APPENDIX H

Geology, Soils, and Seismicity Technical Report

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GEOLOGY, SOILS, AND SEISMICITY TECHNICAL REPORT

NORTH HAIWEE DAM NO. 2 PROJECT

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1 Introduction

This technical report provides an environmental assessment of the North Haiwee Dam No. 2 Project (Proposed Project) with regard to geology, soils, and seismicity. It provides a discussion of the following:

- Various components of the Proposed Project;
- Methodology and assumptions of this environmental analysis;
- Regulatory setting;
- Affected environment;
- Project impacts associated with geologic hazards;
- Project impacts associated with geologic resources; and,
- Potential mitigation measures, if necessary, that could be implemented to reduce or avoid those impacts.

This technical report has been prepared in support of the draft joint Environmental Impact Report/Environmental Assessment (EIR/EA) for the Proposed Project and concludes with an Impact Summary under the National Environmental Policy Act (NEPA) and Significance Conclusions under the California Environmental Quality Act (CEQA). The Draft EIR/EA has been prepared with the City of Los Angeles Department of Water & Power (LADWP) as the lead agency under CEQA and the U.S. Bureau of Land Management (BLM) as the lead agency under NEPA.

2 Project Description

LADWP proposes to improve the seismic reliability of the North Haiwee Reservoir (NHR) located in the Owens Valley, California, approximately 150 miles north of Los Angeles (see Figure 1). The LADWP owns and operates the existing North Haiwee Dam (NHD) (constructed in 1913), which impounds NHR and is an essential component of the Los Angeles Aqueduct (LAA) which transports water from the Owens Valley through NHR to southern California and the City of Los Angeles.

A seismic stability evaluation conducted by LADWP (2001), concluded that NHD could experience structural failure in the event of a Maximum Credible Earthquake (MCE) scenario. Extensive liquefaction during the MCE would occur in the foundation of NHD, causing the crest of the existing Dam to settle between five and nine feet. This could result in an uncontrolled release of water from NHR and the consequent inability to transport water along the LAA to the City of Los Angeles.

Based on this seismic evaluation, the California Department of Water Resources, Division of Safety of Dams (DSOD) directed LADWP to operate NHR at a restricted maximum surface water elevation of 3,757.5 feet since July 2012 instead of the previously approved water level of up to 3,760 feet, in order to prevent flooding in the event of a MCE. These restrictions placed on operations of NHR provide a narrow range of elevations that meet the requirements of DSOD while still allowing the LAA system to operate effectively. In order to resume operations of NHR of up to 3,760 feet, LADWP needs to comply with DSOD requirements, and has been in coordination with DSOD regarding continuous progress on seismic improvements. To that end, LADWP is proposing the North Haiwee Dam No. 2 Project (Proposed Project), which includes the construction of North Haiwee Dam No. 2 (new Dam or NHD2) to the north of the existing Dam to serve as a backup dam in the event NHD is damaged by the an earthquake event.

Two build alternatives, referred to as the “Excavate and Recompact Alternative” and the “Cement Deep Soil Mixing (CDSM) Alternative,” are being considered for construction of the NHD2. The Excavate and Recompact Alternative involves excavation of the dam foundation down to 30 feet below ground surface (bgs), and subsequent refilling and mechanical compaction of the soil to treat liquefiable soils. The CDSM Alternative involves drilling large diameter boreholes. As the drill rig advances the large diameter borehole, it will inject cement and/or other admixtures and blend these with the native soil to create a strengthened column. The CDSM Alternative would involve excavation of the dam foundation to 15 feet bgs, and then installation of the CDSM columns. Columns would be approximately six feet in diameter, and would be from 55 to 80 feet bgs, depending on their location within the dam footprint. Following installation of the columns the excavated area would be refilled and recompacted, as it would under the Excavate and Recompact Alternative.

The Proposed Project consists of the following components, which are common to both Build Alternatives:

- Construction of the NHD2 components: NHD2, the east and west berms, and grading of the basin area between NHD and NHD2;
- Realignment of Cactus Flats Road;
- Realignment of LAA and construction of the diversion structure and temporary bridge;
- Construction of the diversion channel and NHD modifications;
- Excavation of materials from Borrow Site 10[1]; and
- Purchase and hauling of materials from Borrow Site 15.

The differentiating component between the two Build Alternatives is the method of construction of the foundation of NHD2, which affects the timeline and construction efforts of the NHD2 components and use of Borrow Sites 10 and 15. Construction of the remaining Proposed Project components is the same between the two Build Alternatives, except for the timeline of the diversion channel and NHD modifications.

NHD2 would be constructed approximately 800 feet north of and roughly parallel to the NHD axis (see Figure 3). NHD2, which would serve as a backup dam in the event NHD is damaged by an earthquake event, would be designed to retain water in NHR. NHD2 would be a zoned earthen embankment dam comprised of shell, core, filter, and drain materials.

The westerly abutment of NHD2 would encroach upon a portion of the existing LAA. In order to construct NHD2 and maintain operations of the LAA, the Proposed Project would realign a portion of the LAA (see Figures 3 and 4). Once the realigned LAA is constructed, the flow of water through the existing LAA would be halted temporarily to connect the newly built segment to the existing LAA. After the LAA is reconnected, the obsolete LAA segment would be demolished and backfilled. Any excess soil from the excavation would be analyzed for potential use as material for NHD2. The realigned LAA would have the following design parameters:

- Trapezoidal Concrete Channel
- Approximately 1,900 feet in length
- Channel Width: 32 to 35 feet
- Channel Depth: 12 to 15 feet
- Channel Side Slopes: 1 Horizontal: 1 Vertical.

The area between NHD and the proposed NHD2 would be utilized as a basin (see Figure 3). Water would travel from the realigned LAA into the Basin, and then through a notch that will be cut into NHD, into the existing NHR. The Basin and its appurtenant components would be constructed incrementally during construction of the proposed LAA Realignment, during construction of NHD2, and after construction of NHD2. During construction of the LAA Realignment, a diversion structure would be constructed that would allow for the water to be diverted from the LAA into the Basin. During construction of NHD2 the Basin floor would be graded to create a level bottom and two earthen berms would be constructed to close in the west and east sides of the Basin. After construction of NHD2, a diversion channel that connects the Diversion Structure to the Basin would be constructed and the notch in NHD would be excavated. In

[1] Borrow Site 10 refers to the LAA Excavation Area and Borrow Site 15 refers to the existing mine in Keeler in the Draft EIR/EA.

addition, a geomembrane would be installed on the Basin floor and slope protection measures would be added to the upstream (north side) of NHD. The proposed Diversion Structure, Diversion Channel, and notch would match the design parameters for the proposed LAA Realignment, allowing the proposed Basin to handle the LAA system’s flow rate of 900 cubic feet per second.

The bottom of the proposed Basin would be graded to create a level bottom during earthwork for NHD2. The proposed West and East Berms would be constructed at the same time. These berms would be constructed to prevent water from flooding out of the proposed Basin. The berms would be constructed using soil generated from Borrow Site 10, the proposed LAA Realignment, and leveling of the proposed Basin.

One to two feet of soil would be removed from the northern side of NHD (the downstream face), and a combination of filter layer and geomembrane would be installed to protect the slope once the proposed Basin is operational and the northern side of NHD is mostly submerged. A geomembrane would also be placed on the floor of the proposed Basin. These measures would help to enhance water quality and prevent erosion issues once the proposed Basin is filled. The proposed notch would be constructed through mechanical excavation and would be reinforced with six to eight inches of concrete with welded wire reinforcement.

As with the existing LAA, construction of NHD2 would interrupt the existing Cactus Flats Road, directly blocking the roadway. Cactus Flats Road, which falls under the jurisdiction of Inyo County, is not a primary roadway, but is used by mining vehicles traveling to and from local mining sites, LADWP personnel, and other motorists. In order to maintain access to this public road, the existing Cactus Flats Road would be realigned to accommodate NHD2, as shown on Figure 3. The preliminary design parameters for the realigned portion of Cactus Flats Road are an approximate length of 4,413 feet and width of 28 feet. The realigned Cactus Flats Road would have a grade of up to ten percent (dependent on final design) and would include excavation of a hillside cut and placement of a compacted fill that will be up to 20 feet thick. The road surface will include base material (approximately 2,700 feet) and will include a 4-foot wide concrete drainage culvert. The realigned Cactus Flats road will also necessitate the construction of a 14-foot wide north-south trending access road that it will intersect along the east side of the Haiwee Valley.

The construction of NHD2 would require various materials (riprap, gravel, and/or sand) to construct the new earthen dam. These materials would be sourced from two borrow sites (see Figure 2).

Borrow Site 10 (see Figures 3 and 4), located on BLM-managed land and LADWP property, is within and around the area where excavation for and construction of the realigned LAA would occur. Borrow Site 10 is proposed as a source of sand and gravel materials. Borrow Site 15 is proposed as a source of riprap and gravel materials. The borrow site is an active rock (dolomite) quarry on private land owned by Federal White Aggregate Incorporated. The quarry is currently being mined to provide crushed rock (rock aggregate) for the Owens Lake Dust Mitigation Project. As Borrow Site 15 is an existing active mine and LADWP would purchase materials from this borrow site, it will not be considered as part of the environmental analysis as it relates to geology, soils, and seismicity.

Refer to Chapter 1 (Introduction) and Chapter 2 (Project Description and Alternatives) of the Draft EIR/EA for further description of the Proposed Project, including purpose and need, objectives, regulatory requirements, alternatives, construction, and operations. Borrow Site 10 refers to the LAA Excavation Area and Borrow Site 15 refers to the existing mine in Keeler in the Draft EIR/EA.

3 Methodology and Assumptions

3.1 Methodology

This technical report presents a qualitative environmental assessment of the Proposed Project with regard to geology, soils, and seismicity. Based on the geologic conditions at and in the vicinity of the various components of the Proposed Project, the NEPA impact assessment, as described in this report, considered the following:

- Intensity of an impact, i.e., the extent or magnitude to which a particular impact would affect a given area.
- Duration of an impact, i.e., temporary or permanent.
- Probability of an impact, i.e., the relative likelihood of large seismic events would be low within the anticipated time frame of construction activities and would increase over the operational life of a facility.

This assessment is based on a review of geologic information that was collected from Project-related geologic/geotechnical reports prepared by LADWP and their design consultants, from published geologic reports and maps by the United States Geological Survey (USGS), the California Division of Mines and Geology (CDMG), which is now the California Geological Survey (CGS), and from academic research papers conducted in the vicinity of the Project Site.

The impact categories analyzed in this report correspond with criteria from CEQA. Regarding geologic hazards, an impact is considered to be significant and to require mitigation if it would result in exposure of people or structures to potentially substantial adverse effects, including the risk of loss, injury, or death involving any of the following:

- Rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map or based on other substantial evidence of active faulting.
- Strong seismic ground shaking.
- Seismically induced ground failure, including liquefaction, lateral spreading, and differential settlement.
- Landslides, including seismically induced landslides.
- Construction on a geologic unit or soil that is unstable or that would become unstable as a result of the Proposed Project, with the potential to result in onsite or offsite landslide, subsidence, or collapse. or
- Construction on expansive soil.

Regarding the potential loss of geologic resources, an impact is considered significant and would require mitigation if it would result in the following:

- Substantially accelerated soil erosion or substantial loss of topsoil; or,
- Loss or substantial reduction in availability of a known mineral, petroleum or natural gas, or geothermal resource of regional or statewide value.

3.2 Assumptions

The key assumptions of this assessment are that the Proposed Project would be designed, constructed and maintained in accordance all applicable laws, ordinances and regulations and with its primary design objective. That is, the NHD2, the Basin, the east and west berms, the realigned LAA, the Diversion Structure, and NHD modifications would be designed and constructed to provide sufficient seismic reliability of NHR to maintain the function of an essential water conveyance infrastructure component for the Los Angeles region, and protect local populations from a hazardous flooding event. The applicable laws, ordinances and regulations are summarized in the following section.

4 Regulatory Framework

4.1 Federal

NEPA applies to actions initiated by, funded by, or requiring discretionary approvals from federal government agencies. The Proposed Project would require discretionary approval from the BLM because the Proposed Project would affect federally-owned lands. The BLM, as the NEPA Lead Agency, will prepare NEPA documentation for the proposed action. NEPA requires the consideration of potential environmental effects, including potential effects to geology, soils, and geologic resources, in the evaluation of any proposed federal agency action.

4.1.1 Federal Laws

There are no specific federal regulations that are directly pertinent to geologic and seismic hazards assessments. However, there are a few federal regulations that have incidental relevance to some of the geologic considerations, such as erosion of soils, considered under the CEQA.

The Clean Water Act (CWA) provides guidance for the restoration and maintenance of the chemical, physical, and biological integrity of the nation's waters. Under the provisions of the CWA, the National Pollutant Discharge Elimination System (NPDES) permit program controls water pollution by regulating point sources that discharge pollutants into waters of the United States. One source of water pollution addressed by the CWA and the NPDES is sediment derived from grading activities. Thus, control of sediment discharge required by the CWA has a beneficial consequence related to the potential for soil erosion.

The Farmland Protection Policy Act directs federal agencies to identify and quantify adverse impacts of their actions on farmland. The Act's purpose is to minimize conversion of agricultural land and soils to non-agricultural use. The Farmland Protection Policy Act is intended to minimize the impact Federal programs have on the unnecessary and irreversible conversion of farmland to nonagricultural uses.

Grading and development on federal lands would be governed by the BLM. A primary source of specifications for development actions on federal land, including clearing and grubbing, grading, excavation and fill, storm drainage, use of explosives, and seeding and soil remediation, is contained in the BLM 9100 Series Manuals (BLM, 2015).

4.2 State

4.2.1 Surface Mining and Reclamation Act

Pursuant to the Surface Mining and Reclamation Act of 1975 (SMARA), the State Board of Mining and Geology adopted guidelines for the management of mineral resources and preparation of local general plans. The purpose of SMARA is to identify significant mineral resources, and provide this information to local jurisdictions to be considered before land-use decisions are made that may preclude future mining. However, local governments retain the authority to control the use of lands within their jurisdictions. All local jurisdictions within the Project vicinity have implemented the requirements of SMARA in their general plans. Inyo County is the Lead Agency for the processing of surfacing mining reclamation plan applications.

Inyo County, in concurrence with the State of California, has determined that the Proposed Project is not subject to SMARA, per exceptions listed under Section 2714 of SMARA.

4.2.2 Alquist-Priolo Earthquake Fault Zoning Act

Because surface faulting is generally confined to a relatively narrow zone, avoidance is often a practical means of mitigating surface fault rupture hazards for many facilities. Therefore, to help identify and reduce the hazard of surface fault rupture, the Alquist-Priolo Earthquake Fault Zoning Act (A-P Act), a state law, regulates certain development projects near active faults. The purpose of the A-P Act is to prohibit the location of most structures intended for human occupancy across the trace of an active fault. To be zoned under the A-P Act, a fault must be considered active or both sufficiently active and well defined (Bryant and Hart, 2007). The CGS defines an “active fault” as one that has had surface displacement within Holocene time (approximately the last 11,000 years). A “sufficiently active fault” is one that has evidence of Holocene surface displacement along one or more of its segments or branches, and to be “well defined” its trace must be clearly detectable as a physical feature at or just below the ground surface (Bryant and Hart, 2007). The A-P Act requires that cities and counties regulate certain development projects within the zones, which include withholding permits until geologic investigations demonstrate that development sites are not threatened by future surface displacement.

4.2.3 Regulations Pertaining to Supervision of Dams and Reservoirs

Since August 14, 1929, the State of California has regulated dams to prevent failure, to safeguard life, and to protect property. The legislation was a result of the failure of St. Francis Dam in March of 1928. A state commission reported that the dam failed because it was ill-built in a geologically unstable site. The failure of the St. Francis Dam prompted the State Legislature, on August 14, 1929, to create what is today the DSOD, under the California Department of Water Resources.

The DSOD, under the police power of the state, shall oversee the construction, enlargement, alteration, repair, maintenance, operation, and removal of dams and reservoirs for the protection of life and property. DSOD engineers and engineering geologists review and approve plans and specifications for the design of dams and oversee their construction to insure compliance with the approved plans and specifications. Reviews include site geology, seismic setting, site investigations, construction material evaluation, dam stability, hydrology, hydraulics, and structural review of appurtenant structures. In addition, DSOD engineers inspect operating dams on a yearly schedule to insure they are performing and being maintained in a safe manner. It is unlawful to construct, enlarge, repair, alter, remove, maintain, or operate any dam or reservoir except upon approval of the DSOD.

Construction of any new dam or reservoir or the enlargement of any dam or reservoir shall not be commenced until the owner has applied for and obtained from the DSOD written approval of plans and specifications. The DSOD may also require the following:

(a) Data concerning subsoil and foundation conditions and the materials entering into construction of the dam or reservoir.

(b) Investigations of, and reports on, subsurface conditions, involving such matters as exploratory pits, trenches and adits, drilling, coring, geophysical surveys, tests to determine leakage rates, and physical tests to measure in place the properties and behavior of foundation materials at the dam or reservoir site.

(c) Investigations of, and reports on, the geology of the dam or reservoir site and its vicinity, possible geologic hazards, availability and quality of construction materials, and other pertinent features.

With regard to seismic hazards and dam safety analysis, the DSOD adopted more conservative criteria for designating a fault as active or inactive (Fraser, 2001) than what was accepted for the A-P Act. The DSOD defines three general categories of fault activity which are, “active fault,” “inactive fault,” and “conditionally active fault.” An “active fault” is a fault that has ruptured within the last 35,000 years and an “inactive fault” is a fault that is overlain by unbroken (unfaulted) geologic materials that are older than

35,000 years. A "conditionally active fault" is a fault that is known to either be of Quaternary age and/or to have attributes consistent with the current tectonic regime, but its displacement history during the last 35,000 years is not sufficiently known to determine the fault to be either active or inactive. The DSOD treats the "conditionally active fault" the same as the "active fault" for dam design or evaluation with the understanding that additional investigation could change the designation. The DSOD allows construction of dams across active and conditionally active faults if appropriate design mitigation can be provided (Fraser, 2009). The design mitigation requires paleo-seismic investigations that provide the accurate location and character of the fault zone. The anticipated slip per event and the sense of movement are the design parameters that are typically required for development of mitigation measures for dams that cross active faults.

4.2.4 Stormwater Pollution Prevention Plan

The State of California administers the permit program authorized by the CWA (Federal Law). Under the provisions of the CWA, the NPDES permit program controls water pollution by regulating point sources that discharge pollutants into waters of the United States.

Dischargers whose projects disturb one or more acres of soil or whose projects disturb less than one acre but are part of a larger common plan of development that in total disturbs one or more acres, are required to obtain coverage under the General Permit for Discharges of Stormwater Associated with Construction Activity. Construction activity subject to this permit includes clearing, grading and disturbances to the ground such as stockpiling or excavation.

The Construction General Permit requires the development and implementation of a Stormwater Pollution Prevention Plan (SWPPP). The SWPPP must list Best Management Practices (BMPs) that the discharger will use to protect reduce/minimize stormwater runoff. BMPs in the SWPPP would typically include measures such as limiting construction activities to the minimum area necessary, using silt fences or straw bales to filter sediment in runoff, re-vegetating bare soil areas before onset of the wet season, and locating covered material storage areas away from drainage channels. Additionally, the SWPPP must contain a sediment monitoring plan if the site discharges directly to a water body.

4.3 Regional and Local

California state law requires each city and county to adopt a General Plan which provides policy regarding acceptable land uses. The policies of the General Plan are intended to provide guidance for most land-use decisions. General plans are required to address the specified provisions of each of seven mandated elements, including a Public Safety Element and a Conservation/Open Space Element. The Proposed Project is located within the purview of the Inyo County General Plan (ICGP, 2001).

The Public Safety Element of the ICGP (2001) identifies various hazards that may occur within their jurisdictions, including seismic and geologic hazards, and provides basic policies that consider geologic conditions for land development and use in order to preserve life and protect property in the event of a natural disaster. These policies provide basic guidelines and requirements for analysis and mitigation of seismic and geologic hazards. The Public Safety Element of the ICGP seeks to minimize exposure to hazards and structural damage to habitable structures from geologic and seismic conditions. The safety element includes several policies that restrict development of habitable structures in seismic hazard zones, support seismic upgrades to older buildings, provide disaster education materials, and require new developments to provide engineering design strategies to comply with appropriate building standards. However the Proposed Project would not include habitable structures. Thus, the Public Safety Element of the ICGP has no specific policies that are relevant to the Proposed Project.

The Conservation/Open Space Element of the ICGP (2001) seeks to maintain the productivity of Inyo County's soils. The Conservation/Open Space Element includes the following policies regarding soil and erosion:

- **Policy S-2.1 Soil Erosion.** Minimize soil erosion from wind and water related to new development.
- **Policy S-2.3 Soil Instability.** In areas of unstable soils and/or steep terrain, the County shall limit the intensity of development in order to minimize the potential for erosion and landform instability.

The Conservation/Open Space Element of the ICGP also seeks to maintain the critical mineral and energy resources of the County. The policies adopted by the element are focused on protection of sufficient sand and gravel resources, reclamation and other mitigation of mining impacts, and protection of new and existing residential land uses from impacts associated with mining operations, such as noise and dust. The Conservation/Open Space Element includes the following policies regarding mining:

- **Policy MER-1.1 Resource Extraction and the Environment.** Support the production of mineral resource where it would not significantly impact sensitive resources as defined by CEQA and this General Plan.
- **Policy MER-1.2 Minimize Land Conflicts.** New mining operations shall be designed to provide a buffer between existing or likely adjacent uses to minimize incompatibility with nearby uses, and adequately mitigate their environmental and aesthetic impacts.
- **Policy MER-1.3 SMARA Compliance.** The County shall ensure that all mining projects comply with the requirements of the California SMARA. As part of this compliance, all mining operations shall prepare and implement reclamation plans that mitigate environmental impacts and incorporate adequate security to guarantee proposed reclamation.
- **Policy MER-1.4 Environmental Contamination.** All mining operations will be required to take precautions to avoid contamination from wastes or incidents related to the storage and disposal of hazardous materials, or general operating activity at the site.
- **Policy MER-1.5 Maintain Accessibility.** Ensure that extractive resource areas are protected from incompatible development that could interfere with extractive operations, now or in the future.

5 Existing Conditions

Comprehensive geologic/geotechnical investigations have been performed at the Project Site by LADWP and their consultants to support the design of the Proposed Project (URS, 2007; Black & Veatch, 2013, 2014, 2015; LADWP, 2015). This section summarizes the key findings of these investigations with regard to the environmental assessment of geologic hazards.

5.1 Geologic Setting

The Project Site and Borrow Sites are located in the southern end of the Owens Valley. The Owens Valley is an approximately 100 mile long graben (fault bounded valley). In the vicinity of the Project Site, the southern Owens Valley is located between the Sierra Nevada mountain range on the west and the Inyo Mountains and the Coso Range on the east (see Figure 5). The major active fault zones that are located within Owens Valley in the vicinity of the Project Site (see Figure 6) include the Owens Valley Fault Zone (OVFZ) and the Sierra Nevada Frontal Fault Zone (SNFFZ) (Jennings & Bryant, 2010). The OVFZ is a predominantly right-lateral strike slip fault (Beanland & Cark, 1994) whereas the SNFFZ is primarily a normal slip fault (Slemmons et al., 2008). The primary strands of the OVFZ extend across Owens Lake into the northern Coso Range (Slemmons et al., 2008) about three miles (five kilometers [km]) to the east of NHR. The SNFFZ, which extends along the eastern Sierra Nevada range front from south of the Project area to north of Owens Valley, is located as close as approximately one mile (2 km) to the west of NHR.

Like most of California, the Project Site is located in a seismically active region that is well known for its many active faults and historic seismicity. Therefore, the Project Site may be subjected to future seismic shaking and strong ground motion resulting from seismic activity along local, regional, and more distant active faults.

NHR occupies a paleo-drainage that flowed from Owens Lake on the north to Rose Valley on the south (Bacon et al., 2006), which is informally named the “Haiwee Valley.” The Haiwee Valley is bounded on the west by late Pleistocene and Holocene alluvial fans that emanate from the Sierra Nevada and on the east by Mio-Pliocene age volcanic and sedimentary rocks of the Coso Formation and early to mid-Pleistocene alluvial fan deposits that flank the northwestern edge of the Coso Range. The Coso Formation is a Pliocene age, weakly lithified, sedimentary, and volcaniclastic rock formation that consists of arkosic sandstones, siltstones, rhyolitic tuffs, and occasional fanglomerates (Bacon et al., 1981). The Haiwee Valley is filled with Holocene alluvial fan and channel deposits that originate from both the Sierra Nevada and the Coso Range (URS, 2007; Black & Veatch, 2013).

5.1.1 Proposed North Haiwee Dam No. 2

The proposed NHD2, which would be constructed 800 feet north of the existing NHD, would span the Haiwee Valley from the distal edge of the Sierran alluvial fans on the west to the alluvial fan deposits of the northern Coso Range on the east (see Figure 7). The Haiwee Valley has a relatively flat to very gently north-eastward sloping surface that is approximately 1,600 feet wide along the dam axis. Modest slopes rise from the valley floor at each abutment. Along the proposed axis of NHD2, the valley floor varies in elevation from a high of approximately 3,750 feet near the base of west abutment to an elevation of approximately 3,735 feet near the base of the east abutment.

As shown on Figure 7, modified land (ml) of the LAA on late Pleistocene age alluvial fan deposits (Qaf3) encompass the west abutment of the proposed NHD2. Older alluvial fan deposits (Qoa1) would form the east abutment of NHD2, and Holocene age alluvial fan deposits (Qaf1) would comprise the NHD2 foundation between the east and west abutments. Based on borings that were completed by the engineering design team at and near the proposed NHD2 footprint (Black & Veatch, 2013; LADWP 2015), the alluvial deposits in the Haiwee Valley are up to about 100 feet thick and are underlain by bedrock of the Coso Formation. Beneath the NHD2 footprint, the Coso Formation is principally interbedded sandstone and siltstone (Black & Veatch, 2013). Along the northwestern flank of the Coso Range, and presumably beneath the NHD2 footprint, the bedding of the Coso Formation dips about 10 to 20 degrees towards the northwest.

The depth to groundwater in Haiwee Valley at the proposed NHD2 footprint is relatively shallow and fluctuates depending on seasonal rainfall and the water level in NHR (Black & Veatch, 2014). Groundwater levels were measured in July 2006 at approximately 13 feet below ground surface (bgs) at the proposed east abutment of NHD2 and 16 feet bgs near the proposed west abutment (URS, 2007). Groundwater levels were deeper in November and December 2013 when they were measured at approximately 19 feet bgs in an observation well near the proposed east abutment, and approximately 37 feet bgs in an observation well near the proposed west abutment (Black & Veatch, 2014).

Comprehensive investigations of local faulting were performed at and near NHD (DSOD, 2002, 2003; URS, 2007; Black & Veatch, 2013) to assess the surface fault rupture hazard for the existing Dam and NHD2. The principal conclusion of the final fault investigations (Black & Veatch, 2013) was that no active faults cut through the proposed NHD2 footprint. A fault that was informally named “Fault A” is the nearest active fault (by the DSOD criterion of having at least one event in the last 35,000 years) to the proposed NHD2 footprint (see Figure 7). The comprehensive fault investigations, which included fault trenching, seismic reflection surveys, drilling and cone penetration test (CPT) investigations, geologic mapping and development/analysis of LIDAR images, demonstrated that Fault A is located no closer than about 900 feet to the east of the proposed right abutment footprint of NHD2 (Black & Veatch, 2013).

5.1.2 Proposed LAA Realignment

As noted above, the westerly abutment of NHD2 would encroach upon a portion of the existing LAA and therefore, the LAA would need to be realigned. The LAA Realignment would involve excavation of a trapezoidal channel that is approximately 1,900 feet in length, 32 to 35 feet wide, and 12 to 15 feet deep within the Pleistocene age alluvial fan deposits (Qaf3) that would form the west abutment of NHD2 (see Figure 7). The alluvial fan surface along the proposed LAA Realignment, which is as much as 50 feet above the elevation of the aqueduct, would need to be excavated (lowered) to enable excavation and installation of the aqueduct channel. This necessary excavation would be part of what is considered Borrow Site 10 (see discussion below in Section 5.1.5). Depending on how much borrow material would be taken from Borrow Site 10, the proposed LAA Realignment could result in a cut slope adjacent to the west side of the aqueduct that is up to 50 feet high.

The engineering design team for the Proposed Project completed 16 borings along and near the proposed LAA Realignment to investigate the subsurface conditions and to determine the suitability of the soil for use as borrow material for NHD2 (LADWP, 2015). Based on these investigations, the Qaf3 deposits that underlie the proposed LAA Realignment mostly consist of well consolidated silty sand with few gravel and cobble beds. Based on these borings and soil borings done for NHD2, it is expected that groundwater in the vicinity of the proposed LAA Realignment footprint would range from approximately 50 to 75 feet bgs.

The proposed LAA Realignment footprint would not be located within an Alquist-Priolo Earthquake Fault Zone (Bryant and Hart, 2007), nor is there evidence that suggests the existence of faulting. There are no known faults, either active or inactive, that trend through the proposed LAA Realignment (URS, 2007, Black & Veatch, 2013).

5.1.3 Proposed Basin

As noted above, the area between the existing NHD and the proposed NHD2 would be modified so it could be utilized as a Basin. Construction of the proposed Basin will involve several components, including a Diversion Structure and Diversion Channel to convey water to the Basin, West and East Berms that will prevent water from flowing out of the proposed Basin, grading to create a level basin floor, and excavation of a notch in the existing Dam to connect the Basin and NHR.

The proposed Basin would be contained by the distal edge of the Sierran alluvial fans and a West Berm on the west; by NHD2 on the north; by older alluvial fan deposits of the northern Coso Range and an East Berm on the east; and by NHD on the south (see Figure 7). The Basin floor would span the Haiwee Valley, which currently has a gently north-eastward sloping surface that is underlain by young alluvial fan deposits.

As shown on Figure 7, artificial fill/modified land (af/ml) developed along late Pleistocene age alluvial fan deposits (Qaf3) will underlie the proposed Diversion Structure. The Diversion Channel and the West Berm will mostly be constructed on alluvial fan deposits (Qaf3) and af/ml associated with the existing LAA. The East Berm will abut older alluvial fan deposits (Qoa1) at its north end, spanning a lower area underlain by alluvial fan and channel deposits (Qaf1), and abut NHD (af) on its south side. Most of the Basin area is underlain by the alluvial fan and channel deposits (Qaf1). The notch will be cut through the fill (af) that comprises the NHD embankment.

The comprehensive investigations of local faulting that were performed at and near NHD (DSOD, 2002, 2003; URS, 2007; Black & Veatch, 2013) to assess the surface fault rupture hazard for the existing Dam and NHD2 also demonstrate that no active faulting will cross beneath any of the Basin components.

5.1.4 Proposed Cactus Flats Road Realignment

As noted above, NHD2 would encroach upon a portion of the existing Cactus Flats Road and therefore, the road would need to be realigned. The proposed Cactus Flats Road Realignment would involve construction of a 28-foot wide roadway for an approximate length of 4,413 feet. As shown on Figure 7, proceeding from northwest to southeast, the realigned portion of Cactus Flats Road would traverse relatively level ground of the Haiwee Valley, climb a west facing slope up to a relatively flat higher terrace surface, before rejoining the existing Cactus Flats Road approximately 900 feet southeast of NHD.

The subsurface conditions along the proposed Cactus Flats Road Realignment have been investigated by ten borings performed by the engineering design team for the Proposed Project. Based on these borings, the portion of the roadway that crosses the Haiwee Valley is underlain by Holocene age alluvial fan (Qaf1) deposits that are typically poorly consolidated silty sands. Based on nearby geotechnical borings and observation wells (Black & Veatch, 2013, 2014) that were completed for NHD2, it is anticipated that the depth to groundwater beneath the proposed Cactus Flats Road Realignment would fluctuate between 30 and 50 feet bgs. The portion of the proposed Cactus Flats Road Realignment that crosses the west facing slope is underlain by older (early Pleistocene) alluvial fan deposits (Qoa1) that are typically moderately well consolidated silty sands with occasional beds and discontinuous lenses of gravel with cobbles. The portion of the proposed Cactus Flats Road Realignment footprint that crosses the higher terrace surface is underlain by late Pleistocene fluvial terrace deposits overlain by colluvium (Qc/Qt3) and late Pleistocene to Holocene age alluvial channel and fan deposits (Qaf1, Qaf2, Qaf3). All of these deposits are typically poorly to moderately well consolidated sands and gravels. Some of the Qt3 deposits are well cemented by caliche (calcium carbonate).

Based on nearby borings performed for the Proposed Project (Black & Veatch, 2013), it is anticipated that groundwater along the west facing slope and the higher terrace portions of the proposed Cactus Flats Road Realignment footprint would be greater than 50 feet bgs.

The proposed Cactus Flats Road Realignment is not located within an Alquist-Priolo Earthquake Fault Zone (Bryant and Hart, 2007). However, the final fault investigations that were performed for the Proposed Project at and near NHD (Black & Veatch, 2013) suggested that a latest Pleistocene to Holocene age fault that was informally named Fault A possibly[2] crosses the proposed Cactus Flats Road Realignment somewhere near its southern end, as shown on Figure 7.

5.1.5 Borrow Site 10

Borrow Site 10 is an approximately 13.7 acre site (see Figure 4) that is located adjacent to the west side of the existing LAA. It is principally underlain by Pleistocene age alluvial fan deposits (Qaf3) that form the west abutment of NHD2 (see Figure 7). The alluvial fan surface within Borrow Site 10 slopes gradually towards the northeast. As noted above, the alluvial fan surface along the proposed LAA Realignment is as much as 50 feet above the elevation of the existing LAA. Thus, the surface of the fan would need to be excavated (lowered) to enable excavation and installation of the proposed LAA Realignment. This necessary excavation for the proposed LAA Realignment would be part of Borrow Site 10. Depending on the need for borrow materials for the NHD2 embankment, excavation within Borrow Site 10 beyond what is required for the proposed LAA Realignment may also be necessary.

As noted above, geotechnical borings were drilled along and near the Proposed Project to investigate the subsurface conditions and to determine the suitability of the soil for use as borrow material for NHD2 (LADWP, 2015). Based on these investigations, the Qaf3 deposits mostly consist of well consolidated silty sand with few beds of gravel with cobbles. Based on these borings as well as soil borings done for NHD2, it is expected that groundwater in Borrow Site 10 would range from approximately 50 to 75 feet bgs.

Borrow Site 10 is not located within an Alquist-Priolo Earthquake Fault Zone (Bryant and Hart, 2007), nor is there evidence that suggests the existence of faulting. There are no known faults, either active or inactive, that trend through Borrow Site 10 (URS, 2007, Black & Veatch, 2013).

[2] The location of Fault A shown on Figure 7 is approximate based on subsurface geophysical data (Advanced Geoscience Inc. 2012). Its exact location at the surface is unknown, so it is also possible that it crosses Cactus Flats Road further to the east, outside the limits of the Cactus Flats Road Realignment.

6 Impact Analysis

This section describes the impact analysis relating to geology, soils and seismicity for the Proposed Project components which include NHD2, the LAA Realignment, the Basin and its appurtenant constructions, the Cactus Flats Road Realignment, and Borrow Site 10. Borrow Site 15 is a commercial mining operation owned by Federal White Aggregate Incorporated, from which the LADWP would purchase crushed rock. As such, it is not under the regulatory purview of the CEQA/NEPA documents (EIR/EA) for the Proposed Project. Thus, impacts to Borrow Site 15 associated with geology, soils, and seismicity are not included in this impact analysis.

Impacts related to geology, soils and seismicity were analyzed qualitatively, based on a review of published geologic information, project specific investigations that have been done for the Proposed Project, and on professional judgment in accordance with the current standard of care for the geologic and geotechnical engineering professions. Analysis focused on the Proposed Project's potential to increase the risk of personal injury loss of life, and damage to property, including new facilities, as a result of existing geologic conditions in the Project area, and on the Proposed Project's potential to result in a reduction in the availability of geologic resources. The impact categories analyzed in this report generally correspond with criteria from CEQA.

6.1 Surface Fault Rupture

Surface fault rupture is ground deformation that occurs along the surface trace of the causative fault during an earthquake. Surface fault rupture is considered a potential hazard along faults that have ruptured the surface of the earth during the relatively recent geologic past (active faults). The presumption is that future surface fault rupture will occur where previous recent displacement (during the latest Quaternary) has taken place. If a fault is considered to be inactive, meaning that it has not had activity with the recent geologic past, it is presumed to not pose a surface fault rupture hazard.

As noted above in Section 4.2.2, the A-P Act is a state law that helps identify and reduce the hazard of surface fault rupture and regulates certain development projects (i.e., structures intended for human occupancy) near active faults. Although the A-P Act is not directly applicable to the types of facilities that are planned for the Proposed Project (i.e. dams, roads, aqueducts), the law provides for the delineation of active fault zones in the State of California by the CGS. Thus, the identification of an Alquist-Priolo Earthquake Fault Zone by the CGS at a particular site can be considered an indication that a surface fault rupture hazard likely exists at that site. However, surface fault rupture is not necessarily restricted to Alquist-Priolo Earthquake Fault Zones, as not all active faults in the State of California have been zoned by the CGS. For example, Fault A is an active fault that was discovered during the design investigations for the Project and which cuts across the Project area (see Figure 7) approximately 900 feet to the east of the NHD2 footprint. Although it is not an Alquist-Priolo zoned fault, it is known to have experienced surface displacement within latest Pleistocene to Holocene time (Black & Veatch, 2013) and is regarded as an active fault by the DSOD criterion.

The following subsections describe the level of hazard from surface fault rupture for each Project facility during construction and operation.

6.1.1 Construction Impacts of Surface Fault Rupture

North Haiwee Dam No. 2

The NHD2 site is not located within an Alquist-Priolo Earthquake Fault Zone (Bryant and Hart, 2007), and previously completed investigations by the LADWP and their geotechnical dam design consultants (Black & Veatch, 2013) have demonstrated that there are no "active" or "conditionally active" faults that cross the proposed NHD2 footprint. Therefore, surface fault rupture would not pose a hazard during construction of NHD2 for either the Excavate and Recompact Alternative or the CDSM Alternative. There would be no impacts from surface fault rupture hazard during construction of NHD2.

Los Angeles Aqueduct Realignment

The LAA Realignment site is not located within an Alquist-Priolo Earthquake Fault Zone (Bryant and Hart, 2007). Furthermore, the previously completed fault investigations (Black & Veatch, 2013) performed for NHD2 have also demonstrated that there are no “active” or “conditionally active” faults that cross the proposed LAA Realignment footprint. Therefore, surface fault rupture would not pose a hazard during construction of the LAA Realignment. There would be no impacts from surface fault rupture hazard during construction of the LAA Realignment.

Basin

The Basin, including all of its components, is not located within an Alquist-Priolo Earthquake Fault Zone (Bryant and Hart, 2007). Furthermore, the previously completed fault investigations (Black & Veatch, 2013) performed for NHD2 have also demonstrated that there are no “active” or “conditionally active” faults that cross the proposed Basin or any of its components. Therefore, surface fault rupture would not pose a hazard during construction of the Basin. There would be no impacts from surface fault rupture hazard during construction of the Basin.

Cactus Flats Road Realignment

The proposed Cactus Flats Road Realignment is not located within an Alquist-Priolo Earthquake Fault Zone (Bryant and Hart, 2007). However, local fault investigations (Black & Veatch, 2013) performed for NHD2 suggest that Fault A, which was identified as an active fault according to DSOD criteria, might cross the realigned portion of Cactus Flats Road. Therefore, it is conceivable that surface fault rupture could adversely impact the Cactus Flats Road Realignment. However, even with active faults, surface fault rupture is a relatively infrequent event. Due to the infrequent occurrence of surface fault rupture and the short duration of construction, the probability that a surface fault rupture would coincide with construction is extremely low. LADWP would implement Health and Safety and Emergency Response Plans during the construction phase that would outline proper safety procedures during a seismic event. These plans would be prepared in accordance with applicable regulations and would mitigate potential hazards due to surface fault rupture during construction activities associated with the proposed Cactus Flats Road Realignment. With implementation of the Health and Safety Plan and the Emergency Response Plan, impacts would be less than significant.

Borrow Site 10

Borrow Site 10 is not located within an Alquist-Priolo Earthquake Fault Zone, and no evidence exists that suggests that a fault cuts through Borrow Site 10. Therefore, surface fault rupture would not pose a hazard during mining operations of the Borrow Site. There would be no impacts from surface fault rupture hazard during construction in Borrow Site 10.

6.1.2 Operational Impacts of Surface Fault Rupture

North Haiwee Dam No. 2

The NHD2 site is not located within an Alquist-Priolo Earthquake Fault Zone (Bryant and Hart, 2007), and previously completed investigations by the LADWP and their geotechnical dam design consultants (Black & Veatch, 2013) have demonstrated that there are no “active” or “conditionally active” faults that cross the proposed NHD2. Therefore, surface fault rupture would not pose an operational impact for both the Excavate and Recompact Alternative and the CDSM Alternative. There would be no impacts from surface fault rupture hazard during operation of NHD2.

Los Angeles Aqueduct Realignment

The LAA Realignment would not be located within an Alquist-Priolo Earthquake Fault Zone (Bryant and Hart, 2007). Furthermore, the local fault investigations (Black & Veatch, 2013) performed for NHD2 have demonstrated that there are no “active” or “conditionally active” faults that would cross the LAA Realignment. Therefore, surface fault rupture would not pose an operational hazard for the LAA Realignment. There would be no impacts from surface fault rupture hazard during operation of the LAA Realignment.

Basin

The Basin would not be located within an Alquist-Priolo Earthquake Fault Zone (Bryant and Hart, 2007). Furthermore, the local fault investigations (Black & Veatch, 2013) performed for NHD2 have demonstrated that there are no “active” or “conditionally active” faults that would cross the footprint of the Basin. Therefore, surface fault rupture would not pose an operational hazard for the Basin or any of its components. There would be no impacts from surface fault rupture hazard during operation of the Basin.

Cactus Flats Road Realignment

The Cactus Flats Road Realignment would not be located within an Alquist-Priolo Earthquake Fault Zone (Bryant and Hart, 2007). However, local fault investigations (Black & Veatch, 2013) performed for NHD2 suggest that Fault A, which was identified as an active fault according to DSOD criteria, might cross the Cactus Flats Road Realignment. Therefore, it is possible that surface fault rupture could adversely impact the Cactus Flats Road Realignment. However, the proposed Cactus Flats Road Realignment would be designed and constructed in accordance with the latest versions of the applicable federal, state, and local codes relative to seismic criteria. Additionally, the proposed Cactus Flats Road Realignment would be located in the vicinity of the existing Cactus Flats Road alignment and, thus, would be exposed to the same risks as under existing conditions. Therefore, operation of the proposed Cactus Flats Road Realignment would not substantially increase the risk of hazards associated with surface fault rupture, and impacts would be less than significant.

Borrow Site 10

There would be no operational activities in Borrow Site 10 after construction activities are completed. Upon completion of construction (excavation), the Borrow Site would be vacant land that would have undergone restoration per the topsoil salvage and revegetation plan that will be prepared for this project. The topsoil salvage and revegetation plan would be implemented to ensure that adverse environmental hazards to public health and safety are eliminated, and would involve backfilling, grading, re-vegetation, soil stabilization, or other measures. Therefore, there would be no operational impact from surface fault rupture.

6.1.3 Cumulative Impacts of Surface Fault Rupture

The Proposed Project would not make any contribution to cumulative impacts with regard to surface fault rupture hazards.

6.2 Strong Seismic Ground Shaking

The Project Site and the Borrow Sites are located in a region that is well known for its many active faults and historic seismicity. Because the Project Site is in a seismically active region, it follows that it will be subjected to future seismic shaking and strong ground motion resulting from seismic activity along local, regional, and more distant active faults.

Strong seismic ground shaking occurs as energy is released during an earthquake. The intensity of ground motion depends upon the distance to the fault rupture, the earthquake magnitude, and the geologic conditions underlying and surrounding the site. In accordance with the standard of practice and DSOD guidelines, the design of NHD2 requires that a Deterministic Seismic Hazard Analysis (DSHA) be performed to estimate the maximum ground motions that could occur at the Project Site. In a DSHA, significant faults within the proximity of the site are identified and assessed for activity. For each seismic source, an earthquake scenario consisting of the maximum magnitude a fault is capable of generating (MCE) at the closest distance to the site under consideration is specified as the basis for the ground motion estimate. Statistically-based ground motion estimates for the several significant seismic sources are considered and a decision is made by the design team which fault and earthquake scenario controls the maximum loading for the structure.

The DSHA is intended to represent a conservative estimate of seismic parameters to provide guidance for engineering design. The three faults that were considered potential seismic sources in the DSHA for NHD2 included the SNFFZ, the OVFZ, and Fault A (Black & Veatch, 2015). The geoseismic characteristics of these faults are listed in Table 1, including an estimate of the maximum earthquake magnitude that might be generated by each fault.

TABLE 1
SUMMARY OF POTENTIAL SEISMIC SOURCES

Fault or Fault Zone	Fault Type	Approx. Closest Distance to Site in kilometers(miles)(1)	Approx. Max Magnitude, Mw(2)
Sierra Nevada Frontal Fault Zone (SNFFZ)	Normal Dip Slip	2 (1.2)	7 3/4
Owens Valley Fault Zone (OVFZ)	Strike-Slip	5.1 (3.2)	7 1/2
Fault A	Strike-Slip	0.6 (0.4)	6 1/2

Notes:

1. NHD2 location is assumed to be approximate center of proposed dam with latitude/ longitude coordinates of 36.2313, 117.9669. Distances noted for the SNFFZ and the OVFZ are the closest distance to the surface trace or surface projection of the fault as measured from the Uniform California Earthquake Rupture Forecast, Version 3 (UCERF3) earthquake source model (Field et al., 2013). Distance noted for “Fault A” is the closest distance to the inferred surface trace of the fault from Black & Veatch 2013.
2. Maximum credible earthquake values reported as maximum moment magnitude. The moment magnitude scale (abbreviated as M_W) is used to measure the size of earthquakes in terms of the energy released. The magnitude is based on the seismic moment of the earthquake, which is equal to the rigidity of the earth multiplied by the average amount of slip on the fault and the size of the area that slipped. An increase of one step on this logarithmic scale corresponds to a ~ 32 times increase in the amount of energy released, and an increase of two steps corresponds to a 1000 times increase in energy. Thus, an earthquake of M_W of 7.0 contains 1,000 times as much energy as one of 5.0 and about 32 times that of 6.0.

Source: Black & Veatch, 2015

For NHD2, the ground motions induced by seismic events are characterized by a value of spectral acceleration (SA). SA is a unit measured in the acceleration due to Earth's gravity, equivalent to g-force (g) that describes the maximum acceleration in an earthquake on an object. The SA at different frequencies are typically plotted to form a response spectrum. Ground Motion Prediction Equations (GMPEs), or “attenuation” relationships, provide a means of predicting the level of ground shaking at any given site, based on an earthquake magnitude, source-to-site distance, local soil conditions, and fault mechanism. Using the GMPE parameters, response spectra were developed for the SNFFZ, OVFZ, and Fault A earthquake scenarios. The DSHA demonstrated that the SNFFZ spectrum has the largest amplitude of the three scenarios at all periods between 0.01 and 10 seconds (s). Thus, the MCE response spectrum recommended for design analyses is based on the deterministic SNFFZ scenario. This spectrum is listed in Table 2.

TABLE 2
RECOMMENDED SPECTRUM FOR NHD2 DESIGN ANALYSIS

Period (seconds)	Spectral Acceleration (gravity)
0.00	0.825
0.01	0.825
0.02	0.849
0.03	0.914
0.05	1.100
0.08	1.342
0.10	1.544
0.15	1.826
0.20	2.043
0.25	2.032
0.30	1.961
0.40	1.713
0.50	1.503
0.75	1.157
1.00	0.893
1.50	0.586
2.00	0.492
3.00	0.361
4.00	0.244
5.00	0.183
7.50	0.092
10.00	0.057

Source: Black & Veatch, 2015

The following subsections describe the level of hazard from strong ground shaking for each Project facility during construction and operation.

6.2.1 Construction Impacts of Seismic Ground Shaking

North Haiwee Dam No. 2

Strong seismic ground shaking could potentially occur during construction of NHD2. However, due to the infrequent occurrence of seismic events and the temporary nature of construction activities, the probability that strong seismic shaking would coincide with construction activities is extremely low. LADWP would implement Health and Safety and Emergency Response Plans during the construction phase that would outline proper safety procedures during a seismic event. These plans would be prepared in accordance with applicable regulations and would mitigate potential hazards due to seismic ground shaking during construction activities associated with the proposed NHD2. With implementation of the Health and Safety Plan and the Emergency Response Plan, construction impacts would be less than significant for both the Excavate and Recompact Alternative and the CDSM Alternative.

Los Angeles Aqueduct Realignment

Strong seismic ground shaking could potentially occur during construction of the LAA Realignment. However, due to the infrequent occurrence of seismic events and the short duration of construction, the probability that strong seismic shaking would coincide with construction activities is extremely low. The preparation of Health and Safety and Emergency Response Plans in accordance with applicable regulations would mitigate potential hazards due to seismic ground shaking during the construction phase of the proposed LAA Realignment. With implementation of the Health and Safety Plan and the Emergency Response Plan, construction impacts would be less than significant.

Basin

Strong seismic ground shaking could potentially occur during construction of the Basin and its components. However, due to the infrequent occurrence of seismic events and the short duration of construction, the probability that strong seismic shaking would coincide with construction activities is extremely low. The preparation of Health and Safety and Emergency Response Plans in accordance with applicable regulations would mitigate potential hazards due to seismic ground shaking during the construction phase of the proposed Basin. With implementation of the Health and Safety Plan and the Emergency Response Plan, construction impacts would be less than significant.

Cactus Flats Road Realignment

Strong seismic ground shaking could potentially occur during construction of the Cactus Flat Road Realignment. However, due to the infrequent occurrence of seismic events and the short duration of construction, the probability that strong seismic shaking would coincide with construction activities is extremely low. The preparation of Health and Safety and Emergency Response Plans in accordance with applicable regulations would mitigate potential hazards due to seismic ground shaking during the construction phase of the proposed Cactus Flats Road Realignment. With implementation of the Health and Safety Plan and the Emergency Response Plan, construction impacts would be less than significant.

Borrow Site 10

Strong seismic ground shaking could potentially occur during excavation of Borrow Site 10. However, due to the infrequent occurrence of seismic events and the short duration of mining operations, the probability that strong seismic shaking would coincide with construction activities is extremely low. The preparation of Health and Safety and Emergency Response Plans in accordance with applicable regulations would mitigate potential hazards due to seismic ground shaking. With implementation of the Health and Safety Plan and the Emergency Response Plan, the impact of seismic ground shaking during excavation of the borrow site would be less than significant.

6.2.2 Operational Impacts of Seismic Ground Shaking

North Haiwee Dam No. 2

It is expected that strong seismic ground shaking will occur during the design life of NHD2, and like most engineering structures, earthen dams can potentially fail due to faulty design, improper construction, and/or poor maintenance practices. However, well-compacted rolled-fill dams are typically resistant to earthquake forces provided they are constructed on rock or overburden foundations that are resistant to liquefaction.

The design objective of the Proposed Project is for the LAA, including NHR, to remain operational after the design earthquake event. This criterion requires that the safety of the dam embankment not be impaired by (1) extensive cracking, (2) crest settlement that would excessively impair freeboard, or (3) excessive deformation in critical zones such as filters and drains.

As noted above, a DSHA was performed to provide a conservative estimate of the intensity of strong ground motion that can be expected at the dam site (Black & Veatch, 2015). The estimated ground motions would be input for stability and deformation analyses of the seismic behavior of the dam. Based on the results of these analyses, a seismically durable NHD2 that can withstand the impacts of strong seismic shaking would be designed and constructed. Since these are the design objectives of NHD2, the impacts from strong seismic ground shaking would be less than significant during operation of NHD2.

Los Angeles Aqueduct Realignment

As with NHD2, it is expected that strong seismic ground shaking will occur during the design life of the realigned portion of the LAA. However, as a relatively modest excavation into native ground, it is not likely that the LAA Realignment would be vulnerable to significant damage by seismic shaking. The LAA Realignment would be a 35 feet wide by 15 feet deep, trapezoidal, concrete lined (approximately 6 to 10 inches thick with steel reinforcement) channel with 1:1 (horizontal to vertical) side slopes that would be excavated into alluvial fan deposits. Strong ground shaking from a seismic event could reasonably cause some minor cracking of the aqueduct's concrete liner. However, it is not expected that significant deformation and catastrophic failure of the LAA could occur directly from strong ground shaking. Furthermore, it is expected that LAA could be repaired in a relatively short amount of time if any minor damage were to occur during a seismic event. Therefore, strong seismic ground shaking would not be considered to pose a significant impact for the operation of the LAA Realignment.

Basin

It is expected that strong seismic ground shaking will occur during the design life of the Basin and its various components. The various components of the Basin could potentially fail due to faulty design, improper construction, and/or poor maintenance practices. However, the design objective of the Proposed Project, including the Basin, will be to remain operational after an earthquake event. Thus, the components of the Basin that would be designed and constructed would be seismically durable and able to withstand the impacts of strong seismic shaking. Well-compacted, rolled-fills (i.e. the East and West Berms) and reinforced concrete (i.e. the Diversion Structure, the Diversion Channel lining, and the notch lining) are typically resistant to earthquake forces (seismic loading).

Strong ground shaking from a seismic event could reasonably cause some minor cracking of the concrete liner for the Diversion Channel and the notch as well as some minor cracking of the Diversion Structure. However, it is expected that the Basin components could be repaired in a relatively short amount of time if minor damage were to occur during a seismic event. Therefore, strong seismic ground shaking would not pose a significant hazard for the operation of the Basin. The impacts from strong seismic ground shaking would be less than significant during operation of the Basin.

Cactus Flats Road Realignment

Shaking of the ground caused by the passage of seismic waves could potentially occur during the design life of the Cactus Flats Road Realignment and could produce some cracking of the road pavement and concrete culverts. However, it is not expected that significant deformation and catastrophic failure of the Cactus Flats Road Realignment would occur directly from strong ground shaking. Additionally, it is expected that relatively minor effort would be required to repair the Cactus Flats Road Realignment if damage were to occur during a seismic event. Therefore, strong seismic ground shaking would not be considered to pose a significant impact to the operation of the Cactus Flats Road Realignment.

Borrow Site 10

There would be no operational activities in Borrow Site 10 after construction activities are completed. Upon completion of construction (excavation), the borrow site would be vacant land that would have undergone restoration per the topsoil salvage and revegetation plan that will be prepared for this project. The topsoil salvage and revegetation plan would be implemented to ensure that adverse environmental hazards to public health and safety are eliminated, and would involve backfilling, grading, re-vegetation, soil stabilization, or other measures. Therefore, there would be no operational impact from seismic ground shaking.

6.2.3 Cumulative Impacts of Seismic Ground Shaking

The Proposed Project would not make any contribution to cumulative impacts with regard to seismic ground shaking.

6.3 Seismic Related Ground Failure

Liquefaction, lateral spreading, and seismically induced settlement are types of seismic related ground failure that could potentially occur at a project site that could be subjected to strong seismic shaking. Liquefaction is a phenomenon that causes water-saturated, cohesionless granular materials to change into a fluid-like state when subjected to powerful shaking associated with strong earthquakes. Liquefaction causes soils to lose their strength and their ability to support a load; therefore, liquefaction-related ground failures are a substantial seismic hazard. The susceptibility of a site to undergo liquefaction is a function of the type of sedimentary deposit, the density of cohesionless sediment, and the depth to groundwater. Saturated, cohesionless granular sediment situated at depths fewer than 30 feet are generally regarded as the most susceptible to liquefaction (Tinsley et al., 1985). Liquefaction-induced lateral spreading involves the movement of soil blocks on gently sloping ground over shallow liquefied soil deposits.

Seismically induced settlement can occur when relatively soft or loose soils are being compacted during earthquake shaking. Subsurface conditions susceptible to this hazard include loose or porous, poorly cemented soils near the ground surface. Differential seismic settlement occurs when seismic shaking causes one type of soil or rock to settle more than another type. It may also occur within a soil deposit with relatively homogeneous properties if the seismic shaking is uneven, which could occur because of variable geometry, for example, and variable depth of the soil deposit. Differential seismic settlement is most likely to occur in areas that transition between rock formations and more recently deposited alluvial soils or human-placed artificial fill.

The following subsections describe the level of hazard from seismic related ground failure for each Project facility during construction and operation.

6.3.1 Construction Impacts of Seismic Related Ground Failure

North Haiwee Dam No. 2

Seismic related ground failure would not be considered a significant hazard during construction of NHD2. Because the NHD2 construction site is located in a seismic region and liquefiable susceptible ground occurs along much of the dam site, it is conceivable that liquefaction, lateral spreading, or seismically induced settlement related damage could occur during excavation of the NHD2 foundation. However, due to the infrequent occurrence of seismic events and the short duration of construction, the probability that strong seismic shaking would coincide with construction activities is very low. LADWP would implement Health and Safety and Emergency Response Plans during the construction phase that would outline proper safety procedures during a seismic event. These plans would be prepared in accordance with applicable regulations and would mitigate potential hazards due to seismic related ground failure during construction activities associated with the proposed NHD2. With implementation of the Health and Safety Plan and the Emergency Response Plan, construction impacts would be less than significant for both the Excavate and Recompact Alternative and the CDSM Alternative.

Los Angeles Aqueduct Realignment

Seismic related ground failure would not be a significant hazard during construction of the LAA Realignment. The entire reach of the LAA Realignment would involve excavation and construction through alluvial fan deposits that have geotechnical properties (i.e. dense soils and deep groundwater) that suggest that it would not be susceptible to liquefaction, lateral spreading, or seismically induced settlement. Even if this was not the case and seismically related ground failure could occur at the site, the probability that a strong seismic event would coincide with the short duration of the construction activities is extremely low. The preparation of Health and Safety and Emergency Response Plans in accordance with applicable regulations would mitigate potential hazards due to seismic related ground failure during the construction phase of the proposed LAA Realignment. With implementation of the

Health and Safety Plan and the Emergency Response Plan, construction impacts would be less than significant.

Basin

Seismic related ground failure would not be a significant hazard during construction of the Basin. Although seismically related ground failure could occur at the site, the probability that a strong seismic event would coincide with the short duration of the construction activities is extremely low. The preparation of Health and Safety and Emergency Response Plans in accordance with applicable regulations would mitigate potential hazards due to seismic related ground failure during the construction phase of the proposed Basin. With implementation of the Health and Safety Plan and the Emergency Response Plan, construction impacts would be less than significant.

Cactus Flats Road Realignment

Seismic related ground failure would not be considered a significant hazard during construction of the Cactus Flats Road Realignment. Liquefaction potentially could occur in the Haiwee Valley due to the cohesionless granular sediment and shallow groundwater that is characteristic of the Haiwee Valley deposits. However, due to the infrequent occurrence of seismic events and the short duration of construction, the probability that strong seismic shaking would coincide with construction activities is very low. The preparation of Health and Safety and Emergency Response Plans in accordance with applicable regulations would mitigate potential hazards due to seismic related ground failure during the construction phase of the proposed Cactus Flats Road Realignment. With implementation of the Health and Safety Plan and the Emergency Response Plan, construction impacts would be less than significant.

Borrow Site 10

Seismic related ground failure would not be considered a significant hazard during excavation of Borrow Site 10. The Borrow Site would involve excavation of unsaturated alluvial fan deposits. Such materials would not be susceptible to liquefaction, lateral spreading, or seismically induced settlement. Therefore, the impacts from seismic related ground failure would be less than significant for the excavation of Borrow Site 10.

6.3.2 Operational Impacts of Seismic Related Ground Failure

North Haiwee Dam No. 2

The potential for liquefaction of the existing Dam and the underlying alluvium during a strong earthquake in the Owens Valley is the impetus for the LADWP to undertake the Proposed Project. The design objectives of NHD2 are to reduce the seismic deformations due to liquefaction to an acceptable value to provide sufficient seismic reliability for NHR, and to protect local populations from a hazardous flooding event.

The design of NHD2 will involve a combination of removal of potentially liquefiable deposits under the dam footprint to some depth, and improvement of the remaining potentially liquefiable deposits (foundation treatment) to either reduce their potential to deform after liquefying, or to eliminate their potential for liquefaction entirely. The NHD2 design involves a comprehensive geotechnical investigation to characterize the soil, rock, and groundwater conditions of the dam foundation. Seismically induced displacement analyses would be performed to verify that the deformations of the embankment dam are acceptable. These investigations and analyses would be performed to verify that the NHD2 design objective is achieved. Furthermore, prior to construction and operations of NHD2, DSOD will review the dam design and approve the seismic safety of the new Dam. Therefore, the impacts from seismic related ground failure would be less than significant during operation of NHD2 for both the Excavate and Recompact Alternative and the CDSM Alternative.

Los Angeles Aqueduct Realignment

Seismic related ground failure would not be a significant hazard for operation of the LAA Realignment. The LAA Realignment would be located in an area of known alluvial fan deposits that have geotechnical properties (i.e. dense soils and deep groundwater) that suggest that it would not be susceptible to liquefaction, lateral spreading, or seismically induced settlement. Therefore, the impacts from seismic related ground failure would be less than significant for operation of the LAA Realignment.

Basin

Seismic related ground failure would not be a significant hazard for operation of the Basin and its various components. The Diversion Structure would be located in an area of known alluvial fan deposits (Qaf3) that have geotechnical properties (i.e. dense soils and deep groundwater) that suggest that it would not be susceptible to liquefaction, lateral spreading, or seismically induced settlement.

As noted above, it is understood that NHD could experience extensive liquefaction during a MCE that would occur in the foundation of NHD, causing the crest of NHD to settle and an uncontrolled release of water. This is the main reason for construction of NHD2 which would serve as a backup dam.

Some of the components of the Basin, which are constructed either on NHD or on liquefiable alluvium that forms the foundation of NHD (i.e., the East Berm, the West Berm, the notch, the Diversion Channel, the geomembranes installed for slope and Basin protection), would also be susceptible to liquefaction induced damage. However, the potential damage sustained by these components of the Basin would not result in a catastrophic release of water out of the Basin. Thus, it is unlikely that potential damage could result in exposure of people to substantial adverse effects including the risk of loss, injury, or death. Because the Basin would not be a necessary component of the LAA system, it could be repaired and returned to service at the discretion of LADWP. Furthermore, due to the infrequent occurrence of seismic events that could generate seismic related ground failure, the liquefaction is not expected to pose a high level of risk. Operational impacts would therefore be less than significant.

Cactus Flats Road Realignment

For operation of the Cactus Flats Road Realignment, liquefaction potentially could occur due to the cohesionless granular sediment and shallow groundwater that is characteristic of the Haiwee Valley. However, due to the infrequent occurrence of seismic events that could generate seismic related ground failure, liquefaction is not expected to pose a high level of risk. Operational impacts would therefore be less than significant.

Borrow Site 10

There would be no operational activities in Borrow Site 10 after construction activities are completed. Upon completion of construction (excavation), the Borrow Site would be vacant land that would have undergone restoration per the topsoil salvage and revegetation plan that will be prepared for this project. The topsoil salvage and revegetation plan would be implemented to ensure that adverse environmental hazards to public health and safety are eliminated, and would involve backfilling, grading, re-vegetation, soil stabilization, or other measures. Therefore, there would be no operational impact from seismic related ground failure.

6.3.3 Cumulative Impacts of Seismic Related Ground Failure

There would be no cumulative impacts related to seismic ground shaking.

6.4 Landsliding or Slope Failure

Landsliding or slope failure is the downward and outward movement of slope-forming materials – natural rock, soils, artificial fills, or a combination of materials. Landslides are often triggered by earthquakes, or a rise in groundwater brought about by precipitation. Landsliding usually occurs in areas of moderate to high relief, weak soil or rock strength, and high groundwater. Areas that are most susceptible to landslides are steep slopes in poorly cemented or highly fractured rocks, areas underlain by loose and weak soils, and areas on or adjacent to existing landslides. In general, the Project Site is located in the Owens Valley where the landscape is relatively flat. Thus, much of the landscape is not prone to landsliding.

However, construction grading activities can potentially create unstable slopes and slope failure if care is not taken to assure that temporary or permanent cut slopes are not over-steepened. Slope stability analyses are routinely performed to assess the safe design of constructed slopes. Successful design of constructed slope requires geological/geotechnical information and site characteristics regarding the of soil/rock mass, slope geometry, groundwater conditions.

The following subsections describe the level of hazard from landsliding for each Project facility during construction and operation.

6.4.1 Construction Impacts of Landsliding or Slope Failure

North Haiwee Dam No. 2

Landsliding or slope failure would not be a significant hazard during construction of NHD2. The footprint of NHD2 does not cross an area where landslides have been identified on either the Project geologic map (see Figure 7) or on published geologic mapping (Stinson, 1977; Duffield & Bacon, 1981; Whitmarsh, 1997; Jayko, 2009). Most of the NHD2 footprint is located along the flat terrain of the Haiwee Valley where landsliding could not occur. Although the abutments of NHD2 would be constructed along modest slopes, the abutments are underlain by dense alluvial deposits that are not prone to landsliding.

It is conceivable that improper excavation of the NHD2 foundation could potentially create over-steepened (unstable) temporary slopes that would be susceptible to slope failure. However, in accordance with standard design practices, stability analyses would be performed and grading measures would be implemented (i.e. maximum slope gradients, benching) to ensure stability of the temporary slopes. Therefore, the impacts from landsliding and slope failure would be less than significant for the construction of NHD2.

Los Angeles Aqueduct Realignment

Landsliding or slope failure would not be a significant hazard during construction of the LAA Realignment. The LAA Realignment does not cross an area where landslides have been identified. No landslides have been mapped at the LAA Realignment site on either the Project geologic map (see Figure 7) or on published geologic mapping (Stinson, 1977; Duffield & Bacon, 1981; Whitmarsh, 1997; Jayko, 2009). The LAA Realignment would be along relatively flat ground and within alluvial deposits that are not prone to landsliding. The excavated channel of the LAA would be relatively modest, up to 15 feet deep with 1:1 (horizontal to vertical) side slopes. However, depending on the material that would be taken from Borrow Site 10, there could be up to 50-foot-high cut slopes bordering both sides of the LAA Realignment.

It is conceivable that improper excavation of the cut slopes for the LAA Realignment could result in an over-steepened (unstable) slope that is susceptible to slope failure. However, the materials that would comprise the cut slopes are not be prone to slope failure. This is evident by inspecting the slopes that exist near the south side of Borrow Site 10, which include a natural slope at the contact between the alluvial fan deposits (Qaf3) and the alluvial deposits (Qaf1), and a cut slope (ml) that was excavated for a NHD borrow site circa 1913, near the contact between Qaf3 and ml (see Figure 7). Both of these locally steep south facing slopes, which are underlain by the Qaf3 deposits, have exhibited no sign of instability or slope failure. Furthermore, in accordance with standard design practices, stability analyses would be performed and grading measures would be implemented (i.e. maximum slope gradients, benching) to ensure stability of the cut slopes.

Therefore, landsliding or slope failure would not be anticipated to be a significant hazard. The impacts from landsliding and slope failure would be less than significant for the construction of the LAA Realignment.

Basin

Landsliding or slope failure would not be a significant hazard during construction of the Basin. The Basin and its components do not cross an area where landslides have been identified. No landslides have been mapped at the Basin site on either the Project geologic map (see Figure 7) or on published geologic mapping (Stinson, 1977; Duffield & Bacon, 1981; Whitmarsh, 1997; Jayko, 2009). Most of the Basin would be along relatively flat ground and within alluvial deposits that are not prone to landsliding. The excavated notch would be relatively modest, up to 18 feet deep with 1:1 (horizontal to vertical) side slopes.

It is conceivable that improper construction of the of the side slopes for the notch as well as the Berms could be over-steepened (unstable) and susceptible to slope failure. However, in accordance with standard design practices, stability analyses would be performed and grading measures would be implemented (i.e. maximum slope gradients, benching) to ensure stability of the slopes. Therefore, landsliding or slope failure would not be anticipated to be a significant hazard. The impacts from landsliding and slope failure would be less than significant for the construction of the Basin.

Cactus Flats Road Realignment

Landsliding or slope failure would not be a significant hazard during construction of the Cactus Flats Road Realignment. The Cactus Flats Road Realignment does not cross an area where landslides have been identified. No landslides have been mapped at the Cactus Flats Road Realignment site on either the Project geologic map (see Figure 7) or on published geologic mapping (Stinson, 1977; Duffield & Bacon, 1981; Whitmarsh, 1997; Jayko, 2009). Most of the Cactus Flats Road Realignment would be located on flat ground where landsliding could not occur, with the one exception being where the Cactus Flats Road Realignment would transition from the Haiwee Valley up to the higher terrace surface. The transition, through the west facing slope between the Haiwee Valley and the upper terrace, would likely require some cut and fill grading. It is conceivable that improper excavation of these cut slopes could potentially create over-steepened (unstable) slopes that might be susceptible to slope failure. However, in accordance with standard design practices, stability analyses would be performed and grading measures would be implemented (i.e. slope gradients, benching) to ensure stability of the cut slopes. Therefore, the impacts from landsliding and slope failure would be less than significant for the construction of the Cactus Flats Road Realignment.

Borrow Site 10

Landsliding or slope failure would not be anticipated to be a significant hazard during construction (excavation) of the Borrow Site for the Proposed Project. Borrow Site 10 does not cross an area where landslides have been identified. Borrow Site 10 is located within the Project geologic map area and no landslides have been mapped within the borrow area (see Figure 7). Likewise, no landslides have been mapped at Borrow Site 10 on published geologic mapping (Stinson, 1977; Duffield & Bacon, 1981; Whitmarsh, 1997; Jayko, 2009).

It is conceivable that improper excavation in the Borrow Site could potentially create over-steepened (unstable) temporary slopes that would be susceptible to slope failure. However, it is not anticipated that mining operations would generally result in such cut slopes. Although the excavation plans are not available at this time, it is anticipated that, in most cases, the mining operations would involve a relatively shallow stripping of near surface materials over wide areas resulting in modest cut slopes along the back edge of the Borrow Site. Furthermore, the materials that would be mined would not be prone to slope failure. As noted above for the LAA Realignment, this is evident in Borrow Site 10 by inspecting the slopes near its south side, which include a natural slope at the contact between the alluvial fan deposits (Qaf3) and the alluvial deposits (Qaf1), and a cut slope (ml) that was excavated for a NHD borrow site, circa 1913, near the contact between Qaf3 and ml (see Figure 7). Both of these steep south facing slopes, which are underlain by the Qaf3 deposits, have no sign of instability or slope failure.

Final construction activity in Borrow Site 10 would be restoration and revegetation of the excavated land per the topsoil salvage and revegetation plan that will be prepared for this project. The topsoil salvage and revegetation plan would be implemented to ensure that adverse environmental hazards to public health and safety are eliminated, and would involve backfilling, grading, re-vegetation, soil stabilization, or other measures.

Considering the above discussion, the impacts from landsliding or slope failure would be less than significant for the excavation (construction) of Borrow Site 10.

6.4.2 Operational Impacts of Landsliding or Slope Failure

North Haiwee Dam No. 2

Landsliding and slope failure would not be a significant hazard during operation of NHD2. The footprint of the proposed Dam does not cross an area where landslides have been identified on either the Project geologic map (see Figure 7) or on published geologic mapping (Stinson, 1977; Duffield & Bacon, 1981; Whitmarsh, 1997; Jayko, 2009). Most of the NHD2 footprint is located along the flat Haiwee Valley where landsliding could not occur. Although the abutments of the dam would be constructed along modest slopes, the abutments are underlain by dense alluvial deposits that are not prone to landsliding. Therefore, the impacts from landsliding and slope failure would be less than significant for the operation of NHD2.

Los Angeles Aqueduct Realignment

Landsliding and slope failure would not be a significant hazard during operation of the LAA Realignment, as it does not cross an area where landslides have been identified. No landslides have been mapped at the LAA Realignment site on either the Project geologic map (see Figure 7) or on published geologic mapping (Stinson, 1977; Duffield & Bacon, 1981; Whitmarsh, 1997; Jayko, 2009). The LAA Realignment would be along relatively flat ground and within alluvial deposits that are not prone to landsliding. The excavation for the LAA Realignment would be relatively modest, up to 15 feet deep with 1:1 (horizontal to vertical) side slopes.

Depending on the material that would be taken from Borrow Site 10, there could be up to a 50-foot-high cut slope on the west side of the LAA Realignment. It is conceivable that improper excavation of the cut slopes for the LAA Realignment could produce over-steepened (unstable) slopes that are susceptible to instability. However, in accordance with standard design practices, stability analyses would be performed and grading measures would be implemented (i.e. maximum slope gradients, benching) to ensure stability of the cut slopes. Therefore, landsliding or slope failure would not be anticipated to be a significant hazard. The impacts from landsliding and slope failure would be less than significant for operation of the LAA Realignment.

Basin

Landsliding or slope failure would not be a significant hazard during operation of the Basin, as it does not cross an area where landslides have been identified. No landslides have been mapped at the Basin site on either the Project geologic map (see Figure 7) or on published geologic mapping (Stinson, 1977; Duffield & Bacon, 1981; Whitmarsh, 1997; Jayko, 2009). The Basin would be along relatively flat ground and within alluvial deposits that are not prone to landsliding.

It is conceivable that improper construction of the Berms or the side slopes for the notch could be over-steepened (unstable) and susceptible to slope failure. However, in accordance with standard design practices, stability analyses would be performed and grading measures would be implemented (i.e. maximum slope gradients, benching) to ensure stability of the slopes. Therefore, landsliding or slope failure would not be anticipated to be a significant hazard. The impacts from landsliding or slope failure would be less than significant for operation of the Basin.

Cactus Flats Road Realignment

Landsliding or slope failure would not be a significant hazard for operation of the Cactus Flats Road Realignment. The Cactus Flats Road Realignment does not cross an area where landslides have been identified. No landslides have been mapped at the Cactus Flats Road Realignment site on either the Project geologic map (see Figure 7) or on published geologic mapping (Stinson, 1977; Duffield & Bacon, 1981; Whitmarsh, 1997; Jayko, 2009). Most of the Cactus Flats Road Realignment will be located on flat ground where landsliding could not occur, with the one exception being where the Cactus Flats Road Realignment would transition from the Haiwee Valley up to the higher terrace surface. The transition, through the west facing slope between the Haiwee Valley and the upper terrace, would likely require some cut and fill grading. It is conceivable that improper excavation of these cut slopes could potentially create over-steepened (unstable) slopes that might be susceptible to slope failure. However, in accordance with standard design practices, stability analyses would be performed and grading measures would be implemented (i.e. slope gradients, benching) to ensure stability of the cut slopes. Therefore, the impacts from landsliding and slope failure would be less than significant for operation of the Cactus Flats Road Realignment.

Borrow Site 10

There would be no operational activities in Borrow Site 10 after construction activities are completed. Upon completion of construction (excavation), the Borrow Site would be vacant land that would have undergone restoration per the topsoil salvage and revegetation plan that will be prepared for this project. The topsoil salvage and revegetation plan would be implemented to ensure that adverse environmental hazards to public health and safety are eliminated, and would involve backfilling, grading, re-vegetation, soil stabilization, or other measures. Therefore, there would be no operational impact from landslide or slope failure of Borrow Site 10.

6.4.3 Cumulative Impacts of Landsliding/Slope Failure

The Proposed Project would not make any contribution to cumulative impacts with regard to landsliding or slope failure.

6.5 Subsidence

The extraction of petroleum from sedimentary source rocks, or the extraction of water from underground alluvial aquifers can cause the permanent collapse of the pore space previously occupied by the removed fluid. The compaction of subsurface sediment caused by fluid withdrawal can cause subsidence of the ground surface overlying a pumped reservoir. If the volume of water or petroleum removed is sufficiently great, the amount of resulting subsidence may cause damage to nearby engineered structures. Ground subsidence has not been recognized as a problem in the vicinity of the Project Site. There are no petroleum fluids in the Haiwee Valley area, and the area is not currently being pumped for groundwater. There would be no construction, operational, or cumulative impacts related to subsidence for NHD2, the LAA Realignment, the Basin, the Cactus Flats Road Realignment, or Borrow Site 10.

6.6 Expansive Soils

Expansive soils are fine-grained soils (generally high-plasticity clays) that can undergo a substantial increase in volume with an increase in water content and a substantial decrease in volume with a decrease in water content. Expansive soils can cause uplift pressures leading to structural damage over a long period of time to facilities and structures that are constructed directly on expansive soils.

Expansive soils are not considered a significant concern at the Project Site where comprehensive geotechnical investigations (LADWP, 2015) have demonstrated that the alluvial deposits are typically granular (sandy and gravely) soils that have a low expansion potential. Furthermore, if expansive soils are discovered during construction, the hazard of soil expansion would routinely be addressed through over-excavation and replacement with non-expansive fill or other standard design and construction methods. Also, expansive soils could not pose a hazard to Borrow Site 10 because no facilities or structures would be constructed at those sites. Therefore, the construction and the operational impacts from expansive soils would be less than significant for NHD2, the LAA Realignment, the Basin and its components, the Cactus Flats Road Realignment, and Borrow Site 10. There would be no cumulative impacts from expansive soils.

6.7 Soil Erosion

Construction activities related to NHD2, the LAA Realignment, the Basin, and the Cactus Flats Road Realignment, as well as excavation activities at Borrow Site 10, would include earth-moving activities that would cause a loss or disturbance of existing topsoil[3] and could potentially expose the Project Site to increased wind and water erosion during and following construction. Water caused erosion is most prevalent in unconsolidated alluvium and surficial soils on steep slopes, that are prone to down-cutting, sheet-flow, and slumping during heavy precipitation events.

Construction grading activities could exacerbate erosion in areas where highly susceptible soils are prevalent. However, based on the gentle gradients that exist across most of the Project Site, the potential for water erosion is relatively low. The soils on the Project Site would also be subject to wind erosion during construction activities.

The following subsections describe the level of hazard from soil erosion for each Project facility during construction and operation.

6.7.1 Construction Impacts of Soil Erosion

North Haiwee Dam No. 2

Construction of NHD2 by either the Excavate and Recompact Alternative or the CDSM Alternative would involve disturbance of the dam's footprint related to excavation of the dam foundation as well as some areas outside the footprint to allow for various associated construction activities (i.e. stockpile yards, haul roads, construction yards). As such, it would result in the loss of top soil and could aggravate erosion. However, the LADWP and the contractor would be required to comply with the applicable provisions of a NPDES Construction General Permit. In accordance with the NPDES Construction General Permit, the contractor would be required to develop and implement a site-specific SWPPP that, among other tasks, would be focused on minimizing soil disturbance and erosion by implementing applicable construction BMPs. Standard BMPs typically include minimizing areas of disturbance to only those required for construction, installation of sand bags, silt fences, and straw wattles, utilization of soil stabilizers, and re-vegetating of the temporarily disturbed areas upon completion of construction. Although the primary objective of a SWPPP is to minimize sediment and other pollutants to stormwater in order to protect the quality of our nation's waters, an associated benefit is that it would lessen erosion.

The soils on the Project Site would be subject to wind erosion during construction activities. However the Proposed Project would implement Rule 401 fugitive dust control measures (i.e. water spraying, use of

[3] None of the top soils at the Project Site or in Borrow Site 10 are classified as prime agricultural soils by the United States Department of Agriculture.

gravel pack on haul roads, etc.) as required by the Great Basin Unified Air Pollution Control District (GBUAPCD) as a matter of regulation.

Also, the disturbed area comprising the footprint and foundation of NHD2 would be a temporary condition as eventually it would be covered by the dam embankment, which would be a compacted and engineered fill with a riprap veneer that would not be susceptible to erosion. By implementing the BMPs of a SWPPP and the dust control measures required for the GBUAPCD, the impacts from soil erosion would be reduced to less than significant for the construction of NHD2.

Los Angeles Aqueduct Realignment

Construction of LAA Realignment would involve disturbance of the new alignment's footprint, and leave the existing LAA alignment as a disturbed unpaved surface. These areas, which are underlain by unconsolidated alluvial sediments, would be susceptible to erosion. However, LADWP and the contractor would be required to comply with the applicable provisions of the NPDES Construction General Permit. In accordance with the NPDES Construction General Permit, the contractor would be required to develop and implement a site-specific SWPPP that, among other tasks, would be focused on minimizing soil disturbance and erosion by implementing applicable construction BMPs. Standard BMPs include minimizing areas of disturbance to only those required for construction, installation of sand bags, silt fences, and straw wattles, utilization of soil stabilizers, and at the end of the construction period, re-vegetating of the temporarily disturbed areas. Although the primary objective of a SWPPP is to minimize sediment and other pollutants to stormwater to protect the quality of our nation's waters, an associated benefit relevant to this discussion is that it would also lessen erosion. Also, the disturbed area comprising the footprint of the LAA Realignment would be a temporary condition as eventually it would be mostly covered by the aqueduct concrete lining that would not be susceptible to erosion.

The disturbed soils along the LAA Realignment would be subject to wind erosion during construction activities. However, the Proposed Project would implement Rule 401 fugitive dust control measures (i.e. water spraying, use of gravel pack on haul roads, etc.) as required by the GBUAPCD as a matter of regulation.

By implementing the BMPs of a SWPPP and dust control measures required for the GBUAPCD, the impacts from soil erosion would be reduced to less than significant for the construction of the LAA Realignment.

Basin

Construction of the Basin would involve disturbance of the Basin floor as well as the footprint and adjacent areas for the Diversion Structure, Diversion Channel, the East and West Berms, the notch, and the downstream face of NHD. These areas, which are underlain by unconsolidated alluvial or fill sediments, would be susceptible to erosion. However, LADWP and the contractor would be required to comply with the applicable provisions of the NPDES Construction General Permit. In accordance with the NPDES Construction General Permit, the contractor would be required to develop and implement a site-specific SWPPP that, among other tasks, would be focused on minimizing soil disturbance and erosion by implementing applicable construction BMPs. Standard BMPs include minimizing areas of disturbance to only those required for construction, installation of sand bags, silt fences, and straw wattles, utilization of soil stabilizers, and at the end of the construction period, re-vegetating of the temporarily disturbed areas. Although the primary objective of a SWPPP is to minimize sediment and other pollutants to stormwater to protect the quality of our nation's waters, an associated benefit relevant to this discussion is that it would also lessen erosion. Also, the disturbed areas would be a temporary condition as eventually they would be mostly covered by concrete that would not be susceptible to erosion or would be inundated.

The disturbed soils along the Basin may be subject to wind erosion during construction activities. However, the Proposed Project would implement Rule 401 fugitive dust control measures as required by the GBUAPCD as a matter of regulation. By implementing the BMPs of a SWPPP and dust control measures required for the GBUAPCD, the impacts from soil erosion would be reduced to less than significant for the construction of the Basin.

Cactus Flats Road Realignment

Construction of Cactus Flats Road Realignment would involve disturbance of the new alignment's footprint as a disturbed unpaved surface for part of the construction period. The roadway alignment, which is underlain by unconsolidated alluvial sediments, would be susceptible to erosion. However, the LADWP and the contractor would be required to comply with the applicable provisions of the NPDES Construction General Permit. In accordance with the NPDES Construction General Permit, the contractor would be required to develop and implement a site-specific SWPPP that, among other tasks, would be focused on minimizing soil disturbance and erosion by implementing applicable construction BMPs. Standard BMPs typically include minimizing areas of disturbance to only those required for construction, installation of sand bags, silt fences, and straw wattles, utilization of soil stabilizers, and at the end of the construction period, re-vegetating of the temporarily disturbed areas. Although the primary objective of a SWPPP is to minimize sediment and other pollutants to stormwater in order to protect the quality of our nation's waters, an associated benefit relevant to this discussion is that it would lessen erosion.

The disturbed soils along the Cactus Flats Road Realignment would be subject to wind erosion during construction activities. However, the Proposed Project would implement Rule 401 fugitive dust control measures (i.e. water spraying, use of gravel pack on haul roads, etc.) as required by the GBUAPCD as a matter of regulation.

Also, the disturbed area comprising the footprint of the Cactus Flats Road Realignment would be a temporary condition as eventually it would mostly be covered with a compacted base material that would not be susceptible to erosion. By implementing the BMPs of a SWPPP, and the dust control measures required for the GBUAPCD, the construction impacts from soil erosion would be reduced to less than significant for the Cactus Flats Road Realignment.

Borrow Site 10

Excavation of Borrow Site 10 would involve disturbance of all or some of the Borrow Site during the construction period. The Borrow Site, which is underlain by unconsolidated alluvial sediments, would be susceptible to erosion. However, the LADWP and the contractor would be required to comply with the applicable provisions of the NPDES Construction General Permit. In accordance with the NPDES Construction General Permit, the contractor would be required to develop and implement a site-specific SWPPP that, among other tasks, would be focused on minimizing soil disturbance and erosion by implementing applicable construction BMPs. Standard BMPs typically include minimizing areas of disturbance to only those required for construction, installation of sand bags, silt fences, and straw wattles, utilization of soil stabilizers, and at the end of the construction period, re-vegetating of the temporarily disturbed areas. Although the primary objective of a SWPPP is to minimize sediment and other pollutants to stormwater to protect the quality of our nation's waters, an associated benefit relevant to this discussion is that it would lessen erosion.

The disturbed soils at Borrow Site 10 would be subject to wind erosion during construction activities. However, the Proposed Project would implement Rule 401 fugitive dust control measures (i.e. water spraying, use of gravel pack on haul roads, etc.) as required by the GBUAPCD as a matter of regulation.

By implementing the BMPs of a SWPPP and the dust control measures required for the GBUAPCD, the construction impacts from soil erosion would be reduced to less than significant for the excavation of Borrow Site 10.

6.7.2 Operational Impacts of Soil Erosion

North Haiwee Dam No. 2

The constructed NHD2 will be a compacted/engineered fill with a riprap veneer. As such, the new Dam would not be susceptible to erosion. Areas outside the limits of the NHD2 footprint that would be disturbed during construction would be re-vegetated in accordance with the implementation of a SWPPP. Therefore, the impacts of erosion would be less than significant during operation of NHD2.

Los Angeles Aqueduct Realignment

The constructed LAA Realignment would be a concrete lined aqueduct or canal. As such, the LAA Realignment would not be susceptible to erosion. Associated areas outside the limits of the LAA Realignment that would be disturbed during its construction, including the demolished portion of the old alignment, would be re-vegetated in accordance with the implementation of a SWPPP. Therefore, the impacts of soil erosion would be less than significant during operation of the LAA Realignment.

Basin

The constructed components of the Basin would consist of a concrete Diversion Structure, concrete lined Diversion Channel and notch, and engineered earth fill East and West Berms. A combination of filter layer and geomembrane would be installed on the downstream face of NHD, and also on the bottom of the proposed Basin. These measures would prevent erosion once the proposed Basin is filled. As such, the Basin and its various components would not be susceptible to erosion. Associated areas that would be disturbed during its construction would be re-vegetated in accordance with the implementation of a SWPPP. Therefore, the impacts of soil erosion would be less than significant during operation of the Basin.

Cactus Flats Road Realignment

The constructed Cactus Flats Road Realignment would be a paved road that would include installation of two reinforced concrete culverts. As such, the Cactus Flats Road Realignment would not be susceptible to erosion. Therefore, the impacts of erosion would be less than significant during operation of the Cactus Flats Road Realignment.

Borrow Site 10

There would be no operational activities in Borrow Site 10 after construction activities are completed. Upon completion of construction (excavation), Borrow Site 10 would be vacant land that would have undergone restoration per the topsoil salvage and revegetation plan that will be prepared for this project. The topsoil salvage and revegetation plan would be implemented to ensure that adverse environmental hazards to public health and safety are eliminated, and would involve backfilling, grading, re-vegetation, soil stabilization, or other measures. Therefore, there would be no operational impacts from erosion of Borrow Site 10.

6.7.3 Cumulative Impacts of Soil Erosion

There would be no cumulative impacts related to soil erosion.

6.8 Mineral Resources

This section evaluates the potential for the Proposed Project to adversely affect the availability of known mineral resources. The mineral resources of concern include: metals, industrial minerals (i.e., aggregate, sand and gravel, pumice), oil and gas, and geothermal resources that would be of value to the region and residents of the State. Loss of access to mineral resources would primarily be the result of conversion of lands underlain by these resources to other uses, or within close proximity to the resources, such that the construction and occupancy of the Proposed Project would restrict access, or eliminate safe and environmentally sound measures to implement extractive operations. The potential loss of such resources due to the Proposed Project implementation, if any, is described.

An impact to a geologic resource was considered significant if it resulted in substantial reduction in the availability of a known mineral, fossil fuel, or geothermal resource of regional or statewide value. The following subsections describe the potential for the Proposed Project to impact these resources.

6.8.1 Mineral Resources (Metals and Industrial Minerals)

Based on information obtained from the USGS Mineral Resource Data System (USGS, 2015a), the Project Site is not located at or in the immediate vicinity of active or abandoned mines. Several mines and prospects that are located a few miles to the east and southeast of NHD in the northern Coso Range are accessed by Cactus Flats Road. A pumice mine, known as the Haiwee Quarry, is located approximately 2.5 miles to the southeast of NHD. The Jack Henry Mine, which is located at the southeast end of Cactus Flats Road approximately eight miles southeast of NHD, is a copper, zinc, and lead mine. Several other mines and prospects, including the Five Tunnels Mine (copper, zinc, and lead), the Beebe Mine (copper, zinc, and lead), and the McCloud Mine (gold), are located in the vicinity of the Jack Henry Mine. The Cactus Flats Road Realignment would allow continued access to these mines and other prospects that are located in the northern Coso Range.

Based on the above information, construction and operation of the Proposed Project, including excavation of Borrow Site 10, would not result in the loss or substantial reduction in availability of a known mineral resource of regional or statewide value.

6.8.2 Fossil Fuel Resources

Inyo County and the Owens Valley are not known for having petroleum resources. Based on a review of a California Department of Conservation, Division of Oil, Gas, and Geothermal Resources (DOGGR) volume (DOGGR, 1998), the Project Site is not located within the vicinity of a fossil fuel resource. Implementation of the Proposed Project would not result in the loss or substantial reduction in availability of petroleum resources.

6.8.3 Geothermal Resources

Based on review of the DOGGR California Geothermal Map (DOGGR, 2002), the Project Site is not located in or near a Geothermal Resource Area as classified by DOGGR. Therefore, the Proposed Project, including the excavation of Borrow Site 10, would not result in the loss of geothermal resources.

7 Mitigation Measures

7.1 Mitigation Measures Related to Construction Impacts

There would be no significant construction impacts for the Proposed Project. Therefore, no mitigation measures to address construction impacts are proposed.

7.2 Mitigation Measures Related to Operational Impacts

There would be no significant operational impacts for the Proposed Project. Therefore, no mitigation measures to address operational impacts are proposed.

7.3 Mitigation Measures Related to Cumulative Impacts

There would be no significant cumulative impacts for the Proposed Project. Therefore, no mitigation measures to address cumulative impacts are proposed.

8 CEQA Significance Conclusions

Provided that project design objectives are achieved, and with implementation of standard design measures, engineering protocols, and adherence to existing laws, ordinances and regulations, the Proposed Project would not result in significant unavoidable geology, soils, and seismicity impacts. The Proposed Project would not expose people or structures to substantial adverse effects, including the loss of life, injury, or death involving the following:

- rupture of a known earthquake fault;
- strong seismic ground shaking;
- seismic related ground failure, including liquefaction;
- landslides/slope failure;
- substantial soil erosion or the loss of topsoil;
- be located on an a geologic unit or formation that is unstable, or that would become unstable as a result of the Project; or
- be located on expansive soil.

Furthermore, the Proposed Project would not result in the loss of a known mineral, petroleum, or geothermal resource that would be of value to the region and the residents of the State.

9 NEPA Impacts Summary

Excavation and construction grading activities related to the construction of the LAA Realignment and Borrow Site 10 could impact (disturb) up to 14 acres of BLM-managed land. The Proposed Project would comply with all federal, state and local laws and criteria. In compliance with requirements of the NPDES permit, a SWPPP would be developed and prepared for the Proposed Project to ensure that protection of water quality and soil resources is consistent with County and State regulations. The plan would include measures that prevent excessive and unnatural soil erosion. The SWPPP, which would cover all activities associated with the construction of the Proposed Project, including clearing, grading, and other ground disturbance activities, would prevent off-site migration of eroded soils. Grading and development on federal lands (i.e., Borrow Site 10, the LAA Realignment and the Diversion Structure) would be governed by the BLM in accordance with the BLM 9100 Series Manuals (BLM, 2015).

10 References

Advanced Geoscience Inc. 2012, Final Report Seismic Surveys for Investigation of Subsurface Faulting at North Haiwee Dam Inyo County, California, Report prepared for the LADWP dated September 7, 2009 and available as an Appendix in Black and Veatch 2013

Bacon, C.R., Giovenetti, D.M. Duffield, W.A., Dalrymple, G.B., and Drake, R.E., 1981, Age of the Coso Formation, Inyo County California: USGS Bulletin 1527.

Bacon, S.N., Burke, R.M., Pezzopane, S.K. and A.S. Jayko, 2006. Last glacial maximum and Holocene lake levels of Owens Lake, eastern California. Quaternary Science Reviews, v. 25, p. 1264-1282.

Beanland, S. and M. Clark, 1994. The Owens Valley Fault Zone, Eastern California and Surface Rupture Associated with the 1872 Earthquake. United States Geological Survey Bulletin. No. 1982.

Black & Veatch 2013, Local Fault Investigation for Proposed North Haiwee Dam No. 2, Inyo County, California, Final Technical Report prepared for the Los Angeles Department of Water & Power dated September 24, 2013

_____, 2014, Aquifer Pumping Tests, Proposed North Haiwee Dam No. 2, Final Technical Report prepared for the Los Angeles Department of Water & Power dated August 15, 2014

_____, 2015, Ground Motion hazard Analysis, North Haiwee Dam Number 2, Final Technical Report prepared for the Los Angeles Department of Water & Power dated January 12, 2015

Bryant, W.A., and Hart, E.W., 2007, Fault Rupture Hazard Zones in California, Alquist-Priolo Earthquake Fault Zoning Act with Index to Earthquake Fault Zones Maps, CGS Special Publication 42.

Bureau of Land Management (BLM), 2015, 9100 Series available at http://www.blm.gov/style/medialib/blm/wo/Information_Resources_Management/policy/blm_manual.Par.80761.File.dat/9100.pdf

California Department of Conservation Division of Oil, Gas, and Geothermal Resources (DOGGR), 1998 California Oil & Gas Fields, Volume 1 - Central California, Contour maps, cross section, and data sheets for California's oil and gas fields, 499 pages, (Central California)

______, 2002, Geothermal Map of California. Scale 1:1, 500,000.

Division of Safety of Dams (DSOD), 2002, Geologic inspection of site conditions, North Haiwee Dam No. 6-24, March 20, 2002

______, 2003, Geologic review of proposed geologic exploration, North Haiwee Dam No. 6-24, January 28, 2003.

Duffield, W.A., and Bacon, C.R., 1981. Geologic map of the Coso volcanic field and adjacent areas, Inyo County, California: U.S. Geological Survey Miscellaneous Investigations Series Map I-1200, scale 1:50,000.

Inyo County General Plan, 2001, Public Safety Element, December 2001, pages 9-1 to 9-42.

Field, E.H., Biasi, G.P., Bird, P., Dawson, T.E., Felzer, K.R., Jackson, D.D., Johnson, K.M., Jordan, T.H., Madden, C., Michael, A.J., Milner, K.R., Page, M.T., Parsons, T., Powers, P.M., Shaw, B.E., Thatcher, W.R., Weldon, R.J., II, and Zeng, Y., 2013, Uniform California earthquake rupture forecast, version 3 (UCERF3) – The time-independent model: U.S. Geological Survey Open-File Report 2013-1165, 97 p., California Geological Society Special Report 228, and Southern California Earthquake Center Publication 1792. http://pubs.usgs.gov/of/2013/1165/.

Fraser, W. A., 2001, California Division of Safety of Dams Fault Activity Guidelines *in* Engineering Geology Practice in Northern California, Engineering Geology Practice in Northern California, California Geological Survey Bulletin 210, Ferriz and Anderson (ed.), pages 319 to 325

_____, 2009, Determining Fault Rupture Parameters for Dams, Evaluation Risk Analysis, & Mitigation, Association of Environmental and Engineering Geologist, Shlemon Specialty Conference, February 19-20, 2009, abstract and presentation

Inyo County General Plan, 2001, Approved December 11, 2001, available at the Inyo County Planning Department website, available at http://inyoplanning.org/general_plan/index.htm

Jayko, A.S., 2009, Surficial geologic map of the Darwin Hills 30' x 60' quadrangle, Inyo County, California: U.S. Geological Survey Scientific Investigations Map 3040, 20 p. pamphlet, 2 plates, scale 1:100,000.

Jennings, C.W. and Bryant W.A., 2010 Fault Activity Map of California, California Geological Survey, Geologic Data Map No. 6., available at http://www.quake.ca.gov/gmaps/FAM/faultactivitymap.html

Lettis Consultants International, 2013, Lidar Survey, Analysis, and Interpretation of Faulting for the Los Angeles Department of Water & Power, North Haiwee dam Seismic Improvement Project, Prepared for Black & Veatch Corporation, dated March 26, 2013 and available as an appendix in Black & Veatch 2013

Los Angeles Department of Water and Power, 2001 North Haiwee Dam Seismic Stability Evaluation, July 2001, Volume I and Volume II

_____, 2015, North Haiwee Dam No. 2 Project Geotechnical Data Report, Working Draft, (July 16, 2015) Volume 1, Text, Tables, and Figures, Volume II Appendices

MWH, Final Report on the Owens Lake Groundwater Evaluation Project, 2012.

Slemmons, D.B., Vittori, E., Jasko, A.K., Carver, G., and Bacon, S.N., 2008. Quaternary fault and lineament map of Owens Valley, Inyo County, eastern California, The Geological Society of America Map and Chart 96.

Stinson, M.C., 1977, Geology of the Haiwee 15' Quadrangle, Inyo County, California 1977a , California Division of Mines and Geology, Map Sheet 37, Scale 1:62,500

Tinsley, J.C., T.L. Youd, D.M. Perkins, and A.T.F. Chen, 1985. Evaluating Liquefaction Potential, in J.I. Ziony (ed.) Evaluating Earthquake Hazards in the Los Angeles Region - An Earth-Science Perspective, U.S. Geological Survey Professional Paper 1360.

United States Geological Survey (USGS), 2015a, United States Mineral Resource Data System available at http://mrdata.usgs.gov/mrds/

______, 2015b, Quaternary Fault and Fold Database, online database available at http://earthquake.usgs.gov/hazards/qfaults/ contains

URS Corporation, 2007. Preliminary Local Fault Investigations for Proposed North Haiwee Dam Number 2, Inyo County, California. Draft Report prepared for the LADWP dated December 20, 2007.

Whitmarsh, R.S., 1997, Geologic Map of the Haiwee Reservoirs 7.5' Quadrangle; Inyo County, California: Geological Society of America Digital Maps and Charts Series.

11 List of Abbreviations and Acronyms

A-P Act	Alquist-Priolo Earthquake Fault Zoning Act
af	artificial fill
bgs	below ground surface
BLM	Bureau of Land Management
BMP	Best Management Practice
CDMG	California Division of Mines and Geology
CDSM	Cement Deep Soil Mixing
CEQA	California Environmental Quality Act
CGS	California Geological Survey
CPT	Cone Penetration Test
CWA	Clean Water Act
DOGGR	California Department of Conservation Division of Oil, Gas, and Geothermal Resources
DSHA	Deterministic Seismic Hazard Analysis

DSOD	California Department of Water Resources, Division of Safety of Dams
EIR/EA	Environmental Impact Report/Environmental Assessment
Existing Dam	Existing North Haiwee Dam
ICGP	Inyo County General Plan
GBUAPCD	Great Basin Unified Air Pollution Control District
GMPE	Ground Motion Prediction Equation
km	kilometer
LAA	Los Angeles Aqueduct
LADWP	City of Los Angeles Department of Water and Power
MCE	Maximum Credible Earthquake
ml	modified land
NEPA	National Environmental Policy Act
New Dam	North Haiwee Dam No. 2
NHD	Existing North Haiwee Dam
NHD2	North Haiwee Dam No. 2
NHR	North Haiwee Reservoir
NPDES	National Pollutant Discharge Elimination System
OVFZ	Owens Valley Fault Zone
Proposed Project	North Haiwee Dam No. 2 Project
Qaf1	Mid-Late Holocene alluvial fan deposits
Qaf2	Late Pleistocene to early Holocene alluvial fan deposits
Qaf3	Late Pleistocene alluvial fan deposits
Qc	Holocene colluvial deposits
Qoa1	Older alluvial fan deposits
Qt3	Late Pleistocene fluvial terrace deposits
SNFFZ	Sierra Nevada Fault Zone
SA	Spectral Acceleration
SWPPP	Stormwater Pollution Prevention Plan
USGS	United States Geological Survey

12 Preparer Qualifications

12.1 AECOM

Christopher Goetz, AECOM, State of California Certified Engineering Geologist/Geology Task Manager

FIGURES

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Source: Esri Maps & Data, 2015; Prepared By: AECOM, 2016.

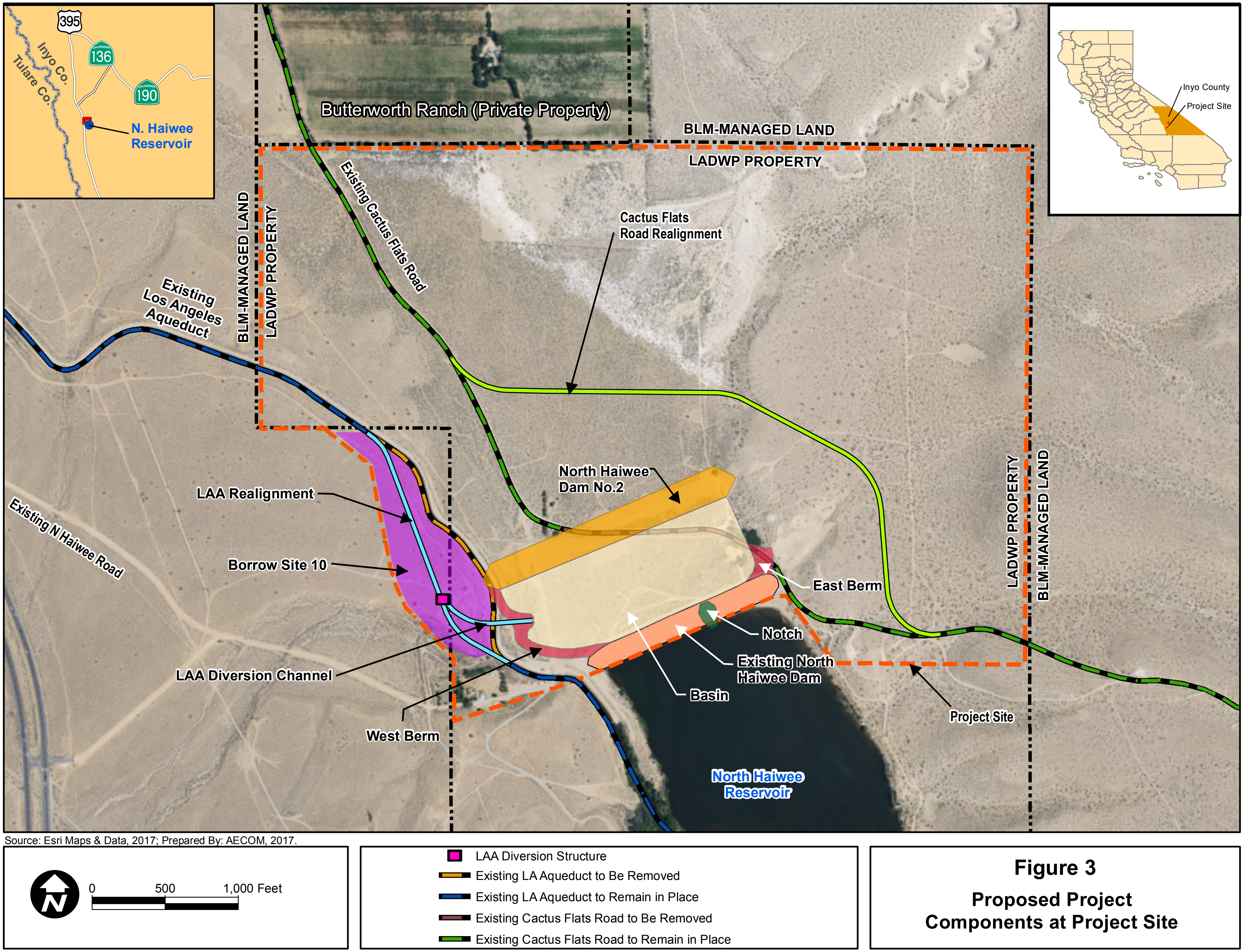
0 25 50 Miles

County Boundary

Figure 1
Site Location Map

Source: Esri Maps & Data, 2015; Prepared By: AECOM, 2016.

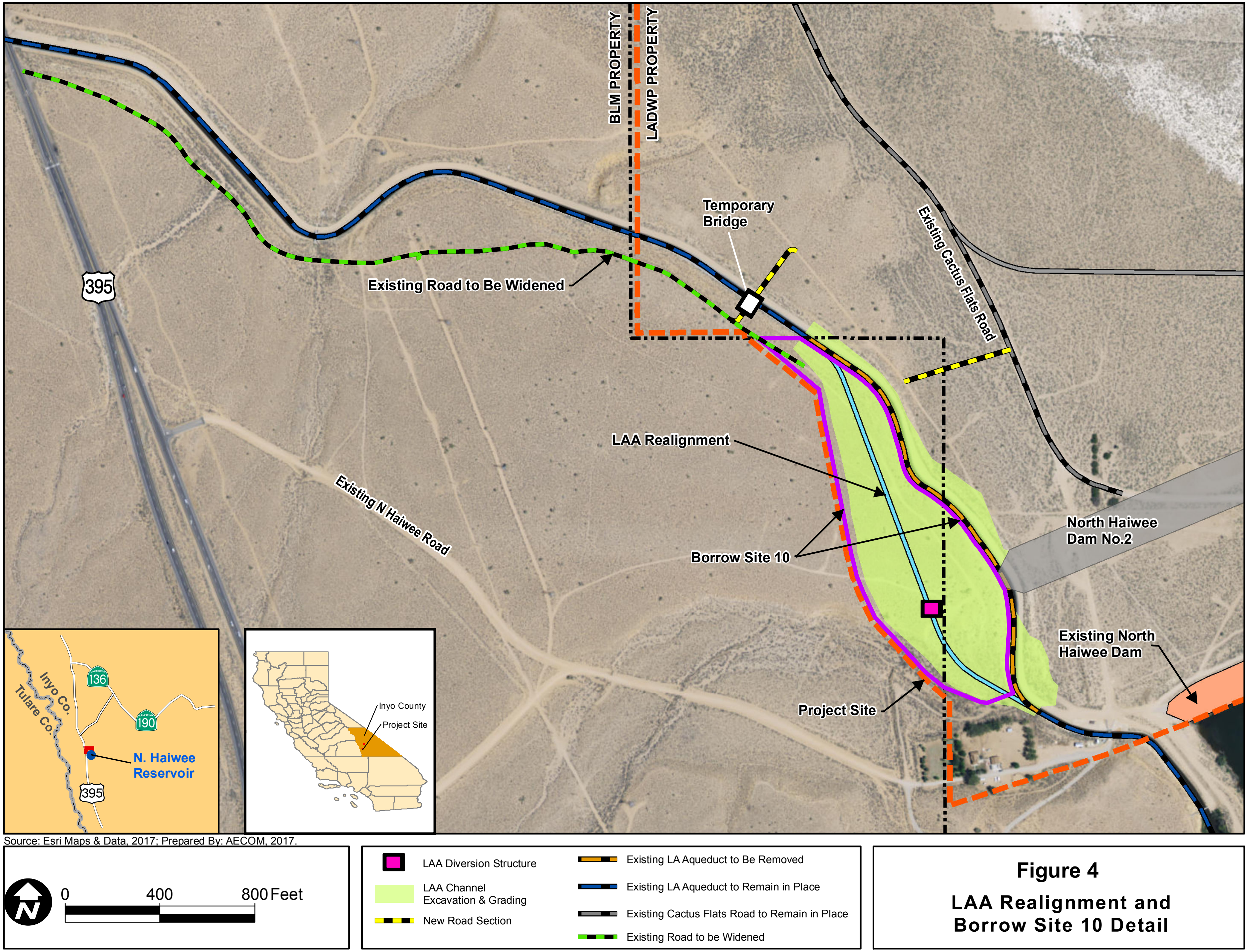
Figure 2
Project Vicinity



Source: Esri Maps & Data, 2017; Prepared By: AECOM, 2017.

Figure 3

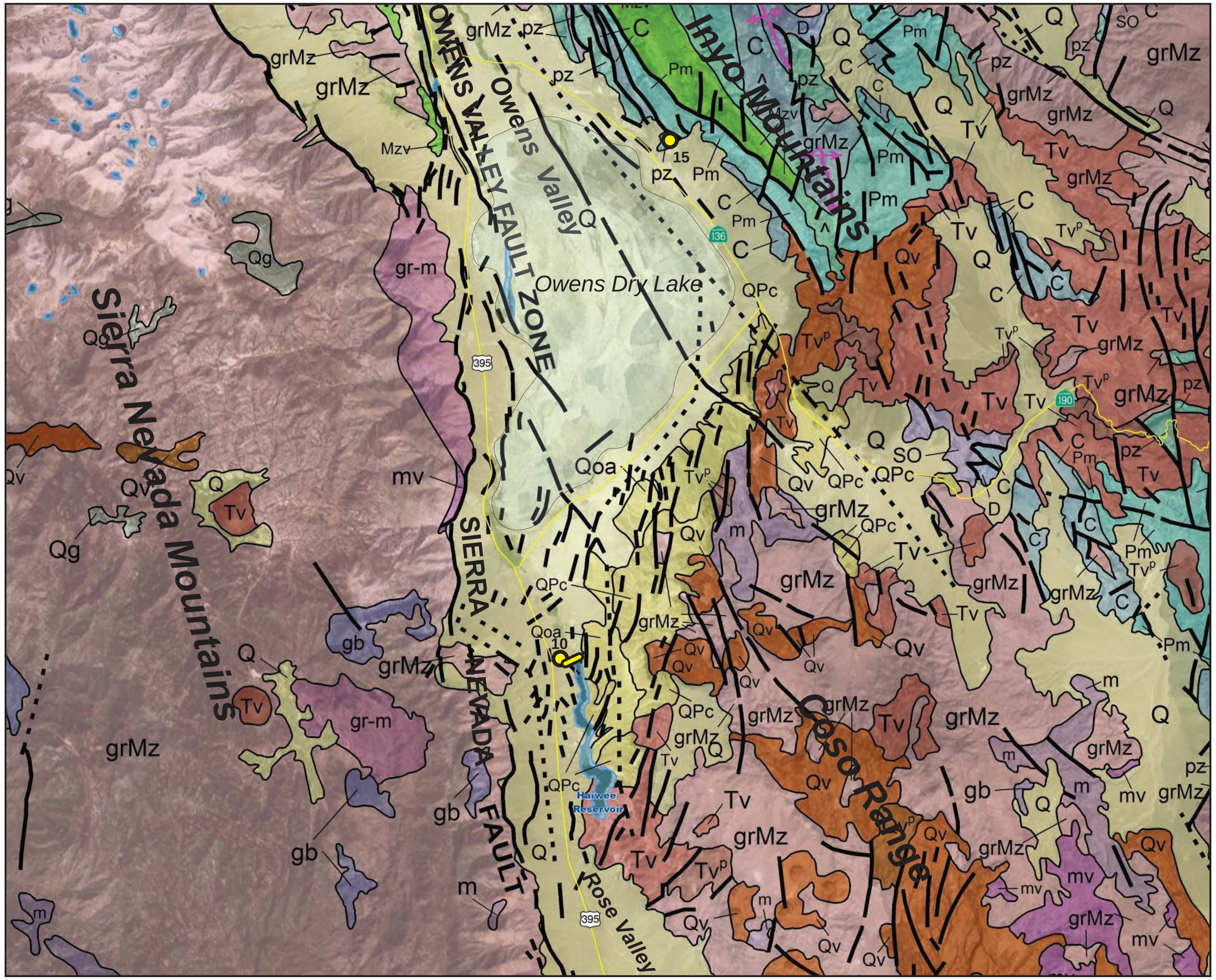
Proposed Project Components at Project Site



Source: Esri Maps & Data, 2017; Prepared By: AECOM, 2017.

Figure 4

LAA Realignment and Borrow Site 10 Detail



LEGEND

	NHD2 Dam Site
15	borrow site (borrow site number indicated)
	geologic contact, approximately located
	fault trace, solid where well located, dashed where approximate
	water
Q-	Quaternary alluvium
Qg-	Quaternary glacial till and moraines
Qoa-	Quaternary older alluvium
QPc-	Pleistocene and/or Pliocene sandstone, shale & gravel
Qv-	Quaternary pyroclastic and volcanic mudflow deposits
Tv-	Tertiary volcanic flow rocks
Tvp-	Tertiary pyroclastic & volcanic flow rocks
gr-m-	Mesozoic to Precambrian granitic and metamorphic rocks
Mzv-	Mesozoic meta-volcanic rocks
Mv-	undivided pre Cenozoic meta-volcanic rocks
grMz-	Mesozoic granite, quartz monzonite, and granodiorite
um-	ultramafic rocks, mostly Mesozoic
gb-	Mesozoic gabbro and diorite
Pz-	Paleozoic meta-sedimentary rocks, slate, dolostone, marble, chert
Pm-	Permian shale, conglomerate, limestone, dolomite, sandstone
C-	Carboniferous shale, limestone, dolomite, sandstone, chert, marble
D-	Devonian Limestone, dolomite, sandstone, shale
SO-	Silurian to Ordovician sandstone, shale, quartzite, marble, dolomite
m-	Paleozoic meta-sedimentary & meta-volcanic of great variety

N

0 5 10
miles

Sources:California Geological Survey - Geologic Map of California, 2010; Esri Digital Globe, 2013; Prepared by: AECOM, 2016.

Figure 5
Regional Geologic Map

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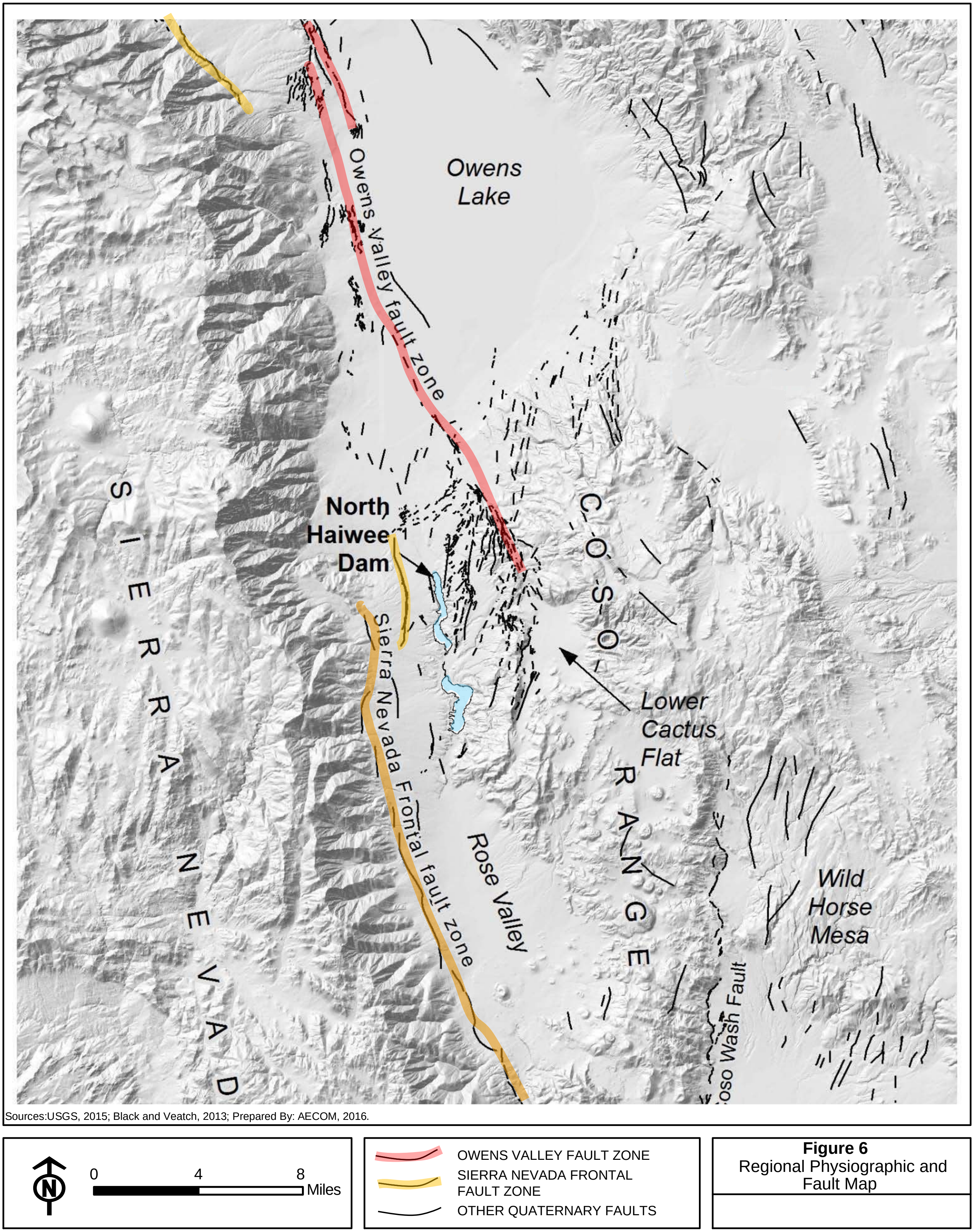

Sources:USGS, 2015; Black and Veatch, 2013; Prepared By: AECOM, 2016.

Figure 6
Regional Physiographic and Fault Map

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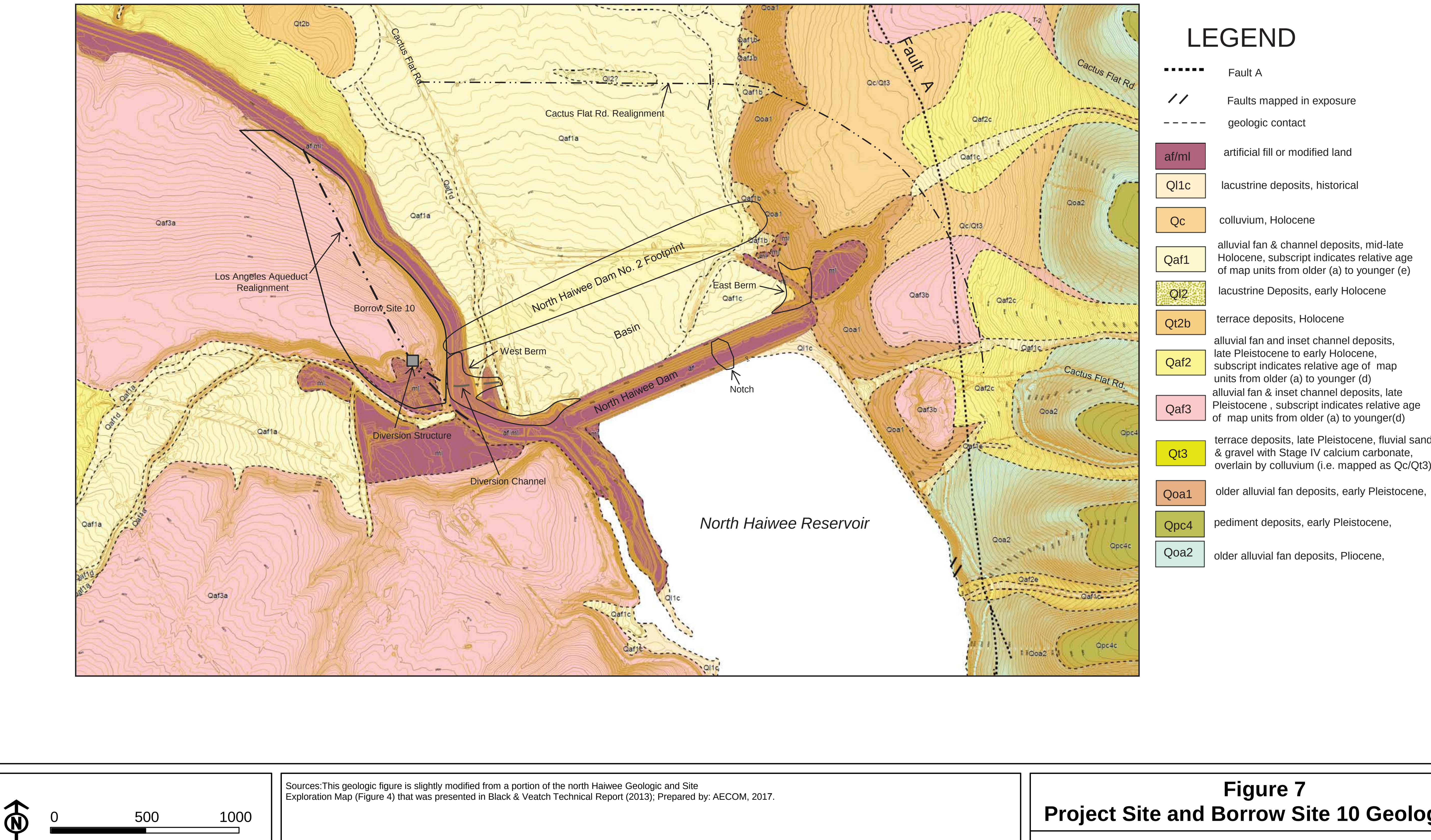

Sources:This geologic figure is slightly modified from a portion of the north Haiwee Geologic and Site Exploration Map (Figure 4) that was presented in Black & Veatch Technical Report (2013); Prepared by: AECOM, 2017.

Figure 7
Project Site and Borrow Site 10 Geologic Map

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