

## Mitigation Action Items

**Requirement §201.6(c)(3)(ii):** *[The mitigation strategy shall include a] section that identifies and analyzes a comprehensive range of specific mitigation actions and projects being considered to reduce the effects of each hazard, with particular emphasis on new and existing buildings and infrastructure.*

**Priority: 1 of 38**

**Status: Existing**

**Hazard Addressed: Flood Hazard**

**Project#: OCPW1: Mitigate flood hazard  
Santa Ana River Channel Project**

**Rationale:** Design, land acquisition, mitigation, construction and maintenance of flood control improvements to protect property and lives by removing/reducing (via flow containment within the improved channel) the FEMA Special Flood Hazard Area by constructing the Lower Santa Ana River to convey the 190-year storm event; construction of Seven Oaks Dam and Prado Dam. Maintain ultimate capacity and/or mitigation including clearing vegetation and/or replacing aging/eroding/damaged channel structures.

**Relates to Plan Goal(s) and Objectives:** Protect lives and property.

The Santa Ana River Mainstem Project (SARP) was initiated in 1964, in partial response to a resolution of the House Committee on Public Works adopted May 8, 1964. A survey report was completed by the District in 1975. The report was reviewed, and then submitted to Congress in September 1978.

Congress authorized Santa Ana River Mainstem Project for construction in 1986 under new guidelines for cost sharing of water resources projects between Federal and local governments. The local sponsors must pay between 25% and 50% of total cost of the project with the remaining cost provided by the Federal government.

In September 1980, the Corps of Engineers completed the Phase I General Design Memorandum (GDM) for the Santa Ana Mainstem. Construction of the SARP was authorized by Section 401(a) of the Water Resources Development Act of 1986. Construction of SARP was initiated in 1989, and completion is scheduled for 2014.

On December 14, 1989, the U.S. Army Corps of Engineers (COE) and the County Flood Control District of Orange, Riverside and San Bernardino as Local Sponsors, entered into a four-party Local Cooperation Agreement (LCA) defining the responsibilities and cost-sharing of each party for each feature.

The Local Sponsors are to acquire all lands, easements, rights-of-way and perform relocations required to make way for construction of the Mainstem Project. The COE will construct the improvements. On completion, the Local Sponsors are responsible for the operation and maintenance of the Project features; except for Prado Dam where Orange County is responsible to pay for incremental operations/maintenance costs and the COE will continue to operate the Dam.

In 2003, a new agreement was entered between the Corps of Engineers and Orange County Flood Control District where the Prado Dam feature of the Santa Ana Mainstem Project were separated and Orange County was the sole local sponsor for Prado Dam. The project is designed to prevent flooding of 110,000 acres and causing 3,000 fatalities and more than \$15 billion in property damage. The project features are; constructing 23 miles of the Lower Santa Ana River from the Pacific Ocean to Prado Dam; raising Prado Dam elevation and reservoir capacity and construction of Seven Oaks Dam, the 6<sup>th</sup> tallest earthdam in the United States.

**Implementor:** Orange County Flood Control District/Orange County Public Works Flood Control Section

**Estimated Cost:** \$1,890,000,000

**Time Period:** 25 years

**Funding Source:** Federal and local sponsorship

**Source and Date:** Orange County Strategic Financial Plan (2009)

**Adopted Plan Number:** Local Cooperation Agreement

**Reference Page:** N/A

**Initiative and Implementation Status:**

The U.S. Army Corps of Engineers has completed construction of the Lower Santa Ana River from the Pacific Ocean to Prado Dam to convey the 190-year storm event and the Seven Oaks Dam. Currently the Orange County Flood Control District is acquiring land necessary to accommodate the increase in reservoir capacity with the Prado Dam spillway elevation being raised by the USACOE.

**Priority: 2 of 38**

**Status: Existing**

**Hazard Addressed: Flood Hazard**

**Project#: OCPW2: Mitigate flood hazard  
East Garden Grove-Wintersburg Channel (Facility No. C05) Project**

**Rationale:** Design, obtain regulatory permits, construction and maintenance of flood control improvements to protect property and lives by removing/reducing (via flow containment within the improved channel) the FEMA Special Flood Hazard Area by constructing ultimate channel improvements to convey the 100-year storm event. Maintain ultimate capacity including clearing vegetation and/or replacing aging/eroding/damaged channel structures.

**Relates to Plan Goal(s) and Objectives:**

Protect property and lives by removing/reducing (via flow containment within the improved channel) the FEMA Special Flood Hazard Area (SFHA) by constructing the ultimate channel improvements to convey the 100-year storm event. The watershed for East Garden Grove-Wintersburg and Oceanview Channel is the largest SFHA remaining in Orange County traversing over 15.5 miles through seven cities; Huntington Beach, Westminster, Fountain Valley, Garden Grove, Santa Ana, Orange and Anaheim outletting into Bolsa Chica Tidal Bay, then Anaheim Bay and Pacific Ocean.

Our objective is to design, construct, and maintain the channel capacity to convey the 100-year storm event including but not exclusive to clearing vegetation, debris, sediment (structured and non-structured), and/or replacing deteriorating, eroded, damaged channel structure or system.

**Implementor:** Orange County Flood Control District/Orange County Public Works Flood Control Section

**Estimated Cost:** \$230,000,000

**Construction Time Period:** 1995 to 2035

**Funding Source:** Orange County Flood Fund is mainly acquired from a portion of Orange County property taxes, and Federal/state grants.

**Source and Date:** Orange County Strategic Financial Plan (2009)

**Adopted Plan Number:** EIR No. 560, East Garden Grove-Wintersburg/Oceanview Channel System (C05/C06), dated February 1998; Project Report for East Garden Grove-Wintersburg and Oceanview Channels, dated December 1994.

**Reference Page:** N/A

**Initiative and Implementation Status:** The Orange County Flood Control District has constructed five flood control capital improvement projects, (1995 thru 2001) upstream and downstream of the I-405 Freeway totaling 1.3 miles at a cost of \$15,000,000. An additional seven projects, totaling 6.5 miles and estimated cost of \$150,000,000 (2010 dollars) within the 7-Year Flood Control Capital Improvement Project Plan are currently undergoing the design process which includes obtaining regulatory permits:

- Under 4 miles from Outer Bolsa Bay to downstream I-405 Freeway
- Under 2 miles from upstream I-405 Freeway to McFadden/Brookhurst
- Haster Retarding Basin and Pump Station
- Newland Storm Channel, under 1 mile from C05 confluence to d/s Bolsa Ave
- Edinger Storm Channel, under 1 mile from C05 to 1,350' u/s Edinger Ave

- About ½ mile from upstream of Haster Retarding Basin to Chapman Ave (terminus)

Approximately 6 miles of channel improvements from McFadden/Brookhurst to Haster Retarding Basin and beyond to the terminus are not in the 7-Year Flood Control Capital Improvement Plan; the estimated cost is \$60,000,000 (2010 dollars).

**Priority: 3 of 38**

**Status: Existing**

**Hazard Addressed: Flood Hazard**

**Project#: OCPW3: Mitigate flood hazard  
San Juan Creek Channel (Facility No. L01) Project, Lower Reach**

**Rationale:** Design, obtain regulatory permits, construction and maintenance of flood control improvements. This channel has sustained numerous damages caused by heavy storms; most recently two storms in January 2005 caused two segments of levee embankment to breach threatening an estimated 1,000 homes in the immediate vicinity, five neighborhoods were evacuated during the peak of the storm. By constructing the interim improvements, property and lives are immediately protected against catastrophic levee failure.

Design, Regulatory Permits, Construct, Maintain. Protect property and lives by removing/reducing (via flow containment within the improved channel) the FEMA Special Flood Hazard Area by constructing ultimate channel improvements to convey the 100-year storm event. Maintain ultimate capacity including clearing vegetation and/or replacing aging/eroding/damaged channel structures.

**Relates to Plan Goal(s) and Objectives:**

Protect property and lives by constructing the interim project which will immediately protect homes within the vicinity from catastrophic levee failure. Steel Sheet Pile (SSP) walls will be driven behind the existing channel wall lined with riprap or concrete keeping the levee behind intact when high velocity flows scour and degradation of the channel invert occurs. Regulatory permits from the US Army Corps of Engineers (Section 404), Department of Fish and Game (CDFG Section 1601), California Regional Water Quality Control Board (Section 401), and the California Coastal Commission are not required for this interim project stage.

The SSP will be utilized as a component of the ultimate channel improvements along with improvements to the channel invert that will convey the 100-year storm event. The OC Public Works is working with the U.S. Army Corps of Engineers in preparing feasibility study to determine if there is Federal interest in assisting with construction of improvements including stabilizing the channel invert and ultimately removing/reducing (via flow containment within the improved channel) the FEMA Special Flood Hazard Area.

Our objective is to maintain a capacity to convey the 100-year storm event including but not exclusive to clearing vegetation, debris, sediment; and/or replacing deteriorating, eroded and damaged channel structure or system.

**Implementor:** Orange County Flood Control District/Orange County Public Works Flood Control Section

**Estimated Cost:** \$91,000,000

**Time Period:**

**Funding Source:** Orange County Flood Fund is mainly acquired from a portion of Orange County property taxes, and Federal/state grants.

**Source and Date:** Orange County Strategic Financial Plan (2009)

**Adopted Plan Number:** N/A

**Reference Page:** N/A

**Initiative and Implementation Status:** The Orange County Flood Control District has constructed three flood control capital improvement projects, (2008 thru current) from upstream of Stonehill Drive to downstream of the confluence with Trabuco Creek Channel on the left side only and on both sides of the channel from downstream of

the confluence with Trabuco Creek Channel to just downstream of the I-5 (San Diego) Freeway totaling under 1 mile at a cost of \$22,600,000. The remaining five projects, totaling over 1.5 miles and estimated cost of \$44,400,000 (2010 dollars) within the 7-Year Flood Control Capital Improvement Project Plan are currently undergoing the design process which includes obtaining regulatory permits:

- Under ½ mile segment on the right side of the channel immediately upstream of Stonehill Drive **Phase 5**
- Under ¾ mile segment on the right side of the channel farther upstream of Stonehill Drive **Phase 4**
- Under ½ mile segment on the left side of the channel immediately upstream of Stonehill Drive **Phase 6**
- About ½ mile segment on both sides of the channel immediately upstream of the confluence with Trabuco Creek Channel **Phase 7**
- About 1/3 mile segment on both sides of the channel farther upstream of the confluence with Trabuco Creek Channel **Phase 8**

Approximately 1 mile of channel improvements from the Pacific Ocean to Stonehill Drive and a longer segment from downstream I-5 (San Diego) Freeway to the terminus are not in the 7-Year Flood Control Capital Improvement Plan; the estimated cost is undetermined at this time.

Drainage Area 112,670 AC, 29,000 linear feet

**Priority: 4 of 38**

**Status: Existing**

**Hazard Addressed: Flood Hazard**

**Project#: OCPW4: Mitigate flood hazard  
Trabuco Creek Channel (Facility No. L02) Project**

**Rationale:** Design, obtain regulatory permits, construction and maintenance of flood control improvements to protect property and lives by constructing interim improvements that will ultimately convey the 100-year storm event within existing right-of-way.

**Relates to Plan Goal(s) and Objectives:**

Protect property and lives by removing/reducing (via flow containment within the improved channel) the FEMA Special Flood Hazard Area by constructing the ultimate channel improvements to convey the 100-year storm event.

Maintain the capacity to convey the 100-year storm event including but not exclusive to clearing vegetation, debris, sediment; and/or replacing deteriorating, eroded, damaged channel structure or system.  
Drainage Area 35,000 AC, 13,324 linear feet

**Implementor:** Orange County Flood Control District/Orange County Public Works Flood Control Section

**Estimated Cost:** \$25,800,000<sub>a</sub>, part of the \$91,000,000 for San Juan Creek Channel (Facility No. L01)

**Time Period:**

**Funding Source:** Orange County Flood Fund is mainly acquired from a portion of Orange County property taxes, and Federal/state grants.

**Source and Date:** Orange County Strategic Financial Plan (2009)

**Adopted Plan Number:** N/A

**Reference Page:** N/A

**Initiative and Implementation Status:** Trabuco Creek Channel confluences with San Juan Creek Channel. The Orange County Flood Control District has constructed three flood control capital improvement projects totaling nearly 1 mile in length and costing \$22,600,000 along San Juan Creek Channel immediately downstream of the confluence.

Two projects, nearly one mile in length and estimated cost of \$25,800,000 (2010 dollars) within the 7-Year Flood Control Capital Improvement Project Plan are currently undergoing the design process which includes obtaining regulatory permits:

- About ½ mile segment on both sides of the channel immediately upstream of the confluence with San Juan Creek Channel **Phase 7**
- About 1/3 mile segment on both sides of the channel farther upstream of the confluence with San Juan Creek Channel **Phase 8**

**Priority: 5 of 38**

**Status: Existing**

**Hazard Addressed: Flood Hazard**

**Project#: OCPW5: Mitigate flood hazard  
Westminster Channel (Facility No. C04) Project**

**Rationale:** Design, obtain regulatory permits, construction and maintenance of flood control improvements to protect property and lives by removing/reducing (via flow containment within the improved channel) the FEMA Special Flood Hazard Area by implementing recommended alternatives per project report to convey the 100-year storm event. Maintain ultimate capacity including clearing vegetation and/or replacing aging/eroding/damaged channel structures.

**Relates to Plan Goal(s) and Objectives:** Protect lives and property.

The watershed for Westminster channel has a drainage area of 7,000 AC and traverses nearly 8 miles (41,000 linear feet) through three cities; Huntington Beach, Westminster and Garden Grove. This channel confluences with Bolsa Chica Channel before outletting into Anaheim Harbor and then the Pacific Ocean. The plan and goal is to protect property and lives by removing/reducing (via flow containment within the improved channel) the FEMA Special Flood Hazard Area by constructing the ultimate channel improvements to convey the 100-year storm event.

Post construction objective is to maintain the capacity to convey the 100-year storm event including but not exclusive to clearing vegetation, debris, sediment; and/or replacing deteriorating, eroded and damaged channel structure or system.

**Implementor:** Orange County Flood Control District/Orange County Public Works Flood Control Section

**Estimated Cost:** \$65,000,000 <sup>a,c</sup>

**Construction Time Period:** 2005 to 2035

**Funding Source:** Orange County Flood Fund is mainly acquired from a portion of Orange County property taxes, and Federal/state grants. Most recently a \$7.5 million Hazard Mitigation Grant Program application was approved for improvements along Westminster Channel.

**Source and Date:** Orange County Strategic Financial Plan (2009)

**Adopted Plan Number:** Project Report for Westminster Channel, Facility No. C04, from Bolsa Chica Channel Confluence (C02) to Garden Grove Freeway (SR-22), February 2005

**Reference Page:** N/A

**Initiative and Implementation Status:** The Orange County Flood Control District is constructing a 2,400-foot segment starting downstream Hoover Street to downstream Beach Blvd. The channel project report prioritizes this reach as the worst deficient channel. The next two projects are on the 7-Year Flood Control Capital Improvement Project Plan, beginning with a 6,122 linear feet segment downstream of Bolsa Chica Road to upstream the intersection of Springdale Street and Edinger Avenue of another 5,300 linear feet segment begins upstream of the intersection of Springdale/Edinger to downstream Bolsa Avenue. The estimated costs associated with the two segments total \$38,000,000 (2010 dollars).

*a engineer's estimate TYP*

*c project report*

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**Priority: 6 of 38**

**Status: Existing**

**Hazard Addressed: Flood Hazard**

**Project#: OCPW6: Mitigate flood hazard  
Santa Ana-Delhi Channel (Facility No. F01) Project, Lower Reach**

**Rationale:** Design, obtain regulatory permits, construction and maintenance of flood control improvements to protect property and lives by removing/reducing (via flow containment within the improved channel) the FEMA Special Flood Hazard Area by implementing recommended alternatives per project report to convey the 100-year storm event. Maintain ultimate capacity including clearing vegetation and/or replacing aging/eroding/damaged channel structures.

**Relates to Plan Goal(s) and Objectives:** Protect lives and property.

The watershed for Santa Ana Delhi Channel has a drainage area of 11,160 acres and traverses 5.5 miles (27,000 linear feet) through the cities of Newport Beach, Costa Mesa and Santa Ana. This channel outlets into Upper Newport Back Bay and then the Pacific Ocean. The plan and goal is to protect property and lives by removing/reducing (via flow containment within the improved channel) the FEMA Special Flood Hazard Area by constructing the ultimate channel improvements to convey the 100-year storm event.

Post construction, maintain the capacity to convey the 100-year storm event including but not exclusive to clearing vegetation, debris, sediment; and/or replacing deteriorating, eroded and damaged channel structure or system.

**Implementor:** Orange County Flood Control District/Orange County Public Works Flood Control Section

**Estimated Cost:** \$12,300,000 <sup>a</sup>

**Construction Time Period:** 2010 to 2030

**Funding Source:** Orange County Flood Fund is mainly acquired from a portion of Orange County property taxes, and Federal/state grants.

**Source and Date:** Orange County Strategic Financial Plan (2009)

**Adopted Plan Number:** EIR No. 527 Santa Ana-Delhi Channel System dated January 1994.

**Reference Page:** N/A

**Initiative and Implementation Status:** The lower reach of Santa Ana-Delhi Channel system from downstream Mesa Drive to Flower Street, 3.7 miles (19,700 linear feet), has already been constructed to ultimate conditions and will convey the 100-year storm event. The last remaining 1,500 linear feet segment for this lower reach begins downstream of the pedestrian/hiking/biking/trail bridge and ends downstream of Mesa Drive; this segment is in the 7-Year Flood Control Capital Improvement Project Plan. This project is a mitigation project for all the previous projects constructed in the lower reaches and is estimated to cost \$12,300,000 (2010 dollars).

*a engineer's estimate TYP*

**Priority: 7 of 38**

**Status: Existing**

**Hazard Addressed: Flood Hazard**

**Project#: OCPW7: Mitigate flood hazard  
Oceanview Channel (Facility No. C06) Project**

**Rationale:** Design, obtain regulatory permits, construction and maintenance of flood control improvements to protect property and lives by removing/reducing (via flow containment within the improved channel) the FEMA Special Flood Hazard Area by constructing ultimate channel improvements to convey the 100-year storm event. Maintain ultimate capacity including clearing vegetation and/or replacing aging/eroding/damaged channel structures.

**Relates to Plan Goal(s) and Objectives:** Protect lives and property.

The watershed for Oceanview Channel has a drainage area of 3,380 acres and traverses over 5.5 miles (21,707 linear feet) through two cities; Huntington Beach and Fountain Valley. This channel is a tributary to East Garden Grove-Wintersburg Channel. The plan and goal is to protect property and lives by removing/reducing (via flow containment within the improved channel) the FEMA Special Flood Hazard Area (SFHA) by constructing the ultimate channel improvements to convey the 100-year storm event.

Our objective is to design, construct, and maintain the channel capacity to convey the 100-year storm event including but not exclusive to clearing vegetation, debris, sediment (structured and non-structured); and/or replacing deteriorating, eroded and damaged channel structure or system.

**Implementor:** Orange County Flood Control District/Orange County Public Works Flood Control Section

**Estimated Cost:** \$30,000,000

**Construction Time Period:** 1995 to 2035

**Funding Source:** Orange County Flood Fund is mainly acquired from a portion of Orange County property taxes, and Federal/state grants.

**Source and Date:** Orange County Strategic Financial Plan (2009)

**Adopted Plan Number:** EIR No. 560, East Garden Grove-Wintersburg/Oceanview Channel System (C05/C06), dated February 1998; Project Report for East Garden Grove-Wintersburg and Oceanview Channels, dated December 1994.

**Reference Page:** N/A

**Initiative and Implementation Status:**

The Orange County Flood Control District has constructed the beginning of this channel, a 50-foot segment, with the confluence of East Garden Grove-Wintersburg Channel. The projects, totaling about 1 mile (approximately 5,000 linear feet) and an estimated cost of \$11,000,000 (2010 dollars) are scheduled in the 7-Year Flood Control Capital Improvement Project Plan and is currently undergoing the design process which includes obtaining regulatory permits.

**Priority: 8 of 38**

**Status: Existing**

**Hazard Addressed: Flood Hazard**

**Project#: OCPW8: Mitigate flood hazard  
San Diego Creek Channel (Facility No. F05) Project**

**Rationale:** Design, obtain regulatory permits, construction and maintenance of flood control improvements to protect property and lives by removing/reducing (via flow containment within the improved channel) the FEMA Special Flood Hazard Area by implementing recommended alternatives per project report to convey the 100-year storm event. Maintain ultimate capacity including clearing vegetation and/or replacing aging/eroding/damaged channel structures.

**Relates to Plan Goal(s) and Objectives:** Protect lives and property.

The watershed for the San Diego Creek Channel has a drainage area of 76,670 acres and traverses 6 miles (42,100 linear feet) through the City of Irvine. This channel outlets into Upper Newport Back Bay and then the Pacific Ocean. The plan and goal is to maintain the capacity to convey the 100-year storm event including but not exclusive to clearing vegetation, debris, sediment; and/or replacing deteriorating, eroded and damaged channel structure or system. The recently revised digital FIRM indicates a Zone A downstream of I-405 Freeway. Our goal is also protecting property and lives by removing/reducing (via flow containment within the improved channel) the FEMA Special Flood Hazard Area.

**Implementor:** Orange County Flood Control District/Orange County Public Works Flood Control Section

**Estimated Cost:** \$20,000,000

**Construction Time Period:** 2010 to 2035

**Funding Source:** Orange County Flood Fund is mainly acquired from a portion of Orange County property taxes, and Federal/state grants.

**Source and Date:** Orange County Strategic Financial Plan (2009)

**Adopted Plan Number:** N/A

**Reference Page:** N/A

**Initiative and Implementation Status:** San Diego Creek Channel from Upper Newport Back Bay to downstream I-405 San Diego Freeway previously had the capacity to convey the 100-year storm. Regulatory agencies would not permit Operation & Maintenance crews to maintain the channel. In the process of designing and obtaining regulatory permits for the rehabilitation of this channel segment to previous conditions to restore flood capacity, the Regulatory agencies conditioned two (2) offsite mitigation projects costing nearly \$2,000,000 in addition to an Environmental Impact Report has been certified and we are in the process of obtaining permits. Additional time was added for the design and construction process for the offsite mitigation projects.

**Priority: 9 of 38**

**Status: New**

**Hazard Addressed: Flood Hazard**

**Project#: OCPW9: Mitigate flood hazard  
Lane Channel (Facility No. F08) Project**

**Rationale:** Design, obtain regulatory permits, construction and maintenance of flood control improvements to protect property and lives by removing/reducing (via flow containment within the improved channel) the FEMA Special Flood Hazard Area by implementing recommended alternatives per project report to convey the 100-year storm event. Maintain ultimate capacity including clearing vegetation and/or replacing aging/eroding/damaged channel structures.

**Relates to Plan Goal(s) and Objectives:** Protect lives and property.

The watershed of Lane Channel has a drainage area of 3,143 acres and traverses 3.5 miles (18,491 linear feet) through the City of Irvine; the channel begins at the confluence with San Diego Creek Channel and ends upstream of SR-55 Freeway. This channel was built in the 1960's through the use of bond funds, mainly to drain and alleviate flooding in the agricultural fields and has now developed rapidly into a high density commercial business area subjecting the channel to more frequent and increased quantities of storm water flows, scouring the side slopes. Over time, the channel slopes eroded drastically resulting in a widened channel eventually widened to the point of conveying the 100-year storm flows with limited flooding.

The objective is to protect property and lives by removing/reducing (via flow containment within the improved channel) the FEMA Special Flood Hazard Area by constructing the ultimate channel improvements to convey the 100-year storm event including partially retaining and stabilizing the channel sides. Post construction, maintain the capacity to convey the 100-year storm event including but not exclusive to clearing vegetation, debris, sediment; and/or replacing deteriorating, eroded and damaged channel structure or system.

**Implementor:** Orange County Flood Control District/Orange County Public Works Flood Control Section

**Estimated Cost:** \$45,000,000

**Time Period:** 2010 to 2035

**Funding Source:** Orange County Flood Fund is mainly acquired from a portion of Orange County property taxes, and federal/state grants.

**Source and Date:** Orange County Strategic Financial Plan (2009)

**Adopted Plan Number:** N/A

**Reference Page:** N/A

**Initiative and Implementation Status:** The City of Irvine had constructed a 2,200 linear feet segment from 1000' downstream Redhill Avenue to downstream the SR-55 freeway to convey the 100-year storm event.

Two projects totalling, nearly 10,000 linear feet estimated at \$31,000,000 (2010 dollars), not including \$14,000,000 (\$45M - \$31M) improvements constructed before, are scheduled in the 7-Year Flood Control Capital Improvement Project Plan. The beginning reach starting at the confluence with San Diego Creek and ends at Von Karman, is currently undergoing the design process for repair and construction to convey the 100-year storm event. The upstream segment from Von Karman to 1000' downstream of Redhill Avenue was recently selected into the 7-Year Flood Control Capital Improvement Project Plan.

**Priority: 10 of 38**

**Status: Existing**

**Hazard Addressed: Flood Hazard**

**Project#: OCPW10: Mitigate flood hazard  
Carbon Creek Channel (Facility No. B01) Project**

**Rationale:** Design, obtain regulatory permits, construction and maintenance of flood control improvements to protect property and lives by removing/reducing (via flow containment within the improved channel) the FEMA Special Flood Hazard Area by implementing recommended alternatives per project report to convey the 100-year storm event. Maintain ultimate capacity including clearing vegetation and/or replacing aging/eroding/damaged channel structures.

**Relates to Plan Goal(s) and Objectives:** Protect lives and property.

The watershed for Carbon Canyon Creek Channel as a drainage area of 12,620 AC and traverses nearly 13 miles (67,486 linear feet) through the cities of Cypress, Anaheim, Fullerton and Placentia. This channel is a tributary to Los Alamitos Channel. The plan and goal is to protect property and lives by removing/reducing (via flow containment within the improved channel) the FEMA Special Flood Hazard Area by constructing the ultimate channel improvements to convey the 100-year storm event.

Post construction, maintain the capacity to convey the 100-year storm event including but not exclusive to clearing vegetation, debris, sediment; and/or replacing deteriorating, eroded and damaged channel structure or system.

**Implementor:** Orange County Flood Control District/Orange County Public Works Flood Control Section

**Estimated Cost:** \$60,000,000

**Time Period:** 2010 to 2035

**Funding Source:** Orange County Flood Fund is mainly acquired from a portion of Orange County property taxes, and Federal/state grants.

**Source and Date:** Orange County Strategic Financial Plan (2009)

**Adopted Plan Number:** Design Memorandum for the Carbon Creek Channel System Facility No. B01 from Coyote Creek Channel to Miller Retarding Basin Volumes I and II, January 1989

**Reference Page:** N/A

**Initiative and Implementation Status:** There are six projects (including Cypress Pump Station) listed on the 7-Year Flood Control Capital Improvement Project Plan. The projects located in the middle of the channel system within the City of Anaheim total 1.5 miles (8,000 linear feet). The estimated costs associated for these projects are \$60,000,000 (2010 dollars).

**Priority: 11 of 38**

**Status: Existing**

**Hazard Addressed: Flood Hazard**

**Project#: OCPW11: Mitigate flood hazard  
Brea Creek Channel (Facility No. A02) Project**

**Rationale:** Design, obtain regulatory permits, construction and maintenance of flood control improvements to protect property and lives by removing/reducing (via flow containment within the improved channel) the FEMA Special Flood Hazard Area by implementing recommended alternatives per project report to convey the 100-year storm event. Maintain ultimate capacity including clearing vegetation and/or replacing aging/eroding/damaged channel structures.

**Relates to Plan Goal(s) and Objectives:** Protect lives and property.

The watershed of Brea Creek Channel has a drainage area of 6,900 acres and traverses 5.5 miles (29,346 linear feet) through the cities of Buena Park and Fullerton. The plan and goal is to protect property and lives by removing/reducing (via flow containment within the improved channel) the FEMA Special Flood Hazard Area by constructing the ultimate channel improvements to convey the 100-year storm event.

Post construction, maintain the capacity to convey the 100-year storm event including but not exclusive to clearing vegetation, debris, sediment; and/or replacing deteriorating, eroded, and damaged channel structure or system.

**Implementor:** Orange County Flood Control District/Orange County Public Works Flood Control Section

**Estimated Cost:** \$8,400,000

**Time Period:**

**Funding Source:** Orange County Flood Fund is mainly acquired from a portion of Orange County property taxes, and federal/state grants.

**Source and Date:** Orange County Strategic Financial Plan (2009)

**Adopted Plan Number:** N/A

**Reference Page:** N/A

**Initiative and Implementation Status:** There is one project listed on the 7-Year Flood Control Capital Improvement Project Plan. The project is located near the beginning of the channel system within the City of Buena Park totaling 1 mile (5,900 linear feet). The estimated cost associated for the project is \$8,400,000 (2010 dollars). Plans and specifications for this project are completed. The Orange County Flood Control District continues to seek Caltrans assistance with this project at State Route No. 39 (Beach Boulevard).

**Priority: 12 of 38**

**Status: Existing**

**Hazard Addressed: Flood Hazard**

**Project#: OCPW12: Mitigate flood hazard  
Fullerton Creek Channel (Facility No. A03) Project**

**Rationale:** Design, obtain regulatory permits, construction and maintenance of flood control improvements to protect property and lives by removing/reducing (via flow containment within the improved channel) the FEMA Special Flood Hazard Area by implementing recommended alternatives per project report to convey the 100-year storm event. Maintain ultimate capacity including clearing vegetation and/or replacing aging/eroding/damaged channel structures.

**Relates to Plan Goal(s) and Objectives:** Protect lives and property.

The watershed for Fullerton Creek Channel has a drainage area of 10,000 acres and traverses 9 miles (48,200 linear feet) through the cities of Brea, Buena Park, Fullerton, La Habra, and La Palma. The plan and goal is to protect property and lives by removing/reducing (via flow containment within the improved channel) the FEMA Special Flood Hazard Area by constructing approximately 26,000 linear feet of ultimate channel improvements to convey the 100-year storm event.

Post construction, maintain the capacity to convey the 100-year storm event including but not exclusive to clearing vegetation, debris, sediment; and/or replacing deteriorating, eroded and damaged channel structure or system.

**Implementor:** Orange County Flood Control District/Orange County Public Works Flood Control Section

**Estimated Cost:** \$26,000,000

**Time Period:** 1985 to 2035

**Funding Source:** Orange County Flood Fund is mainly acquired from a portion of Orange County property taxes, and Federal/state grants.

**Source and Date:** Orange County Strategic Financial Plan (2009)

**Adopted Plan Number:** Fullerton Creek Channel, Facility No. A03 from Coyote Creek Channel (A01) to 100 feet upstream of Dorothy Lane, June 1999.

**Reference Page:** N/A

**Initiative and Implementation Status:** Several projects have been constructed to convey the 100-year storm event.

There are three projects listed on the 7-Year Flood Control Capital Improvement Project Plan. The projects are located in the middle of the channel system within the City of Buena Park totaling 1 mile (5,900 linear feet). The estimated costs associated for three projects are \$26,600,000 (2010 dollars).

**Priority: 13 of 38**

**Status: Existing**

**Hazard Addressed: Flood Hazard**

**Project#: OCPW13: Mitigate flood hazard  
Santa Ana-Santa Fe Channel (Facility No. F10) Project**

**Rationale:** Design, obtain regulatory permits, construction and maintenance of flood control improvements to protect property and lives by removing/reducing (via flow containment within the improved channel) the FEMA Special Flood Hazard Area by designing and constructing the ultimate improvements to convey the 100-year storm event. Maintain ultimate capacity including clearing vegetation and/or replacing aging/eroding/damaged channel structures.

**Relates to Plan Goal(s) and Objectives:** Protect lives and property.

The watershed for Santa Ana-Santa Fe Channel has a drainage area of 3,940 acres and traverses 3.5 miles (18,346 linear feet) through the cities of Tustin and Santa Ana; this channel is a tributary to Peters Canyon Channel which is a primary tributary to San Diego Creek Channel. The plan and goal is to protect property and lives by removing/reducing (via flow containment within the improved channel) the FEMA Special Flood Hazard Area by constructing the ultimate channel improvements to convey the 100-year storm event.

For post construction, the goal is to maintain the capacity to convey the 100-year storm event including but not exclusive to clearing vegetation, debris, sediment; and/or replacing deteriorating, eroded and damaged channel structure or system.

**Implementor:** Orange County Flood Control District/Orange County Public Works Flood Control Section

**Estimated Cost:** \$48,000,000 <sup>b</sup>

**Time Period:** 2010 thru 2035

**Funding Source:** Orange County Flood Fund is mainly acquired from a portion of Orange County property taxes, and federal/state grants.

**Source and Date:** Orange County Strategic Financial Plan (2009)

**Adopted Plan Number:**

**Reference Page:** N/A

**Initiative and Implementation Status:** A 2-mile (approximately 10,000 linear feet) reach starting at the confluence with Peters Canyon Channel to upstream Redhill Avenue has been selected to be included in the 7-Year Flood Control Capital Improvement Project Plan because it is deficient the adjacent areas are in a FEMA SFHA, and the City has noted property damages due to previous storms. The estimated costs associated for this project is \$21,000,000 (2010 dollars).

**b** *deficiency study*



**Priority: 14 of 38**

**Status: Existing**

**Hazard Addressed: Flood Hazard**

**Project#: OCPW14: Mitigate flood hazard  
Santa Ana Gardens Channel (Facility No. F02) Project**

**Rationale:** Design, obtain regulatory permits, construction and maintenance of flood control improvements to protect property and lives by removing/reducing (via flow containment within the improved channel) the FEMA Special Flood Hazard Area by implementing recommended alternatives per project report to convey the 100-year storm event. Maintain ultimate capacity including clearing vegetation and/or replacing aging/eroding/damaged channel structures.

**Relates to Plan Goal(s) and Objectives:** Protect lives and property.

The watershed for the Santa Ana Gardens Channel has a drainage area of 2,600 acres and traverses 4 miles (20,640 linear feet) through the cities of Costa Mesa and Santa Ana. This channel is a tributary to the Santa Ana-Delhi Channel which eventually outlets into Upper Newport Back Bay then into the Pacific Ocean. The plan and goal is to protect property and lives by removing/reducing (via flow containment within the improved channel) the FEMA Special Flood Hazard Area by constructing the ultimate channel improvements to convey the 100-year storm event.

Maintain the capacity to convey the 100-year storm event including but not exclusive to clearing vegetation, debris, sediment; and/or replacing deteriorating, eroded and damaged channel structure or system.

**Implementor:** Orange County Flood Control District/Orange County Public Works Flood Control Section

**Estimated Cost:** \$11,200,000

**Time Period:** 2010 thru 2035

**Funding Source:** Orange County Flood Fund is mainly acquired from a portion of Orange County property taxes, and Federal/state grants.

**Source and Date:** Orange County Strategic Financial Plan (2009)

**Adopted Plan Number:**

**Reference Page:** N/A

**Initiative and Implementation Status:** The project listed in the 7-Year Flood Control Capital Improvement Project Plan includes this segment. The project is located near the beginning of the channel system within the City of Costa Mesa totaling 1/3 mile (1,600 linear feet). The estimated cost associated for this project is \$11,200,000 (2010 dollars).

**Priority: 15 of 38**

**Status: Existing**

**Hazard Addressed: Flood Hazard**

**Project#: OCPW15: Mitigate flood hazard  
Bolsa Chica Channel (Facility No. C02) Project**

**Rationale:** Design, obtain regulatory permits, construction and maintenance of flood control improvements to protect property and lives by removing/reducing (via flow containment within the improved channel) the FEMA Special Flood Hazard Area by implementing recommended alternatives per project report to convey the 100-year storm event. Maintain ultimate capacity including clearing vegetation and/or replacing aging/eroding/damaged channel structures.

**Relates to Plan Goal(s) and Objectives:** Protect lives and property.

The watershed for Bolsa Chica Channel has a drainage area of 23,680 acres and traverses 7 miles (37,000 linear feet) through the cities of Seal Beach, Huntington Beach, Westminster, Los Alamitos, Garden Grove, and Cypress. This channel outlets into Anaheim Bay and then into the Pacific Ocean. The plan and goal is to protect property and lives by removing/reducing (via flow containment within the improved channel) the FEMA Special Flood Hazard Area by constructing the ultimate channel improvements to convey the 100-year storm event.

Maintain the capacity to convey the 100-year storm event including but not exclusive to clearing vegetation, debris, sediment; and/or replacing deteriorating, eroded and damaged channel structure or system.

**Implementor:** Orange County Flood Control District/Orange County Public Works Flood Control Section

**Estimated Cost:** \$14,000,000

**Time Period:** 2010 thru 2035

**Funding Source:** Orange County Flood Fund is mainly acquired from a portion of Orange County property taxes, and Federal/state grants.

**Source and Date:** Orange County Strategic Financial Plan (2009)

**Adopted Plan Number:**

Project Report Bolsa Chica Channel Facility No. C02, from Huntington Harbor Outlet to Cerritos Ave, June 1983.  
Supplemental Project Report Bolsa Chica Channel Facility No. C02, from Huntington Harbor Outlet to Cerritos Ave, August 1987.

**Reference Page:** N/A

**Initiative and Implementation Status:** There is one project listed in the 7-Year Flood Control Capital Improvement Project Plan. The project, a retarding basin, is located near the end of the channel system within the U.S. Joint Armed Forces Reserve Center. The estimated cost associated for the project is \$14,000,000 (2010 dollars).

**Priority: 16 of 38**

**Status: Existing**

**Hazard Addressed: Flood Hazard**

**Project#: OCPW16: Mitigate flood hazard  
Huntington Beach Channel (Facility No. D01) Project**

**Rationale:** Construction, repair, and maintenance of flood control improvements to protect property and lives by removing/reducing (via flow containment within the improved channel) the FEMA Special Flood Hazard Area (SFHA) by constructing ultimate channel improvements to convey the 100-year storm event. Maintain ultimate capacity including clearing vegetation and/or replacing aging/eroding/damaged channel structures.

**Relates to Plan Goal(s) and Objectives:** Protect lives and property.

The Talbert Valley Channel System consists of three facilities; Huntington Beach Channel (Facility No. D01), Talbert Channel (Facility No. D02) and Fountain Valley Channel (Facility No. D05). Huntington Beach Channel (D01) extends from its confluence with Talbert Channel approximately three miles upstream to Adams Avenue. Talbert Channel (D02) extends from its ocean outlet near the Santa Ana River upstream approximately 5.7 miles to Slater Avenue and the Fountain Valley Channel (D05) extends approximately three miles from its confluence with the Talbert Channel upstream to Euclid Street. The ultimate improvement is designed to provide this channel system to safely convey the peak discharges expected during a 100-year frequency storm.

Maintain the capacity to convey the 100-year storm event including but not exclusive to clearing vegetation, debris, sediment; and/or replacing deteriorating, eroded and damaged channel structure or system including but not limited to sheet pile system, pump stations, retarding basins and maintenance roadway and appurtenances.

**Implementor:** Orange County Flood Control District/Orange County Public Works Flood Control Section

**Estimated Cost:** \$32,000,000

**Time Period:** 1977 to current

**Funding Source:** Orange County Flood Fund is mainly acquired from a portion of Orange County property taxes, and federal/state grants.

**Source and Date:** Orange County Strategic Financial Plan (2009)

**Adopted Plan Number:** Project Report, Talbert Valley Channels; Talbert Channel – Pacific Ocean to Slater Avenue, Huntington Beach channel D02 to Adams, Fountain Valley Channel D02 to Euclid, November 1984

**Reference Page:** N/A

**Initiative and Implementation Status:** Approximately three miles of Huntington Beach Channel (Facility No. D01) have been constructed to convey the 100-year storm event. A Letter of Map Revision (LOMR) was processed and submitted to FEMA, resulting in revision to the Flood Insurance Rate Maps to reflect the Special Flood Hazard Area as removed/reduced to containment within the channel; as indicated on panel nos. 06059C0261J, 06059C0262J, 06059C0263J and 06059C0264J dated December 3, 2009.

Currently, advertisement for maintenance and repair to the sheet pile system is being sought along with the permits required by the regulatory agencies to maintain this channel system.

**Priority: 17 of 38**

**Status: Existing**

**Hazard Addressed: Flood Hazard**

**Project#: OCPW17: Mitigate flood hazard  
Talbert Channel (Facility No. D02) Project**

**Rationale:** Construction, repair, and maintenance of flood control improvements to protect property and lives by removing/reducing (via flow containment within the improved channel) the FEMA Special Flood Hazard Area (SFHA) by constructing ultimate channel improvements to convey the 100-year storm event. Maintain ultimate capacity including clearing vegetation and/or replacing aging/eroding/damaged channel structures.

**Relates to Plan Goal(s) and Objectives:** Protect lives and property.

The Talbert Valley Channel System consist of three facilities; Huntington Beach Channel (Facility No. D01), Talbert Channel (Facility No. D02) and Fountain Valley Channel (Facility No. D05). Huntington Beach Channel (D01) extends from its confluence with Talbert Channel approximately three miles upstream to Adams Avenue. Talbert Channel (D02) extends from its ocean outlet near the Santa Ana River upstream approximately 5.7 miles to Slater Avenue and the Fountain Valley Channel (D05) extends approximately three miles from its confluence with the Talbert Channel upstream to Euclid Street. The ultimate improvement is designed to provide this channel system to safely convey the peak discharges expected during a 100-year frequency storm.

Maintain the capacity to convey the 100-year storm event including but not exclusive to clearing vegetation, debris, sediment; and/or replacing deteriorating, eroded and damaged channel structure or system including but not limited to sheet pile system, pump stations and retarding basins.

**Implementor:** Orange County Flood Control District/Orange County Public Works Flood Control Section

**Estimated Cost:** \$63,000,000

**Time Period:** 1976 to current

**Funding Source:** Orange County Flood Fund is mainly acquired from a portion of Orange County property taxes, and Federal/state grants.

**Source and Date:** Orange County Strategic Financial Plan (2009)

**Adopted Plan Number:** Project Report, Talbert Valley Channel; Talbert Channel – Pacific Ocean to Slater Avenue, Huntington Beach channel D02 to Adams, Fountain Valley Channel D02 to Euclid, November 1984

**Reference Page:** N/A

**Initiative and Implementation Status:** Nearly six miles of Talbert Channel (Facility No. D02) have been constructed to convey the 100-year storm event. A Letter of Map Revision (LOMR) was processed and submitted to FEMA, resulting in revision to the Flood Insurance Rate Maps to reflect the Special Flood Hazard Area as removed/reduced to containment within the channel; as indicated on panel nos. 06059C0261J, 06059C0262J, 06059C0263J and 06059C0264J dated December 3, 2009.

Currently, advertisement for maintenance and repair to the sheet pile system is being sought along with the permits required by the regulatory agencies to maintain this channel system.

**Priority: 18 of 38**

**Status: Existing**

**Hazard Addressed: Flood Hazard**

**Project#: OCPW18: Mitigate flood hazard  
Fountain Valley Channel (Facility No. D05) Project**

**Rationale:** Construction, repair, and maintenance of flood control improvements to protect property and lives by removing/reducing (via flow containment within the improved channel) the FEMA Special Flood Hazard Area (SFHA) by constructing ultimate channel improvements to convey the 100-year storm event. Maintain ultimate capacity including clearing vegetation and/or replacing aging/eroding/damaged channel structures.

**Relates to Plan Goal(s) and Objectives:** Protect lives and property.

The Talbert Valley Channel System consist of three facilities; Huntington Beach Channel (Facility No. D01), Talbert Channel (Facility No. D02) and Fountain Valley Channel (Facility No. D05). Huntington Beach Channel (D01) extends from its confluence with Talbert Channel approximately three miles upstream to Adams Avenue. Talbert Channel (D02) extends from its ocean outlet near the Santa Ana River upstream approximately 5.7 miles to Slater Avenue and the Fountain Valley Channel (D05) extends approximately three miles from its confluence with the Talbert Channel upstream to Euclid Street. The ultimate improvement is designed to provide this channel system to safely convey the peak discharges expected during a 100-year frequency storm.

Objective is to maintain the capacity to convey the 100-year storm event including but not exclusive to clearing vegetation, debris, sediment; and/or replacing deteriorating, eroded and damaged channel structure or system including but not limited to sheet pile system, pump stations and retarding basins.

**Implementor:** Orange County Flood Control District/Orange County Public Works Flood Control Section

**Estimated Cost:** \$33,000,000

**Time Period:** 1984 to 1992

**Funding Source:** Orange County Flood Fund is mainly acquired from a portion of Orange County property taxes, and Federal/state grants.

**Source and Date:** Orange County Strategic Financial Plan (2009)

**Adopted Plan Number:** Project Report: Talbert Valley Channels, Talbert Channel – Pacific Ocean to Slater Avenue, Huntington Beach Channel - D02 to Adams, Fountain Valley Channel - D02 to Euclid, November 1984

**Reference Page:** N/A

**Initiative and Implementation Status:** Approximately three miles of Fountain Valley Channel (Facility No. D05) in addition to South Park Pump Station (Facility No. E01PS2) were constructed in 1992 to convey the 100-year storm event. The current Flood Insurance Rate Maps indicate the Special Flood Hazard Area as removed/reduced via flow containment within the channel on panel nos. 06059C0254J, 06059C0258J, and 06059C0262J dated December 3, 2009.

**Priority: 19 of 38**

**Status: Existing**

**Hazard Addressed: Flood Hazard**

**Project#: OCPW20: Mitigate flood hazard  
Peters Canyon Channel (Facility No. F06) Project**

**Rationale:** Design, obtain regulatory permits, construction and maintenance of flood control improvements to protect property and lives by removing/reducing (via flow containment within the improved channel) the FEMA Special Flood Hazard Area by designing and constructing the ultimate improvements to convey the 100-year storm event. Maintain ultimate capacity including clearing vegetation and/or replacing aging/eroding/damaged channel structures.

**Relates to Plan Goal(s) and Objectives:** Protect lives and property.

The watershed for Peters Canyon Channel has a drainage area of 29,000 acres and traverses 4.5 mile (24,000 linear feet) through the cities of Irvine and Tustin. This channel is a tributary to San Diego Creek Channel. The plan and goal is to protect property and lives by removing/reducing (via flow containment within the improved channel) the FEMA Special Flood Hazard Area by constructing the ultimate channel improvements to convey the 100-year storm event.

During post construction the goal is to maintain the capacity to convey the 100-year storm event including but not exclusive to clearing vegetation, debris, sediment; and/or replacing deteriorating, eroded and damaged channel structure or system.

**Implementor:** Orange County Flood Control District/Orange County Public Works Flood Control Section

**Estimated Cost:** \$26,600,000

**Time Period:**

**Funding Source:** Orange County Flood Fund is mainly acquired from a portion of Orange County property taxes, and Federal/state grants.

**Source and Date:** Orange County Strategic Financial Plan (2009)

**Adopted Plan Number:** N/A

**Reference Page:** N/A

**Initiative and Implementation Status:**

A segment of the channel, upstream and downstream of Barranca Parkway has been constructed to ultimate conditions to convey the 100-year storm event. This project was partially funded from the Assessment Districts through the City of Irvine. There are three projects on the 7-Year Flood Control Capital Improvement Project Plan starting from the confluence with San Diego Creek Channel and ending at Warner Avenue totaling 3,600 linear feet. The estimated costs associated with the three projects total \$26,600,000 (2010 dollars).

**Priority: 20 of 38**

**Status: Existing**

**Hazard Addressed: Flood Hazard**

**Project#: OCPW20: Mitigate flood hazard  
Laguna Canyon Channel (Facility No. I02) Project**

**Rationale:** Design, obtain regulatory permits, construction and maintenance of flood control improvements to protect property and lives by removing/reducing (via flow containment within the improved channel) the FEMA Special Flood Hazard Area by implementing recommended alternatives per the project report, the 100-year storm event can be conveyed. Maintain ultimate capacity including clearing vegetation and/or replacing aging/eroding/damaged channel structures.

**Relates to Plan Goal(s) and Objectives:** Protect lives and property.

The watershed for Laguna Canyon Channel has a drainage area of 5,900 acres and traverses 3 miles (17,410 linear feet) through the City of Laguna Beach and unincorporated Orange County. The plan and goal is to protect property and lives by removing/reducing (via flow containment within the improved channel) the FEMA Special Flood Hazard Area by constructing the ultimate channel improvements to convey the 100-year storm event.

During post construction the goal is to maintain the capacity to convey the 100-year storm event including but not exclusive to clearing vegetation, debris, sediment; and/or replacing deteriorating, eroded and damaged channel structure or system.

**Implementor:** Orange County Flood Control District/Orange County Public Works Flood Control Section

**Estimated Cost:** \$23,000,000 <sup>a</sup>

**Time Period:**

**Funding Source:** Orange County Flood Fund is mainly acquired from a portion of Orange County property taxes, and Federal/state grants.

**Source and Date:** Orange County Strategic Financial Plan (2009)

**Adopted Plan Number:** N/A

**Reference Page:** N/A

**Initiative and Implementation Status:** There is one project listed in the 7-Year Flood Control Capital Improvement Project Plan. The project requires acquiring real estate for construction of flood control facilities for a 1 mile reach. The upstream end of the channel is from the GTE Facilities to El Toro Road. The estimated costs associated for this project is \$23,000,000 (2010 dollars).

*a engineer's estimate TYP*

*b deficiency study*

*c project report*