Appendix C. Description of Construction Activities for Structural Modifications

STATE OF CALIFORNIA
THE NATURAL RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES

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Table of Contents

List of Tables

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1.0 Introduction

This appendix provides a general description of construction activities, focused on levee construction. It is based on the Program Environmental Impact Report (PEIR) for the 2012 Central Valley Flood Protection Plan (CVFPP) (California Department of Water Resources [DWR] 2012).

2.0 Mobilization

Construction activities for levees and related infrastructure, begins with a mobilization phase. This phase involves installing temporary construction offices, setting up staging areas, and transporting equipment to the work site. Creating access to the site is often a necessary step, as is confirming contracts for raw materials that must be acquired from offsite sources.

- **Staging areas:** One or more staging areas are typically required for storage and distribution of construction materials and equipment. These areas are usually located in or near active construction sites and may be relocated as construction progresses, especially for long, linear levee improvement projects. Staging areas often include parking for construction workers.

- **Access and haul routes:** Access and haul routes are used to transport materials among borrow sites, staging areas, and construction sites. Access routes are also used by project personnel. These routes typically consist of public roads near construction sites; however, temporary new off-road haul routes may be constructed between borrow sites, staging areas, and construction sites. Projects involving construction near water may use barges to transport equipment and materials along water routes. Some newly constructed roadways may be retained for permanent use when needed to provide ongoing access for operation and maintenance (O&M) activities (e.g., for newly constructed levee segments not served by a previously existing road).

- **Borrow sites:** Borrow sites are areas from which earthen materials are removed for use in construction, and are typically developed for large-scale projects. Sites nearest to the construction areas are usually preferred. Excavation depths for borrow sites typically range from 2 to 10 feet, depending on volume requirements, the quality and extent of material available, and the method of reclaiming the borrow site. For example, in some instances, lowering the floodway can both provide materials suitable for construction and restore ecosystem processes. However, borrow sites can create isolated depressions that cause drainage issues and strand fish, so they must be sited carefully. The preparation and reclamation of borrow sites are similar to the processes used for construction sites (described below).

3.0 Timing

The time needed to construct structural modifications can be as short as a few days (in the case of minor repairs) or as long as several years (for major upgrades). Major construction activities typically occur in the dry season (May–October), with some mobilization occurring as early as April. Construction usually occurs only during daylight hours; however, some activities, expedited projects, emergency repairs, and projects nearing the flood season may require continuous daytime and nighttime work. Depending on weather and river conditions, construction can extend well into November. If a construction phase will extend into the following year's construction season, the site is secured and "winterized," which involves implementing any permit-required best management practices (e.g., storm water pollution prevention plan), before the start of the flood season (typically 1 November).

4.0 Equipment

Table 1 lists the various types of equipment that may be used during construction. A minor repair project, such as a small erosion repair, will use only a small number of a few types of equipment. A major project with an expedited schedule may use a dozen or more of many types of equipment.

Table 1. Types of Construction Equipment

• Excavators	• Haul trucks	• Truck-mounted cranes	• Chippers/grinders
• Scrapers	• Highway dump trucks	• Truck-mounted augers	• Generators
• Bulldozers	• Sheepsfoot or tramping-foot rollers	• Concrete trucks	• Slurry pumps
• Backhoes	• Smooth drum compactors	• Asphalt pavers	• Pile drivers
• Front-end loaders	• Roller compactors	• Hydroseeding trucks	• Integrated tool carriers
• Graders	• Pickup trucks	• Water trucks	• Lubricating and fueling trucks
• Crawlers/tractors	• Barges		

Source: DWR 2012.

5.0 Site Preparation

Site preparation typically involves clearing the ground of structures, woody vegetation, and debris. Structures may consist of residences, agricultural outbuildings, irrigation facilities (distribution boxes, wells, standpipes, and pipes), power poles, utility lines, and piping. Preparation may also involve removing stability or seepage berms along a levee. In addition, regulatory agency approval may be required before any site preparation activities are started if surveys and protection measures (e.g., activity avoidance buffers), tests, or other permit-required activities must be completed and verified. Clearing may be followed by grubbing to remove trees and other vegetation, stumps, root balls, and belowground infrastructure. Typically, up to 12 inches of earthen material from the ground may be stripped as part of site preparation.

6.0 Soil Borrow (Fill) and Fill Transport

Flood protection projects generally require offsite soil borrow (fill), and may also use rock or aggregate material for erosion repair, drainage layers under seepage berms, and temporary access or haul roads (for construction) or permanent access roads (for O&M). Cement or bentonite may be used to construct seepage cutoff walls as part of levee improvement projects. Concrete, brick, masonry, steel, and similar materials are typically used for structures associated with modifications (e.g., construction of pump buildings).

Fill from borrow sites may be delivered to a levee project site using haul trucks or scrapers, depending on the distance between sites. Scrapers are used when the borrow site is relatively close to the project site (i.e., generally less than 1 mile away), as when lowering the adjacent floodplain can provide suitable earthen materials. Otherwise, haul trucks are loaded by excavators and travel to the project site on existing paved or unpaved roads, or on temporary new unpaved roads. The volume of fill needed for earthen facilities can range from a few hundred cubic yards for minor levee repairs to millions of cubic yards for projects involving miles of levee widening or construction of setback levees.

For waterside construction projects, such as erosion repairs, barges may be used to transport construction materials (rocks or fill) from borrow or quarry sites because a barge on the water may provide the best way to access the construction site. Barges may have a built-in crane for moving materials to the bank. Barges may also be used to transport workers and equipment to waterside project sites and to support special equipment needed for waterside projects, such as pile drivers for installing instream sheet piles.

7.0 Postconstruction Work

When construction activities are complete, any material stripped from the soil surface during site preparation is placed on appropriate facilities (e.g., levees and seepage berms) and on any temporarily disturbed areas where topsoil was removed. As needed, levee slopes, seepage berms, and temporarily disturbed areas are seeded with appropriate herbaceous seed mixes. An aggregate-based patrol road may be constructed on the crown of a new levee or near the landside edge of a seepage berm, or in both locations. Any remaining construction debris is hauled to an appropriate waste facility. Equipment and materials are removed from the site, and staging areas and temporary access roads are restored to preproject conditions (e.g., stabilized with an herbaceous seed mix, planted for restoration to native habitat, or returned to agricultural production).

8.0 Construction of Specialized Structures

The construction process used to create levee embankments, seepage berms, cutoff walls, and pressure relief wells is described further below.

- **Levee embankments:** Constructing levee embankments may involve widening and flattening the landside slope of an existing levee, expanding the width of the entire levee by widening both the crown and the base, or building an entirely new levee next to or set back from an existing levee.

  During construction, fill from borrow sites is delivered to the levee construction site using haul trucks or scrapers. At the levee construction sites, the material is spread by graders and compacted by compaction equipment (i.e., sheepsfoot, smooth drum compactor, roller compactor) to build levee embankments. A water truck is used if needed to properly moisture-condition the soils for compaction and to control dust.

- **Seepage berms:** Seepage berms may be built as part of levee embankment construction or as an addition to existing levees. Seepage berms are wide embankments placed landward from the levee's landside toe to lengthen the underseepage path, thereby lowering to acceptable levels the exit gradient of seepage through permeable layers under the levees. Berms typically extend 80–300 feet from the landside toe of the levee. The thickness of a berm depends on the severity of the seepage flow, but generally ranges from 5 to 8 feet.

  A common type of seepage berm consists of a rocky drainage layer covered by a soil layer, which together control the exit gradient of water seeping through the material under the levee. The water seeps under the levee, enters the rock layer, and is controlled or contained within the rock layer by the overlying soil layer. A geotextile (filter fabric) is placed between the drainage rocks and the native soil below to prevent the water seeping into the drainage rock from carrying soil with it.

- **Cutoff walls:** A cutoff wall is a barrier installed inside a levee to minimize seepage. Cutoff walls may be constructed either through the top of an existing levee, along the toe of an existing levee, or as part of the construction of widened or setback levees. Several building methods are available to accommodate site conditions and schedule requirements. The most common methods are to install cutoff walls consisting of a soil-bentonite mix or a soil-cement-bentonite (SCB) mix, using conventional trenching methods, and to install them using deep soil mixing.

  Slurry cutoff walls are typically constructed using an excavator with a long-stick boom capable of digging a trench to a depth of approximately 80 feet. Soil and bentonite (and cement, if needed) are mixed in a batch plant to achieve the required strength and impermeability for the cutoff wall. The mixture is pumped into the trench as it is excavated to create the desired wall and to prevent the trench from caving in.

  In the deep soil mixing method, truck-mounted augers or other equipment are used to mix bentonite (and cement, if needed) with soil as the equipment moves deeper underground. Because the method is not limited by the reach of an excavator boom, cutoff walls more than 100 feet deep can be constructed this way.

  If cutoff walls are installed in an existing levee using excavators, several feet of the levee crown are typically removed before construction to facilitate installation of the wall. If special installation methods, such as deep soil mixing, are used, removal of the levee crown may not be required.

  Both methods of constructing slurry cutoff walls require that batch plants operate near the excavation area so that the soil-bentonite or SCB slurries can be prepared with appropriate consistencies and compositions. Batch plants typically require a water source to create the slurry and a storage site for bags of bentonite and (sometimes) cement. Water trucks often provide water to the batch plants. Batch plants may occupy an area of as much as 1,000–2,000 square feet. Plant components may be placed linearly on the crown of a levee, or on the levee toe. Hoses are typically used to move the slurry from the plant to the trench.

- **Pressure relief wells:** Where needed, pressure relief wells can be installed along the landside toe of a levee to intercept and provide controlled outlets for seepage that otherwise would emerge uncontrolled landward of the levee, resulting in weakening of levee materials.

  These wells are installed using a truck-mounted auger that bores a hole into the ground to the required depth of the well; the well casing, well screen sections, and filter pack are installed, and the well is finished by pumping water from it to clean out the bentonite drilling fluid and to consolidate the well's gravel pack. After the solids are settled out, water from the well construction is discharged to nearby fields or drainage ditches. Pressure relief well systems are often used where the pervious strata underlying a levee are too deep or too thick to be penetrated by cutoff walls or toe drains. Special permits (e.g., for discharge of water from the well) may be required for ongoing well operation.

9.0 Revetment

Facility remediation, improvement, and construction projects may involve installing revetment (a facing, made of rock or pieces of concrete), generally on the water side of a levee or along an eroding bank. Revetment provides structural integrity and erosion protection to the levee prism. Frequently, soil is mixed with the rock during installation to fill voids between rocks and sometimes to provide substrate for plantings (subject to approval by USACE and/or CVFPB). The size of the rock to be installed is typically determined based on an engineering evaluation that accounts for the anticipated erosive power of the river at that location.

Installation of revetment may require from 1 week to 3 months of active construction, depending primarily on the length of the site. Heavy equipment and vehicles used during construction may include bulldozers, trucks (i.e., pickup trucks, haul trucks, or highway dump trucks), barges with cranes, concrete trucks with extended arms (for use in depositing soil/rock mixtures), and excavators (DWR 2013). Rock may be installed using equipment on the levee crown or from barges, depending on access restrictions and the distance between the revetment site and the water.

10.0 References

[DWR] California Department of Water Resources. 2012. 2012 Central Valley Flood Protection Plan Consolidated Final Program Environmental Impact Report. State Clearinghouse Number 2010102044. Sacramento, California.

[DWR] California Department of Water Resources. 2013. Public Draft Program Environmental Impact Report for Small Erosion Repair Program. State Clearinghouse Number 2009112088. Sacramento, California. Available at www.water.ca.gov/floodmgmt/fmo/msb/smallerosionrepairs.cfm. Accessed 9 February 2014.

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