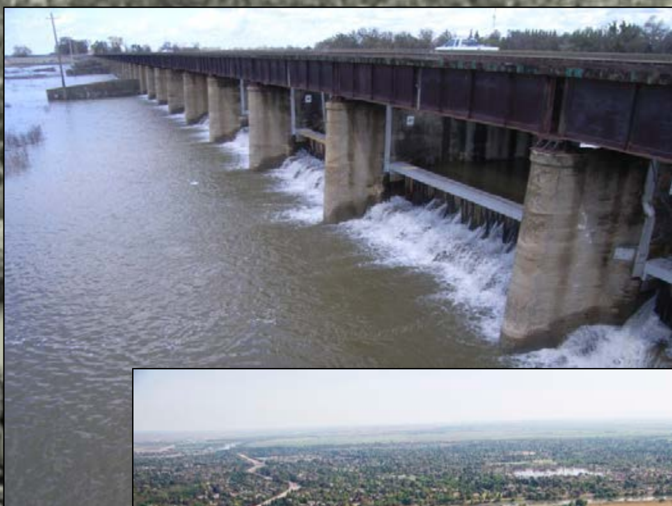
APPENDIX C

ENGINEERING

American River Watershed

Common Features
General Reevaluation Report



Draft
Engineering Appendix

February 2015

Central Valley Flood Protection Board

SAFCA
Sacramento Area Flood Control Agency

US Army Corps of Engineers®
Sacramento District

Cover Photos courtesy of the Sacramento District:
Sacramento Weir during operation
Sacramento River facing south near the Pocket and Little Pocket neighborhoods
High flows on the American River at the Highway 160 overcrossing
Folsom Dam releasing high flows

AMERICAN RIVER, CALIFORNIA
COMMON FEATURES PROJECT
GENERAL REEVALUATION REPORT

Draft Engineering Appendix for Public Review

U.S. Army Corps of Engineers
Sacramento District

February 2015

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CHAPTER 1 – INTRODUCTION

1.1 Introduction

This engineering appendix documents the design for the American River Common Features General Reevaluation Report (ARCF GRR). The purpose of the ARCF GRR is to evaluate the level of Federal interest in measures needed to reduce the flood risk to the City of Sacramento and surrounding areas. The study area includes the American River Watershed with several tributaries, the Sacramento River, and the Yolo and Sacramento Bypasses. This appendix summarizes the existing conditions, proposed alternatives, design considerations, costs, and schedule for the alternatives retained in the final array of alternatives. Information and analysis for other alternatives in the preliminary array of alternatives were developed by various sources including previous USACE reports and sponsor provided reports. The detail provided by these sources varies but were considered adequate for screening alternatives.

1.2 Project Location and Background

The ARCF GRR analyzed over 90 miles of levee and associated features in Sacramento, Sutter, and Yolo Counties that reduced flood risk in the greater Sacramento Area. Many of these levees were initially constructed by local interests. The levees were generally built close to the rivers to use as much land as possible for agricultural production and flush out hydraulic mining debris which had contributed to flooding in the past. The historic floods of 1907 and 1909 initiated a new comprehensive approach to flood management within the area. Since then, the United States Army Corps of Engineers (USACE) along with the State of California have managed flood risk in the Sacramento Area using an integrated system of levees, overflow bypasses, and dams known as the Sacramento River Flood Control Project (SRFCP).

The study area includes portions of the Sacramento and American River Watersheds. The flood plain includes most of the developed portions of the City of Sacramento, the Natomas basin, and portions of Sacramento and Sutter Counties. The study area also includes other flood facilities including the Fremont and Sacramento Weirs and Yolo Bypass. The Natomas Post Authorization Change Report (NPACR) and resulting Chief’s Report were completed in December 2010. The remaining portion of the project, including potential Natomas Basin levee raises, is being addressed in this report.

1.3 Reach Delineation

The ARCF GRR study area, shown in Figure 1-1, has been divided into three basins; Natomas (NAT), American River North (ARN), and American River South (ARS), which were further subdivided into study reaches. This report covers the approximate areas:

- 12 miles of the north and south banks of the American River immediately upstream of the confluence with the Sacramento River
- 18 miles of the east bank of the Sacramento River, downstream of the NCC down to the American River
- 5 miles of the south bank of the Natomas Cross Canal (NCC)

- 3 miles of the Pleasant Grove Creek Canal (PGCC)
- 26 miles of the Natomas East Main Drainage Canal and tributaries (NEMDC)
- 15 miles of the east bank of the Sacramento River downstream of the American River down to Morrison Creek

For the purposes of the feasibility planning process, the three study area basins were further subdivided into reaches based on common elements, such as geographic features. In general, this report presents information either by basin or reach. However, in some cases the report structure deviates from basin or reach based organization. For instance, geology and geomorphology, construction history, and past performance are better related to channel features than basin related reaches. Therefore, for those topics, the information has been presented in the following groups: American River (both banks), Sacramento River (south of the American River confluence), East Side tributaries (Dry and Robla Creeks, NEMDC east, and Arcade Creek), and Natomas Basin.

The American River North Basin (ARN) includes levees on the north (right) bank of the American River upstream of NEMDC, the east (left) bank of NEMDC from the American River to Arcade Creek and from Arcade Creek up to Dry/Robla Creeks, both banks of Arcade Creek from NEMDC up to Marysville Blvd, both banks of Dry/Robla Creek from NEMDC up to Marysville Blvd, and Magpie Creek between Vinci Ave and Raley Blvd. The levees in the American River North Basin have been divided into nine planning reaches; ARN A, B, C, D, E, F, G, H, and I.

The American River South Basin (ARS) includes levees on the south bank (left) bank of the American River upstream of the Sacramento River and the east (left) bank of the Sacramento River from the American River down to Morrison Creek. The levees in the American River South Basin have been divided into seven planning reaches; ARS A, B, C, D, E, F, and G.

The Natomas Basin (NAT) includes levees on the east (left) bank of the Sacramento River from Verona to the American River, the south (left) bank of the NCC, the west (left) bank of the PGCC, west (right) bank of the NEMDC, and the north (right) bank of the American River from the NEMDC to the Sacramento River. The levees in the Natomas Basin have been divided into nine planning reaches; NAT A, B, C, D, E, F, G, H, and I.

1.4 Coordination

The Project Delivery Team, consisting of U.S. Army Corps of Engineers (USACE), the State of California Department of Water Resources (DWR), the Central Valley Flood Protection Board (CVFPB), and Sacramento Area Flood Control Agency (SAFCA), coordinated in the preparation of this appendix. The designs for the identified alternatives were developed by the Sacramento District Corps of Engineers using assumptions and guidance as described in this Appendix.

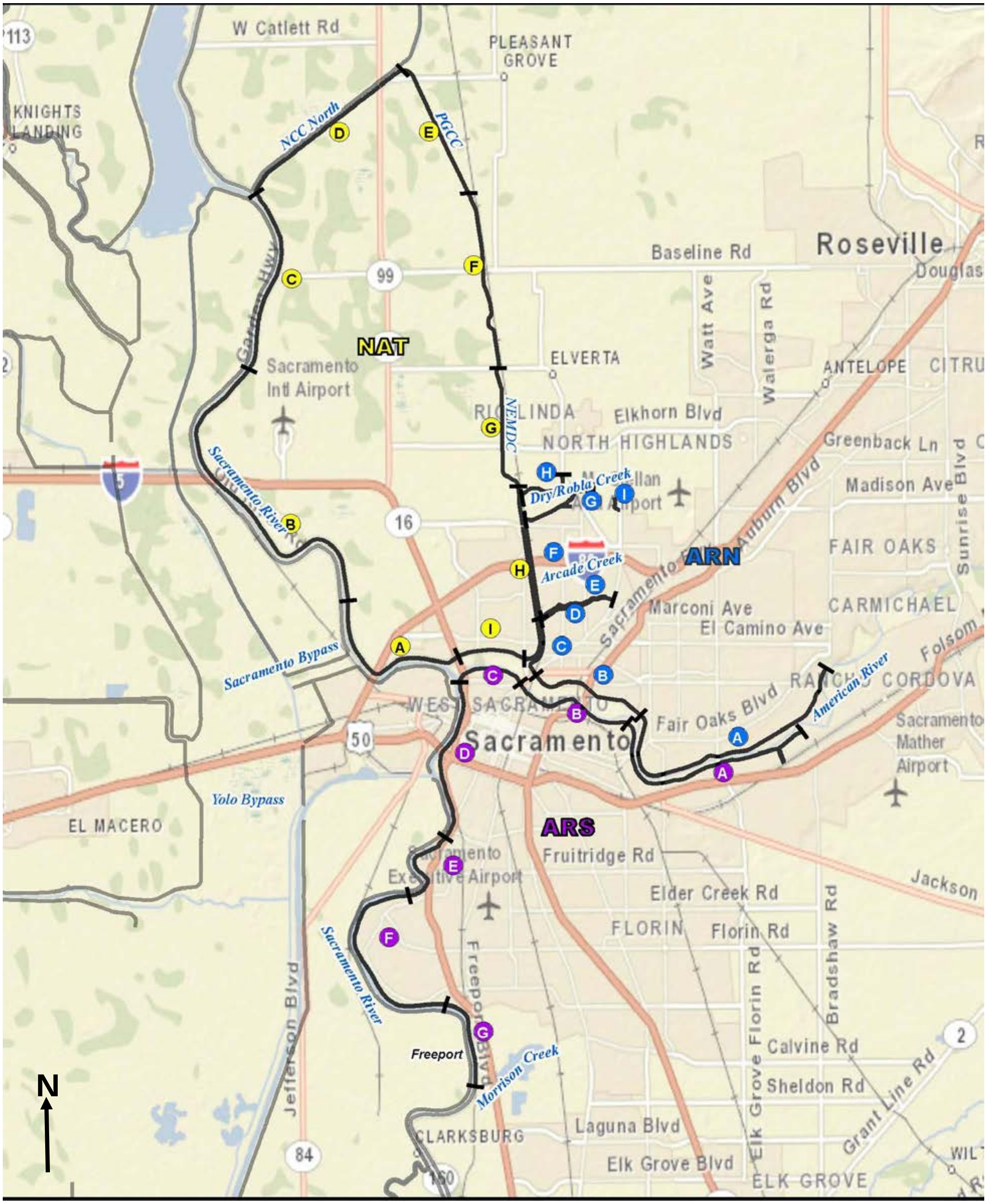

Figure 1 - Study Area Map

CHAPTER 2 – GENERAL DESIGN CONSIDERATIONS

2.1 General

The GRR includes a discussion of the full array of measures and alternatives. The technical appendices only include the Final Alternatives for which qualitative analysis was conducted. The Final Alternatives consist of three alternatives including the No Action Plan. This chapter summarizes the design considerations necessary for evaluation of the without-project condition and for development of the alternatives.

2.2 Hydrology

The hydrologic information used in support of this study is presented in *Synthetic Hydrology Technical Documentation* (USACE 2009) which completed ATR certification in January 2009. For details about the boundary conditions, calibration, data verification, and other topics related to the hydraulic modeling See Attachment A – Hydrology Executive Report for information.

2.3 Hydraulic Design

For alternative selection, the water surface for a median 200-year Annual Chance of Exceedance (ACE) event plus 3 feet was chosen as the top of levee (TOL) design profile. This approach is supported by an economic analysis of levee raises above existing TOL discussed within the economic appendix. The design profile also aligns with the sponsor's Urban Levee Design Criteria and the intent of Folsom Dam JFP to control releases up to a 200-year event. Raises beyond the 200-yr event were determined infeasible because the American River system could not contain the releases from Folsom Dam JFP to within the channel and both ARN and ARS basins would be inundated by water outflanking the levee system. In areas where the existing top of levee was higher than the criteria, the top of levee was used for the design profile. The top elevations for height improvements (levees and floodwalls) for the alternatives were determined using the median 200-year ACE event plus 3 feet.

The water surfaces were developed using hydraulic modeling by the Sacramento District Hydraulic Design Section. Much of the hydraulic data used to calibrate this data came from the Comp Study UNET model and flow/stage data from the 1997 flood event. See Attachment B – Hydraulic Executive Report for more information.

2.4 Geotechnical Design

This section summarizes the geotechnical analysis and resulting recommendations. See Attachment C – Geotechnical Report for additional detail.

2.4.1 Geotechnical Analysis

For the purposes of problem identification and alternatives analysis, several different failure modes have been evaluated for the without project condition. The failure modes included seepage (under and through), slope stability, erosion, overtopping and seismic. The details of the analysis and full report are included in Attachment C – Geotechnical Report.

Where levee height, geometry, erosion, access, vegetation, seepage, and slope stability deficiencies were identified (criteria not met) improvement measures consisting of cutoff walls, seepage berms, relief wells, stability berms, geotextile reinforcement, flattened embankment slopes, flood walls, retaining walls, sliver fills, and various other measures were included in development of conceptual alternative cross-sections.

2.4.2 Vegetation Variance

The majority of the Sacramento River levee within the study area, requires seepage, slope stability, height, and erosion improvements in order to meet USACE criteria. In areas requiring levee raising, construction of the levee improvements will require complete vegetation removal on the levee from approximately 15 feet landward of the landside toe to approximately 1/2 the height of the levee on the waterside slope. On the waterside, where construction does not remove vegetation, Army Corps ETL 1110-2-583, *Guidelines for Landscape Planting and Vegetation Management at Levees, Floodwalls, Embankment Dams, and Appurtenant Structures*, would require a vegetation free zone on the levee slope to 15 feet waterward of the waterside levee toe. The Sacramento District will instead seek a Vegetation Variance Request (VVR) which will keep the remaining vegetation left in place.

To show that the safety, structural integrity, and functionality of the levee would be retained, an evaluation of underseepage and waterside embankment slope stability was performed using a realistic vegetation scenario. The scenario analyzed the effects of a tree falling during a flood event and the resulting scouring of the root ball area.

The analyses section/index point at LM 5.92 was chosen for the VVR analyses because it was considered to be representative of the most critical channel and levee geometry and the without project analyses showed the section does not meet underseepage and slope stability criteria. The cross-section geometry of the index point incorporated tree fall and scour by using a maximum depth of scour for cottonwoods as approximately 11.0ft; the associated soil removed was projected at a 2:1 slope from the base of the scour toward both the landside, and waterside slopes. The base scour width was equal to the maximum potential diameter at breast height (dbh) of Cottonwoods (12.0ft) projected horizontally at a depth of 11.0ft below the existing ground profile. The results show that the tree fall and scour did not significantly affect levee performance and that the levee meets USACE seepage and slope stability criteria considering the seepage and stability improvement measures are in place ("with project" conditions). Therefore, it is a reasonable conclusion that with a VVR to allow vegetation to remain, the safety, structural integrity, and functionality of the levees within the study area would be retained. More information on the VVR and graphical representation can be found in the draft EIS/EIR under chapters 1 and 2 respectively.

2.4.3 Borrow and Stockpile Sites

It is anticipated that significant quantities of material will be required for construction of the proposed project. Several different improvement measures such as seepage berms, cutoff walls, embankment construction/reconstruction, and erosion protection are proposed. The Sacramento District Geotechnical Engineering Branch, SOP-003 *Geotechnical Levee Practice*, (SOP-003) established the requirements of engineered fill to be used for the construction of the levee embankments.

The material is expected to be sourced from several sites including; newly identified borrow sites within approximately 25 miles of the study area, existing borrow sites identified for the Natomas Basin by SAFCA, the Deep Water Ship Channel dredge disposal area, the existing levees, and existing commercial sources. Test pits and laboratory testing on materials collected from test pits were provided by SAFCA as part of the Natomas Levee Improvement Program (NLIP) for borrow sites established for the Natomas Basin. Additionally, the Sacramento District has studied the Deep Water Ship Channel spoil areas as a borrow source several time in the past, and a discussion of that borrow source is included below. Typically projects constructed by the Sacramento District utilize commercial borrow sites near the project area.

It is anticipated that the required soil fill import for the proposed project will exceed the capacities of the already identified borrow sites in the Natomas Basin, and obtaining significant quantities of material from commercial sites may be cost prohibitive. Therefore, a desktop regional borrow study was performed to identify potential borrow sites, within 25 miles of the study area, where enough soil could be sourced to satisfy the project needs. This study was performed by obtaining National Resources Conservation Service (NRCS) National Cooperative Soil Survey (NCSS) data, sorting the NCSS data based on material classification and engineering properties, using aerial photographs to identify areas of open or agricultural land, and then merging the sorted NCSS data with the open or agricultural land areas to obtain locations, acreage, and volume of potential borrow sites. Results of the desktop regional borrow study indicate adequate materials available within the assumed 25 mile area.

Depending on the selected improvement measure, it is possible that existing levee material could be used as a source of borrow material. Typically, the existing levee is composed of poorly graded sands, silty sands, and sandy silts on the rivers and streams, while the bypass levees were constructed of fat clays. This material can be considered suitable for use in the construction of some stability berms, seepage berms, and for reconstructing the levee embankment where a cutoff wall with an impervious clay cap is proposed.

Levee materials such as impervious fill, sand filter, and topsoil are largely expected to be import materials. These materials will be stockpiled or delivered and placed at the same time to construct the proposed levee improvements.

2.5 Civil Design

2.5.1 General

This section describes the civil design and site considerations required for construction of project features, access roads, contracting staging areas, real estate requirements, relocations, and quantities developed for the alternatives analyzed for the GRR. Design consideration information includes floodwall and levee construction guidance, EM 1110-2-1913 *Design and Construction of Levees*, and ER 1110-2-1150 *Engineering and Design for Civil Works Projects*.

2.5.2 Alignment and Stationing

For purposes of this report, river miles were used for figures and display purposes. Levee stationing in feet was developed for each feature for design purposes and quantity take-offs for purposes of this report. Alignments for existing levee improvements were determined by the existing features such as existing landside or waterside toe, waterside crest, etc.

The landside toe was determined using the Light Detection and Ranging (LiDAR) data along with recent aerial photos and was visually located by Civil Design. Most of the access-related improvements were developed using offsets of this approximation.

2.5.3 Topographic Data

The topographic data used for civil design alternative quantity estimates were based on LiDAR surveys conducted in 2007. The surveyed area consisted of a larger survey contract through the DWR in support of its Urban Levee Evaluation (ULE) geotechnical evaluations. Bathymetry data along the Sacramento and portion of American River was also used in conjunction with the LiDAR surveys under the same DWR geotechnical evaluations. Additional bathymetry was used to complete the rest of the American River study area from an updated 2006 Ayres model.

2.5.4 Datum/Units

The North American Datum of 1983 (NAD83) was used throughout the project area for horizontal control. For vertical control, some of the older datasets used were developed using the National Geodetic Datum of 1929 (NGVD29). These datasets were converted to the National American Vertical Datum of 1988 (NAVD88). English units have been used on this project as preferred by the Non-Federal Sponsor (NFS).

2.5.5 Relocations and Utilities

Utilities and various encroachments were researched and identified using a variety of sources including: State DWR Levee Logs, USACE Periodic Inspection data, and Central Valley Flood Protection Board (CVFPB) permitting data. All of these sources were compiled into a central spreadsheet for organization and priority identification purposes. Field surveys followed the research, attempting to identify both public and non public encroachments as well as verifying existing descriptions, materials, and sizes. The surveys were conducted for the ARS and ARN basins due to the higher risk associated with utilities near urban areas and the proposed levee improvement features within the area. The Natomas basin was not included because the NPACR was assumed authorized and built which included utility relocations.

The field survey and spreadsheet data were combined into a final document recording basic descriptions, owner, and permit number as applicable. Typical fixes were created to reflect existing conditions and proposed improvements to accommodate levee construction features and USACE policy compliance. Features like replacement/relocation of pipe, impervious fill around pipes, and positive closure represented a majority of the reoccurring items requiring relocation. Larger pumping stations were not assigned a typical fix; instead they were estimated by comparing to similar fixes identified in the NPACR and pro-rating. The pro-rate was related by pipe size and quantity of pipes penetrating the levee, assuming that all of the pipes would require relocation, positive closure, and new pumping equipment to meet USACE policies. The typical fixes and pumping plant pro-rates were then assigned to the utilities outlined in the document and evaluated for compensability.

Private encroachments identified in the field surveys were tabulated separately from the utilities and recorded for the NFS. These were items such as fence intersections, landscaping, pools and stairs along the landside of the levee which are included into the total project cost for alternative selection. ARS Reaches E-G were chosen as the best representation of NFS estimated costs for private encroachments as these reaches contained a majority of the private encroachments. The impact of the encroachments will vary between the alternatives due to the differences in levee raise which requires additional easement to construct and maintain, beyond that which is covered by the System Wide Implementation Framework (SWIF).

2.5.6 Construction Access, Haul Routes, and Staging Areas

Permanent access along most of the project is currently available using existing levee access roads. For scour protection, sites along the Sacramento River are anticipated to be constructed using barges. For the American River, additional waterside access roads will be constructed for the bank protection sites.

Access for constructing cutoff walls will be accomplished using existing levee access roads and public roads. For levee raising, access will be needed along the landside toe for construction and maintenance. Relocations will be accessed through the routes already mentioned. Further refinement of access requirements will be analyzed during the Preconstruction, Engineering and Design (PED) phase.

Haul routes will generally use existing public roadways that connect to the existing project. As borrow sources were not specifically identified, exact haul routes were not identified.

Since there have been many projects along the levees in this study, it is expected that previously used staging areas will be the primary location for staging for this project. There are other available sites such as parks, levee ramps, and vacant land along the levees that may serve as staging areas. Refinements of staging requirements and identification of staging areas will be completed during the PED phase. It is estimated that approximately one acre of staging area will be needed per mile along the project.

2.5.7 Real Estate Requirements

Real estate requirements for the study area consist of Flowage Easements (FE), Flood Protection Levee Easements (FPLE), Temporary Work Area Easement (TWAE), and Bank Protection Easement (BPE). These easements were needed to provide adequate construction room to build proposed flood risk management features and secure lands needed for Operations and Maintenance (O&M). The easements are described in Engineering Circular (EC) 405-1-11, and summarized below as they apply to the project.

Bank Protection Easement (BPE) – Easement needed for construction and maintenance of erosion protection features. Included are the rights to trim and cut vegetation, shape and grade slope, and place riprap. The easement includes all area required to construct and maintain erosion protection features that are outside of the FPLE.

Flowage Easement (FE) – Lands that will be subject to permanent and occasional flooding as a result of levee setbacks and degrading of existing levees within the project. This easement will be used for the widened Sacramento Bypass and Magpie floodplain detention features.

Temporary Work Area Easement (TWAE) – Easements needed for a limited duration such as during construction. These include areas needed for access roads and staging areas.

Flood Protection Levee Easement (FPLE) – Needed for levee setback areas and in locations where the local maintaining agency does not have sufficient rights on the levee. These include the right to construct, maintain, repair, operate and patrol the flood protection features. This easement includes all area from landside toe to waterside toe of the existing and/or proposed levee.

In areas where levees will be raised, a FPLE is needed for construction and maintenance for the expanded levee footprint. The easement needed for the expanded footprint is estimated to be 15 feet landward from the existing landside levee toe. Only levee raise areas will require the additional landward FPLE, with remaining areas to be included under the SWIF. See the GRR chapter 2 paragraph 6.6 for discussion of without project future conditions.

During PED, slope flattening will be analyzed further and it is expected that areas with proposed construction improvements will require slopes to be flattened. It is anticipated the slope flattening will not have impacts on permanent easements but will require a TWAE for construction when not coincident with levee raise. The slope flattening work will require approximately 10 feet extending from the toe of the levee towards the landside or waterside for construction. The work does not alter the project footprint for either alternative; instead it reestablishes design slopes with the sloughed material at the toe of the levee. The areas for slope flattening were not defined in this study along the Sacramento River due to the extensive analysis required to define these areas. However, it is estimated that slope flattening could occur on 15% of the levee lengths (9,300 feet) to allow estimation of Real Estate costs for this study. The qualitative estimate came from reviewing levee LiDAR data using slope shading techniques to indicate potential areas where levee slopes were over steepened. The real estate requirement will not be needed in areas of levee raising so it primarily affects the cost for Alternative 2. There is potential for slope flattening for Alternative 1 but it has been reduced to 5,300 feet for estimation of Real Estate costs. In ARN, both sides of Arcade Creek appear to require slope flattening. On the north side of Arcade, the TWAE extends to the landside as there appears to be minimal impact to existing homes and it is preferable to extend towards the landside to avoid hydraulic impacts to the creek. On the south side, the TWAE extends towards the waterside to avoid impact to existing residential property.

The project does not include work or real estate requirements to bring levees in compliance with Engineering Technical Letter (ETL) 1110-2-583. For areas along the Sacramento River with vegetation that doesn't meet the ETL, this report assumes the Sponsor has rights to meet requirements of the variance described in paragraph 2.4.2 Vegetation Variance. All work and real estate needs related to vegetation removal or access requirements on the landside of the levee will be covered under a System Wide Improvement Framework (SWIF).

More information on the types of easements, relocations, and estimates can be found in Appendix D – Real Estate.

2.6 Scour Protection Analysis

This section summarizes the erosion protection analysis and resulting recommendations. See Attachment E – Erosion Protection Report for additional detail.

Two erosion protection measures have been proposed that could be implemented in combination along the levee alignment depending on factors such as bank/bench geometry, existing habitat, and existing land use among other considerations. The location of these fixes relied heavily on the existing ground constraints and whether the waterside bench was large enough for the buried trench.

From engineering design perspective and initial environmental input, the Launchable Rock Trench method was preferred and used wherever physically possible and bank protection only when necessary. Because of the differences between the American River and Sacramento Rivers within the study area, this approach led to the majority of the erosion fixes on the American River as Launchable Rock Trench and the majority on the Sacramento River as Bank Protection. However, after impact analysis it was later determined that bank protection would be preferred because of the reduced impacts to vegetation requiring removal during the trench construction. A sensitivity analysis between the two designs was evaluated and costs were determined to be similar with regards to construction and real estate. Therefore, prior to the planning feasibility report milestone (FRM), updates to the plates and quantities will be performed to capture the preferred erosion protection method.

Both erosion designs used the same rock revetment gradations which were calculated using the CHANLPRO software and hydraulic inputs. Section design thicknesses, launching distances, and quantities were dictated by the revetment size and guidance from EM 1110-2-1601, *Hydraulic Design of Flood Control Channels*. The amount of launchable rock needed for both designs was close to 10 cubic yards per lineal foot to account for scour and will potentially allow launching distances up to 25 feet with 3 feet design thickness. Depending on site conditions, sand filters and geotextiles would be used accordingly.

Both erosion protection measures propose planting areas within the design. Plantings are not considered detrimental to the erosion protection features if, at a minimum, they are not within the vegetation free zone and the roots will not penetrate into the launchable rock trench. As shown in Figures 2, 3, and 4, the erosion protection includes 1) a sand filter (minimum 1-foot thick) to prevent migration of material, 2) rock sized as described in paragraph above, 3) cut slopes are no steeper than 1.5H:1V but should also match the waterside levee slope angle when excavating against the levee, and 4) the base of the launchable rock trench should correspond to the elevation of the summer mean water surface elevation to limit the vertical distance the rock must launch to during an event.

2.7 Environmental Impact Assessment

The waterside and landside areas of levees provide a large amount of habitat for the Sacramento Area. These areas are important for nesting and roosting habitats for a variety of wildlife species, some of which are special-status. The waterside wooded areas are especially valuable because of the Shaded Riverine Aquatic (SRA) habitat which creates nutrient rich areas and cooler temperatures for fish to take shelter.

The harmful effects that construction could have within the project area were considered during alternative evaluation. The affected areas are described in the Environmental Impact Statement along with any options that may reduce or mitigate for the proposed flood features.

2.7.1 Hazardous, Toxic, and Radioactive Wastes (HTRW)

A Phase 1 Environmental Site Assessment (ESA) was performed in accordance with the scope and limitations of ASTM E 1527-05 and USACE ER 1165-2-132 for the American River Common Features GRR study. There are many contaminated properties adjacent to the landside of the levees that should be avoided due to the nature of the contamination or the nature of the work proposed on the levees. The ESA has identified sites with recognized and probably unavoidable environmental conditions at the locations shown in Table 1 below.

Table 1 - Sites with Recognized Environmental Conditions

Site Name	Reach	Issue
Old North Sacramento	ARN Reach C NEMDC	CVOC, TPH Groundwater Plumes adjacent to levee, multiple properties
Full Stop Mini Mart	ARN Reach D Arcade Creek	TPHg plume at levee bridge crossing with air sparging
Robertson/Harbor Sand & Gravel	ARS Reach B American River	Levee Encroachment, recycled pavement
TOSCO Corp. Conoco-Phillips Sacramento Terminal	ARS Reach D Sacramento River	Petroleum release site on water side of the levee
TOSCO Corp./ Conoco-Phillips Sacramento Terminal	ARS Reach D Sacramento River	Petroleum release site on land side of the levee. Petroleum pipelines pass through the levee.
Southern Pacific Rail Yard	ARS Reach D Sacramento River	CVOC, TPH Groundwater Plume, land use restrictions
Old Bryte Landfill	Sacramento Bypass	Lead in soil

The historical land uses of the region may also contribute to residual contamination of the entire project area with agricultural fertilizers, herbicides, and pesticides as well as arsenic and mercury from mining operations in the region. Additional sampling will be required during subsequent investigations to determine if project areas have been impacted by these historical contaminants.

On-line records are limited. For contaminated sites identified as unavoidable under the alternatives considered by the American River Common Features GRR, a public records review is recommended at the Central Valley Regional Water Quality Control Board office and the Sacramento Regional Office of the Department of Toxic Substances Control as the next step to determine if additional investigation is required to determine the impact of these sites on the proposed project. Current groundwater plume maps and environmental liens / deed restrictions incorporating land use controls are particularly needed. Emphasis is needed on the Sacramento Terminal Bulk Fuel Handling Facility, the Old Southern Pacific Rail Yard, and the Old Bryte Landfill.

A follow on Phase 1 ESA will need to be performed at the beginning of Preconstruction Engineering and Design (PED). The subsequent Phase 1 ESA(s) will investigate if new sites have emerged and if existing sites still need to be addressed prior to construction.

2.7.2 Environmental Commitments

American River

During the PED phase, plans will be evaluated to reduce the impact on vegetation and wildlife. Refinements that could be implemented to reduce the loss of riparian habitat are; reduced footprint and replacing the trench cross section with bank protection and planting berm cross section where large riparian habitat areas exist adjacent to the levee toe (when no hydraulic impacts would occur).

Where the bank protection cross section and planting berm can be constructed trees would remain the area that is 15 feet from the levee toe and complies with the Corps vegetation policy. Trees would be protected in place to the extent practical along the natural channel during the placement of rock. The rock would anchor the trees in place and reduce the risk of them falling over during a high flow event. Additional plantings would be installed on the newly constructed berm to provide habitat for fish and avian species. The planting berm would be used to minimize impacts to fish and wildlife species; however, the impact to riparian habitat would still be significant.

To compensate for the removal of 65 acres of riparian habitat on the American River, approximately 130 acres of replacement habitat will be created. Species selected to compensate for the riparian corridor removal will be consistent with the approved list of trees, shrubs, and herbaceous plants native to the American River Parkway. The 130 acres will create habitat connectivity and wildlife migratory corridors that provide for the habitat needs of important native wildlife species, without compromising the integrity of the flood management facilities, the flood conveyance capacity of the Parkway, and Parkway management goals in the Parkway Plan (See EIS for more information on the Parkway Plan). Some of the 130 acres of riparian would be planted on top of the rock trench. Corps vegetation policy allows for trees to be planted 15 feet from the levee toe. In order to comply with this policy and reduce the amount of maintenance on the compensation lands, trees could be planted on top of the rock trench starting at 15 feet from the waterside toe. In other words if the trench is 70 feet wide the outer 55 feet could be planted with riparian habitat. Additionally, to comply with the Parkway Plan, lands within the Parkway will be evaluated for compensation opportunities. The exact location of the compensation lands in the Parkway will be coordinated in the PED phase of the project with Sacramento County Parks Department and comply with the Parkway Plan objectives and goals. It is assumed that sufficient lands will be available within the Parkway, however, if there is not sufficient land, other locations within Sacramento County will be identified and public coordination will occur.

East Side Tributaries

Compensation for the removal of approximately 200 trees in the Arcade Creek area will be done in compliance with the Sacramento City tree ordinance. It is estimated that 2 acres will be required to accommodate the planting of approximately 450 trees. There are multiple locations that are suitable for planting the compensation trees within the City of Sacramento Parks land.

Sacramento River

Avoidance and minimization measures incorporated as part of the Sacramento River design include compliance with the Corps vegetation policy through a vegetation variance, and installation of a planting berm where erosion protection is required.

The vegetation variance would allow waterside trees on the lower 1/2 of the waterside slope to remain in place. This allows approximately 930 trees along 10 miles of the Sacramento River from the American River confluence to Freeport to continue to provide habitat for fish and wildlife species. Along with retaining the trees, additional plantings of small vegetation will be done on the newly constructed berm. Species of plants will be coordinated with the National Marine Fisheries Service, Fish and Wildlife Service, and State and local partners.

On the landside, where the footprint cannot be reduced, approximately 600 trees will be removed to construct the levee and provide access in accordance with Corps and State policy. These trees are considered to be riparian habitat because of the close proximately to the waterside riparian corridor. Compensation for the tree removal was evaluated based on other projects in the Central Valley where riparian trees were removed, coordination with FWS, and local tree ordinances. Based on this evaluation and the lack of riparian habitat in the urban area, up to 95 acres could be required to compensate for the loss of these trees. There are parcels of land within a short distance that could be planted, however, further evaluation on availability of these lands and coordination with the resource agencies will be needed. Lands within the extended Sacramento Bypass could be used to compensate for some of the landside trees being removed. A hydraulic analysis would need to be done to determine what extent planting could occur. If sufficient compensation lands cannot be located, credits in a FWS approved mitigation bank will be purchased to meet the requirement of 95 acres.

Sacramento Weir and Bypass

Impacts associated with the Sacramento Weir and Bypass are related to the construction of Alternative 2 (See Section 4.3 Alternative 2 – Sacramento Bypass and Weir Widening**)** only, therefore, avoidance, minimization, and mitigation measures discussed in this section would only be implemented if Alternative 2 is constructed.

As stated above a maximum of 8-acres of riparian vegetation will be removed to construct the 1,500 foot long weir. Compensation was determined by evaluating other projects with similar impacts in the Central Valley, coordination with resource agencies, and evaluation of compensation plantings ability to provide similar wildlife habitat. Because new plantings will take many years to establish a temporal loss was considered in the calculation for compensation acreage. A total of 20 acres would be needed to compensate for the removal of the vegetation along the Sacramento River and within the new weir footprint. Plantings could be accomplished within the expanded bypass if hydraulic analysis determines that it would result in no reduction in conveyance capacity. Specific lands for compensation have not been identified; however, lands considered will provide similar habitat to that being impacted. If appropriate lands cannot be located, a FWS approved mitigation bank may be used to offset the impacts.

2.8 Operation, Maintenance, Repair, Replacement, and Rehabilitation (OMRR&R)

The Non-Federal Sponsor (NFS) is responsible for project Operation, Maintenance, Repair, Replacement, and Rehabilitation (OMRR&R) for project features. The costs of OMRR&R are represented as the averaged annualized cost to maintain the flood control features over the project lifespan. The regulation which governs this work is under the provisions of Title 33, Flood Control Regulation, Maintenance and Operation of Flood Control Work approved by the Secretary of the Army, published 17 August 1944 Federal Register.

The GRR evaluates the additional effort required by the local maintaining agency (LMA's) to Operate, Maintain, Repair, Replace, and Rehabilitate (OMRR&R) for the added features of the alternatives. The following provides a general description of additional features proposed as part of the GRR study and describes the Corps understanding of increases/decreases in OMRR&R effort as a result.

USACE worked with staff from the LMA's to develop the differential costs associated with the project features. Costs associated with OMRR&R are presented in section 5.4.1 Cost Engineering Data & Results.

Cutoff Walls

Cutoff walls are proposed in levees along the Sacramento River, NEMDC, and Arcade Creek. The cutoff wall will be within the subsurface of the levee and therefore no additional maintenance cost is needed for the cutoff wall features. However, in the future, features which disturb the wall will require additional costs to repair and replace portions of the wall.

Construction Access for Operations and Maintenance

Construction access to the levee toe will be provided in areas where the levee is being raised or slopes are flattened to allow for OMRR&R. The access requirements include a 10 foot wide easement on the landside of the levee. Generally, the local sponsor will need to increase mowing, rodent control, and encroachment removal to include this additional area. For purposes of this GRR, the Corps has included costs equivalent to increasing the current budgets for vegetation control, rodent control, and mowing by 15 and 5 percent to account for the additional area for alternatives 1 and 2, respectively.

Floodwalls and Retaining Walls

The required maintenance for the floodwalls and retaining walls includes caulking and graffiti removal. The exposed area for the proposed floodwalls and retaining walls is minimal and impact on OMRR&R is considered negligible. Therefore, no cost increase is included.

Erosion Protection

There is new erosion protection proposed for most areas along the American and Sacramento Rivers that are not currently protected with modern bank protection. The erosion protection along the Sacramento River is mainly bank protection type similar to existing Sacramento River Bank Protection Project sites. The maintenance required for these areas includes replacing rock damaged by floods or other means. The bank protection will offset the need to repair levees with erosion damage after flood events.

The maintenance required for the launchable rock trench includes vegetation control and mowing from levee crown to 15’ waterside of the toe. The vegetation and mowing are typically already included in existing OMRR&R operations. The required efforts are considered offsetting and no additional costs were calculated.

There will also be vegetation (mainly trees) planted in designated areas for both bank protection and launchable rock trench control types. The vegetation will be outside the 15’ waterside of the levee toe boundary. The proposed plantings are native plants and should regenerate and require no maintenance. Additional costs for establishment period have been included into the construction costs and are not part of O&M. No additional costs were calculated for additional plantings.

2.9 Cost Engineering

2.9.1 General

The project cost estimates were prepared by Cost Engineering Section, Sacramento District, and based on quantities and data furnished by the Civil Design Section A, Environmental Planning, and Real Estate sections. Summary of estimates for the preliminary alternatives for the Plan are provided in Attachment D – Cost Estimates.

Real estate estimates were based on footprint requirements for project construction. Operation and maintenance estimates were provided by Civil Design Branch. Alternative level estimates were prepared based on refinements to the preliminary layouts, features, and measures as determined by screening analysis done by Planning Division, and input from the potential non-Federal sponsors. The cost estimates for the preliminary alternatives, were prepared by the Cost Engineering Section of the Sacramento District. Design guidance came from ER 1110-2-1302, *Civil Works Cost Engineering*. Detailed preparation and the format of all estimates follow the guidance in Engineer Technical Letter (ETL) 1110-2-573.

A combined Value Engineering study for this project and the West Sacramento study was completed in November 2013. The study had the following objectives: validate alternatives, facilitate communication, manage risk, and improve value. It analyzed an array of alternatives and provided a comparison of value between alternatives. Results indicate Alternative 1 has the highest value with Alternative 2 as the second highest value.

CHAPTER 3 – EXISTING CONDITIONS

3.1 General

The purpose of this chapter is to provide an overview of the existing levee system in the study areas. The discussion will focus on describing the existing features. Hydraulic and geotechnical analyses of the existing condition and performance of the levee system are discussed in paragraphs 2.3 and 2.4 of this report. Refer to the Attachment B – Hydraulic Executive Report and Attachment C – Geotechnical Report for more detail.

The levees providing flood risk management to the ARCF GRR study area are susceptible to through seepage, underseepage, slope stability, overtopping, and erosion. In addition to these problems there are instances of utility facilities, existing drainage ditches and irrigation structures landside of the levee which compromise levee integrity. This section presents the problems that remain for the levees within the ARCF GRR study area.

3.2 American River

On the American River (both banks, Reaches ARN A and B and ARS A, B, and C) seepage and stability improvements have been accomplished as authorized by WRDA 1996 and 1999. Geotechnical seepage and slope stability analyses performed for the ARCF GRR confirmed that at the critical cross-sections, the improvements constructed for WRDA 1996 and 1999 negate need for additional seepage and stability improvements as part of the ARCF GRR. The WRDA improvements also have addressed height issues by designing the TOL design profile to convey 160,000cfs with 3 feet of freeboard.

The American River levees were originally intended to convey a release from Folsom Dam of 115,000 cfs. During several events since the construction of Folsom Dam, flows have exceeded design capacity and caused significant erosion distress. Additionally, the objective release from Folsom Dam is for 160,000 cfs. Due to the past performance and future without project conditions, erosion is the driving potential failure mode along the American River requiring additional improvements to convey design flows.

3.3 Sacramento River South

On the Sacramento River east levee south of the confluence with American River (Reaches ARS D through G), the need for further seepage and slope stability improvements has been identified through geotechnical analyses. Although the majority of the levee embankments contain a through seepage cutoff wall from the Sacramento Urban Area Levee Reconstruction Project of the early 1990s, analyses and past performance indicate a deeper underseepage and underseepage induced slope stability deficiency exists. In these areas, the low permeable confining layers are typically found deep below the levee and may require deep cutoff wall construction methods. Additionally, the levee at Pioneer Reservoir was improved by the Sacramento District with relief wells and a landside seepage berm in 2006 to meet criteria at the 100 year flood event.

Levee and existing floodwall height deficiencies have been identified along the Sacramento River levee for the 200-year event. Deficiencies ranged from 1 to 2 feet with a majority beginning at the end Reach E and carried through Reach G. Some of the existing improvements in the area had already built up the levees which would not require any further height improvements.

At several locations the typical design levee section criteria is not applicable due to geometric configuration, historic encroachments, roadways adjacent to the levee, or high ground adjacent to the embankment. These locations include several segments of high ground (typically man-made such as the Sacramento Railyards or the Interstate-5 embankment) downstream of the confluence with the American River and adjacent to the levee embankment. Through portions of Old Sacramento the “Boat Section” of Interstate-5 parallels the floodwall and levee alignment. The “Boat Section” consists of a deep cut for the roadway supported by two retaining walls that buttress I-5 off ramp embankments. At this location, a system of floodwalls, retaining walls and pumped wells operate for the interstate and City of Sacramento waterfront. The features mentioned are expected to handle any seepage and stability issues.

Slope stability issues have been identified for certain areas along the Sacramento River. Over steepened slopes combined with loadings from adjacent roads, railroads, and structures may result in stability issues which need to be addressed.

The Sacramento River levees also have erosion problems similar to the American River. Analysis performed under programs such as the DWR Urban Levee Geotechnical Evaluations (ULE) and the USACE levee screening tool indicate that there is medium to high risk of breach due to erosion. Additional information can be obtained under Attachment E – Erosion Protection Report.

3.4 East Side Tributaries

Based on hydraulic modeling, areas of the East Side Tributaries have been identified with overtopping issues for the 200-year Annual Chance of Exceedance (ACE) design event. The existing top of levee for NEMDC is above the mean 200 year ACE event with varying degrees of assurance. There are also existing levee crown floodwalls within Arcade Reaches D and E starting approximately halfway through the reach terminating at the upstream terminus of the study area. The floodwalls were built up to several feet high by SAFCA under the Arcade Creek Levee Improvements project in 1996 which targeted the FEMA 100-year design surface.

The NEMDC, Arcade Creek north, Dry Creek, and Robla Creek levees sections were improved in the 1990’s to early 2000’s by SAFCA, and although they did not include internal seepage improvements, the levees meet geotechnical analyses criteria for seepage and slope stability, except in limited segments. The exception being a portion of NEMDC south of the Arden-Garden Connector Bridge, both banks of Arcade Creek, and a section of NEMDC north where the historic Magpie Creek intersects the levee foundation. These areas have been identified as having underseepage and underseepage induced slope stability problems. NEMDC segments also have an active railroad operated by Union Pacific Railroad (UPR) running parallel and within close proximity of the levee. This railroad cannot be relocated or temporarily shut down, therefore design of the seepage mitigation features will need to consider and include the appropriate construction methods. Seepage and stability improvements were also recently constructed in Reach C under the WRDA 99 authorization. These improvements extend from the downstream end of Reach C upstream near the Arden-Garden Connector Bridge.

Dry Creek, Reach H was evaluated and determined to low probability of failure with regards to seepage and stability issues and there were no overtopping or erosion improvements needed. The driving factors for levee fragility were judgment based and were tied primarily to encroachments and utilities. The SWIF will address these issues and therefore the reach will no longer be considered for project features.

The Arcade Creek north bank has a large open channel landside ditch used to collect stormwaters and deliver them to nearby City Sump No. 158. There are seepage and stability concerns for this particular area which will need to be addressed.

3.5 Natomas Basin

Levee improvements to address seepage, stability, and erosion problems in the Natomas Basin were addressed in the 2010 Natomas PACR and authorized in WRRDA 2014. Additional improvements, consisting of levee raises, were analyzed as part of this study but are not included in the recommendation in light of other ongoing work by local interests which could render these improvements unnecessary. See Chapter 3 of the GRR document for additional information.

3.6 Magpie Creek

The existing Magpie Creek Diversion Channel (MCDC) was constructed as a 1950's era flood control project. The diversion channel intercepts upstream flows near Raley Boulevard at the confluence of Don Julio and Magpie Creeks. Flow is diverted northwestward to Robla (also known as Rio Linda) Creek, rather than through the original Magpie Creek channel. Downstream of the diversion point, the original Magpie Creek channel still carries local runoff. Magpie and Robla Creeks both discharge into the NEMDC about 2.5 miles west of Raley Boulevard.

In the early 1990’s, the Sacramento District and SAFCA began studying the Magpie Creek and MCDC flood control project after the realization that the system was overtopped during frequent events. In the late 1990’s and early 2000’s, both the Sacramento District and SAFCA developed various improvement alternatives for the project. No construction occurred as a result of these studies. While the alternatives varied slightly, they included similar measures such as, levee raises (either embankment or floodwall), new levee construction, channel improvements (deepening or widening), and construction of detention basins.

There are no seepage and stability issues noted for this area. Design of features will focus on the hydraulic conveyance of the 200-year event.

3.7 Sacramento Bypass

The existing Sacramento Weir structure and bypass were completed by 1916. The geotechnical performance of the north levee is relatively unknown, with no significant exploratory data to conduct an evaluation. However, there have been some instances where the north and south levees experienced underseepage and slope stability related distresses. Therefore seepage and stability issues should be implemented within the design. The weir structure also has no known deficiencies or performance issues.

In summary, the project area has erosion, stability, seepage, and height issues which require flood risk mitigation. The following table summarizes the existing issues by reach:

Table 2 - Reach Issues

BASIN	REACH	REACH LENGTH (MI)	EXISTING ISSUES
ARS	A	6.9	EROSION
	B	3.3	EROSION
	C	1.9	EROSION
	D	4.3	SEEPAGE, STABILITY, HEIGHT, EROSION
	E	2.4	SEEPAGE, STABILITY, HEIGHT, EROSION
	F	5.4	SEEPAGE, STABILITY, HEIGHT, EROSION
	G	2.5	SEEPAGE, STABILITY, HEIGHT, EROSION
ARN	A	7.5	EROSION
	B	3.1	EROSION
	C	1.5	SEEPAGE, STABILITY, HEIGHT
	D	2.1	SEEPAGE, STABILITY, HEIGHT
	E	2.1	SEEPAGE, STABILITY, HEIGHT
	F	2.6	SEEPAGE, STABILITY, HEIGHT
	G	2.2	HEIGHT
	H	1.6	-
	I	0.6	HEIGHT

CHAPTER 4 – ALTERNATIVE DESCRIPTIONS

4.1 General

The project alternatives consisted of: no-action, fix in-place (Alternative 1), fix in-place with bypass widening (Alternative 2). These alternatives were carried through for economic analysis and into alternative selection.

The no-action alternative does not include any additional features for this project. As such, there is no cost estimate or additional description for the no action alternative provided in this Appendix.

4.2 Alternative 1 – Fix In Place

The fix in-place method would combine a variety of flood risk management improvements and keep the project features within the existing levee footprint as much as possible. This method is a traditional approach to providing flood protection without the use of various structures, detention basins or bypasses. It is also a widely utilized flood protection fix in the Sacramento region in general and a prominent existing feature along the American River levees within the project area. The following table summarizes the features for Alternative 1:

Table 3 – Alternative 1 Improvements

<table>
<tr><th colspan="7">FEATURES GRR - ALTERNATIVE 1</th></tr>
<tr><th>WATER-COURSE</th><th>BASIN</th><th>REACH</th><th>REACH LENGTH (FEET)</th><th>FEATURE LENGTH (FEET)</th><th>IMPROVEMENT</th><th>FEATURES</th></tr>
<tr><td rowspan="2">NEMDC</td><td rowspan="16">ARN</td><td rowspan="2">C</td><td rowspan="2">8,330</td><td>2,850</td><td>HEIGHT</td><td>1 - 2' FLOODWALL</td></tr>
<tr><td>2,450</td><td>SEEPAGE/ STABILITY</td><td>80' CUTOFF WALL</td></tr>
<tr><td rowspan="2">Arcade Creek (S. Bank)</td><td rowspan="2">D</td><td rowspan="2">10,965</td><td>10,965</td><td>HEIGHT</td><td>1 - 4' FLOODWALL</td></tr>
<tr><td>10,965</td><td>SEEPAGE/ STABILITY</td><td>45' CUTOFF WALL WITH GEOTEXTILE REINFORCED SLOPE</td></tr>
<tr><td rowspan="3">Arcade Creek (N. Bank)</td><td rowspan="3">E</td><td rowspan="3">11,155</td><td>11,155</td><td>HEIGHT</td><td>1 - 4' FLOODWALL</td></tr>
<tr><td>11,155</td><td>SEEPAGE/ STABILITY</td><td>45' CUTOFF WALL</td></tr>
<tr><td>2,900</td><td>DRAINAGE CHANNEL</td><td>REPLACE EXISTING DITCH W/CLOSED BOX CULVERT</td></tr>
<tr><td rowspan="2">NEMDC</td><td rowspan="2">F</td><td rowspan="2">13,710</td><td>12,700</td><td>HEIGHT</td><td>2 - 4' FLOODWALL</td></tr>
<tr><td>5,700</td><td>SEEPAGE/ STABILITY</td><td>80' CUTOFF WALL</td></tr>
<tr><td>Robla/ Dry Creek Left Bank</td><td>G</td><td>11,725</td><td>2,400</td><td>HEIGHT</td><td>1 - 2' FLOODWALL</td></tr>
<tr><td>Dry Creek Right Bank</td><td>H</td><td>8,420</td><td>0</td><td>NONE</td><td>-</td></tr>
<tr><td>Magpie Creek</td><td>I</td><td>-</td><td>3,100</td><td>HEIGHT</td><td>NEW LEVEE WITH FLOODGATES, LEVEE RAISE, FLOODPLAIN PRESERVATION, CULVERT IMPROVEMENTS</td></tr>
</table>

Table 3 – Alternative 1 Improvements (Continued)

COMMON FEATURES GRR - ALTERNATIVE 1 (CONTINUED)						
WATER-COURSE	BASIN	REACH	REACH LENGTH (FEET)	FEATURE LENGTH (FEET)	IMPROVEMENT	FEATURES
AMERICAN RIVER	ARS	A	36,190	6,850	EROSION PROTECTION	BANK PROTECTION
				17,750		ROCK TRENCH
		B	17,405	850	EROSION PROTECTION	BANK PROTECTION
				6,400		ROCK TRENCH
		C	9,895	3,800	EROSION PROTECTION	BANK PROTECTION
				2,150		ROCK TRENCH
	ARN	A	36,400	18,150	EROSION PROTECTION	ROCK TRENCH
		B	1,100	950	EROSION PROTECTION	ROCK TRENCH
SACRAMENTO RIVER	ARS	D	22,825	9,200	EROSION PROTECTION	BANK PROTECTION
				2,100		ROCK TRENCH
				3,000	HEIGHT	2 - 4' FLOODWALL
				4,500		1 - 2' RAISE EXISTING FLOODWALL
				600	SEEPAGE/ STABILITY	~3' SEEPAGE BERM AT PIONEER RESERVOIR
				2,500		80' CONVENTIONAL CUTOFF WALL
				6,500		120' DSM CUTOFF WALL
		E	12,560	8,850	EROSION PROTECTION	BANK PROTECTION
				3,200	HEIGHT	LEVEE RAISE
				8,400	SEEPAGE/ STABILITY	95 - 135' DSM CUTOFF WALL
		F	28,635	21,100	EROSION PROTECTION	BANK PROTECTION
				1,000		ROCK TRENCH
				20,700	HEIGHT	LEVEE RAISE
				2,300	SEEPAGE/ STABILITY	80' CONVENTIONAL CUTOFF WALL
				24,250	SEEPAGE/ STABILITY	95 - 145' DSM CUTOFF WALL
		G	13,105	11,150	EROSION PROTECTION	BANK PROTECTION
				1,000	SEEPAGE	95' DSM CUTOFF WALL
				11,500	STABILITY	GEOTEXTILE STABILIZED SLOPE
				11,700	HEIGHT	LEVEE RAISE
		ALL	62,000	5,300	STABILITY	SLOPE FLATTENING

4.3 Alternative 2 – Sacramento Bypass and Weir Widening

Alternative 2 includes expanding the Sacramento Weir and Bypass (SWB) which will allow more water to be released upstream of ARS sub-basin, Reaches D-G; therefore, reducing the need for height improvements in these areas. However, this alternative does not reduce the need for seepage, stability and erosion improvements within those reaches. Alternative 2 includes all of the fix-in-place methods proposed in Alternative 1, with the exception of levee raising on the Sacramento River. The following table summarizes the features in Alternative 2:

Table 4 – Alternative 2 Improvements

COMMON FEATURES GRR - ALTERNATIVE 2						
WATER-COURSE	BASIN	REACH	REACH LENGTH (FEET)	FEATURE LENGTH (FEET)	IMPROVEMENT	FEATURES
NEMDC	ARN	C	8,330	2,850	HEIGHT	1 - 2' FLOODWALL
				2,450	SEEPAGE/ STABILITY	80' CUTOFF WALL
Arcade Creek (S. Bank)		D	10,965	10,965	HEIGHT	1 - 4' FLOODWALL
				10,965	SEEPAGE/ STABILITY	45' CUTOFF WALL WITH GEOTEXTILE REINFORCED SLOPE
Arcade Creek (N. Bank)		E	11,155	11,155	HEIGHT	1 - 4' FLOODWALL
				11,155	SEEPAGE/ STABILITY	45' CUTOFF WALL
				2,900	DRAINAGE CHANNEL	REPLACE EXISTING DITCH W/CLOSED BOX CULVERT
NEMDC		F	13,710	12,700	HEIGHT	2 - 4' FLOODWALL
				5,700	SEEPAGE/ STABILITY	80' CUTOFF WALL
Robla/ Dry Creek Left Bank		G	11,725	2,400	HEIGHT	1 - 2' FLOODWALL
Dry Creek Right Bank		H	8,420	0	NONE	-
Magpie Creek		I	-	3,100	HEIGHT	NEW LEVEE WITH FLOODGATES, LEVEE RAISE, FLOODPLAIN PRESERVATION, CULVERT IMPROVEMENTS

Table 4 – Alternative 2 Improvements (Continued)

COMMON FEATURES GRR - ALTERNATIVE 2						
WATER-COURSE	BASIN	REACH	REACH LENGTH (FEET)	FEATURE LENGTH (FEET)	IMPROVEMENT	FEATURES
AMERICAN RIVER	ARS	A	36,190	6,850	EROSION PROTECTION	BANK PROTECTION
				17,750		ROCK TRENCH
		B	17,405	850	EROSION PROTECTION	BANK PROTECTION
				6,400		ROCK TRENCH
		C	9,895	3,800	EROSION PROTECTION	BANK PROTECTION
				2,150		ROCK TRENCH
	ARN	A	36,400	18,150	EROSION PROTECTION	ROCK TRENCH
		B	1,100	950	EROSION PROTECTION	ROCK TRENCH
SACRAMENTO RIVER	ARS	D	22,825	9,200	EROSION PROTECTION	BANK PROTECTION
				2,100		ROCK TRENCH
				800	HEIGHT	2 - 4' FLOODWALL
				600	SEEPAGE/ STABILITY	~3' SEEPAGE BERM AT PIONEER RESERVOIR
				2,500		80' CONVENTIONAL CUTOFF WALL
				6,500		120' DSM CUTOFF WALL
		E	12,560	8,850	EROSION PROTECTION	BANK PROTECTION
				8,400	SEEPAGE/ STABILITY	95 - 135' DSM CUTOFF WALL
		F	28,635	21,100	EROSION PROTECTION	BANK PROTECTION
				1,000		ROCK TRENCH
				1,200	HEIGHT	LEVEE RAISE
				2,300	SEEPAGE/ STABILITY	80' CONVENTIONAL CUTOFF WALL
				24,250	SEEPAGE/ STABILITY	95 - 145' DSM CUTOFF WALL
		G	13,105	1,000	SEEPAGE	95' DSM CUTOFF WALL
				1,600	HEIGHT	RAISE EXISTING FLOODWALL
				11,500	STABILITY	GEOTEXTILE STABILIZED SLOPE
		ALL	62,000	9,300	STABILITY	SLOPE FLATTENING
	SWB	-	-	1,500	HEIGHT	SACRAMENTO WEIR AND BYPASS WIDENING

4.4 Feature Descriptions

4.4.1 Erosion Protection Improvements

For both Alternatives, erosion protection extents are the same as shown in the above tables. Two erosion protection measures have been proposed that could be implemented in combination along the levee alignment depending on factors such as, bank/bench geometry, existing habitat, and existing land use among other considerations.

Bank Protection

The Bank Protection fix will include placing revetment on the existing levee waterside and project the revetment to a finished surface slope of 2H:1V or 3H:1V. The revetment will begin at the existing levee waterside hinge (when no bench exists) or waterside bench hinge depending on site conditions. Revetment will be placed on existing slope with little to no engineered slope reconstruction. Layer thickness will be approximately 1.5 feet deep and continue down to the Summer Mean Water Surface Elevation (SMWSE). At the SMWSE, there will be a riparian bench formed with a soil trench wrapped in geotextile within the design section. After the bench, the slope continues to project down to channel bottom at an increased slope of 1:1 (see Figure 2).

Existing large vegetation will be allowed as described in section 2.4.2 Vegetation Variance and to the extent practical during construction. Plantings and woody vegetation will be established within the design to create a self mitigating design, as acceptable. Factors which affected the design and quantity of revetment needed within the design were: the amount of launchable rock needed, the location of the SMWSE, and existing ground and channel geometry.

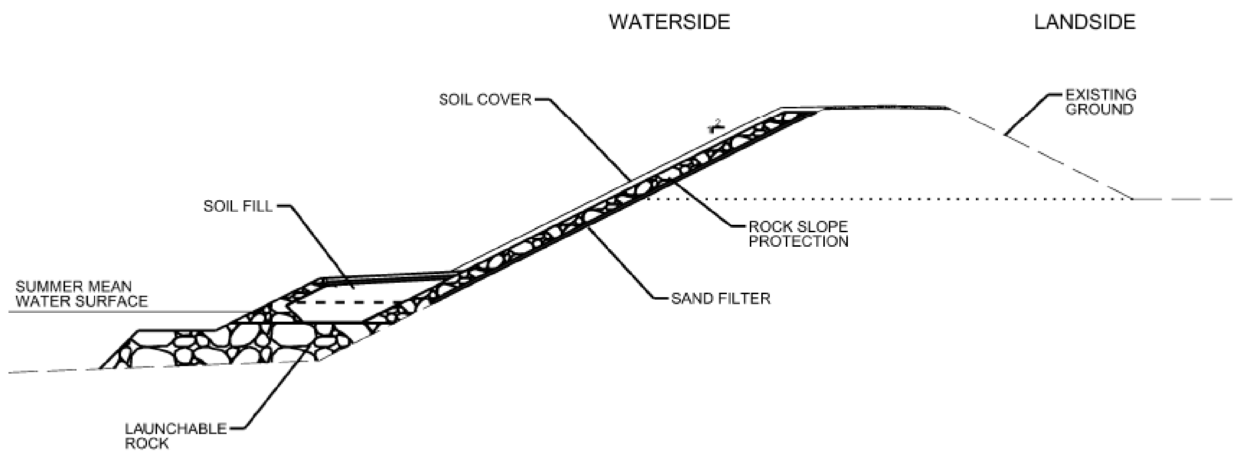

Figure 2 - Bank Protection Erosion Protection (insufficient bench)

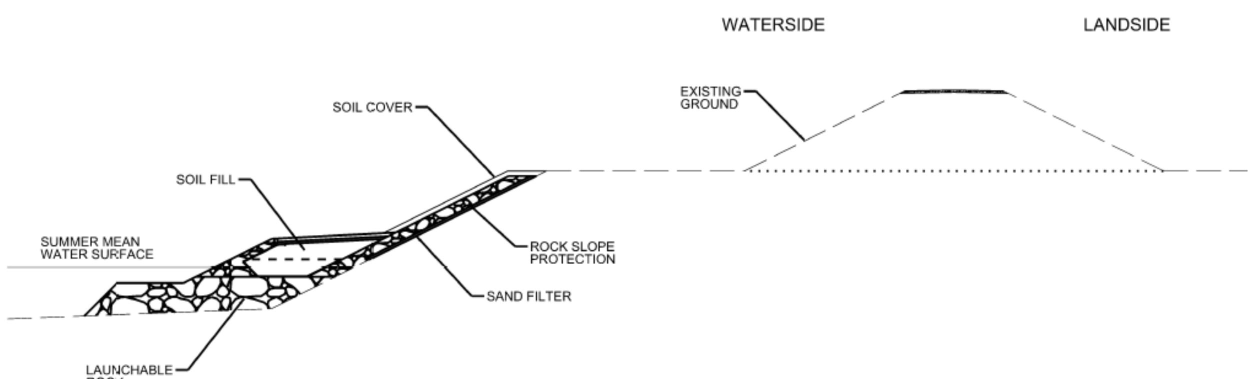

Figure 3 - Bank Protection Erosion Protection (sufficient bench)

Launchable Rock Trench

The Launchable Rock Trench fix provides the same protection to the levee as the bank protection by allowing the existing berm to be sacrificial. In order to be considered, the waterside berm width needed to be at least 50 feet wide for construction. The construction methodology would follow the trenchfill methods widely used on the Arkansas and Mississippi Rivers. The rock trench is constructed at the waterside toe of the levee and is excavated to a level that reduces the revetment launching distance and increases the reliability of design. The trench then is backfilled with rock revetment to provide enough quantity for launching. The typical design trench was approximately 10 feet wide at bottom, 40 feet wide at top, and 10 feet deep (see Figure 4). The trench would then be covered with native fill at a minimum of 3 feet thickness to allow for mitigation features such as vegetation and woody plantings to be replanted above the trench but outside the vegetation free zone.

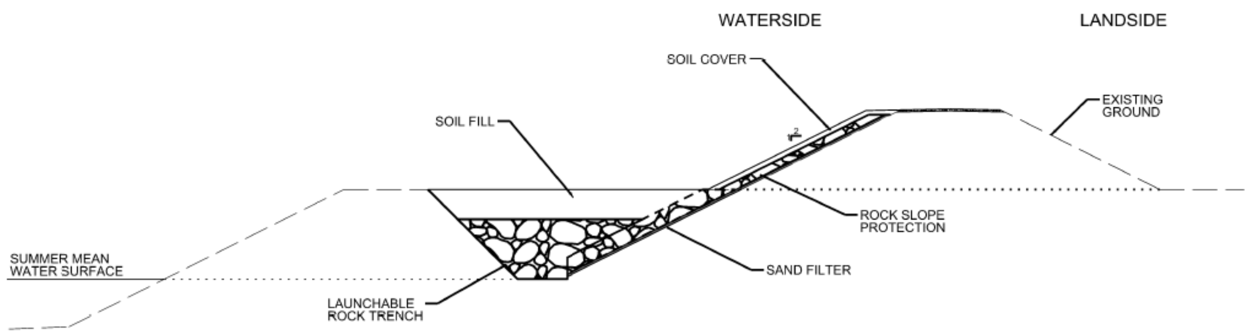

Figure 4 – Launchable Rock Trench Erosion Protection

<u>4.4.2 Seepage/Stability Improvements</u>

For both Alternatives, there are seepage and stability improvements proposed. Cutoff walls, seepage berms, geotextile stabilized slopes, and slope flattening are features proposed for seepage and stability improvements.

To address seepage and seepage related slope stability problems, the predominant recommendation is cutoff walls. Due to several factors, including constraints on expanding the levee footprint restricted by urban development, seepage berms, relief wells, and the majority of other seepage improvement measures were considered infeasible by the PDT.

Sacramento River

Figure 5 shows a typical seepage and stability fix for the Reaches D through F on the Sacramento River. Based on the seepage cutoff wall depths, a combination of conventional open trench and Deep Soil Mixing (DSM) cutoff wall construction methods is anticipated. Both Soil Bentonite (SB) and Soil Cement Bentonite (SCB) cutoff walls are appropriate in these reaches. The conventional method is used for wall depths of up to 85 feet and the DSM method was used for walls deeper than 85 feet. Both methods provide a barrier of low-permeable material within the levees which typically consist of sandy material. The depths of wall were determined by geotechnical analysis and typically tie into a confining low permeable layer. The levee will be degraded by approximately half its height in order to establish a working platform as well as provide levee stability during construction.

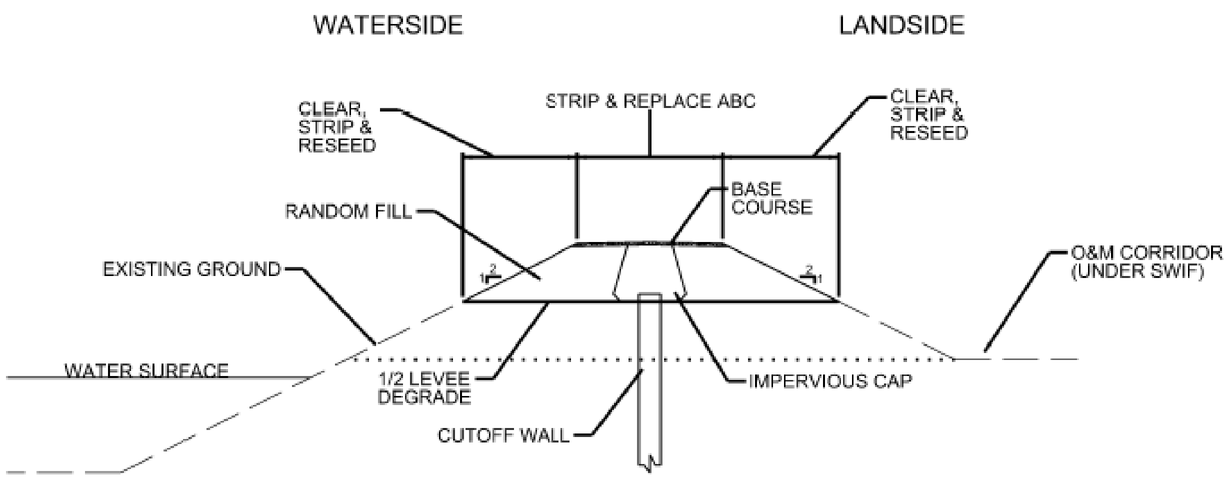

Figure 5 - Sacramento River Reaches D through F Cutoff Wall Typical Section

Levee reconstruction includes placement of random fill with an impervious cap above the cutoff wall. The levee fill will have side slopes graded to a minimum of 2H:1V slopes or existing slope if greater. The levee crown will be constructed to a minimum width of 20 feet and surfaced with aggregate base for the levee road.

Through portions of Old Sacramento and the “Boat Section” of Interstate-5 no improvement are recommended due to system of floodwalls, retaining walls and pumped wells operated for the interstate and City of Sacramento. In the same vicinity, the past Pioneer Reservoir improvements by the Sacramento District (berm and relief wells) targeted the 100-year event for design criteria. At this location additional thickness should be added to the seepage berm to increase the level of protection.

There are areas along the Sacramento River that will require slope flattening. Slope flattening will reestablish existing design slopes primarily by reusing existing levee material and mechanically strengthening. The areas are intermittently dispersed along most of these reaches and will be influenced by proposed fixes. It is estimated the total length will be approximately 15% of the existing levee lengths (not including Reach G or areas for levee raising) or approximately 9,300 lineal feet for Alternative 2. Alternative 1 has a greater amount of raise within the reaches D – G therefore additional slope flattening will be less, approximately 5,300 lineal feet. It is assumed the slope flattening can be completed without any additional permanent real estate easements but will require temporary easements during construction. A typical slope flattening section is shown below in Figure 6.

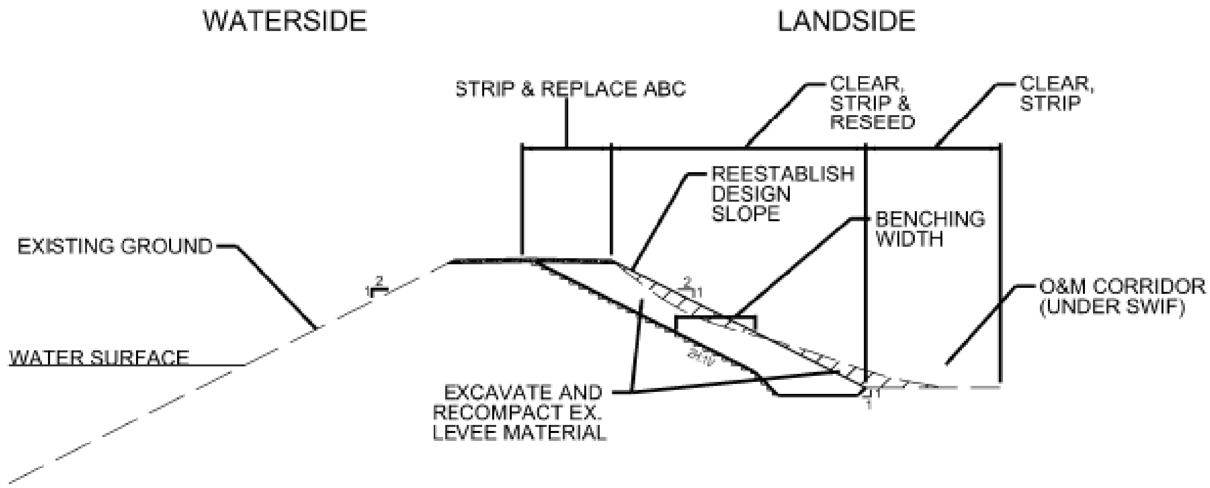

Figure 6 - Sacramento River Slope Flattening Typical Section

In ARS Reach G a slope stability deficiency has been identified. Due to adjacent roadways, railroad embankments, and structures, more common slope stability improvements, such as stability berms, were deemed not feasible. Therefore, to address the slope stability deficiency, a partial levee degrade and placement of geotextile within the reconstructed levee embankment spaced approximately 3 feet vertically is recommended. A typical geotextile section is shown in Figure 7 below.

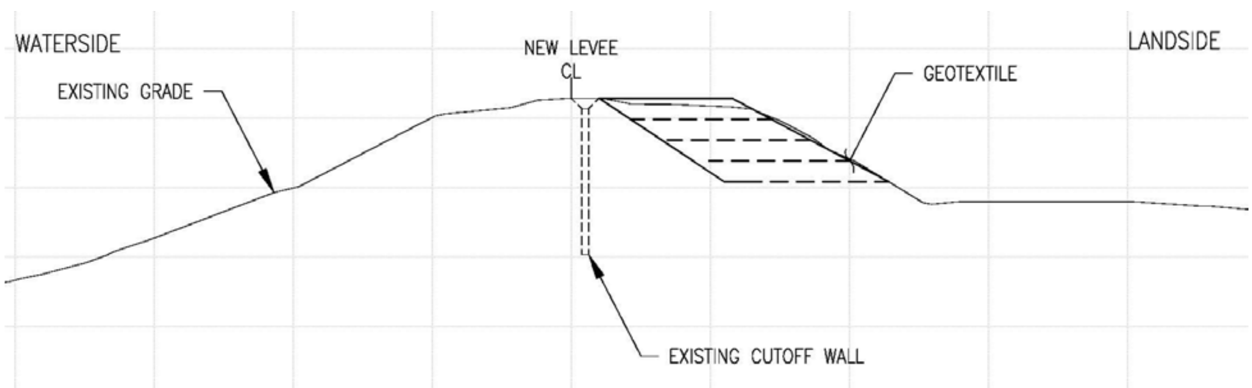

Figure 7 - Sacramento River Reach G Typical Section

Tributaries - NEMDC

A typical NEMDC levee improvement cross-section is shown in Figure 8. The measure includes a cutoff wall that will be constructed by either conventional open trench methods (SB or SCB) or DSM methods as applicable. For levee segments which run parallel and in close proximity of the active UPR railroad, DSM methods are recommended to mitigate the risk of trench collapse from the railroad surcharge and dynamic vibrations during construction.

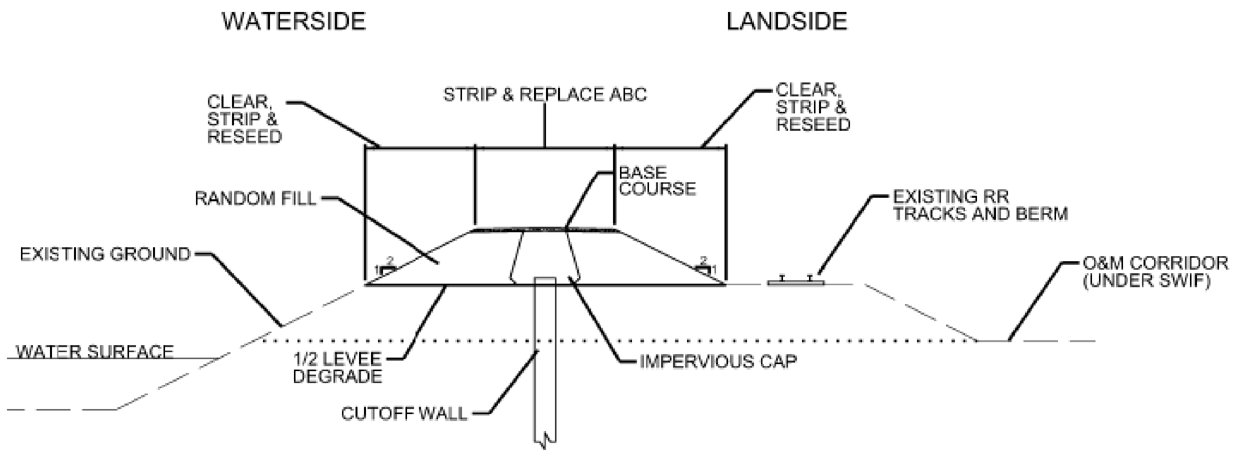

Figure 8 – NEMDC Cutoff Wall Typical Section

Tributaries – Arcade Creek

The Arcade Creek south bank cutoff wall is proposed in conjunction with a full levee height degrade and incorporation of geotextile. The improvements are proposed from the confluence of NEMDC upstream to Rio Linda Blvd. The geotextile is placed within the reconstructed levee embankment spaced approximately 3 feet vertically allowing for the existing levee slopes (steeper in some locations than 2H:1V) to remain and allow for landside access under the SWIF (see Figure 9).

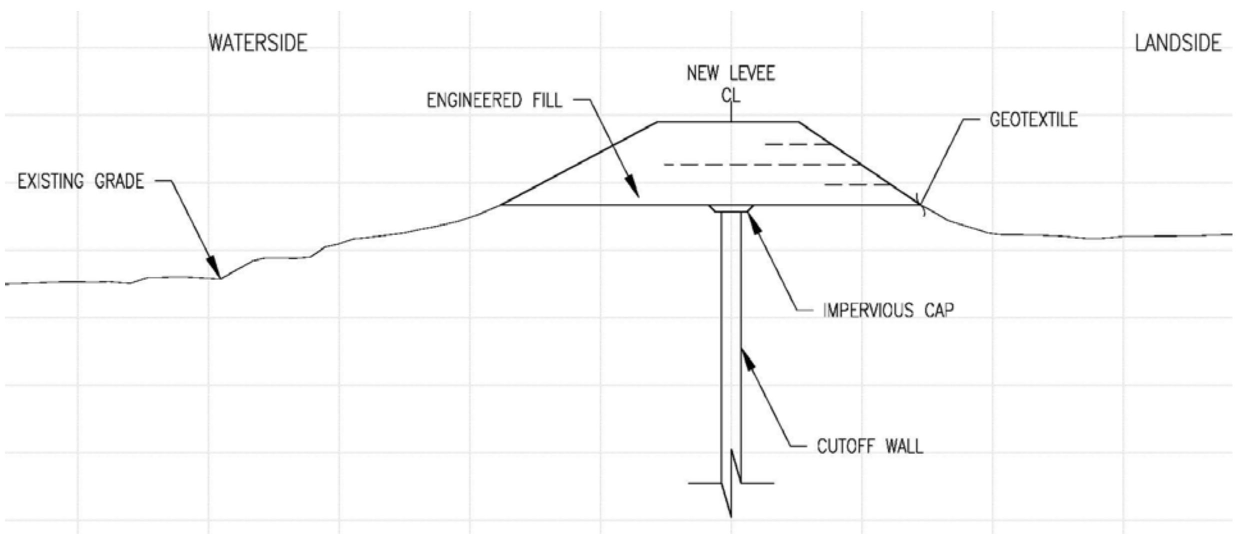

Figure 9 - Arcade Creek South Cutoff Wall Typical Section

The Arcade Creek north bank cutoff wall is proposed from the confluence of NEMDC upstream to Rio Linda Blvd. In addition, a landside ditch from the confluence to Sump Station 158 will be replaced with a box culvert or buried conduits as shown in Figure 10.

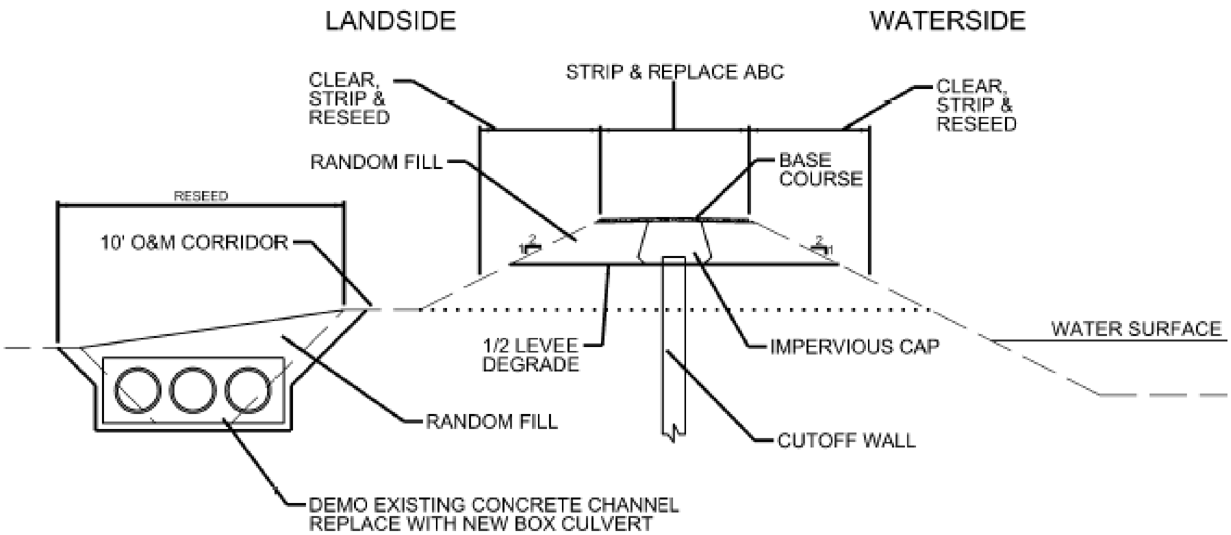

Figure 10 - Arcade Creek North Cutoff Wall Typical Section

4.4.3 Height Improvements

There are height improvements proposed for both Alternatives. The height improvements include levee raising, floodwalls, height improvements to existing floodwalls, and bypass and weir widening. During PED, other feasible methods to address height may be considered such as landside/waterside levee raising, or retaining walls.

Sacramento River

Height fixes are proposed in some segments of the Sacramento River levee which consist of a levee embankment raise, sliver fills, raising existing floodwalls, or a floodwall constructed at the levee crest. Parts of Reach D and Reach G will require new floodwalls or raising and bolstering of existing floodwalls to meet the design profile with required assurance. Figure 11 shows a typical Sacramento River levee section with the proposed levee raise improvement measures. Additional FPLE and TWAE easements will be required where levee raising occurs.

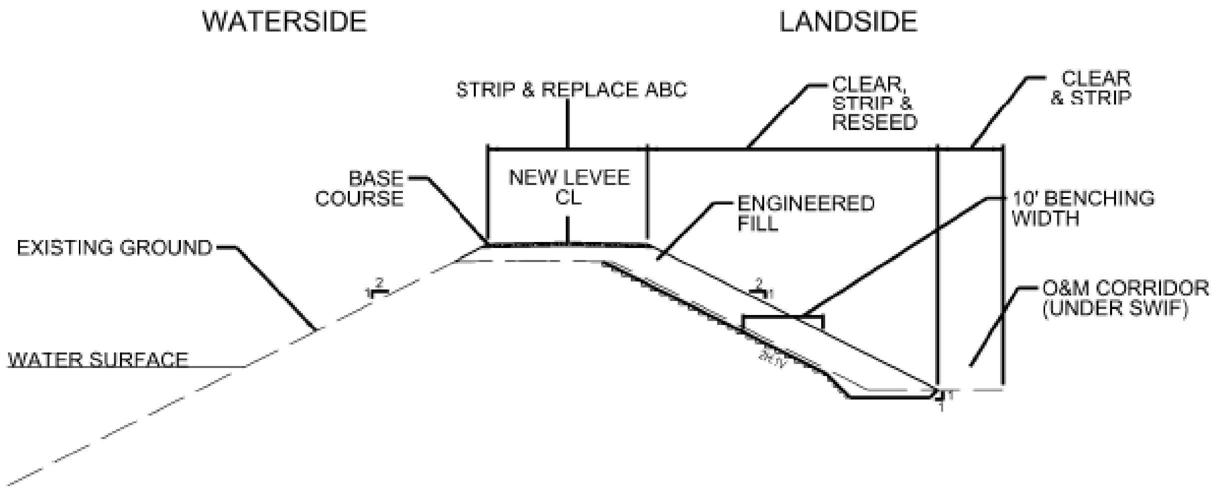

Figure 11 - Sacramento River Reaches D through F Levee Raise Typical Section

Tributaries – NEMDC, Robla/Dry Creek, Arcade Creek

Height improvements are proposed in some segments of the NEMDC, Robla/Dry Creek left bank, and Arcade Creek levees which will consist of floodwalls (see Figure 12). The 1 -2’ raises recommended for the ARN tributary levees would provide assurance of containing the 200 ACE event in the American River North Basin. The recommended levee raises would also bring the NEMDC east side levee to a consistent level of performance. Existing floodwalls on Arcade Creek will be removed during seepage and stability improvements and new floodwalls designed to the 200 ACE event will be constructed in those reaches.

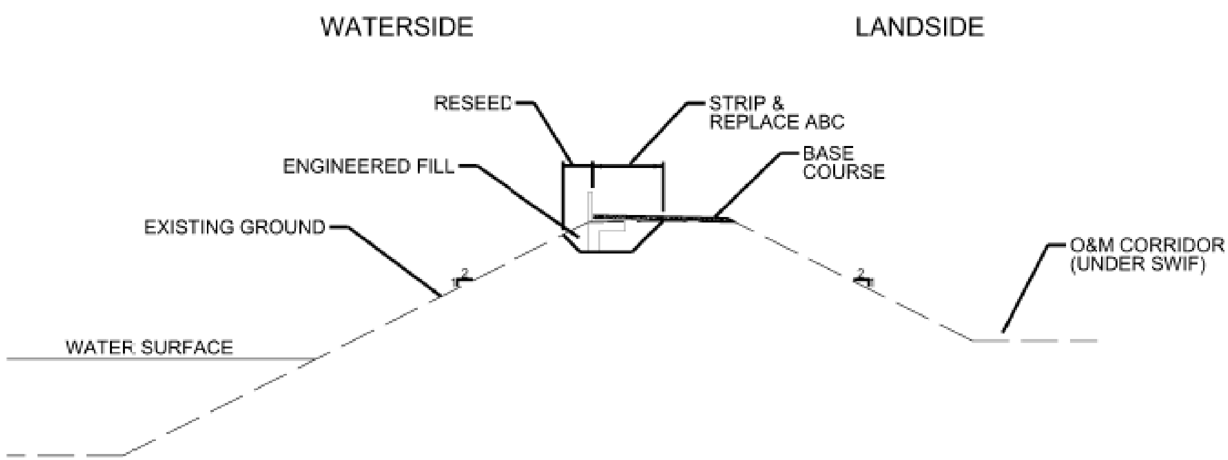

Figure 12 - Floodwall on Levee Crest

Tributaries – Magpie Creek

A number of features are proposed for the Magpie Creek Diversion Canal (MCDC) under Alternative 1 and 2. The features are consistent with the 2003 USACE Magpie Creek project report. The project includes raising the existing left bank levee (looking downstream, see Figure 13) of the MCDC for a distance of approximately 2,100 feet. The levee raise would begin just downstream from Raley Boulevard and continue to about 100 feet south of Vinci Avenue Bridge. In addition, a new 10-foot-wide maintenance road will be graded at the landside base of the new raised MCDC levee. A new levee would be constructed along the west side of Raley Boulevard south from the bridge down to Santa Ana Avenue for a distance of approximately 1,000 feet. The new levee would prevent floodwaters upstream of Raley Blvd from outflanking the existing levee.

A 5-foot high floodgate will be installed across the driveway of the Kelly-Moore paint store. An additional 4-foot high floodgate will be required at the driveway of a new development just south of the Kelly-Moore Paint Store property. A new aggregate base maintenance road will be constructed between Vinci Avenue and Dry Creek Road adjacent to the left bank (looking downstream) of the MCDC for a distance of approximately 2,700 feet.

A new culvert will be constructed under the Sacramento Northern Railway Bike Trail embankment. The culvert will be a triple 5-foot by 5-foot reinforced concrete box.
A new channel would be excavated upstream and downstream from the culvert, connecting the culvert with Robla Creek. The new channel would be slightly above the existing channel invert to allow low flows to continue through the existing bridge. Stone protection would be placed in the bed and sides of the new channel to minimize erosion.

The area inundated east of Raley Blvd by a design event without the project in place is estimated to be 76 acres (excluding roadways and channels, the inundated land would be 73 acres). Construction of the proposed improvements would slightly increase the water surface elevation during all flood events greater than a 5-year frequency. The project would seek a total of 79 acres of land to preserve the existing floodplain in perpetuity and mitigate for proposed project features.

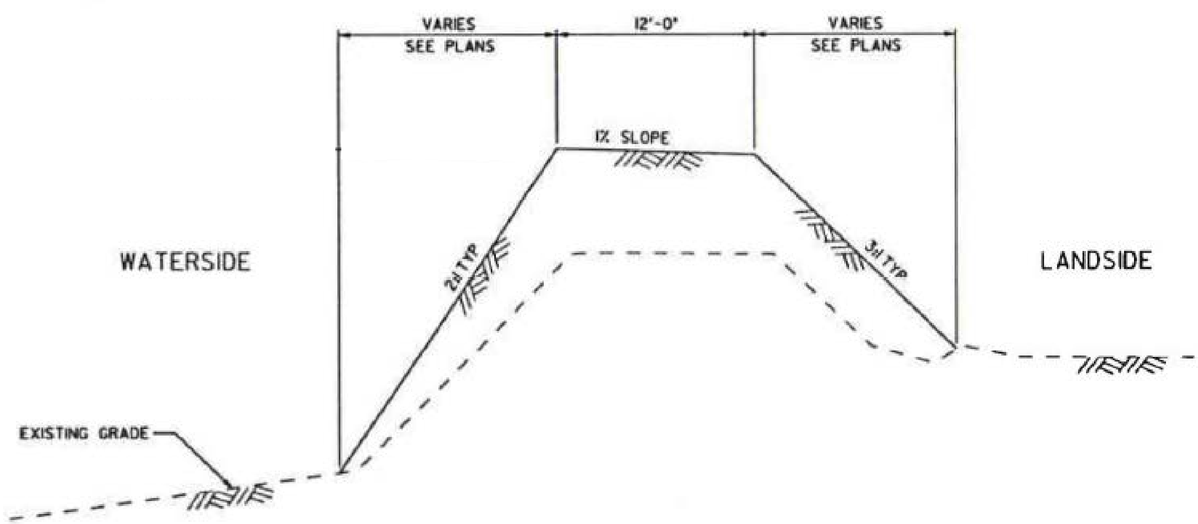

Figure 13 - Typical MCDC Levee Embankment Improvement Cross-Section

Sacramento Bypass and Weir Expansion

The Sacramento Bypass and Weir currently allows excess flood waters to spill out of the leveed river system into the Yolo Bypass thereby reducing the loading on the levees downstream. Alternative 2 expands capacity for the weir and bypass by constructing a new weir structure and relocating the bypass levee. Based on preliminary hydraulic analysis, the proposed weir expansion and levee offset is approximately 1,500 feet and would be located to the north of the existing bypass.

For this alternative, the existing north levee of the Sacramento Bypass would be degraded and a new levee constructed approximately 1,500 feet to the north. A new weir would be extended north of the existing Sacramento Weir without impacting the existing structure. The new weir would be extend approximately 1,500 feet and include a seepage cutoff wall below.

The new north levee of the Sacramento Bypass would be constructed per the standard levee section for new construction which includes 3H:1V waterside and landside slopes, and a minimum crest width of 20 feet. The new north levee would include a 300-foot wide drained landside seepage berm ranging from 5 feet thick at the landside levee toe tapering to 3 feet thick at the berm toe and constructed of random fill with a 1.5-foot thick drainage and filter layer at the base. In addition to the seepage berm, a system of relief wells spaced at 200-foot intervals with a connecting drainage channel is proposed 15 feet landward from the berm toe.

Existing infrastructure, including roads, railways, canals, and pump stations will be relocated to maintain current operation. Refinements to this feature in PED include optimizing width of weir and bypass, possible environmental corridor alternatives, the need for operable gates, and system operation.

CHAPTER 5 – QUANTITY DEVELOPMENT, CONSTRUCTION SCHEDULE, AND COST ENGINEERING

5.1 General

The combination of improvements were quantified for the alternatives and estimated at a preliminary design level for the project area. Quantities were determined with cross sections of typical fixes to develop a civil cost estimate. These estimates would then have additional costs added to them like: Storm Water Pollution Prevention Plan (SWPPP), cultural resource preservation, Preconstruction Engineering and Design (PED), construction management costs, real estate and relocation costs, and fish and wildlife facilities. Cost risk contingencies were also assigned to these estimates to determine the initial cost for the alternative.

5.2 Preliminary Design and Quantity Development for Alternatives

Preliminary design for the alternatives were based on information developed for previous studies and engineering reports as well as new information developed for this study. For Magpie Creek features, the previous Corps Continuing Authorities Program (CAP) study features were used from the 2003 report. For the Sacramento Bypass and Weir widening, the design and cost engineering information was partially derived from previous work by Parsons Brinkerhoff (Parsons Brinkerhoff, 2008) and supplemented with information by the PDT.

Preliminary design for the erosion control features were based on typical cross sections that were based on previous erosion protection projects on the American River. A channel stability analysis (Ayres Associates, 2010) was used to determine areas requiring revetment with the assumption that all areas without modern revetment will be protected. Modern protection was determined by field inspection of areas having rock riprap with overall condition of good or very good. Additional analysis and supporting data are discussed under Attachment E – Erosion Protection Report.

Quantities were calculated for the proposed types of features and tabulated per reach, and by basin. Typical cross sections were generated to capture the types of fixes needed along the levee as well as the existing geometry of the levee. These sections were then referenced into a dynamic spreadsheet where the type of fix, hydraulic data, and existing levee geometry would be identified. By developing many fixes with varying levee geometry, the spreadsheet would calculate civil quantities using average end area method and generate better quantities than standard typical section methods allow. These quantities were then delivered to cost engineering where unit costs, site specific factors, and risk assessment were evaluated to determine initial alternative costs.

Quantities for construction of the proposed features were developed by District Civil Design staff. The engineering design and quantity development was in accordance with ETL 1110-2-573 *Construction Cost Estimating Guide for Civil Works* and ER 1110-2-1302 *Civil Works Cost Engineering*. Quantities do not include shrinkage and bulking factors or loss and waste factors for handling and hauling. For Preliminary Cost Estimates, design features focused on the cost drivers (i.e. Pareto Principle) such as cutoff wall, rip rap, levee excavation, and backfill quantities, etc.

5.3 Preliminary Construction Schedules

For economic and construction assessment, it was assumed that after authorization, the project would receive optimal annual funding appropriations and would be accomplished without resource limitations. When generating the schedule the PDT also considered a variety of factors such as: construction production rates, contractor capacity and availability, air emissions, sponsor capability, and design complexity. Considering these factors, both Alternatives 1 and 2 were estimated to take approximately 10 years. Annual appropriations under both Alternatives would vary because of phasing and feature differences, however, typical annual appropriations ranged between $100 – 200M. At the time of the draft release, the construction schedule has not been updated to reflect some minor changes in costs. The changes will have no affect on the selection of alternatives and will be updated for the feasibility report milestone.

A construction priority analysis was performed using levee fragility curves, hydraulic stage-frequency data, and economic data for the without project condition. The results determined which reaches had the highest risk of failure as a function of their economic consequences (see tables below). For Alternative 2, the Sacramento Bypass and Weir (SBW) widening is shown as starting after most of the levee fixes since it has no impact on the damages for more frequent events.

Table 5 - Reach Construction Priority

BASIN	INDEX POINT	HYDRAULIC STAGE (NAVD 88)		PR (FAILURE)		CONSEQ-UENCE	IMPACT	CONSTRUCTION PRIORITY
		100-YR	200-YR	100-YR	200-YR			
ARS	F	29.29	30.99	0.32	0.399	13600	5426	1
ARS	E	32.46	34.26	0.327	0.398	13600	5413	2
ARS	A	48.03	53.08	0.066	0.458	9800	4488	3
ARS	G	28.21	29.85	0.254	0.33	13600	4488	4
ARS	D	33.28	35.11	0.148	0.229	13600	3114	5
ARS	B	38.15	41.35	0.221	0.315	9800	3087	6
ARN	A	46.26	51.1	0.1179	0.463	4500	2084	7
ARS	C	35.86	38.23	0.092	0.14	9800	1372	8
ARN	B	37.01	39.89	0.102	0.145	4500	653	9
ARN	D	39.03	41.3	0.514	0.72	733	528	10
ARN	F	40.1	42.18	0.578	0.686	733	503	11
ARN	E	39.09	41.35	0.451	0.663	733	486	12
ARN	C	38.79	41.21	0.124	0.448	733	329	13
ARN	G	41.49	43.24	0.088	0.152	733	111	14
ARN	I	-	-	-	-	-	*	15
SBW	-	-	-	-	-	-	*	16

* Not included in evaluation priority, will be refined in PED

The following tables were generated using the reach priorities and cost estimates to form rudimentary diagrammatic construction schedules for the alternatives (see tables below).

Table 6 - Alternative 1 Preliminary Construction Schedule

AMERICAN RIVER COMMON FEATURES CONSTRUCTION SCHEDULE - ALTERNATIVE 1												
PRIORITY	BASIN	REACH	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5	YEAR 6	YEAR 7	YEAR 8	YEAR 9	YEAR 10
1	ARS	F										
2	ARS	E										
3	ARS	A										
4	ARS	G										
5	ARS	D										
6	ARS	B										
7	ARN	A										
8	ARS	C										
9	ARN	B										
10	ARN	D										
11	ARN	F										
12	ARN	E										
13	ARN	C										
14	ARN	G										
15	ARN	I										

Table 7 - Alternative 2 Preliminary Construction Schedule

AMERICAN RIVER COMMON FEATURES CONSTRUCTION SCHEDULE - ALTERNATIVE 2												
PRIORITY	BASIN	REACH	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5	YEAR 6	YEAR 7	YEAR 8	YEAR 9	YEAR 10
1	ARS	F										
2	ARS	E										
3	ARS	A										
4	ARS	G										
5	ARS	D										
6	ARS	B										
7	ARN	A										
8	ARS	C										
9	ARN	B										
10	SBW											
11	ARN	D										
12	ARN	F										
13	ARN	E										
14	ARN	C										
15	ARN	G										
16	ARN	I										

5.4 Cost Engineering

5.4.1 Cost Engineering Data & Results

Quantity Takeoffs

Quantities for most project items were provided by the Civil Design Engineers, primarily using typical cross sections of levee improvements or utility penetrations. See Section 5.2 – Preliminary Design and Quantity Development for Alternatives for more information.

General Methodology in Cost Estimate Preparation

Preliminary level cost estimates (Class 4) were used in the evaluation of the final array of alternatives and the identification of the tentatively selected plan. The Cost Engineering team utilized a number of different methods to determine project costs, including the following:

- Generic/parametric/characteristic unit construction costs for typical levee improvements were developed using estimating software MII (MCACES, 2nd Generation). For a typical task such as slurry wall placement or borrow material acquisition and placement, a unit cost was established based on a ‘typical’ crew, production rate, material cost, assumed/typical haul distance, etc. Current Davis Bacon labor rates (late 2012), MII Equipment rates (2011 Equipment Book), current fuel prices (late 2012) and generic/typical Contractor markups were utilized to establish unit costs.

- Historical cost data for some items have been utilized based on past projects in the vicinity of Sacramento, such as the Sacramento Bank Protection Project. Pump station costs were based on costs for similar pump stations from the Natomas PACR.

- Cost Data from previous studies in the Sacramento area, specifically, those developed for SAFCA by Parsons-Brinckerhoff for the Sacramento Bypass Expansion (March 2009) were utilized to develop costs for the proposed Sacramento Bypass Expansion for Alternative 2. These costs were escalated to October 2013.

- Cost Data supplied by other Disciplines, specifically Real Estate Division and Environmental Resources Branch (Mitigation and SWPP/Storm Water Pollution Prevention).

- Cost Engineering judgment and experience was used to base some costs on a percentage of construction costs (e.g. Cultural Resources, Traffic Control, PED cost, Construction Management cost). The percentages are based on historical data and typical rates used by SPK Cost Engineers in the past.

The estimated project cost summaries (first cost) follow the Civil Works Work Breakdown Structure (CWWBS) code of accounts. Feature codes typically involved in this estimate are:

01-Lands and Damages (Real Estate)
02-Relocations
06-Fish and Wildlife Facilities
11-Levees and Floodwalls
13-Pumping Plants
15-Floodway Control Diversion Structures
18-Cultural Resource Preservation
30-Preconstruction Engineering and Design
31-Construction Management

The 30 and 31 accounts involve any costs associated with USACE staffing on the project for the federal share and anticipated costs associated with local sponsor costs for the non-federal share. The cost estimate for each Alternative is the summation of the costs from the major cost categories. The costs do not account for life cycle costs.

OMRR&R Costs

Sacramento District Civil Design Section developed OMRR&R costs associated with the project features. The costs were developed with input and review from two of the local maintaining agencies (LMA). Specifically, several meetings and conversations between the Corps, the Department of Water Resource's Maintenance Area 9 (MA-9), and American River Flood Control District (ARFCD) staff resulted in a mutual understanding of the increased efforts as a result of new project features and the impact on costs. Some of the OMRR&R costs considered related to inspection, mowing, rodent control, mechanical maintenance, and graffiti removal.

A few of the OMRR&R feature costs were developed quantitatively, however, many of the costs were developed using qualitative judgment by Corps and LMA staff. The following Table 8 shows the increased OMRR&R Costs for each alternative:

Table 8 – Annual Increase in OMRR&R Costs

ANNUAL INCREASE IN OMRR&R COSTS			
LMA	**Description**	**Alternative 1 Cost**	**Alternative 2 Cost**
MA-9	WEIR WIDENING	$ -	$ 56,250
	NORTH BYPASS LEVEE	$ -	$ 137,400
	BYPASS CHANNEL	$ -	$ 15,000
	LEVEE MAINTENANCE	$ 49,400	$ 16,467
ARFCD	ACCESS ROADS	$ 5,400	$ 5,400
	GENERAL MAINTENANCE	$ 230,500	$ 230,500
OMRR&R Total		**$ 286,000**	**$ 462,000**

Total Project Schedule

No formal construction schedule coordinated with an MII cost estimate has been developed at this stage, but the assumption has been made that the yearly federal monetary allotment for the project will be approximately $100-200M. The initial PED portion and real estate efforts are assumed to take between 1-3 years prior to construction depending on the reach and types of features. These durations were evaluated on a reach by reach basis and are incorporated in Tables Table 6 - Alternative 1 Preliminary Construction Schedule and Table 7 - Alternative 2 Preliminary Construction Schedule. For the purposes of alternative selection and economic analysis, the construction durations for both Alternative 1 and 2 were estimated to be 10 years. For more information, see section 5.3.

Cost Uncertainties and Cost Risk Analysis

There are inherent uncertainties in the costs at this preliminary level of design (screening alternatives) since there are no detailed designs, plans or specifications. There are also inherent uncertainties as the construction contractor(s) are responsible for obtaining the construction materials, accomplishing the work in a timely manner as per the project due date, using overtime and/or multiple crews to accomplish the same, etc. Funding appropriations are uncertain. The Central Valley of California is home to many threatened/endangered species that require much of the work to be done within certain construction windows, typically May-October.

More than 50% of the costs for this project are directly related to levee improvements. A large percentage of this is obtaining and hauling materials for levee protection (stone) and placement of levee fill or impervious fill material (clay cap). For the purposes of the cost estimates, the assumption has been made that stone material will be placed from the waterside (via barge) for work along the Sacramento River and from the landside (trucked) for work along the American River. Stone materials are expected to come from either the Bay Area (via barge) or the Sierra Nevada mountains (via trucks). In either case, haul distance is approximately 75-100 miles (one-way). Much of the existing levee material can be re-used but still must be hauled to/from stockpiles. Impervious fill (clay) is assumed to come from within 25 miles (one-way haul). The potential contractors are free to obtain borrow from wherever they see fit, as long as it meets specifications. Haul costs in general have some uncertainty as material supply locations are up to the contractor and there is inherent risk that fuel prices may increase during the long construction duration anticipated for the project. Another work feature of high risk/costs are the cutoff walls, which have large quantities of deep cutoff walls along the Sacramento River, requiring use of the deep soil mixing method (DSM), or some comparable method. DSM will require significant placement time.

Risk analysis results are intended to provide project leadership with contingency information in order to support decision making and risk management as the project progresses from planning through implementation. An abbreviated Cost Risk Analysis (CRA) using the Cost MCX Abbreviated Risk Analysis Template (spreadsheet) was performed for each alternative. The risk analysis process involved dividing project costs into typical risk elements and placing them into a Risk Register, then holding discussions among the PDT members to identify the risks/concerns relative to those risk elements and then justify the likelihood and impact. A Risk Matrix utilizing weighted likelihood/impacts is used to establish the cost contingency to use for each risk element (work feature) for use in alternatives comparisons. To fully recognize its benefits, cost and schedule risk analysis must be considered as an ongoing process conducted concurrent to, and iteratively with, other important project processes such as scope and execution plan development, resource planning, procurement planning, budgeting and scheduling.

The CRA workshop was held in January 2013 with participation from most PDT members. The workshop focused primarily on risk identification using the CRA template and brainstorming techniques. Project risks were identified and the risk register developed within the spreadsheet. The likelihood of and impact on each risk element was assessed by the PDT and after the meeting, the draft risk register and results were forwarded to the PDT for review.

Risk elements were identified for each alternative based on work feature. Prime features identified were categorized to allow relatively easy comparison of the different alternatives. The prime feature items typically accounted for 70 percent or more of the costs. The remaining work features are lumped together in a category for 'Remaining Construction Items'. The items are typically low-level risks but remain within the risk register for historical purposes as well as to support follow-on risk studies as the project and its accompanying risks evolve.

The results of the CRA therefore reflect the risk register parameters and are considered adequate for establishing contingencies for alternatives comparison. See Attachment D for tables displaying results of the CRA for each alternative. The tables also indicate the computed contingencies for each feature of work and the composite contingencies applied to the Total Project Costs (TPC). The bottom portion of the table indicates the overall project contingencies used for real estate, construction, PED & Construction Management.

Review

The screening level cost engineering data has been reviewed (DQC) by estimators at the Sacramento District.

Screening Level Costs

Project First costs for each alternative including contingencies were prepared for the draft report, see Attachment D – Cost Engineering. All costs are considered preliminary and are only to be used to compare the relative cost between the Alternatives. Focus on the Cost Engineering data has been on the alternatives. After the draft release, the TSP and any locally preferred plan (if different from the TSP) will require the development of Feasibility Level Details (by Civil Design) and Cost Engineering data. This includes creation of feasibility level plans and associated quantities, development of a detailed MII estimate, a Total Project Schedule (including Construction), PDT estimates for Planning, Engineering and Design, an updated Cost and Schedule Risk Analysis and a Total Project Cost Summary (TPCS) extending costs out through the life of the Project. The MII estimate must be detailed indicating labor, equipment and materials with accompanying production rates.

<u>5.4.2 Key Assumptions:</u>

Quantities and Cost Estimates

- Cross Sections for the various levee improvements or new levees are representative of the levee reach. Where design is insufficient to produce detailed quantities for each reach, the use of these typical cross-sections represents quantities adequate to screen alternatives to the point of determining a tentatively selected plan.
- Unit Costs utilized are reasonable.

Haul Distances

- Levee Fill Borrow will come from within 25 miles (one-way haul).

Project Schedule

- PED portion of the first project contracts will occur over 1-3 years prior to commencement of construction for specific reach.
- Construction is assumed to take 10 years for Alternatives 1 and 2.

Real Estate

- Costs provided by the Real Estate Division appear reasonable.

Environmental Mitigation

- Costs provided by the Environmental Resources Branch appear reasonable.

Environmental Control

- Quantities and Costs provided by the Environmental Engineers for SWPP appear reasonable.

Cultural Resources

- Costs of 1.5% of the total project costs for mitigation of Cultural Resources (cost shared).
- 0.5% of the Federal Cost share for Data Recovery (100% federal cost) are sufficient.

PED Costs

- 15% of the Federal share of the construction costs & 25% of the Non-Federal share of the construction costs as used in recent years for feasibility studies performed by the Sacramento District is reasonable.

Construction Management Costs

- 8.5% of the Federal share of the construction costs and 10% of the Non-Federal share of the construction costs as used in recent years for feasibility studies performed by the Sacramento District is reasonable.

REFERENCES

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Parsons Brinckerhoff*, Lower Sacramento River Regional Project*, *Conceptual Design and Cost Estimates*, prepared for SAFCA, November 2008.

U.S. Army Corps of Engineers (USACE)*, Draft Supplemental Report to the Section 205 Final Detailed Project Report and Environmental Assessment on Magpie Creek, California, Sacramento District*, *United States Army Corps of Engineers*, USACE Sacramento District, January 2004.

PLATES

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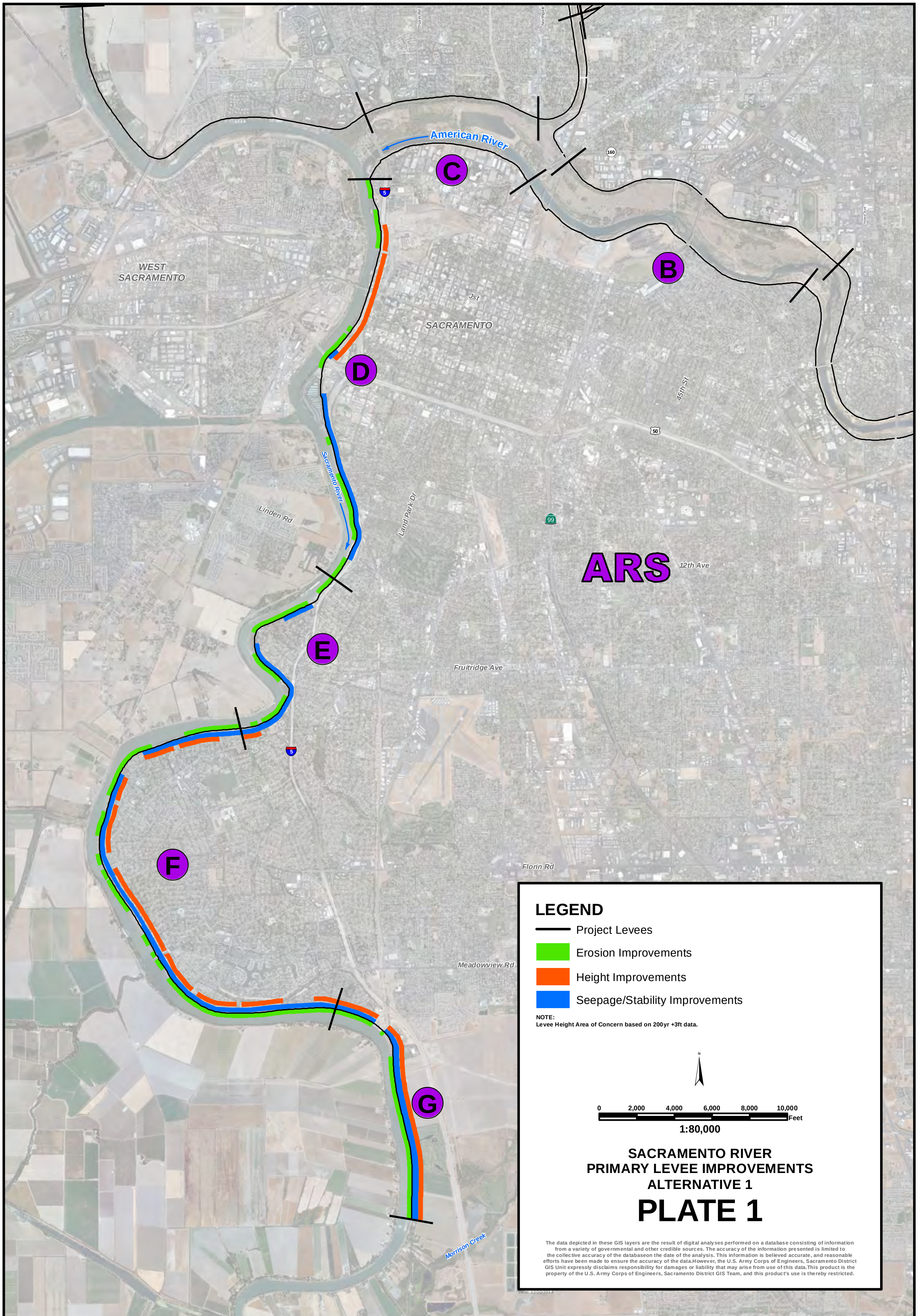
American River
C
B
WEST SACRAMENTO
SACRAMENTO
D
Sacramento River
Linden Rd
Land Park Dr
ARS
12th Ave
E
Fruitridge Ave
F
Florin Rd
Meadowview Rd
G
Morrison Creek
LEGEND
Project Levees
Erosion Improvements
Height Improvements
Seepage/Stability Improvements
NOTE:
Levee Height Area of Concern based on 200yr +3ft data.
0 2,000 4,000 6,000 8,000 10,000 Feet
1:80,000
SACRAMENTO RIVER
PRIMARY LEVEE IMPROVEMENTS
ALTERNATIVE 1
PLATE 1
The data depicted in these GIS layers are the result of digital analyses performed on a database consisting of information from a variety of governmental and other credible sources. The accuracy of the information presented is limited to the collective accuracy of the databaseon the date of the analysis. This information is believed accurate, and reasonable efforts have been made to ensure the accuracy of the data.However, the U.S. Army Corps of Engineers, Sacramento District GIS Unit expressly disclaims responsibility for damages or liability that may arise from use of this data.This product is the property of the U.S. Army Corps of Engineers, Sacramento District GIS Team, and this product's use is thereby restricted.
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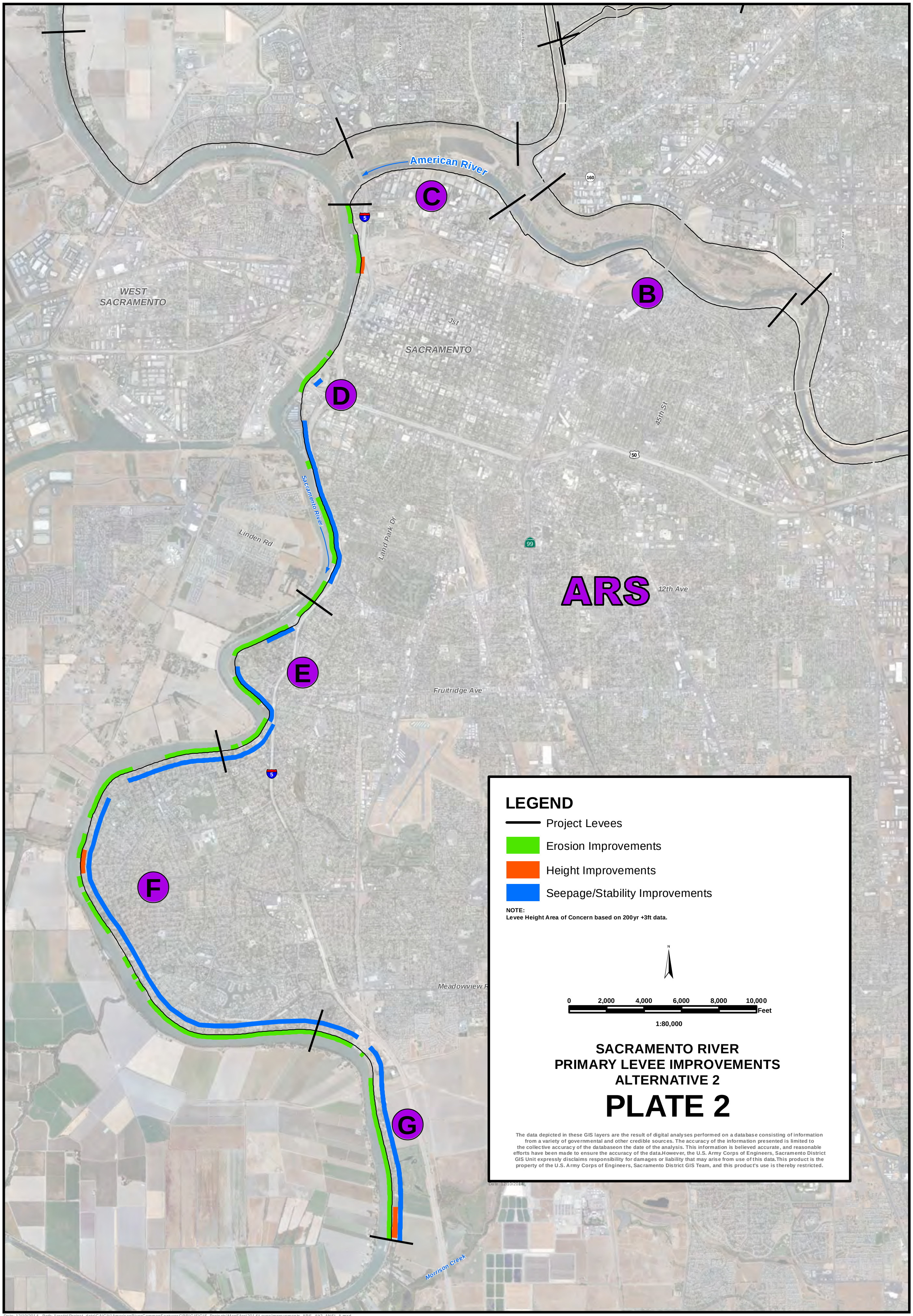
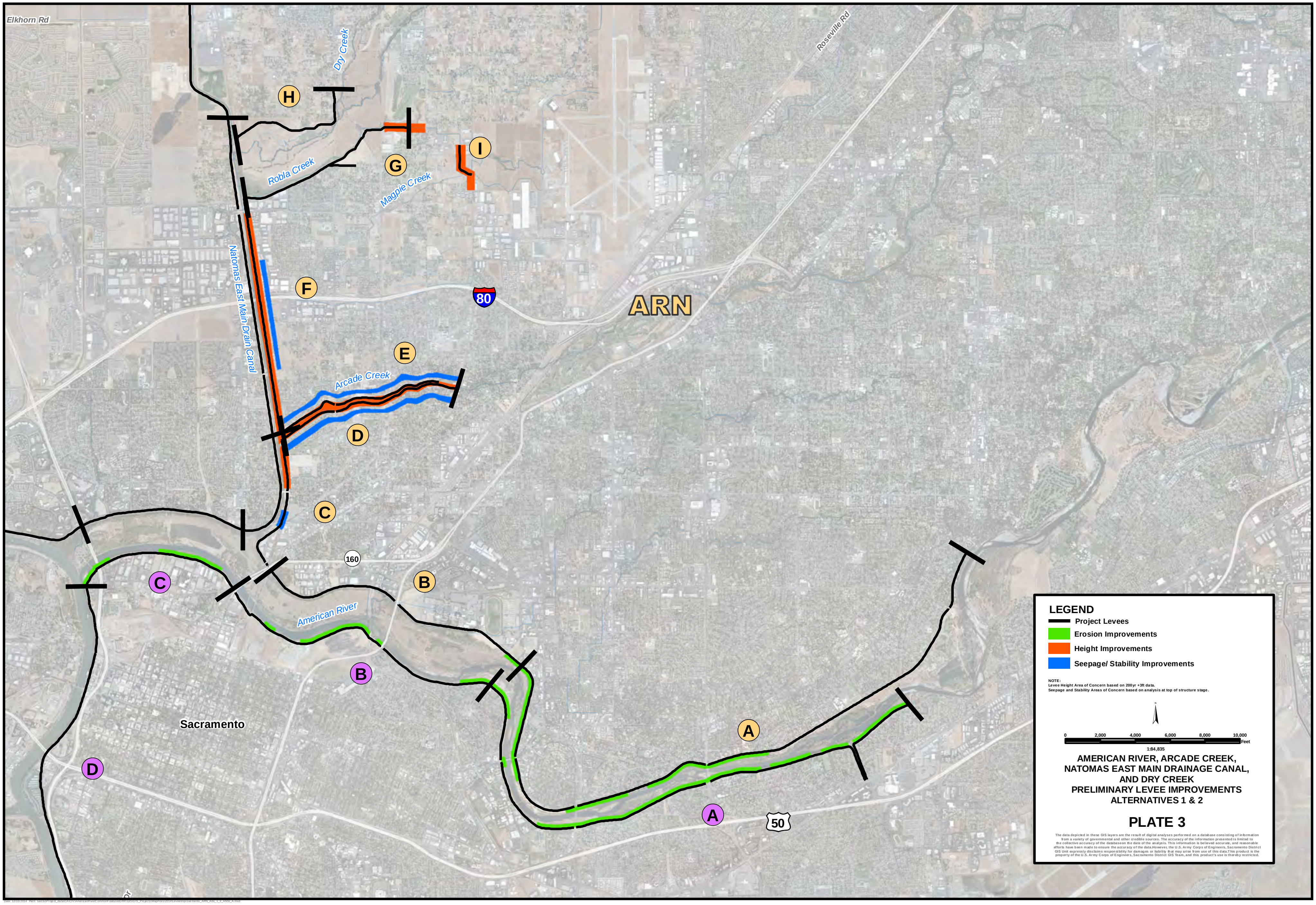
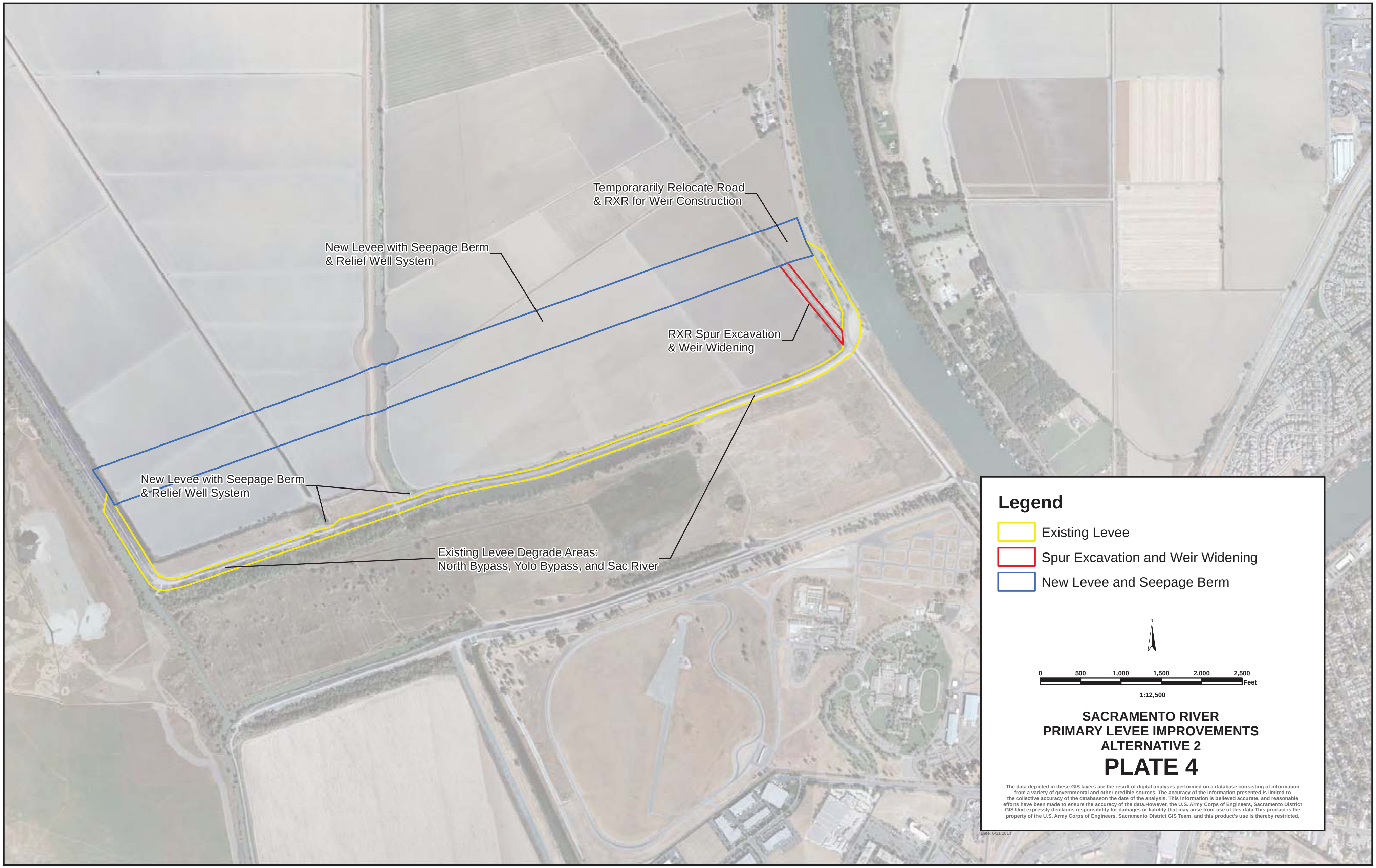


American River
C
B
WEST SACRAMENTO
SACRAMENTO
D
Sacramento River
Linden Rd
Land Park Dr
45th St
ARS
12th Ave
E
Fruitridge Ave
F
Meadowview Rd
G
Morrison Creek
LEGEND
Project Levees
Erosion Improvements
Height Improvements
Seepage/Stability Improvements
NOTE:
Levee Height Area of Concern based on 200yr +3ft data.
0 2,000 4,000 6,000 8,000 10,000 Feet
1:80,000
SACRAMENTO RIVER
PRIMARY LEVEE IMPROVEMENTS
ALTERNATIVE 2
PLATE 2



Elkhorn Rd
Dry Creek
Roseville Rd
H
G
I
Robla Creek
Magpie Creek
Natomas East Main Drain Canal
F
80
ARN
E
Arcade Creek
D
C
160
B
C
American River
B
Sacramento
A
D
A
50
LEGEND
Project Levees
Erosion Improvements
Height Improvements
Seepage/ Stability Improvements
NOTE:
Levee Height Area of Concern based on 200yr +3ft data.
Seepage and Stability Areas of Concern based on analysis at top of structure stage.
N
0
2,000
4,000
6,000
8,000
10,000
Feet
1:84,835
AMERICAN RIVER, ARCADE CREEK,
NATOMAS EAST MAIN DRAINAGE CANAL,
AND DRY CREEK
PRELIMINARY LEVEE IMPROVEMENTS
ALTERNATIVES 1 & 2
PLATE 3
The data depicted in these GIS layers are the result of digital analyses performed on a database consisting of information from a variety of governmental and other credible sources. The accuracy of the information presented is limited to the collective accuracy of the databaseon the date of the analysis. This information is believed accurate, and reasonable efforts have been made to ensure the accuracy of the data.However, the U.S. Army Corps of Engineers, Sacramento District GIS Unit expressly disclaims responsibility for damages or liability that may arise from use of this data.This product is the property of the U.S. Army Corps of Engineers, Sacramento District GIS Team, and this product's use is thereby restricted.


Temporararily Relocate Road
& RXR for Weir Construction
New Levee with Seepage Berm
& Relief Well System
RXR Spur Excavation
& Weir Widening
New Levee with Seepage Berm
& Relief Well System
Existing Levee Degrade Areas:
North Bypass, Yolo Bypass, and Sac River
Legend
Existing Levee
Spur Excavation and Weir Widening
New Levee and Seepage Berm
N
0 500 1,000 1,500 2,000 2,500 Feet
1:12,500
SACRAMENTO RIVER
PRIMARY LEVEE IMPROVEMENTS
ALTERNATIVE 2
PLATE 4
The data depicted in these GIS layers are the result of digital analyses performed on a database consisting of information from a variety of governmental and other credible sources. The accuracy of the information presented is limited to the collective accuracy of the databaseon the date of the analysis. This information is believed accurate, and reasonable efforts have been made to ensure the accuracy of the data.However, the U.S. Army Corps of Engineers, Sacramento District GIS Unit expressly disclaims responsibility for damages or liability that may arise from use of this data.This product is the property of the U.S. Army Corps of Engineers, Sacramento District GIS Team, and this product's use is thereby restricted.
Date: 6/11/2014

ATTACHMENTS

Attachment A – Hydrology Executive Report (Under Separate Cover)

Attachment B – Hydraulic Appendix Executive Report (Under Separate Cover)

Attachment C – Geotechnical Report (Under Separate Cover)

Attachment D – Cost Engineering (Under Separate Cover)

Attachment E – Erosion Protection Report (Under Separate Cover)