refined SR14/SR14A alternatives and similar to the E2/E2A alternatives. As noted above, implementation of HYD-IAMF#5, HYD-IAMF#6, and HYD-IAMF#7 would minimize the severity and duration of groundwater inflow during tunnel construction, but groundwater inflow into the tunnel excavations may still occur. Implementation of the Water Resources AMMP set forth in HWR-MM#4 would minimize impacts that occur and, if necessary, provide compensatory mitigation for unavoidable impacts to surface aquatic resources.

Risk Areas E2 and E2A Build Alternatives

Six High Risk and five Moderate Risk Areas are delineated along the E2 and E2A alignment as summarized in Table 3.8-11. These are numbered on Figure 3.8-A-10 through Figure 3.8-A-15 from Risk Areas 1 through 6. Risk Area 1 is common for the E1, E1A, E2, and E2A alignments, because they share the same alignment in this risk area. The other risk areas along E2 and E2A are designated as Risk Areas 2 through 11 from north to south.

- **Risk Area 1**—Risk Area 1 is a Moderate Risk Area that is along an unnamed fault that the alignment intersects at an acute angle. The Risk Area extends sub-parallel along the alignment between two canyons. The tunnels would be approximately 250 feet below-ground. Notwithstanding the presence of faults, because expected water pressures would be below 25 bar and no groundwater dependent resources are known within the risk area, the probability would be minimal to none that hydrologic resources would be affected.
- **Risk Area 2**—Risk Area 2 is a High Risk Area that is designated along an acute intersection of the Transmission Line fault with the tunnel alignment at a depth of 1,200 feet below-ground. The Risk Area is mapped parallel to the fault extending 1 mile into the water pressure zone above 25 bar and a 0.5 mile from the fault into the water pressure zone lower than 25 bar. With the combination of the fault intersecting the tunnel alignment in the water pressure zone above 25 bar, there is a substantial risk of impacts on groundwater levels. Notwithstanding the presence of a fault and expected water pressures above 25 bar, because there are no known groundwater dependent features present, the probability would be minimal to none that hydrologic resources would be affected.
- **Risk Area 3**—Risk Area 3 is a Moderate Risk Area that is identified as such because of the presence of a single spring that is within a 0.5 mile of the alignment. There is no known fault to explain the spring (#27107113) location and no other information is available regarding its source. Notwithstanding the absence of mapped faults in this area because water pressures are anticipated to be above 25 bar and a spring is present within this risk area, there is a moderate probability that impacts on hydrologic resources would occur.
- **Risk Area 4**—Risk Area 4 is a High Risk Area that is located where the alignment intersects faults or is in close proximity to faults. This Risk Area is mapped adjacent to the Transmission Line fault which trends parallel to the alignment. Smaller conjugate and branch faults intersecting the alignment are included in the Risk Area along with part of the Transmission Line fault. The depth of the tunnel is approximately 1,300 feet below-ground. Intersecting conjugate faults also may tap into a wider range of groundwater with multiple flow paths to reach the tunnels during construction. With the combination of branch and conjugate faults intersecting the tunnel and groundwater pressures exceeding 25 bar, this area is rated as high risk for impacts on the groundwater system occurring at the tunnel elevation and propagating upward and affecting surface water resources. The only known hydrologic feature in this Risk Area is one intermittent stream. Because of the presence of a fault, water pressures likely to be above 25 bar, and the presence of an intermittent stream, there is a high probability that surface and subsurface hydrologic resources within this Risk Area would be adversely affected.

- **Risk Area 5**—Risk Area 5 is a High Risk Area that is mapped where the alignment intersects several smaller faults at a depth exceeding 2,000 feet below-ground. Intersecting conjugate faults also may tap into a wider range of groundwater with multiple flow paths to reach the tunnels during construction. With the combination of branch and conjugate faults intersecting the tunnel and groundwater pressures above 25 bar, this area is rated as high risk for impacts on the groundwater system occurring at the tunnel elevation and propagating upward. Notwithstanding the presence of faults and expected water pressures to be at or above 25 bar, the probability would be minimal to none that hydrologic resources would be affected because there are no known groundwater dependent water features present.
- **Risk Area 6, 7 and 8**—Risk Areas 6, 7 and 8 are High Risk Areas. These three High Risk Areas are grouped around significant fault traces of the San Gabriel fault zone that the tunnel alignment intersects. Being associated with the many fault traces (a zone almost 1 mile in width) of San Gabriel fault along the alignment will expose the tunneling to frequent opportunities for water to flow into the tunnels under water pressures that are above 25 bar. Each fault and very likely broad zones of crushed, sheared and fracture rock between the mapped faults could store large amounts of groundwater and release that water when the tunnel is being excavated. The known hydrologic features in Risk Area 6 are two springs (#27688582 and #27688580) and one intermittent stream. In Risk Area 7, one spring (#27688576) and two intermittent streams are present, and in Risk Area 8, one spring (#27688640), two intermittent streams, and one active well are present. Because of the presence of a fault, water pressures likely to be above 25 bar, and the presence of a springs, intermittent stream and a well, there is a high probability that surface and subsurface hydrologic resources within this Risk Area would be adversely affected.
- **Risk Area 9 and 10**—Risk Areas 9 and 10 are Moderate Risk Areas that also are grouped around significant fault traces of the San Gabriel fault zone that the tunnel alignment intersects. The known hydrologic feature that could be impacted in Risk Area 9 is one intermittent stream. The known hydrologic feature that could be impacted in Risk Area 10 is one intermittent stream. Notwithstanding that water pressures are likely to be below 25 bar within this Risk Area, with the presence of a fault and an intermittent stream, there is a moderate probability that the intermittent stream and subsurface hydrologic resources would be adversely affected.
- **Risk Area 11**—Risk Area 11 is a Moderate Risk Area that is located along part of the Sierra Madre fault system, which is a complex fault zone with many branches and cross-cutting faults within the water pressure zone with less than 25 bar. The known hydrologic feature that could be impacted in Risk Area 11 is one spring. Notwithstanding that water pressures are likely to be below 25 bar within this Risk Area, with the presence of a fault and a spring, there is a moderate probability that the spring and subsurface hydrologic resources would be adversely affected.

Table 3.8-11 E2 and E2A Build Alternatives Risk Areas Summary

E2 Risk Areas	E2A Risk Areas	Risk Area Rating	Groundwater Pressure Rating	Streams Intersected[1]	Springs Present	Known Wells Present	Alignment Length in Risk Area (mi)	Comments
E1/E1A/E2/E2A-1*	E1/E1A/E2/E2A-1*	Moderate	≤25 bar	0	0	0	0.8	Overlaps one mapped fault intersecting tunnels. Within SGMNM
E2/E2A-2	E2/E2A-2	High	>25 bar	0	0	0	1.3	Overlaps Transmission Line fault intersecting tunnels. Overlaps SGMNM
E2/E2A-3	E2/E2A-3	Moderate	>25 bar	0	1	0	0.0	Spring along stream within 0.5 miles of tunnels. Within SGMNM
E2/E2A-4	E2/E2A-4	High	>25 bar	1 Intermittent	0	0	0.8	Overlaps branches of Transmission Line fault intersecting tunnels.
E2/E2A-5	E2/E2A-5	High	>25 bar	0	0	0	0.9	Overlaps several branches of San Gabriel fault zone intersecting tunnels.
E2/E2A-6	E2/E2A-6	High	>25 bar	1 Intermittent	2	0	0.375	Overlaps branch of San Gabriel fault zone intersecting tunnels. Two springs associated with fault.
E2/E2A-7	E2/E2A-7	High	>25 bar	2 Intermittent	1	0	0.3	Overlaps main branch of San Gabriel fault zone intersecting tunnels. One spring associated with fault.
E2/E2A-8	E2/E2A-8	High	>25 bar	2 Intermittent	1	1	0.25	Overlaps main branch of San Gabriel fault zone intersecting tunnels. One spring associated with fault and one active well associated with spring.

E2 Risk Areas	E2A Risk Areas	Risk Area Rating	Groundwater Pressure Rating	Streams Intersected[1]	Springs Present	Known Wells Present	Alignment Length in Risk Area (mi)	Comments
E2/E2A-9	E2/E2A-9	Moderate	≤25 bar	1 Intermittent	0	0	0.125	Overlaps main branch of San Gabriel fault zone intersecting tunnels in less than 25 bar pressure zone.
E2/E2A-10	E2/E2A-10	Moderate	≤25 bar	1 Intermittent	0	0	0.0	Overlaps main branch of San Gabriel fault zone intersecting tunnels in less than 25 bar pressure zone.
E2/E2A-11	E2/E2A-11	Moderate	≤25 bar	0	1	0	0.375	Overlaps several branches of the Sierra Madre fault that intersect the tunnels in the less than 25 bar pressure zone. One spring along fault trace.

* At this location, E1/E1A and E2/E2A share the same Risk Area so the numbering lists both alignment designations.
[1] Ephemeral streams are dry stream beds that flow after periods of rainfall and as defined are not connected to groundwater resources. For the purposes of this analysis, ephemeral streams were not included in risk areas.

The E2 and E2A Build Alternative alignments traverse the greatest number of Moderate and High Risk areas, and have the greatest length of tunnel in water pressure zones above 25 bar. As such the E2 and E2A alternatives would pose the highest risk of hydrologic impacts occurring when compared to the other Build Alternatives. Moreover, to the extent such impacts may occur, they would likely be more severe than the Refined SR14/SR14A alternatives and similar to the E1/E1A alternatives. As noted above, implementation of HYD-IAMF#5, HYD-IAMF#6, and HYD-IAMF#7 would minimize the severity and duration of groundwater inflow during tunnel construction, but groundwater inflow into the tunnel excavations may still occur. Implementation of the Water Resources AMMP set forth in HWR-MM#4 would minimize impacts that occur and, if necessary, provide compensatory mitigation for unavoidable impacts to surface aquatic resources.

Comparison of Hydrogeological Risks Among All Six Build Alternatives

Table 3.8-12 compares the hydrogeology and hydrology risk conditions along the Build Alternatives alignments in the ANF including areas within the SGMNM. The table summarizes the numbers of Moderate and High Risk Areas, and the number of known springs, stream, and wells within these Risk Areas, for each of the Build Alternative alignments. The E2 and E2A Build Alternative alignments traverse the greatest number of Moderate and High Risk Areas, and have the largest number of springs, streams, and wells within these designated Risk Areas. The E1 and E1A Build Alternative alignments have the next greatest number of Moderate and High Risk Areas and the second greatest number of springs, streams, and wells within these designated Risk Areas. The Refined SR14 and SR14A Build Alternatives alignments intersect the fewest Moderate and High Risk Areas. Further, the Refined SR14 and SR14A Build Alternative alignments have the fewest springs, streams, and wells within Moderate and High Risk Areas, as shown in Table 3.8-12.

Table 3.8-12 Build Alternatives Hydrogeology and Hydrology Risks Summary

Impacts	Refined SR14	SR14A	E1	E1A	E2	E2A
Number of Moderate Risk Areas	3	3	4	4	5	5
Number of High Risk Areas	1	1	2	2	6	6
Length (miles) of Tunnel in Groundwater Pressure above 25 bar	1.6	1.6	6.9	6.9	6.6	6.6
Length (miles) of Tunnel in Groundwater Pressure at or below 25 bar	5.6	5.6	10.9	10.9	11.3	11.3
Length of Tunnel Traversing Moderate and High Risk Areas (miles)	1.6	1.6	2.3	2.3	5.2	5.2
Number of Perennial Streams in Moderate Areas	0	0	1	1	0	0
Number of Perennial Streams in High Risk Areas	0	0	1	1	0	0
Number of Intermittent Streams in Moderate Risk Areas	0	0	1	1	2	2
Number of Intermittent Streams in High Risk Areas	0	0	1	1	6	6
Number of Mapped Faults Intersected	15	15	7	7	20	20
Known Springs Present in Risk Areas	0	0	1	1	6	6
Streams Present in Risk Areas[1,2]	11	11	22	22	39	39
Known Active Wells Present in Risk Areas	0	0	1	1	1	1

[1] Streams include intermittent and perennial streams.
[2] Ephemeral streams are dry stream beds that flow after periods of rainfall and as defined are not connected to groundwater resources. For the purposes of this analysis, ephemeral streams were not included in risk areas.

CEQA Conclusion

The CEQA threshold of significance for groundwater impacts is whether the project would substantially decrease groundwater supplies or interfere substantially with groundwater recharge such that the project may impede sustainable groundwater recharge in the basin. This analysis also considers whether changes in groundwater conditions caused by project construction would result in impacts to surface water resources, including seeps, springs, and streams.

While project construction could temporarily affect groundwater conditions in High Risk Areas, this effect would not interfere substantially with groundwater recharge such that the project may impede sustainable groundwater recharge in a groundwater basin. The groundwater that would be encountered during tunnel construction would be isolated and within fractured rock strata and is classified as an aquitard, in that the low permeability and low porosity of the aquitard retards water traveling between groundwater basins separated by bedrock mountains. Potentially effected groundwater would affect smaller, liminal aquitards, but would not affect groundwater recharge in a basin.

The inflow of groundwater into the tunnels during and after construction if not properly controlled could lower groundwater pressures in proximity to the tunnel alignment, which could adversely affect hydrologic conditions for groundwater dependent resources such as springs, streams, and wells. HYD-IAMF#5, HYD-IAMF#6, and HYD-IAMF#7 commit the Authority to incorporate certain design features and construction methods into the Project that would avoid or minimize the potential for groundwater to seep into the tunnel during construction. However, it is expected that groundwater inflow would occur under certain circumstances, most likely in areas of the Build Alternatives identified as High Risk Areas. These areas were identified as High Risk because of the presence of faults and high groundwater pressures at the intersection with the tunnel alignments. Conditions would be expected to begin to return to normal once the tunnel lining has been installed. However, effects on groundwater could persist and could vary from several days to months or even up to several years after construction (Berg 2012).

While the inflow of groundwater into tunnels beneath the ANF is not considered a significant impact under CEQA, this inflow could result in lower groundwater pressures which could potentially impact surface water features (e.g., seeps, springs, intermittent and perennial streams) and water levels in wells that are connected to groundwater resources. Impacts to these surface features (including wells) could be significant and could occur under any of the six Build Alternatives. However, the level of risk and impact potential varies considerably. The Refined SR14 and SR14A Build Alternatives, as compared to the other Build Alternatives, would have the lowest potential risk and lowest potential impacts on surface resources (see Table 3.8-12), because the alignments traverse areas with lower groundwater pressures and no known groundwater dependent resources within the identified Risk Areas. The E2 and E2A Build Alternatives would have the highest risk and highest potential impacts on hydrologic resources when compared to the other Build Alternatives because of the comparatively higher groundwater pressures and greater prevalence of springs and streams within the identified Risk Areas.

To address impacts to surface water resources and wells, the Authority would implement an AMMP, described in Appendix 3.8-C. As described in Section 3.8.7, Mitigation Measures, HWR-MM#4, the AMMP includes monitoring protocols to establish baseline conditions for surface water resources and to allow for the detection of changes in groundwater conditions related to tunnel construction to ensure timely implementation of remedial measures. The monitoring program would continue for up to 10 years after the completion of construction. The AMMP also includes provisions for augmenting water supplies for surface water resources and wells and establishes performance standards that the remedial actions must achieve to approximately match baseline conditions. The sources and means of conveyance of such water supplies are discussed in Appendix 3.8-D. The AMMP also includes actions to restore affected resources and, if necessary, to provide compensatory mitigation for affected water resource if effects cannot be arrested or substantially reduced through other response actions. As a result, HWR-MM#4 would effectively mitigate or offset impacts to affected water resources. With implementation of HWR-MM#4, the impact of the Refined SR14, SR14A, E1, E1A, E2, and E2A Build Alternatives on surface water resources would be reduced to less than significant level with mitigation.

Operations Impacts

Impact HWR#6: ***Project Operation Effects on Water.***

Throughout the lifetime of the Palmdale to Burbank Project Section, trackway, ancillary facilities, and station sites could generate small quantities of pollutants, including sediment, trash and debris, oil, grease, and maintenance-related chemicals. The Palmdale to Burbank Project Section station would generate the most pollutants, such as trash and debris and would be minimal at other ancillary facilities along the selected Build Alternative alignment. Also, an increase in impervious surface area would increase the total amount of pollutants in stormwater runoff. The main source of pollutants would be from parking lots associated with the stations and would include heavy metals, organic compounds, trash and debris, oil and grease, nutrients, pesticides, and sediments. Water quality would be permanently affected if pollutants accumulated on permanent facilities and became dispersed into nearby surface waters during operations of the Palmdale to Burbank Project Section. Surface waters that occur along the six Build Alternatives are depicted on Figure 3.8-A-25 through Figure 3.8-A-96. With respect to the pollutants on the 303(d) list, certain contaminants have the potential to bioaccumulate within the aquatic environment or stimulate the growth of microbes (e.g., algae), resulting in adverse effects on aquatic life. The discharge of pollutants into surface waterbodies is not likely to cause a violation of the water quality objectives for bioaccumulation and biostimulatory substances. Considering that the Project would implement treatment BMPs to reduce the quantity and improve the quality of stormwater runoff prior to discharge to surface waters, the Palmdale to Burbank Project Section would not contribute to the relevant 303(d) contaminants coliform bacteria or ammonia because neither pollutant is associated with HSR construction or operations activities.

Trash and chemicals could accumulate in the permanent footprint and on impervious surfaces associated with new roadways, viaducts, and access roads. Storm events could disperse pollutants from permanent footprint features and impervious surfaces into adjacent surface waters. Most of these new impervious surfaces would be located along the Santa Clara River; other portions of the Palmdale to Burbank area are already urbanized and thus characterized by impervious surfaces.

Operations of the California HSR System would increase the amount of the pollutants associated with rail operations. Specifically, dust generated by braking would be continuously generated and released by trains. Brake dust consists of particulate metals (primarily iron), but may also include copper, silicon, calcium, manganese, chromium, and barium. Although brake dust consists primarily of particulate metals, some of these metals could become dissolved in rainwater. Although brake dust would be released into the environment during operations, the electric trains would use regenerative braking technology, resulting in reduced physical braking and associated wear compared to conventional petroleum-fueled trains. Brake dust would not be generated in equal amounts throughout the HSR alignment. The primary locations where brake dust would be generated are areas where the trains must reduce their travel speed, such as approaches to stations, turns, and elevation changes (primarily descents). Long stretches of flat terrain with a straight rail alignment would generate less brake dust than other areas. In addition, brake dust is generally anticipated to be retained in track ballast.

In consideration of the potential for brake-pad particles to be conveyed to surface waters during rain events, the contractor shall prepare a stormwater management and treatment plan for review and approval by the Authority (HYD-IAMF#1). The plan would include post-construction BMPs and low-impact development techniques to reduce the quantity and improve the quality of stormwater runoff before runoff is discharged into a surface waterbody. These potential treatment BMPs would be capable of reducing particulate and dissolved metal concentrations in runoff. Post-construction BMPs would minimize continuous impacts from brake dust deposited on impervious surfaces by capturing runoff and improving the quality of runoff prior to discharge into waterbodies. Along at grade, cut, and fill sections of the HSR alignment, brake dust is generally anticipated to be retained in track ballast. Accordingly, post-construction BMPs would minimize continuous impacts from brake dust deposited on impervious surfaces by capturing and improving the quality of runoff prior to discharge into waterbodies.

Although not quantifiable at this time, the amount of brake dust that could be discharged into surface waterbodies is not anticipated to be sufficient to substantially alter water quality because the electric trains would use regenerative braking technology to reduce brake pad wear and the amount of potential metal particles deposited within the track right-of-way. The project would minimize water quality impacts from brake dust to the maximum extent practicable using the best available technology.

Direct water quality impacts related to erosion and sedimentation would be unlikely during operations of the Build Alternatives because exposed soils would be protected by BMPs implemented during the construction period. However, stormwater generated by the Build Alternatives' impervious surfaces located near surface waters could cause sedimentation from erosion from the surrounding upland areas throughout the lifetime of the Palmdale to Burbank Project Section.

As stated above, permanent treatment BMPs would be incorporated into the design of the Build Alternatives to reduce pollutants in stormwater, thereby reducing water quality impacts. HYD-IAMF#1 will require on-site stormwater management facilities to capture runoff from pollutant-generating surfaces, including station areas, access roads, new road overpasses and underpasses, reconstructed interchanges, and new or relocated roads and highways. Potentially contaminated runoff from surfaces associated with the Build Alternatives would be captured and treated in these stormwater management facilities prior to discharge of the treated water. Because pollutants would be generated in small quantities and BMPs would be implemented to minimize the discharge of these pollutants to receiving waters, the potential for introducing new sources of polluted runoff would be minor throughout the lifetime of the Palmdale to Burbank Project Section.

In areas with high groundwater, seepage of uncontained chemical spills could result in direct impacts on groundwater basins. The magnitude of impacts associated with a release or spill would vary depending on the distance of the spill from surface water features, the total volume of materials, soil permeability, physiological features of the location, and climatic conditions at the time of the release. As discussed in Section 3.10, HMW-IAMF#9 will minimize the hazardous materials selected for use throughout HSR operations and maintenance, and HMW-IAMF#10 will implement hazardous materials plans to provide for the correct handling of hazardous materials throughout operations and maintenance activities.

Improper use or storage of chemicals for routine cleaning and maintenance could result in water quality degradation. As outlined in HYD-IAMF#4, requirements of the Industrial NPDES Permit as maintenance activities would require the discharge of water for uses such as washing trains and equipment. Coverage under this permit will require the preparation of a site-specific Industrial SWPPP and annual monitoring and reporting. The Industrial SWPPP would implement measures to minimize runoff and promote on-site infiltration and/or retention basins, reducing hydrological impacts.

CEQA Conclusion

Per HMW-IAMF#9 and HMW-IAMF#10, the Authority will prepare hazardous materials monitoring plans and would, to the extent feasible, limit the use of hazardous substances utilized during operations. HYD-IAMF#1 and HYD-IAMF#4 will provide the control and treatment of stormwater runoff throughout operations of the Palmdale to Burbank Project Section, prior to discharge. With implementation of these IAMFs, operations of each of the six Build Alternatives would not violate water quality standards or WDRs or otherwise substantially degrade surface or groundwater quality. Also, operations of the Build Alternatives would not conflict with or obstruct the implementation of a water quality control plan. This impact would be less than significant for the Refined SR14, SR14A, E1, E1A, E2 and E2A Build Alternatives. Therefore, CEQA does not require mitigation.

3.8.7 Mitigation Measures

The following mitigation measures specific to Palmdale to Burbank Project Section would be implemented to reduce adverse impacts resulting from construction and operations of each of the six Build Alternatives.

HWR-MM#1: Minimize Construction-period Water Quality Impacts Associated with Tunnel Construction

Prior to construction start, the Authority will establish the baseline groundwater condition in existing private water wells within the tunnel construction RSA by collecting samples for analytical laboratory testing. These initial samples shall be collected quarterly for at least one year before construction start to account for any seasonal variation in groundwater chemistry. During tunnel construction, the samples shall be collected on a monthly to quarterly basis, depending on the tunnel construction schedule. The frequency of sample collection and the number of sampled wells shall be determined by the Authority before construction start and after consultation with property owners whose wells are within the RSA. Before and during construction, all respective water well owners shall be offered the opportunity to be present while samples are collected from their private water wells. Split samples will be collected by the Authority from identified private water wells and submitted to laboratories for analysis of regulated constituents including Title 22 metals (i.e., mercury, antimony, arsenic, barium, beryllium, cadmium, total chromium, cobalt, copper, iron, lead, manganese, molybdenum, nickel, selenium, silver, thallium, vanadium, and zinc) and any secondary geochemical parameters (i.e., pH, total hardness, calcium, magnesium, sodium, potassium, total alkalinity, hydroxide, carbonate, bicarbonate, chloride, sulfate, nitrate as nitrogen [N], fluoride, and nitrite as N) that the Authority determines to be appropriate after consultation with affected well owners. Split sampling consists of a single sample that is divided into two separate sub-samples for laboratory testing to determine the precision of laboratory results.

If during tunnel construction, changes to the referenced constituents are detected and those changes exceed normal variations observed during baseline conditions, the Authority would notify the Regional Water Quality Control Board (RWQCB) of the detected changes and seek the RWQCB's approval for a plan to avoid or minimize the risk that changes to the groundwater would exceed applicable state and federal water quality standards in the existing private water wells. Avoidance or mitigation measures that may be undertaken could include: groundwater barriers designed and monitored to prevent further mobilization of changes, groundwater monitoring and treatment procedures to assess the extent of changes and potential causes. Before construction start, the Authority will consult with private well owners and the RWQCB on its proposed monitoring plan as well as any proposed measures to be taken in the event changes are detected during monitoring. The Authority's plan will include measures to ensure that changes, if they occur, will not exceed applicable federal and state water quality standards.

HWR-MM#2: Minimize Impacts Associated with Construction in Floodplains Due to Permanent Structures Located within the SFHAs During Construction

The Authority will implement the following measures to reduce impacts on SFHAs:

- Restore the floodplain to its prior operation in instances where floodplains would be affected by construction within 1 year of completing construction at each affected location. This would include grading to restore preconstruction contours and revegetation with appropriate native species.
- Avoid placement of facilities in the floodplain or raise the ground with fill above the base flood elevation to the extent practicable.
- Use construction methods and facilities to avoid or minimize potential encroachments onto surface water resources.

HWR-MM#3: Compensation for Impacts on Hansen Spreading Grounds

For the Refined SR14, SR14A, E1, E1A Build Alternatives the reduction in the area and capacity of the Hansen Spreading Grounds would be mitigated as listed below or by an equally effective option to compensate for loss in recharge area and capacity.

The Authority would provide replacement groundwater recharge areas to compensate for the HSR footprint within the Hansen Spreading Grounds and to ensure no net loss in recharge area or capacity. New recharge areas would be placed in the vicinity of existing recharge ponds.

HWR-MM#4: Implement a Water Resources Adaptive Management and Monitoring Plan Including Compensatory Mitigation Measures as Necessary

The Authority will implement an AMMP to detect adverse changes in surface and subsurface conditions within the ANF that could occur during and after construction of the HSR tunnels including the construction of associated adits. The actions described in this mitigation measure would provide for timely detection of hydrological changes and, if necessary, appropriate remediation. Monitoring would ensure the effectiveness of the measures and determine if additional action would be required. Additionally, monitoring activities would continue for a period of 10 years after completion of the Palmdale to Burbank Project Section. If impacts persist after this period, monitoring would continue, as necessary. Overall, the purpose of the AMMP is to:

- Establish baseline groundwater and surface water hydrologic conditions within the tunnel construction RSA with data collection and in situ monitoring devices.
- Develop a monitoring program to detect real-time changes in groundwater and surface water conditions during and after construction through comparisons to baseline conditions and evaluation of paired reference sites.
- Establish numeric triggers, such as groundwater flow rate into the tunnel and groundwater levels, which would indicate that certain adaptive management measures are required to avoid or reduce impacts on groundwater and surface water resources during construction. Adaptive management measures may include providing supplemental water to affected surface water resources and other feasible measures to substantially maintain surface water resource conditions during and after construction, such as stream flows documented during preconstruction, to avoid or minimize desiccation of known springs and streams and disruptions to private water supplies. Groundwater losses that are unaccounted for could create a loss of available groundwater to the surrounding habitat, springs, or domestic wells. Collection of data regarding tunnel outflows and groundwater levels would be collected daily.
- Generate quarterly and annual reports to keep state and federal resource agencies apprised of groundwater and surface water conditions before, during, and after construction.

Baseline Inventory and Monitoring of Groundwater and Surface Water Resources

The Authority will establish baseline hydrologic conditions within the tunnel construction RSA through data collection and monitoring. The baseline inventory would include surveys and maps that identify the surface water resources within the RSA. Baseline surveys would generate information sufficient to characterize potential surface water and groundwater resources within the RSA.

Construction Monitoring

The Authority will designate locations within the tunnel construction RSA for monitoring springs, streams, and wells. The purpose of this monitoring is to capture nearly real-time changes in groundwater conditions (e.g., flow, pressure readings) that might be related to tunneling activities. Monitoring data collected during construction would be compared to baseline data collected during preconstruction monitoring and with paired reference sites that would not be affected by groundwater drawdown. The monitoring plan would include a schedule for monitoring activities that reflects periods when effects are most likely to occur at specific locations (e.g., when tunneling is nearing Moderate and High Risk Areas). The monitoring plan would account for a potential delay between groundwater drawdown associated with tunneling and the appearance of surface water effects. After construction, a substantial baseline monitoring system would be conducted to evaluate the recovery of water resources through datasets, and results would be compared to construction and preconstruction data to identify hydrogeological changes. The monitoring plan would include monitoring of inflow into the tunnels and would be quantified through use of 3-D surface and groundwater modeling programs to help predict rates of recovery for water resources affected during construction.

Post-Construction Monitoring

After construction, additional monitoring activities would be conducted to evaluate the recovery of water resources. The post-construction monitoring program would be modified to focus on areas where construction monitoring documented water resource effects caused by tunnel construction. The post-construction monitoring would continue for 10 years, or longer if required, until such time that conditions are comparable to the range of baseline conditions that existed before construction. Over time, groundwater resources would recover from losses sustained during construction through recharge by natural precipitation. Such recharge may take months to years after the tunnel lining system is installed (Berg 2012).

Response Actions

Springs and Streams Impacts

The Authority will prepare contingency plans to provide supplemental water as necessary to support springs and streams determined through modeling and monitoring to be adversely affected by groundwater reductions. Seasonal variation as documented during the preconstruction baseline monitoring would be considered in establishing the amount of supplemental water sufficient to offset the impact. For all features, supplemental water would provide minimum flows and periods of inundation to match baseline conditions. The periods in which supplemental water would be provided, in general, would likely reflect the period in which baseflows occur, which is late spring, summer, and early fall outside of rain periods, but could vary between different types of springs and streams. The measures to address impacts on riparian/aquatic vegetation, wildlife breeding cycles, aquatic wildlife, or protected tree health are provided in Mitigation Measure BIO-MM#93 in Section 3.7, Biological and Aquatic Resources.

Adaptive Management Triggers

The AMMP includes quantitative triggers that signal the onset of effects on surface water resources and groundwater levels and compel the implementation of adaptive management measures. The triggers include water pressure/level readings measured in piezometers established along the Project alignment and flow rates of springs and streams falling below baseline conditions.

Adaptive Management Measures

Supplemental water would be supplied to affected springs or streams to approximate baseline levels until groundwater recharged naturally. The actual method of distribution of supplemental water would vary according to site-specific characteristics. For example, at some locations, a drip irrigation system may be more appropriate, whereas at other locations, it may be more appropriate to simply discharge water directly to a creek bed. At the specific site, water would be discharged at a point within the creek, or more broadly distributed, according to the site characteristics. See Section 3.6, Public Utilities and Energy, for discussion of the potential sources of water for construction purposes. Those sources would also be relied upon to provide supplemental water for affected seeps, springs, or streams.

Well Impacts

The AMMP includes quantitative triggers that signal the onset of effects on surface water resources and groundwater levels and compel the implementation of adaptive management measures. If a well is determined to be affected by tunnel construction the well would be evaluated to determine the best approach to address the effect. Actions could include modifying the well equipment, such as by lowering the pump in the well, cleaning the pump, or providing a larger pump. Other additional actions may include providing potable water supplementation until water levels recover in the water supply well. See Section 3.6, Public Utilities and Energy, for discussion of the potential sources of water for construction purposes. Those sources would also be relied upon for potable water supplementation.

3.8.7.1 Impacts of Mitigation

This section evaluates the potential for the hydrological mitigation measures to result in secondary environmental effects. Adhering to applicable regulations, obtaining regulatory permits, incorporating BMPs, and applying standard mitigation measures, would reduce secondary impacts with the potential to occur as a result of implementation of hydrological mitigation measures. The following mitigation measures have the potential to result in secondary environmental impacts:

- **Mitigation Measure HWR-MM#1** will prescribe groundwater monitoring and treatment procedures to minimize the spread of potentially contaminated groundwater encountered during subsurface construction. Groundwater barriers could affect the typical groundwater flow patterns or result in the isolation of contaminated aquifers; however, this will be a deliberate effort to prevent the spread of existing contamination that could be mobilized during subsurface construction activities. HWR-MM#1 would not result in secondary environmental impacts.
- **Mitigation Measure HWR-MM#2** will require the restoration of areas disturbed during construction of the Palmdale to Burbank Project Section and will implement design guidelines to minimize impacts on floodplains. HWR-MM#2 would not result in secondary environmental impacts outside of the construction footprint.
- **Mitigation Measure HWR-MM#3** will entail the creation of new groundwater recharge areas to compensate for the reduction in the Hansen Spreading Grounds footprint. New recharge areas would be placed in the vicinity of existing recharge ponds.

  Temporary construction areas not needed for project operation in the vicinity of the spreading grounds will be converted to replacement groundwater recharge areas. However, creation of new groundwater recharge areas could result in secondary environmental effects or environmental effects outside of the current Build Alternatives footprint. Impacts could include emissions and fugitive dust from construction equipment, construction-related noise, construction-related road closures or traffic delays, mobilization of extant hazardous materials or wastes, private property acquisitions or displacements, and impacts on biological and cultural resources. However, such impacts would be minimal, temporary, and confined to the vicinity of the new recharge areas that are anticipated to be in areas of industrial/ warehousing land uses.

  Natural aquatic resources would be avoided during creation of new groundwater recharge areas. Additionally, construction of new recharge areas will apply the IAMFs, and construction-period mitigation measures discussed in Section 3.2, Transportation, Section 3.3, Air Quality and Global Climate Change, Section 3.4, Noise and Vibration, Section 3.7, Biological and Aquatic Resources, Section 3.10, Hazardous Materials and Wastes, Section 3.12, Socioeconomics and Communities, and Section 3.17, Cultural Resources. Therefore, HWR-MM#3 would not result in significant secondary environmental effects.
- **Mitigation Measure HWR-MM#4,** which will involve implementing the surface water hydrology monitoring requirements of the AMMP, could have secondary impacts on water quality and biological resources. These secondary impacts would result from accessing waterbodies and springs to perform monitoring. Accessing these waterbodies may require minor vegetation trimming or removal and monitors may need to walk through waterbodies. These activities could result in small areas of disturbed soil, which could erode or wash into a waterbody and create localized areas of increased turbidity and suspended sediment concentrations. However, these increases in turbidity and suspended sediment concentrations are not expected to exceed applicable water quality standards or substantially

disrupt aquatic species Therefore, implementing monitoring requirements of the AMMP is not expected to have a secondary impact on water quality and biological resources. Supplemental water may be required to potentially restore baseline levels of surface water resources and associated habitat that are adversely affected by changes to the quantity and availability of water resources caused by tunnel construction. Impacts such as air quality emissions, and additional truck trips would be required to transport the supplemental water to the Build Alternatives. As noted in Section 3.2, Transportation, and Section 3.3, Air Quality and Global Climate Change, implementation of supplemental water would not result in a new exceedance or substantially increase the exceedances that were identified in the Draft EIR/EIS.

Providing supplemental water supply infrastructure on properties where monitoring has detected impacts to water supply as a result of tunnel construction could have secondary impacts on water quality and biological resources. These secondary impacts may result from soil disturbances associated with installing temporary water tanks, temporary water lines, and associated appurtenances. These areas of disturbed soil have the potential to erode and contribute to elevated turbidity and suspended sediment concentrations in receiving waterbodies and may disrupt existing habitat for biological species. However, the secondary impacts on water quality would not be significant, because compliance with the General Construction Permit and requirements of the SWPPP (HYD-IAMF#3) will require the application of soil stabilization and sediment control BMPs, as applicable, to prevent substantial adverse effects on water quality. Applicable mitigation, such as BIO-MM#47 in Section 3.7, Biological and Aquatic Resources, would apply to disturbances due to installation of water supply infrastructure such that impacts would be mitigated to a less than significant level, under CEQA.

The installation of additional groundwater monitoring wells specific to implementing the monitoring requirements of the AMMP could have secondary impacts on groundwater quality and volume. Installing these wells may result in temporary and localized increases in the groundwater table and mixing of drilling water (domestic water supply) with groundwater, locally altering chemistry. Additionally, installing the wells would require the use of material that, if accidentally discharged into the well, could impact groundwater quality. However, these are routine activities and are not expected to have significant impacts on groundwater. After installation of the casing, screens, permeable material (i.e., sand) in the annular space, and bentonite cap, groundwater levels would be allowed to return to existing conditions. Well installation would have limited effects on biological resources; applicable mitigation, such as BIO-MM#47, would apply to well installation such that impacts would be mitigated to a less than significant level, under CEQA.

For private water supply wells outside of the ANF, any replacement wells would be constructed in compliance with industry standards and applicable regulations, including regulations by the Department of Water Resources (e.g., Bulletins 74-81 and 74-90, as adopted by local agencies), the State Water Resources Control Board, and the Department of Toxic Substances Control. The location of and number of wells that could be affected by tunnel construction, if any, is unknown, and therefore, analyzing impacts caused by replacement wells or alternative replacement sources would be speculative. Although the depth of a well may vary by location, well construction near the tunnel alignment would likely require little ground disturbance, would not require substantial use of heavy equipment, and can be completed in a relatively short timeframe. For example, numerous wells near Acton and the San Fernando Valley are relatively shallow and have not required extensive sampling prior to construction. Although equipment could generate pollutant emissions and noise, impacts would be mostly temporary, and after construction, environmental conditions would be similar to conditions with the original well. The relocation of existing wells would not further deplete groundwater supplies through additional groundwater pumping or substantially change the water level in neighboring wells because the replacement wells would be located in the same vicinity as the original wells and would pump at approximately the same rate and depth as the existing wells.

3.8.8 NEPA Impacts Summary

This section summarizes the impacts of the Build Alternatives and compares them to the anticipated impacts of the No Project Alternative. Table 3.8-13 compares the impacts for the six Build Alternatives and is followed by a discussion of the impacts of the different Build Alternatives on hydrology and water resources.

Table 3.8-13 Comparison of High-Speed Rail Build Alternative Impacts for Hydrology and Water Resources

Impacts	Build Alternative						NEPA Conclusion before Mitigation (All Build Alternatives)	Mitigation	NEPA Conclusion post Mitigation (All Build Alternatives)
	Refined SR14	SR14A	E1	E1A	E2	E2A			
Construction Impacts									
Impact HWR#1: Permanent Alteration of Surface Drainage Patterns from Aboveground Temporary Construction Activities and Permanent Structures Required for the Build Alternatives.							No Adverse Effect	No mitigation needed	N/A See Section 3.8.8.1
Number of waterbody crossings at grade[1]	48	43	43	42	34	39			
Number of viaduct waterbody crossings	12	3	7	3	8	3			
Number of tunnel waterbody undercrossings	29	32	43	44	44	40			
Impact HWR#2: Construction Activities Required for the Build Alternatives.							Adverse Effect	HWR-MM#1	No Adverse Effect See Section 3.8.8.2
Acres of construction-period ground disturbance	3,409 – 3,492	3,144 – 3,232	2,249 – 2,263	2,022 – 2,159	2,093 – 2,094	1,963 – 1,964			
Acres of permanent footprint	2,490 – 2,565	2,164 – 2,238	2,156	1,898 – 2,021	1,994 – 2,006	1,835 – 1,847			
Acres of new impervious surfaces	787	752	742	700	650	607			
Impact HWR#3: Changes in Flood Risks Associated with Temporary Construction Activities and Permanent Structures Required for the Build Alternatives.							Adverse Effect	HWR-MM#2	No Adverse Effect See Section 3.8.8.3
Acres of construction-period ground disturbance within SFHAs	279 – 281	291 – 293	306	306	422	421			

Impacts	Build Alternative						NEPA Conclusion before Mitigation (All Build Alternatives)	Mitigation	NEPA Conclusion post Mitigation (All Build Alternatives)
	Refined SR14	SR14A	E1	E1A	E2	E2A			
Acres of permanent footprint within floodplains	279 – 281	291 – 293	306	306	422	421			
Impact HWR#4: Changes in Groundwater Recharge Associated with Temporary Construction Activities and Permanent Structures Required for the Build Alternatives.							Adverse Effect	HWR-MM#3 HWR-MM#4	No Adverse Effect See Section 3.8.8.4
Number of groundwater basins crossed by construction footprint	4	3	3	1	2	0			
Number of water supply wells within 1 mile of alignment centerline	30	30	24	24	22	22			
Impact HWR#5: Changes in Hydrogeologic Conditions Associated with Tunnel Construction Beneath the ANF which May Affect Surface and Subsurface Water Resources.							Adverse Effect	HWR-MM#4	No Adverse Effect See Section 3.8.8.5 and Section 3.8.8.6
Number of Moderate Risk Areas	3	3	4	4	5	5			
Number of High Risk Areas	1	1	2	2	6	6			
Length (miles) of Tunnel in Groundwater Pressure above 25 bar	1.6	1.6	6.9	6.9	6.6	6.6			
Length (miles) of Tunnel in Groundwater Pressure at or below 25 bar	5.6	5.6	10.9	10.9	11.3	11.3			
Length of Tunnel Traversing Moderate and High Risk Areas (miles)	1.6	1.6	2.3	2.3	5.2	5.2			

Impacts	Build Alternative						NEPA Conclusion before Mitigation (All Build Alternatives)	Mitigation	NEPA Conclusion post Mitigation (All Build Alternatives)
	Refined SR14	SR14A	E1	E1A	E2	E2A			
Number of Perennial Streams in Moderate Areas	0	0	1	1	0	0			
Number of Perennial Streams in High Risk Areas	0	0	1	1	0	0			
Number of Intermittent Streams in Moderate Risk Areas	0	0	1	1	2	2			
Number of Intermittent Streams in High Risk Areas	0	0	1	1	6	6			
Known Seeps and Springs Present in Risk Areas	0	0	1	1	6	6			
Streams Present in Risk Areas	11	11	22	22	39	39			
Known Active Wells Present in Risk Areas	0	0	1	1	1	1			
Operations Impacts									
Impact HWR#6: Project Operation Effects on Water.							No Adverse Effect	No mitigation needed	N/A See Section 0
The Refined SR14, SR14A, E1, E1, E2, and E2A Build Alternatives would pose equal risks to water quality during operations.									

[1] "At grade" includes fill, embankment, and cut-and-cover profiles
ANF = Angeles National Forest; SFHA = special flood hazard area; N/A = Not Applicable

The Palmdale to Burbank Project Section area includes a variety of hydrologic resources, including natural and artificial surface waterbodies, SFHAs, and groundwater aquifers. Construction-period ground disturbance, tunneling, and HSR facility installation could result in temporary impacts on hydrologic resources and water quality. IAMFs, including BMPs, will be incorporated into Build Alternative design and construction approaches to avoid and minimize construction and operations impacts. Mitigation measures will also be implemented to further avoid and minimize such impacts and to compensate for unavoidable hydrologic and water quality impacts resulting from any of the six Build Alternatives. Incorporation of IAMFs (defined in Section 3.8.4.2) would reduce impacts on hydrology and water resources by providing stormwater management and flood protection design controls, erosion and sedimentation controls, groundwater quality protection, and waste management.

Between Palmdale and Burbank, the Refined SR14 Build Alternative would cross 48 surface water features at grade and 12 such features by viaduct. The SR14A Build Alternative would cross 43 surface water features at grade and 7 such features by viaduct. The E1 Build Alternative would cross 43 surface water features at grade and 3 such features by viaduct. The E1A Build Alternative would cross 42 surface water features at grade and 3 such features by viaduct. The E2 Build Alternative would cross 34 surface water features at grade and 8 such features by viaduct. The E2A Build Alternative would cross 39 surface water features at grade and 3 such features by viaduct. Refer to Impact HWR#1 for a discussion of where these crossings would be located along each of the six Build Alternatives.

3.8.8.1 Surface Water Drainage

Operations of the Palmdale to Burbank Project Section would result in a permanent footprint and new impervious surfaces that could increase the rate and amount of stormwater runoff and erosion. Runoff from these new impervious surfaces (e.g., station areas, viaducts, access roads) could disperse trash, motor fluids, and other pollutants during operations. Grading and earthmoving during HSR construction would also alter local topography and drainage. New HSR structures within existing drainage areas could impede or alter stormwater flow, changing the quantity, quality, or timing of runoff flowing toward receiving waters. Without adequate drainage facilities, permanent Build Alternatives infrastructure could alter stormwater runoff patterns to create drainage issues throughout the lifetime of the Palmdale to Burbank Project Section. Interruption to these drainage areas could also increase erosion and sedimentation, thus degrading water quality. Relative to the E1 and E2 Build Alternatives, the Refined SR14 Build Alternative would require the largest permanent footprint and create the most extensive impervious surface area. Therefore, the Refined SR14 Build Alternative would have the greatest potential to create hydrological and water quality issues associated with the Build Alternative footprint and new impervious surfaces. The SR14A, E1A, and E2A Build Alternatives would also require the construction of impervious surfaces, although to lesser extent than the Refined SR14, E1, and E2 Build Alternatives. Thus, such impacts would be reduced compared to those resulting from the implementation of the Refined SR14, E1, and E2 Build Alternatives, respectively. The construction period SWPPP (HYD-IAMF#3) will incorporate BMPs to reduce short-term increases in impacts on surface water drainage induced by construction-site runoff. HYD-IAMF#1 and HYD-IAMF#2 will require that surface water crossings maintain preconstruction hydraulic capacity through the implementation of on-site stormwater management BMPs.

3.8.8.2 Water Quality

Installation of HSR trackway and ancillary facilities would require construction activities near surface waters. Vegetation removal and soil disturbance could result in erosion that would degrade water quality. Changes to stormwater patterns during construction could also affect the quantity, quality, or timing of runoff flowing toward receiving waters. The Refined SR14 Build Alternative would cause the most ground disturbance that could result in erosion. Construction activities could also result in chemical or hazardous material spills, and earthmoving operations could expose and/or mobilize existing soil and groundwater contamination. The SWPPP (HYD-IAMF#3) will implement erosion control BMPs during construction. HYD-IAMF#1 and HYD-IAMF#4 will allow for the control and treatment of stormwater runoff prior to discharge throughout the hydrology and water quality RSA. Per HMW-IAMF#9 and HMW-IAMF#10, the Authority will prepare hazardous materials monitoring plans and will, to the extent feasible, limit the use of hazardous substances during operations. In addition, the Palmdale to Burbank Project Section will comply with water quality parameters and monitoring required by applicable regulations and permitting conditions.

Excavation and tunneling in areas of high groundwater could introduce pollutants and mobilize existing soil or groundwater contamination within the groundwater basins traversed by the Build Alternatives. Figure 3.8-A-21 through Figure 3.8-A-23 show where the Build Alternatives would be built over mapped groundwater basins (Appendix 3.8-A). The Refined SR14 Build Alternative would result in the largest amount of footprint overlying groundwater basins and would pose the highest risk of groundwater contamination from dewatering and excavation in areas with high groundwater. However, the SR14A Build Alternative would result in the most linear miles of tunnel in areas with known groundwater basins and would result in the highest water quality impacts from construction-period and operations dewatering associated with tunnels. HWR-MM#1 will establish procedures to address existing groundwater contamination that could be mobilized by HSR construction.

3.8.8.3 Flood Zones

Construction activities and permanent footprint within designated floodplains could increase flooding or change the location and/or direction of flood flows. Temporary impacts could include hazards to construction areas, equipment, and personnel, but flooding risks to HSR facilities and nearby communities could last throughout the lifetime of the Palmdale to Burbank Project Section. The E2 Build Alternative would result in the most temporary disturbance and permanent footprint within SFHAs. In addition, each of the six Build Alternative would include several drainage crossings within or adjacent to ANF that could be susceptible to increased stormwater and debris flow rates resulting from wildfires.

Based on preliminary design information, none of the proposed six Build Alternatives would increase the flood elevation by more than 1 foot. Extensive use of tunnel and viaducts would reduce the amount of floodplain disturbance by minimizing construction within floodplains. HYD-IAMF#1 will implement stormwater management facilities to convey and detain runoff from new impervious surfaces, thus reducing the Palmdale to Burbank Project Section's contribution of runoff during flood events. The flood protection plan included in HYD-IAMF#2 will allow the Build Alternatives to remain operational during flood events and would minimize increases in 100-year or 200-year flood elevations. HYD-IAMF#2 will also incorporate hydraulic modeling specific to post-wildfire conditions to provide the appropriate sizing of HSR structures within and adjacent to the ANF including the SGMNM, to accommodate increased flood/debris flows after a wildfire. In addition, HWR-MM#2 will require the Authority to implement additional protective measures to reduce floodplain impacts during construction and operations.

The SR14A and E2A Build Alternatives would result in slightly lesser impacts compared to the Refined SR14 and E1 Build Alternatives, respectively, due to their smaller footprint within the SFHAs (280 to 281 for the SR14A Build Alternative and 421 acres for the E2A Build Alternative) This reduced footprint would result in less removal of stabilizing vegetation, less disturbance and compaction of soils during construction, and fewer permanent structures that would block or channelize flood flows. The E1A Build Alternative would result in similar impacts on floodplains as the E2 Build Alternative (each would require 306 acres of temporary and permanent footprint within SFHAs).

3.8.8.4 Groundwater Depletion

Impermeable surfaces associated with new HSR alignment and ancillary infrastructure could disrupt the percolation of surface water into groundwater basins, negatively affecting a groundwater basins' ability to recharge. Nearby water supply wells could be affected by a reduction in groundwater availability. The Refined SR14 Build Alternative would have the largest footprint overlying groundwater basins and therefore the greatest probability of reducing groundwater recharge throughout operations of the Build Alternatives. The Refined SR14 Build

Alternative's groundwater RSA would also encompass a larger number of water supply wells (30 wells) compared with the E1 Build Alternative (24 wells) and the E2 Build Alternative (22 wells). Furthermore, the Refined SR14 and E1 Build Alternatives propose footprints within the Hansen Spreading Grounds, which would permanently reduce the size of these groundwater recharge ponds. HWR-MM#3 will require the Authority to provide replacement groundwater recharge areas. The SR14A, E2A, and E2A Build Alternatives would also require alignment and ancillary features that could affect groundwater. The SR14A, E1A, and E2A Build Alternatives would each require the same impermeable surface area as the Refined SR14, E1, and E2 Build Alternatives, respectively. The tunnel construction RSA for the E1A and E2A Build Alternatives would encompass the same set of wells as the E1 and E2 Build Alternatives, respectively. Although unlikely, groundwater could seep into tunnels located outside of the ANF resulting in impacts to seeps, springs, wells, and surface water features dependent on groundwater. Regardless of the Build Alternative, HYD-IAMF#5, HYD-IAMF#6, and HYD-IAMF#7 will require the use of state-of-the-art technology and practices to avoid and minimize the flow of groundwater into tunnels.

3.8.8.5 Hydrologic Resources within the ANF Dependent on Groundwater

Tunneling beneath the ANF could result in impacts on groundwater, which could adversely affect streams, springs, and water supply wells. Groundwater is found along geologic faults in the bedrock forming the mountains. Tunneling could cause groundwater to flow into the tunnel cavities during construction at varying rates depending on groundwater conditions at the site. To assess the relative risk of groundwater reductions affecting these surface features, the analysis identified within the tunnel construction RSA areas of high, medium, and low/no risks. Table 3.8-12 shows, the number of streams, springs, and wells located within High and Medium Risk Areas. As set out in Table 3.8-12, the Refined SR14 and SR14A Build Alternatives would have the fewest of these features within its study area. Both the E1 and E1A and the E2 and E2A Build Alternatives are associated with the greatest potential risk of impacts on hydrology compared to the SR14 and SR14A Build Alternative. Table 3.8-9 through Table 3.8-11 above provide the estimated risk for each of the Build Alternatives.

Groundwater seepage into tunnel structures could affect water levels of springs, streams, and wells reliant on groundwater aquifers. The extent to which groundwater may seep into tunnel cavities depends on the grouting and tunnel lining system's ability to resist hydrostatic pressures. HYD-IAMF#5, HYD-IAMF#6, and HYD-IAMF#7 require the Authority to utilize tunnel design features and construction methods to avoid and minimize groundwater inflows during ANF tunnel construction. This would help minimize or prevent groundwater from flowing into the tunnel during and after construction by matching the tunneling excavation method to the underground conditions. Mitigation Measure HWR-MM#4 requires the Authority to implement an AMMP, which includes monitoring protocols to establish baseline conditions of surface water resources, detect changes in groundwater conditions related to tunnel construction to ensure timely implementation of remedial measures, such as augmenting surface water supplies and wells and supplementing water within affected surface water resources as necessary.

3.8.8.6 Hydrology and Hydrogeology in the ANF

Tunnel construction under the ANF involves complicated hydrogeological and hydrological issues. To assess how these hydrogeological and hydrological issues would affect the feasibility of constructing the tunnels, the Authority conducted preliminary geotechnical investigations in portions of the ANF. These investigations yielded information concerning environmental impacts expected to be encountered in building the proposed tunnel. The investigations, however, were not focused on a specific alignment. Further geotechnical investigations will be conducted, and additional information developed to support design and construction once a specific alternative has been selected. The information garnered from this effort will help guide tunnel design and construction methods to further avoid and reduce impacts to hydrological resources.

While the information needed to fully identify the detailed and specific impacts of each alignment on hydrology will be obtained for the design and construction phases, the information that was developed by the Authority through the geotechnical investigations conducted thus far, along with information derived from similar tunneling projects in similar geologic scenarios, is sufficient for an analysis that allows for a comparison of the reasonably foreseeable impacts of the alternatives and for the Authority to make a reasoned choice among those alternatives. As further discussed below, because the Authority has sufficient information to make a reasoned choice among the alternatives, the lack of more detailed and specific information about the precise tunneling impacts does not trigger the application of 49 C.F.R. 1502.22 - Incomplete or Missing Information. Notwithstanding the foregoing, the following analysis is provided for context.

Incomplete or Unavailable Information Regarding Evaluation of the Effects of Tunnel Construction

Although preliminary assessments of subsurface conditions in the ANF have been conducted to date, many aspects of the hydrogeologic and hydrologic conditions that would be encountered during tunnel construction have been defined only partially, and data gaps remain regarding the surrounding bedrock, groundwater, soil, and surface hydrology conditions present in the vicinity of the proposed tunnels. The current data gaps include the following:

- Geologic conditions, including spatial distribution of rock formations, rock structure types, rock orientation, extent and intensity of fractures and shear zones, and characteristics of the San Gabriel fault zones and Sierra Madre fault zones, including lengths, widths, depths, and alignment of the fault zones in the subsurface
- Hydrogeologic conditions, including aquifer boundaries, groundwater, and hydrostatic pressures, annual and interannual variation of groundwater conditions, responses to rainfall, conductivity, fault and fracture zone features, hydrologic connectivity with surface water resources and overlying alluvial aquifers, and groundwater chemistry
- Hydrologic conditions, including average productivity of existing water supply wells and springs, and the annual and interannual variation in productivity, metrics describing average, peak, and low-flow conditions of streams, and hydroperiods of surface water resources

Additional site-specific investigations of the subsurface would be conducted in advance of final tunnel design, including geotechnical investigations along the tunnel alignment to characterize the differing rock types (strength, fracturing, in-situ stresses, etc.), groundwater pressures at tunnel depth, potential flow quantities, and structural geology along the tunnel alignment, including faults and gouge zones. Additional geotechnical borings would need to be converted to piezometers or fitted with vibrating wire pressure transducers for measuring water pressure changes along the alignment to establish seasonal baseline conditions for deep groundwater and near surface water. Such instrumentation would also be used as the early warning system for pressure changes occurring in the subsurface along the alignment during tunnel construction.

The site characterization studies would be similar in methods to the preliminary geotechnical studies completed for evaluating the feasibility of tunneling and reported in the Authority reports used to develop the current understanding of the rock, hydrogeology, and hydrology (Authority 2019a and 2019b). The comprehensive site-specific geotechnical and hydrogeological/hydrology field investigations would adequately define the field conditions and provide the data necessary for development of a preliminary 3-D predictive model.

Additional types of data planned to be collected during the Project planning and design phase along the tunnel alignment associated with the preferred alternative include:

- Laboratory testing to ascertain general engineering properties of rock and soil in the subsurface, such as moisture content and dry density, grain size distribution, plasticity, compressive strength, tensile strength, Schmidt hammer hardness, and abrasiveness
- In-situ testing and instrumentation would be performed to identify rock permeability and in-situ stress, groundwater pressures, and the presence of subsurface vapors with gas wells
- Ongoing monitoring of seeps and springs, and water supply wells to characterize whether they are precipitation or groundwater maintained (Figure 3.8-A-16)

Relevance of Incomplete or Unavailable Information to Evaluating the Effects of Tunnel Construction

Detailed information and analysis regarding the potential hydrogeologic and hydrologic conditions that may be encountered by a proposed tunnel would be used to refine the design and engineering approaches and methods of construction of the tunnels. This information would also be used to more precisely identify where specific tunnel design and construction methods would be implemented to avoid and minimize effects on groundwater and related surface water resources. For example, the additional information to be collected would refine predictions regarding groundwater inflow rates, durations, and pressures which would help inform the finalization of design features related to TBM features, tunnel lining systems, and grouting approaches.

To reach final design, detailed evaluations of hydrologic conditions and characteristics of existing surface water resources overlying, and in the vicinity of, the tunnel alignments would be necessary to understanding the connections between groundwater and surface water flows, surface water hydroperiod, and daily, seasonal, and interannual variations in hydrologic conditions due to precipitation, temperature, and other variables. Predictive groundwater modeling methods would also be employed prior to final design to estimate potential groundwater conditions that may be encountered by the tunnels. These analytical methods would also be utilized to evaluate hydrological effects of tunnel construction on the local groundwater system, including defining the approximate extent, duration, and intensity of groundwater and surface water effects, as well as post-construction recovery of these resources. However, groundwater modeling methods could only be used to evaluate these conditions and effects if adequate input data, including site-specific geotechnical and hydrologic data collected by subsurface investigations, in situ monitoring, and field investigations, are available. In the absence of these data, these predictive modeling methods cannot be employed. Therefore, at this time, predictive groundwater modeling methods cannot be used to evaluate effects associated with the proposed tunnel construction.

Existing Information for Evaluating the Effects of Tunnel Construction

The geology of the San Gabriel Mountains has been mapped by the California Geological Survey (Campbell et al. 2014) and the United States Geological Survey (Yerkes and Campbell 2005). To supplement this existing data and verify site-specific geologic information, the Authority conducted additional geologic mapping and subsurface investigation in portions of the ANF. The subsurface investigation included drilling six core holes, collecting rock core samples, and performing tests to gather data on rock mass classifications and faults, hydraulic conductivity, groundwater pressures at varying depths, water chemistry of deep groundwater samples, age dating of surface water and deep groundwater samples, and characterization of surface water resources.

Faults

The locations of faults were mapped using available GIS databases of geologic mapping (Campbell et al. 2014). Base maps were created depicting the topography, fault traces, and estimated areas with groundwater pressures above 25 bar within a defined zone extending 1 mile from either side of each of the tunnel alignments (Figure 3.8-A-22, Figure 3.8-A-23, and Figure 3.8-A-24). Each of the tunnel alignments intersect the same regional faults cutting nearly east-west through the San Gabriel Mountains. These include many branches of the San Gabriel fault and Sierra Madre fault zones. The number of mapped faults intersecting construction for each of the proposed alignments is summarized in Table 3.8-6 and Table 3.8-12.

Conductivity

The hydraulic conductivity of the various geologic units and the groundwater pressures anticipated within the tunnel envelope for each alignment are interpreted from in-situ testing and instrumentation data obtained from the six core holes in the ANF, published information for similar geologic conditions, and experiences with other tunneling projects. The predominant lithologies of six borings are as follows:

- Anorthosite with lesser apophysis, inclusions, or dikes of gabbro
- Anorthosite and gabbro with lesser dikes of granite and pegmatite (very coarse- to coarse-grained granite)
- Granite and granite diorite
- Flaser granite diorite
- Granodiorite and dikes of granite, mylonite, and gabbro
- Towsley Formation, sedimentary rocks

For comparison of the Proterozoic- and Mesozoic-age igneous and metamorphic rock lithologies tested in the ANF core holes, the measured ANF ranges of hydraulic conductivity are plotted with compiled published ranges of data from similar rock lithologies (Figure 3.8-A-19). Figure 3.8-A-19 Table 3.8-7presents estimated lengths of tunnels (miles) along each alignment proportional to the frequency of occurrence for measured ranges of hydraulic conductivity in the data from packer testing using 96 ANF data points. Based on the rock types cored for the geotechnical feasibility study, the Refined SR14/SR14A, E1/E1A, and E2/E2A alignments are anticipated to encounter areas with hydraulic conductivity values ranging from very low to very high; however, the majority of the conductivity classifications are expected to be in the low to moderate range.

Groundwater Pressures

Groundwater pressures along each of the alignments have been estimated for comparative purposes. The pressures are interpreted from instrumentation data available for the six core holes in the ANF, published data of groundwater resources in the ANF [i.e., as shown in Appendix A.9 in the Preliminary Geotechnical Data Report for Tunnel Feasibility (Authority 2019b) and topographic and hydrogeologic trends.

Table 3.8-8 summarizes the anticipated groundwater pressure conditions for the ANF tunnel alignments assuming submergence based on the depth of the tunnels below-ground surface less the estimated depth to groundwater. Figure 3.8-A-24 presents a summary of the anticipated groundwater pressures. Based on the limited data and assumptions used, the E1/E1A and E2/E2A alignments have three to five times the lengths of tunnel where the groundwater pressures are anticipated to exceed 25 bar, compared to the Refined SR14/SR14A alignment.

The highest anticipated groundwater pressures are anticipated to be as high as 50 bar for portions of the Refined SR14/SR14A and E1/E1A and greater than 60 bar for E2/E2A.

Age Dating of Water Samples

Chemistry of deep-water samples collected from the geotechnical core holes was analyzed for general chemistry, for radio-carbon age dating, and for radionuclides to compare results to published water chemistry from the Groundwater Ambient Monitoring and Assessment (GAMA) studies managed by the USGS (Davis and Shelton 2014). Chemical differences in the water demonstrate that the water sources for the GAMA program, which are from shallow wells, are not connected to the deep groundwater sampled and tested for the geotechnical investigations. The results of the carbon-14 age dating also indicate that the water collected from deep in the mountain is at least 4,500 years old and has not been replenished or recharged by younger shallow rainwater. So far, the results from water chemistry testing suggest that the deep water within bedrock units beneath the ANF has mixed very little with shallow water that supplies wells and springs with water.

Surface Water Resources

Water supply is obtained by privately owned in-holdings from wells drilled in either alluvium of the canyon bottoms or in bedrock drawing water from bedrock fracture systems. Those wells are not well documented and are located on private property. Water supply may also be obtained from springs located on these in-holdings.

Beginning in 2016, quarterly monitoring of 12 known springs has been conducted in the vicinity of the three tunnel alignments over an approximate 25-square-mile area (Figure 3.8-A-18). The 2016 monitoring of springs indicated that the long period of preceding dry years had resulted in most of the springs being dry or evidenced only by wet soil or greener vegetation where the spring had been identified previously but was reduced to a seep. Quarterly monitoring has continued since September 2016 to develop a database on spring and groundwater responses to seasonal changes in precipitation, flow rates and water chemistry. Monitoring the flow of springs on a quarterly basis has demonstrated that the flows vary with seasonal precipitation.

Data obtained on groundwater chemistry from the geotechnical investigations suggest that the near surface groundwater that feeds the springs has a different source area than the deep water sampled at tunnel depths in the geotechnical investigations. (Authority 2017b). The existing data suggests that most of the spring water is derived from precipitation that seeps into fractures, weathered rock, and faults and then surfaces as springs downgradient. Although the flow of springs in the area varies with seasonal precipitation, the current database is not sufficient to quantify the amount of water discharged from springs in the RSA or to rule out dependence on groundwater.

No field data have been collected for the streams in the RSA. Based on published literature, stream flows in the local canyons vary depending on seasonal trends in precipitation and with the topography, vegetation, and geology of the drainages (USGS 2011 and 2012; USFWS 2019). Based on the limited available information, it appears that streams in the RSA are intermittent (i.e., ceases flow during dry season), ephemeral (i.e., flows only during and shortly after precipitation), and perennial (i.e., continuous flow of surface water throughout the year). Table 3.8-9 summarizes the number of streams in the RSA for each proposed alignment.

Theoretical Approaches Available to Evaluate the Effects of Tunnel Construction

The approach to evaluating potential water resource impacts within the ANF due to tunneling is based on an assessment of known geologic and hydrogeologic conditions, including information and data regarding the hydrogeologic and hydrologic conditions of the western San Gabriel Mountains developed during geotechnical investigations for the HSR (Authority 2019a and 2019b). The approach to the analysis was also informed by case studies of tunnel construction and associated effects on water resources, including tunnels constructed in southern California, the professional judgment of experts in the field of hydrogeology and hydrology.

Based on the available information, key assumptions used in the evaluation include: (1) most potential high groundwater flows would be encountered during tunnel construction where faults are intersected, and tunneling through faults could result in movement of the water parallel to the fault; (2) higher groundwater pressures increase the probability of an effect; (3) springs often occur in association with faults and could be affected through loss of groundwater when tunnel construction intersects faults; and (4) areas supporting springs not associated with known faults are assumed to be either connected through unknown faults and may be at risk or are maintained by annual precipitation infiltrating into a shallow aquifer only and are not at risk.

Based on the foregoing, those areas along the alignments characterized by both high groundwater pressures and faults present conditions that pose the greatest risk that substantial volumes of water seep into the tunnels and adversely affect groundwater and surface water resources.

Table 3.8-12 compares the potential impacts for the Build Alternatives and is followed by a discussion of the potential impacts of the different Build Alternatives on hydrology and water resources. The table summarizes the numbers of Moderate and High Risk Areas, and the number of known springs, streams, and wells within these Risk Areas, for each of the Build Alternative alignments. The E2 and E2A Build Alternative alignments traverse the greatest number of Moderate and High Risk Areas, and have the largest number of springs, streams, and wells within these designated Risk Areas. The E1 and E1A Build Alternative alignments have the next greatest number of Moderate and High Risk Areas and the second greatest number of springs, streams, and wells within these designated Risk Areas. The Refined SR14 and SR14A Build

Alternatives alignments intersect the fewest Moderate and High Risk Areas. Further, the Refined SR14 and SR14A Build Alternative alignments have the fewest springs, streams, and wells within Moderate and High Risk Areas.

Groundwater seepage into tunnel structures during construction could affect water levels of streams, springs and wells reliant on groundwater aquifers. The extent to which groundwater drains into tunnel structures depends on the tunnel lining system's ability to resist hydrostatic pressures. Specialized tunnel design (e.g., one-pass gasketed segmental lining and two-pass tunnel linings) can withstand higher hydrostatic pressure at greater depths. Because of the low water pressure expected to be encountered; these measures would be sufficient to effectively avoid and minimize inflows into the tunnels. Additionally, HYD-IAMF#5, HYD-IAMF#6, and HYD-IAMF#7 requires the Authority to utilize tunnel design features and construction methods to avoid and minimize groundwater inflows during ANF tunnel construction. These measures would ensure that tunneling excavation methods are informed by the underground conditions. HWR-MM#4 requires the Authority to implement an AMMP, which would involve ongoing monitoring and reporting activities to allow for the detection and timely remediation of any effects on hydrologic resources that may occur in the ANF. The AMMP would address foreseeable and unforeseeable impacts associated with the Build Alternatives.

3.8.8.7 Effects on Water Quality during Project Operation

During operations of the Palmdale to Burbank Project Section stations, pollutants would be generated such as trash and debris. Additionally, an increase in pollutants in stormwater runoff due to the increase in impervious surface area would occur. Water quality would be permanently affected if pollutants accumulated on permanent facilities and would be dispersed into nearby surface waters during operations of the Palmdale to Burbank Project Section. Stormwater generated by the Build Alternatives' impervious surfaces located near surface waters could cause sedimentation from erosion from the surrounding upland areas throughout the lifetime of the Palmdale to Burbank Project Section.

Regardless of the Build Alternative, permanent treatment BMPs would be incorporated into the design of the Build Alternatives to reduce pollutants in stormwater, thereby reducing water quality impacts. HYD-IAMF#1 will require on-site stormwater management facilities to capture runoff from pollutant-generating surfaces, including station areas, access roads, new road overpasses and underpasses, reconstructed interchanges, and new or relocated roads and highways. The plan would include post-construction BMPs and low-impact development techniques to reduce the quantity and improve the quality of stormwater runoff before runoff is discharged into a surface waterbody. Potentially contaminated runoff from surfaces associated with the Build Alternatives would be captured and treated in these stormwater management facilities prior to discharge of the treated water. Because pollutants would be generated in small quantities and BMPs would be implemented to minimize the discharge of these pollutants to receiving waters, the potential for introducing new sources of polluted runoff would be minor.

Additionally, HMW IAMF#9 will minimize the hazardous materials selected for use throughout HSR operations and maintenance, and HMW-IAMF#10 will implement hazardous materials plans to provide for the correct handling of hazardous materials throughout operations and maintenance activities. Furthermore, HYD-IAMF#4, would require maintenance activities that would require the discharge of water for uses such as washing trains and equipment under the Industrial NPDES Permit. Coverage under this permit will require the preparation of a site-specific Industrial SWPPP and annual monitoring and reporting. The Industrial SWPPP would implement measures to minimize runoff and promote on-site infiltration and/or retention basins, reducing hydrological impacts. With implementation of these IAMFs, operations of each of the six Build Alternatives would not violate water quality standards.

3.8.9 CEQA Significance Conclusions

Table 3.8-14 summarizes impacts, mitigation measures, and the level of significance after mitigation for the Refined SR14, SR14A, E1, E1A, E2 and E2A Build Alternatives.

Table 3.8-14 Summary of CEQA Significance Conclusions and Mitigation Measures for Hydrology and Water Resources

Impact	Level of CEQA Significance before Mitigation						Mitigation Measures	Level of CEQA Significance after Mitigation					
	Refined SR14	SR14A	E1	E1A	E2	E2A		Refined SR14	SR14A	E1	E1A	E2	E2A
Construction Impacts													
Impact HWR#1: Permanent Alteration of Surface Drainage Patterns from Aboveground Temporary Construction Activities and Permanent Structures Required for the Build Alternatives.	LTS	LTS	LTS	LTS	LTS	LTS	No mitigation measures are required.	N/A	N/A	N/A	N/A	N/A	N/A
Impact HWR#2: Construction Activities Required for the Build Alternatives.	S	S	S	S	S	S	HWR-MM#1	LTS	LTS	LTS	LTS	LTS	LTS
Impact HWR#3: Changes in Flood Risks Associated with Temporary Construction Activities and Permanent Structures Required for the Build Alternatives.	S	S	S	S	S	S	HWR-MM#2	LTS	LTS	LTS	LTS	LTS	LTS

Impact	Level of CEQA Significance before Mitigation						Mitigation Measures	Level of CEQA Significance after Mitigation					
	Refined SR14	SR14A	E1	E1A	E2	E2A		Refined SR14	SR14A	E1	E1A	E2	E2A
Impact HWR#4: Changes in Groundwater Recharge Associated with Temporary Construction Activities and Permanent Structures Required for the Build Alternatives.	S	S	S	S	S	S	HWR-MM#3, HWR-MM#4	LTS	LTS	LTS	LTS	LTS	LTS
Impact HWR#5: Changes in Hydrogeologic Conditions Associated with Tunnel Construction Beneath the ANF which May Affect Surface and Subsurface Water Resources.	S	S	S	S	S	S	HWR-MM#4	LTS	LTS	LTS	LTS	LTS	LTS
Operations Impacts													
Impact HWR#6: Project Operation Effects on Water.	LTS	LTS	LTS	LTS	LTS	LTS	No mitigation measures are required.	N/A	N/A	N/A	N/A	N/A	N/A

ANF = Angeles National Forest; LTS = less than significant; N/A = not applicable; S = Significant; SGMNM = San Gabriel Mountains National Monument; SU = Significant and Unavoidable

3.8.10 United States Forest Service Impact Analysis

This section summarizes the analysis of hydrology and water resources effects of the Build Alternatives that would potentially occur in the ANF, including lands that are part of the SGMNM.

3.8.10.1 Consistency with Applicable United States Forest Service Regulations

Appendix 3.1-B, USFS Policy Consistency Analysis, contains a comprehensive evaluation of relevant laws, regulations, plans, and policies relative to areas within the ANF, including the SGMNM. Policies in the ANF Management plan regarding hydrology and water resources are related to maintaining groundwater levels and protecting associated aquatic resources, maintaining water quality and connectivity of surface waters within USFS lands, protecting watersheds, and limiting impacts on groundwater. Specifically, the Build Alternatives must be consistent with the three standards described in Section 3.8.3, Consistency with Plans and Laws.

Project design and engineering requirements of the Build Alternatives incorporate the measures set out in HYD-IAMF#1 through HYD-IAMF#7, HMW-IMAF#9, and HMW-IAMF#10 to avoid and minimize effects on hydrology, groundwater, and surface water resources in the ANF. HYD-IAMF#1 through HYD-IAMF#4 establish measures for controlling stormwater runoff from the surface of the respective Build Alternative footprints, minimizing effects on water quality, surface waters, watershed conditions, and groundwater levels in the ANF. HMW-IAMF#9, and HMW-IAMF#10 will establish measures to prevent pollutants generated during construction regardless of the Build Alternative from entering surface waters. As such, all six Build Alternatives are considered consistent with these policies related to hydrology and water resources in Appendix 3.1-B.

3.8.10.2 United States Forest Service Resource Analysis

Construction Effects

Surface Waters and Watersheds

In general, the construction of each of the six Build Alternatives would largely avoid directly affecting surface waters and watersheds in the ANF, including in the SGMNM, through the placement of the rail tracks below-ground in tunnels. Some of the HSR infrastructure would be placed aboveground at certain locations within the ANF. These facilities, as well as their impacts to surface water connectivity and flow, are discussed below.

The Vulcan Mine site (Figure 3.8-A-33) would serve as a deposition site for spoil materials generated by tunnel boring associated with the Refined SR14 and SR14A Build Alternatives. Surface waters located in the vicinity of the Vulcan Mine site include the Santa Clara River, over which the HSR would cross on a viaduct outside the boundaries of the ANF. Within the ANF, including areas within the SGMNM, the Refined SR14 Build Alternative would affect one ephemeral tributary of the Santa Clara River and three perennial ponds where an at-grade covered tunnel would be constructed (Figure 3.8-A-33). The Vulcan Mine area proposed for spoil deposition contains an existing perennial pond within the boundaries of the ANF.

To comply with federal and state regulations, the Project would implement BMPs to reduce the potential for erosion to occur at the Vulcan Mine site. Depending on the construction technique used to construct the Refined SR14 Build Alternative, water may be redirected or removed from the ephemeral tributary of the Santa Clara River and three perennial ponds crossed by this Build Alternative footprint. Redirecting the flow in a watercourse would alter drainage patterns and increase the potential for erosion along new drainage paths. Where the placement of fill into waters occurs, the Project would comply with Section 404 of the CWA and the Dredge and Fill Water Discharge Requirements under the Porter-Cologne Water Quality Act, which require authorizations for such discharges. Increased erosion could cause siltation in the flow channel and degradation of downstream water quality. The spoils deposition site would not be covered with impervious surfaces. This area is already highly disturbed from its current use as an open pit mine/quarry and the placement of spoils would not likely directly affect naturally flowing or occurring waterbodies. Furthermore, drainage facilities would be specifically designed to capture and convey stormwater runoff, which would result in minimal permanent drainage impacts within Vulcan Mine site. Upon completion of the spoils deposition at the Vulcan Mine, the newly established contours at the site would allow for a natural overland flow pattern.

As shown on Figure 3.8-A-36 and Figure 3.8-A-61, the Refined SR14 and E1 adit options (A1, A2, and A3) propose ancillary facilities, including powerlines, that would cross the Pacoima Wash. The utility poles for these powerlines would be spaced to avoid direct impacts on the water channel. Additionally, the E1 CSA would cross underneath an intermittent portion of the Pacoima Wash in a bored tunnel. The SR14-A1, E1-A1, and E1-A2 CSAs would be located just outside of the Pacoima Wash.

Figure 3.8-A-83 shows E2 adit option E2-A1 near Little Tujunga Creek and E2-A2 near Gold Creek. The E2-A1 CSA would be located outside of Little Tujunga Creek but would require powerlines to cross both little Tujunga Canyon Creek and an ephemeral tributary. Associated utility lines would cross Little Tujunga Creek before reaching Little Tujunga Canyon Road, along which the utility lines would be collocated. E2-A2 would be located within the path of the intermittent Gold Creek. Powerlines associated with the adit would extend west, crossing Gold Creek, Alder Creek, Little Tujunga Creek, and intermittent tributaries associated with these water bodies. The SR14A, E1A, and E2A Build Alternatives would also require infrastructure within USFS lands. Such impacts would be identical to those resulting from the implementation of the Refined SR14, E1, and E2 Build Alternatives, respectively.

As discussed in Impact HWR#1 (Section 3.8.6.3), HYD-IAMF#1 and HYD-IAMF#2 will require that preconstruction hydraulic capacity be maintained after construction of surface water crossings through the implementation of on-site stormwater management BMPs that provide for runoff dispersion, infiltration, detention, and evaporation. Implementation of these IAMFs during Build Alternatives construction would reduce impacts on hydraulic capacity by minimizing alterations to watercourses, implementing erosion control BMPs, and maintaining existing stormwater patterns. HYD-IAMF#3, which involves the preparation and implementation of a SWPPP, would ensure that changes to drainage, stormwater, and erosion patterns during construction would be avoided and minimized. Hydromodification management procedures would emphasize site retention of stormwater runoff during preconstruction and verify maintenance, using measures such as flow dispersion, infiltration, and evaporation (supplemented by detention where required). In addition, BMPs would retain stormwater runoff on-site per the stormwater management and treatment plan, as outlined in HYD-IAMF#1.

Water Quality

Surface Water Quality

Aboveground construction activities within the ANF would introduce new sources of pollutants, which could contaminate or pollute surface waters within or adjacent to the construction area. Because the alignments for the Build Alternatives in the ANF would largely be underground, few surface features would be directly affected. Surface features that would be potentially affected include Alder Creek, Big Tujunga Creek, and Gold Creek. The SWPPP (IAMF#3) will include BMPs to minimize surface water quality impacts caused by short-term sedimentation during construction. Potential BMPs include erosion control requirements, stormwater management, and channel dewatering for affected stream crossings. Stormwater discharges would comply with the CWA and other applicable state and local stormwater regulations, as described in Sections 3.8.2.1 and 3.8.2.2, as well as conditions of a special use authorization issued by USFS.

None of the six Build Alternatives would introduce substantial new permanent surface facilities in the ANF. Direct water quality impacts related to erosion and sedimentation would be unlikely as a result of the implementation of BMPs. However, stormwater generated by the new impervious surfaces constructed in the ANF, such as access roads, utility corridors, and adit structures, could result in erosion and sedimentation. HYD-IAMF#1 will require on-site stormwater management facilities to capture runoff from impervious surfaces that could generate polluted runoff that would be then treated. Potentially contaminated runoff from surfaces associated with the Build Alternatives would be captured and treated within these stormwater management facilities prior to discharge. Because pollutants would be generated in small quantities and BMPs would be implemented to minimize the discharge of these pollutants to receiving waters, the potential for introducing new sources of polluted runoff on USFS lands would be minor throughout the lifetime of the Project.

Groundwater Quality

Groundwater quality impacts may occur where the construction of aboveground and at grade alignments, grading, trenching, and the placement of utility lines would be required within groundwater basins mapped in the ANF. Portions of the alignments of the Build Alternatives would cross the following groundwater basins in the ANF:

- **San Fernando Valley Groundwater Basin—**The six Build Alternatives would involve crossing the San Fernando Valley Groundwater Basin in the ANF, including the SGMNM (Figure 3.8-A-21). The E1 Build Alternative would require grading and placement of utility lines within this groundwater basin south of Little Tujunga Canyon Road before exiting the ANF (Figure 3.8-A-22). The E2 Build Alternative would encounter this groundwater basin east of Little Tujunga Canyon Road where grading and placement of utility lines would be required.
- **Santa Clara River Valley Groundwater Basin—**The Refined SR14 Build Alternative would cross the Santa Clara River Valley Groundwater Basin in an at grade covered tunnel at the Vulcan Mine (Figure 3.8-A-22) The Refined SR14 Build Alternative's design would include drainage facilities structured to capture upstream stormwater runoff and direct it into the Santa Clara River channel after treatment, which provides the primary groundwater recharge for this groundwater basin. The Construction SWPPP would set forth BMPs to manage the amount and quality of stormwater runoff. One optional adit (E1-A2) for the E1 Build Alternative would require the construction of a utility easement within the Santa Clara River Valley East Sub-basin. See Section 3.8.5.1,Section 3.8.5.2, and Section 3.8.5.3 for further discussion of the Santa Clara River Valley Groundwater Basin.
- **Antelope Valley Groundwater Basin—**The E1 and E2 Build Alternatives would require grading in the Antelope Valley Groundwater Basin in the ANF, including the SGMNM, west of Arrastre Canyon (Figure 3.8-A-23).

The SR14A, E1A, and E2A Build Alternatives would also require that construction activities occur, and permanent facilities remain, within groundwater basins located within the ANF, including portions of the SGMNM. The Refined SR14, E1, and E2 Build Alternatives would share the same alignments and facilities as those alternatives.

Dewatering activities in the ANF could introduce contaminants to groundwater. Dewatering could be required at the San Fernando Valley Groundwater Basin, Santa Clara River Valley Groundwater Basin, and the Antelope Valley Groundwater Basin, where trenching, grading, placement of utility lines, and construction of aboveground and at grade alignment could encounter high groundwater. With respect to the construction of tunnels, any water that seeps into the tunnel cavities would be captured and treated prior to being discharged into natural water courses. In areas with high groundwater, seepage related to uncontained chemical spills could result in direct impacts on groundwater basins. The magnitude of impacts associated with a release or spill would vary depending on the distance of the spill from surface water features, the total volume of materials, soil permeability, physiological features of the location, and climatic conditions at the time of the release.

The construction period SWPPP (HYD-IAMF#3) would ensure that water quality impacts are avoided and minimized, including those potential impacts related to channel dewatering and tunnel construction. HWR-MM#1 will require the Authority to treat potential groundwater contamination based on RWQCB permit requirements (see Impact HWR#2: Construction Activities Required for the Build Alternatives.). Given the above, the Palmdale to Burbank Project Section would not substantially degrade groundwater quality in USFS lands.

Flood Zones

None of the Build Alternatives would create a permanent surface footprint in the FEMA SFHAs in the ANF. However, USFS requested information on proposed drainage crossings within and adjacent to the ANF to determine the number of structures that may be subject to increased flow/debris rates downstream of areas burned by wildfires. The locations of the drainage structures in the ANF were compared to the size of the watershed and the watershed's potential wildfire rating to predict structures that may need to be reevaluated for flows greater than the 100-year event and mud flows (see Section 3.8.8.3 for discussion of flood zones). Each Build Alternative would include several drainage crossings, within or adjacent to ANF, including areas within the SGMNM, that could be susceptible to increased flow/debris rates as the result of a wildfire as noted below:

- Refined SR14 Build Alternative—The alignment and ancillary facilities would cross drainages downstream of potential ANF wildfire areas at three locations: the at grade covered tunnel in Vulcan Mine (Figure 3.8-A-33), the viaduct over the Santa Clara River (Figure 3.8-A-33), and a CSA/utility line crossing associated with SR14-A1 (Figure 3.8-A-36).
- E1 Build Alternative—The alignment would include viaduct and grading improvements near existing culverts in the Aliso Canyon area (Figure 3.8-A-58). In addition, CSAs and ancillary facilities associated with the E1-A1/E1-A2 adit options (Figure 3.8-A-61) would include surface drainage crossings in the ANF including the SGMNM along Little Tujunga Road.
- E2 Build Alternative—The alignment and ancillary facilities would cross drainages downstream of potential ANF wildfire areas at the following locations:
  - Viaducts and grading improvements in Aliso Canyon (Figure 3.8-A-77)
  - CSAs and ancillary facilities associated with the E2-A1/E2-A2 adit options (Figure 3.8-A-90)
  - The tunnel portal at the southern perimeter of ANF, immediately north of the Big Tujunga Creek crossing (Figure 3.8-A-68)

The SR14A, E1A, and E2A Build Alternatives would also require footprints in flood zones located in the ANF, including the SGMNM. Such impacts would be identical to those resulting from the implementation of the Refined SR14, E1, and E2 Build Alternatives, respectively.

Groundwater Recharge

As described in Section 3.8.5.5 portions of the Refined SR14, E1, and E2 Build Alternatives would traverse groundwater basins in the ANF. Permanent impermeable surfaces introduced in and adjacent to the ANF, including areas within the SGMNM, could disrupt infiltration of water from the surface into groundwater basins affecting groundwater levels and associated aquatic resources. Reductions in groundwater recharge could lead to reductions in groundwater levels over time. However, the amount of impervious surface created with in the ANF would be limited to small areas (i.e., construction of permanent adits, utilities, and minor roadway improvements), and would not have an adverse effect on groundwater recharge.

Hydrologic Resources Dependent on Groundwater

As discussed in Impact HWR#5, tunnel construction under the ANF involves complicated hydrogeological and hydrological issues. To assess how these hydrogeological and hydrological issues would affect the feasibility of constructing the tunnels, the Authority conducted preliminary geotechnical investigations in portions of the ANF. These investigations yielded information concerning environmental impacts expected to be encountered in building the proposed tunnel. The investigations, however, were not focused on a specific Build Alternative. Once the Preferred Alternative has been selected, further geotechnical investigations would be conducted, and additional information developed to support design and construction. The information garnered from this effort will help guide tunnel design and construction methods to further avoid and reduce impacts on hydrological resources.

Based on the available information, key assumptions used in the impact evaluation include: (1) most potential high groundwater flows would be encountered during tunnel construction where faults are intersected, and tunneling through faults could result in movement of the water parallel to the fault, (2) higher groundwater pressures increase the probability of an effect, (3) springs often occur in association with faults and could be affected through loss of groundwater when tunnel construction intersects faults, and (4) areas supporting springs not associated with known faults are assumed to be either connected through unknown faults and are also at risk or are maintained by annual precipitation infiltrating into a shallow aquifer only and are not at risk.

Groundwater seepage into tunnel structures during construction could affect streams, springs, wells, and other hydrology features reliant on groundwater aquifers. As set out in Table 3.8-12, the Refined SR14 and SR14A Build Alternatives would have the lowest potential impacts within the ANF.

HYD-IAMF#5, HYD-IAMF#6, and HYD-IAMF#7 requires the Authority to utilize tunnel design features and construction methods to avoid and minimize groundwater inflows during and after tunnel construction. HWR-MM#4 requires the Authority to implement an AMMP, which would involve ongoing monitoring and reporting activities to allow for the detection and timely remediation of effects on hydrologic resources that may occur in the ANF including the SGMNM.

Operations Effects

As discussed in Impact HWR#6, operations of each of the six Build Alternatives would result in the production of pollutants, including trash, debris, oil, grease, brake dust, and maintenance-related chemicals. These pollutants could affect groundwater quality in the ANF, including the SGMNM, along the tunneled alignment and surface water quality at aboveground facilities described above. Implementation of HMW-IAMF#9 would minimize hazardous materials selected for use throughout operations of each of the six Build Alternatives and HMW-IAMF#10 will implement hazardous materials plans to provide for the correct handling of hazardous materials throughout operations and maintenance activities. Additionally, HYD-IAMF#1 will require the use of BMPs to treat stormwater runoff during operations and HYD-IAMF#4 will require the adherence to industrial NPDES requirements. See Section 3.8.6.3 for additional information regarding operations impacts.

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