Advanced Measures Report Based on Technical Assistance Investigation

Santa Maria Valley Levees
Santa Barbara County, CA

September 2007
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I. EXECUTIVE SUMMARY

The Santa Maria Valley levees provide flood control protection to the Santa Maria Valley including 66,000 residents of the City of Santa Maria. The project is located in Santa Barbara County about 160 miles northwest of Los Angeles, California. The project consists of 17 miles of a stone-revetted levee along the south side of the Santa Maria River which protects the City of Santa Maria and about 5 miles of stone-revetted levee along the north side of the river, which largely protects agricultural land. This report focuses on the south levee which protects the urban areas. The levees were designed and constructed by the U.S. Army Corps of Engineers. Construction began in 1959 and was completed in 1963.

The Santa Maria Valley levees have long proven to be deficient despite remedial action by the USACE and ongoing improvements by the local sponsor. The design capacity of the levees is a minimum of 150,000 cfs but river flows as low as 8,000 cfs have routinely caused significant damage. Typically the damage has been caused by low to moderate flows that do not fill the entire river bed but rather meander across the river and impinge upon the levee at sharp angles. These concentrated flows undermine the levee toe and have repeatedly placed the levee and hence the City of Santa Maria in jeopardy. The levees have been damaged this way several times. It should also be noted that the original riprap revetment on the levee has deteriorated significantly since the project construction was completed, in that much of the rock has fractured and broken down into smaller pieces. Relatively recent geotechnical explorations and hydraulic calculations by the Corps have concluded that the existing revetment does not meet current Corps design standards for parallel flow conditions for larger floods. Given the condition of the project the Corps of Engineers has declined to certify the levee and FEMA is currently revising its flood insurance maps with the assumption that the levee project no longer offers any protection to the City of Santa Maria.

Twelve peak flows of between 8,000 cfs and 35,000 cfs have been observed since 1963 and nine times, or 75% of the time, the levee suffered significant damage. In 1998, the damage caused by impinging flow was so severe that the north levee actually breached. Furthermore, if it had not been for aggressive flood fighting operations by the local sponsor, similar breaches in the levee almost certainly would have occurred at several other locations in the past.

Greatly exacerbating the problem and creating an unusual threat to the City of Santa Maria is the recent Zaca wildfire that burned about 26% (122 square miles) of uncontrolled watershed above the Santa Maria Valley levees. The low to moderate flows that threaten the levee are now considered to be even more likely to occur this coming flood season due to the potential for increased runoff from the burned areas. This potential was clearly demonstrated in 1966. In 1966 the Wellman wildfire burned a similar amount of the Sisquoc River watershed. Later that year, a relatively small amount of rainfall (~ 2-year frequency) generated a relatively large peak flow (~ 20-year) that caused significant damage to the south levee. It was later concluded that the only reason the levee didn’t fail completely was because of the short duration of the peak.

Santa Barbara County is requesting emergency Advance Measures prior to the approaching flood season to reduce the significant flood threat to the City of Santa Maria. The proposed measures are to construct a pilot channel to direct low flows away from the south levee, stockpile sufficient quantities of large rock at strategic locations to flood fight an impending levee breach, and preparation of a flood fighting plan of action. The total cost of the proposed advance measures is $730,000 while the annual benefits are $11.7 million. The resulting benefit to cost ratio is 70. There is clearly an extremely strong economic justification for implementation of emergency measures to protect the City of Santa Maria.
II. BASIC REPORT

1. Name and Location

The Santa Maria Valley levees are located in Santa Barbara County, California about 160 miles northwest of Los Angeles, California. The project consists of a set of stone-revetted levees on either side of the Santa Maria River. The 17-mile long levee along the southern side of the Santa Maria River largely protects the City of Santa Maria and the 5-mile long levee along the northern side of the river primarily protects agricultural land. The southern levee is the focus of this PIR.

The Santa Maria River is formed by the confluence of the Cuyama and Sisquoc Rivers. Runoff from the Cuyama River watershed is largely controlled by Twitchell Dam which is located upstream of the confluence. However, about 500 square miles above the levee project including the entire Sisquoc River watershed (471 sq. miles) is uncontrolled. About 26% of the Sisquoc River watershed (24% of all of the uncontrolled area) burned during the Zaca wildfire this summer. Figure 1 shows the general location of the project, the Santa Maria River watershed, and extent of the Zaca wildfire. Figure 2 shows the location of the Santa Maria Valley levees and the areas of critical concern.

![Figure 1: Santa Maria River Basin](image-url)
Figure 2: Project Area

2. Public Sponsor

Santa Barbara County
Public Works Department
123 E. Anapamu St.
Santa Barbara, CA 93101

Contact: Thomas Fayram, PE, CFM - Deputy Public Works Director
Telephone:  (805) 568-3436
Email:   tfayram@cosbpw.net
3. **Summary of Conditions Causing the Imminent Threat of Unusual Flooding**

The Santa Maria Valley levees were intended to protect the valley from a standard project flood (minimum of 150,000 cfs) but beginning with the very first significant flow following completion of the project the levees have proven to be chronically deficient. The levees have been repeatedly damaged by low to moderate flows that do not fill the entire river bed but rather are concentrated in narrower sub channels that meander and strike the levee at a sharp angle. These concentrated flows undermine the levee toe and have repeatedly placed the levee and hence the City of Santa Maria in jeopardy. The levees have been damaged this way several times. River flows as low as 8,000 cfs (5-year flow) caused significant damage to the levee in 1966, twice in 1969, 1978, 1980, 1983, 1995, 1998, and 2001. In 2005, low flows caused scouring around the groin and required dumping of rock during the event. In 1998, the damage caused by impinging flow was so severe that the north levee actually breached. Only diligent patrolling of the levee during flood flows and timely and aggressive flood fighting has prevented similar breaches of the south levee.

No comprehensive record of flows through the project area exists but a reasonable estimate of annual peak flows is available by referring to the US Geological Survey stream gage No. 11140000 Sisquoc River near Garey. This gage is located just upstream of the project area and monitors flow from about 94% of the uncontrolled drainage area. As Figure 3 shows, during the 44-year life of the project the annual peak discharge on the Sisquoc River has exceeded 8,000 cfs twelve times or once every 3.7-years. Seventy-five percent of the time that the peak discharge exceeded 8,000 cfs the levee suffered significant damage, nearly breached, or actually breached. The maximum flow during this period is less than 35,000 cfs, which is less than 25% of design capacity.

Recognizing the levee deficiency early on, the Corps began restudying the project in the 1970’s and in 1981 attempted to correct the deficiency by constructing a series of groins to protect the levee from impinging flows. Only about a fourth of the entire project length was protected with the additional groins. However, low flows in 2005 scoured the riverbed adjacent to the groins and levee toe, requiring a flood fighting response by the county. It appears that the groins effectiveness may be limited in providing protection against cross-channel flows that impinge upon a levee between the groins. Of further concern is the condition of the original riprap revetment. The levee rock has deteriorated significantly since the project construction was completed and much of the rock has fractured and broken down into smaller pieces. Relatively recent geotechnical explorations and hydraulic calculations by the Corps have concluded that the existing revetment does not meet current Corps design standards for parallel flow conditions for larger floods.
Figure 3: History of Damaging Flows

It is clear from the project performance since the 1981 improvements that the levee still remains vulnerable to breaching from relatively frequent floods along most of its length. A future breach is now considered likely without close monitoring of the project and rapid and aggressive flood fighting. Given the condition of the project the Corps of Engineers has declined to certify the levee and FEMA is currently revising its flood insurance maps with the assumption that the levee no longer provides any protection to the City of Santa Maria. Figure 2 shows the extent of flooding resulting from a breach at Suey Crossing and Figure 4 shows FEMA’s draft flood map for the valley.
Greatly exacerbating the problem and creating an unusual threat to the City of Santa Maria is the recent Zaca wildfire that burned about 26% (122 square miles) of uncontrolled watershed above the Santa Maria Valley levees. The low to moderate flows that threaten the levee are now considered to be even more likely to occur this coming flood season due to the potential for increased runoff from the burned areas. Additionally, increased sediment load from the burn areas may increase the likelihood that sediment deposition will fill in the existing natural flow channels in the riverbed. New low flow channels would then be formed which would increase the uncertainty of the location of a levee breach and increase the severity of flood fighting operations.

The current situation is very similar to 1966, three years after construction of the Santa Maria Valley levees. In the summer of that year, the Wellman wildfire burned 29% of the Sisquoc watershed, which is approximately the same acreage (26%) burned in the recent Zaca wildfire (see Figure 5). During the first significant storm after the wildfire in December of 1966, the basin received less than 2-year rainfall per NOAA Atlas II for 24- and 6-hour durations. However, the resulting peak flow was 22,600 cfs, which is the fourth highest flow recorded since the levees were built and has about a 20-year return per the updated frequency curve (see Appendix B-1). The flow caused significant damage to the levee. The post-flood conclusion was that the only reason the levee did not fail completely was because of the short duration of the peak flow. Photographs of the damage caused by the 1966 and other past events are located in Appendix B-4.
One of the requirements for Advance Measures funding is the demonstration of an “imminent threat of unusual flooding” as called for in ER 500-1-1. Like many streams and rivers in the western United States, the Santa Maria River only flows intermittently and only in response to recent rainfall. Furthermore, the watershed can respond rapidly to rainfall and flow can rise from near zero to high discharges in a matter of hours. Figure 6 is an example of quickly the watershed reacts to rainfall. Future rainfall for this coming winter can not be predicted but it is clear that the well documented levee deficiencies and the Zaca wildfire have created the potential for a catastrophic failure the next time a moderate amount of rain falls in the Santa Maria River watershed. The potential for a significant flood flow generated by commonly occurring rainfall amounts was vividly demonstrated by the events of 1966.

In summary, the Zaca wildfire and the levee deficiency has created an unacceptably high risk that a catastrophic level of flooding could be triggered by commonly occurring, relatively small amounts of rainfall. The failure of the south levee would endanger thousand of lives and extensive urban areas in the City of Santa Maria.
4. Course of Action Options

Two alternatives were considered including the no action plan and the recommended plan. It has been determined that without implementation of the recommended plan, the levees offer minimal protection to the City of Santa Maria. The well documented past performance of this project clearly indicates that without preparing to rapidly and aggressively flood fight future flows, another breach of the levee is considered likely in the future. A breach of the south levee would endanger the lives of tens of thousands of people and potentially damage thousand of commercial and residential structures. The Zaca wildfire, which burned about 24% of the uncontrolled watershed above the project area, has greatly exacerbated this risk. This no action plan is unacceptable due to the strong likelihood of a partial or total failure of the levee in the near future.

The recommended plan includes construction of a pilot channel to direct frequently occurring low flows away from the levee at the location of greatest concern, stockpiling large rock for flood fighting at key locations immediately adjacent to the levee, and developing a detailed flood fighting response plan. The recommended plan will provide immediate protection to the levee from the effects of meandering low flows and facilitate timely and aggressive flood fighting of larger flows with sufficient quantities of large rock.
Strategically placing stockpiles of rock also enhances the ability to respond to new locations of flow concentration or impingement that will likely develop in the future.

5. Proposed Work

The proposed work has structural and non-structural components. These components are described below and the location of the structural portion of the proposed work is shown on Figure 7.

- **Stockpiling Large Rock.** The first structural proposal is to stockpile sufficient quantities of rock suitable for flood fighting a potential levee breach. It is recommended to stockpile enough rock to protect 1,000 feet of levee. The amount of rock required to offer that protection is estimated to be 13,500 tons. The City of Santa Maria has already stockpiled 1,300 tons that can be used during a flood fight. Additionally, the County has 1,300 tons of rock leftover from the 1998 breach repair, but this rock must be moved to a location closer to areas of greatest concern. The cost of purchasing the 10,900 tons of rock still needed and relocating 1,300 tons is estimated to be $495,000.

- **Extend existing pilot channel.** In the fall of 2006 the Santa Barbara County constructed a 300’ wide pilot channel to direct low flows away from a critical area where flow impingement on the levee has long been observed. It is proposed to extend this channel 3,850’ upstream to just above Suey Crossing. The new channel would also be 300’ wide. The existing low flow path currently impinges upon the levee or is concentrated parallel against it in this reach and the proposed channel would direct these flows away from this problematic area. The alluvial material removed during construction of the channel would be strategically place along the toe of the levee where possible, and in areas above the ordinary high water mark or locations acceptable to resource agencies. Where place, the alluvial material will help buffer the levees from the effects of impinging flow. The cost of extended the pilot channel is $215,000.

- **Develop Flood Fighting Plan.** A detailed flood fighting plan will be developed that will address inspection mobilization, execution of inspections, mobilization of flood fighting crews including qualified local construction contractors, methods to determine where rock is needed to prevent a breach, and coordination with the Corps and other agencies. It is estimated that the cost of creating comprehensive flood fighting plan is $20,000.
6. Economics

The Santa Maria Valley Levees protect 66,000 people and many thousands of residential, commercial, and public structures located in the City of Santa Maria. It is estimated that the total structure and content value of the city located in the overflow area associated with a breach at Suey Crossing (see Figure 3) is $1.4 billion.

Based on the past performance of the levee and field reconnaissance by USACE engineers the level of protection provided by the levee was judged to be only adequate for a flood with a recurrence interval only in the range of 10 to 15 years. A 10-year level of protection was assumed for the economic analysis because of the effects of the Zaca wildfire and the resulting potential for significantly higher peak discharges. The proposed project is expected to provide benefits at the 25- and 50-year event frequency but is conservatively assumed to provide no benefits for events larger than the 50-year event. However, the rock stockpiling component of the proposed plan would likely provide benefits beyond the 50-year event. The emergency measures are assumed to have an effective life of five years and are expected to cost $730,000 to implement.

As summarized in Table 1, the annualized cost of the project is $168,000 and the annual benefits are $11.7 million, which results in annual net benefits of over $11.5 million and a benefit to cost ratio of 70. There is an extremely strong economic justification for the
implementation of advance emergency measures to reduce the risk of flood damages in the project area.

<table>
<thead>
<tr>
<th>Average Annual Benefits</th>
<th>Annualized Cost</th>
<th>Annual Net Benefits</th>
<th>B/C</th>
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<tr>
<td>$11,710,000</td>
<td>$168,029</td>
<td>$11,541,971</td>
<td>70</td>
</tr>
</tbody>
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7. Public Sponsor’s Share or Contribution

Santa Barbara County is the local sponsor and the lead agency responsible for the maintenance of the Santa Maria Valley levees. As such, the County has diligently and consistently devoted significant resources to the proper care, repair, and upkeep of the levees. The State of California and the City of Santa Maria have also made significant contributions.

Summary of Recent State and Local Actions:

a. 2003 – Installation of pipe & wire groins
b. 2003 to Present – Willow planting as a buffer along levee
c. Spring 2006 – Heavy Rock Reinforcement
d. Fall 2006 – Construction of 2 pilot channels
e. Winter 2006/2007 – In a cooperative project with state, place additional rock at levee toe and install 1,100’ of pipe & wire groins.
f. 2007 – County hires engineering consultant to develop permanent solution to the levee deficiency. Study is complete.
g. Summer 2007 - City of Santa Maria creates stockpile of large rock for future flood fighting
h. Summer 2007 – State of California declares state of emergency because of Zaca wildfire and promises financial assistance to local agencies to reimburse the cost incurred because of the fire. The total cost of fighting the fire is about $120 million so far.

Photographs and further information about the efforts of state and local agencies can be found in Appendix E.

8. Environmental Considerations

A statement on the effect of the proposed work on the environment and any needed mitigation measures will be developed. The areas proposed for stockpiling of rock are existing maintenance staging areas, currently barren, with well defined and permanent
access roads, and are entirely absent of vegetation and wildlife habitat. The environmental impact of stockpiling rock at these locations is limited to temporary air quality and sound issues associated with the movement of large trucks and hauling equipment, and possibly longer term visual aesthetic issues.

The County has prepared an Environmental Impact Report (EIR) addressing the impacts and mitigation associated with construction of the pilot channel. This EIR is based on a previous plan to remove alluvial material to an upland site outside of the river. The current plan is identical except that that with the new plan the alluvial material would be placed within the river boundaries instead of trucked to an offsite location. All material relocated within the river would be placed above the ordinary high water mark. Any negative impacts are considered minimal and appropriate mitigation measures will be undertaken. A summary of USACE staff preliminary findings is contained in Appendix E.

9. Permits

The proposed work has two distinct structural features, stockpiling large rock at three locations and extending an existing pilot channel 3,850’ upstream. The three proposed stockpile locations (see Figure 5) are located on non-wetland areas behind the levee. All of these areas are owned by the County and commonly used as staging areas or for other maintenance activities. None of these areas have any existing habitat. No permit is required for stockpiling rock on these sites. If the levee does fail and flood fighting with rock is initiated, an emergency permit may be required. However, the emergency permit process is not expected to negatively impact flood fighting efforts.

Santa Barbara County has obtained a Section 404 permit for extending the existing pilot channel 3,850’ upstream past Suey Crossing. However, the permit was originally granted with the understanding that the alluvial material removed during construction would be disposed of at an off site location. The current plan proposed for advance measures calls for relocating the material within the river, strategically placed along the toe of the levee in areas above the ordinary high water mark. Staff from the Los Angeles District Regulatory Branch has performed a field visit and preliminarily reviewed the County’s revised material disposal plan. The revised disposal plan appears to satisfy Section 404 criteria and no revision to the existing permit is anticipated. Appendix E contains additional information on the permits required for this project.
APPENDIX A

Request for Assistance
August 6, 2007

Governor's Office of Emergency Services
3850 Schriever Avenue
Mather, CA 95655

California Department of Water Resources
P.O. Box 942836
Sacramento, CA 94236

RE: Corps of Engineers Technical Assistance - Zaca Fire (County of Santa Barbara)

Dear Sirs:

For the last several weeks, Santa Barbara County has been subject to the effects of the Zaca Fire. The fire has burned areas in both the Santa Ynez River and Santa Maria River Watersheds. Most of the vegetation on the mountain area has been lost.

The Santa Maria River has the weakened Levees downstream of the Fire area. Impacts of the fire are an increase in debris and accelerated water runoff. As a result of the Zaca Fire, we expect an increased potential for high runoff this winter, on a Levee systems that is of great concern.

The Santa Barbara County Flood Control District requests that the U.S. Army Corps of Engineers provide technical assistance to Santa Barbara County relating to the impacts of the Zaca Fire.

While the Zaca Fire still burns, the full impacts to the County are not yet known. However, we request assistance with the Fire's impacts relating to: Hydrology & Hydraulics, Erosion Control, Mapping, Modeling, and any other necessary mitigation measures to ensure the safety of our citizens.

We also understand that additional assistance in terms of Advanced Measures must be requested separately, we are currently developing areas of assistance in that regard.

If you have any questions, please contact me at 805.688.3436

Sincerely,

Thomas D. Fayram
Deputy Public Works Director

CC: U.S. Army Corps of Engineers, Los Angeles District Office
Philip M. Demory
Public Works Director
123 East Anapamu Street, Santa Barbara, California 93101
PH: 805.566.3440 FAX: 805.566.3444 www.countyofsb.org/publicwater

Thomas D. Fayram
Deputy Public Works Director
AUG 31, 2007,

Colonel Thomas H. Magness, IV
U.S. Army Corps of Engineers
Los Angeles District
915 Wilshire Boulevard, Suite 980
Los Angeles, California 90017

Request for Technical Assistance of the U.S. Army Corps of Engineers

Dear Colonel Magness:

On behalf of the Santa Barbara County Public Works Department, the Department of Water Resources (DWR) is requesting technical assistance from the U.S. Army Corps of Engineers (Corps) under authority granted to them by Public Law 84-99, to assess the potential for increased storm runoff and debris flows as a result of the Zaca Fire.

As stated in the attached August 8, 2007 letter from Santa Barbara County Public Works Department, the Zaca Fire has burned areas in both the Santa Ynez and Santa Maria River washes. As of August 13, the fire has consumed nearly 60,000 acres and is only 68 percent contained. As you may know, there is a 19-mile long levee on the Santa Maria River that was recently rated "poor" during a recent national levee inventory. The potential for increased storm runoff and debris flows into the Santa Maria River is of great concern to Santa Barbara County.

Assessing the potential for increased storm runoff and debris flows as a result of the Zaca Fire is necessary to better understand the actions that may need to be taken to reduce the risk for loss of life and property damage. Therefore, I request technical assistance to the Corps as authorized by Public Law 84-99.

If you have any questions, please call me at (616) 653-7007, or your staff may contact Brian Heiland, Acting Chief of DWR's Flood Operations Branch, at (616) 574-2616.

Sincerely,

[Signature]

Lester A. Snow
Director

cc: (See attached list.)
APPENDIX B

Data and Documentation Addressing the Imminent Threat of Unusual Flooding

Section B-1: Summary of Hydrology and Sediment/Yield Calculations
Section B-2: Site Visit Memorandum for Record – Hydraulics Section
Section B-3: Site Visit Memorandum for Record – Geotechnical Section
Section B-4: Damage and Flood Fight Photographs
Section B-1: Summary of Hydrology and Sediment Yield Calculations

Sisquoc River drainage area: 471 mi² (using USGS stream gage Sisquoc River nr Garey)

Zaca Wildfire 2007
Total area burned: 375 mi²
Area burned in Sisquoc River watershed: 122 mi² (26%)
Fire contained, but not controlled

Wellman Wildfire 1966
Total area burned: 152 mi²
Area burned in Sisquoc River watershed: 138 mi² (29%)

Precipitation for Figueroa Mtn. precipitation gage (from NCDC database)
- Daily precipitation Dec. 5, 1966: 2.70 inches
  max. 6-hr: 1.30 in
  max. 1-hr: 0.30 in
- Daily precipitation Dec. 6, 1966: 1.90 inches
  max. 6-hr: 0.90 in
  max. 1-hr: 0.30 in

Frequency Precipitation from NOAA Atlas II for Sisquoc River watershed:
- 2-yr 24-hr Mean: 3.86 in
- 2-yr 6-hr Mean: 2.10 in

Pre-fire discharge estimates (for USGS Gage 11140000 Sisquoc R near Garey):
FFA Results
- 500-yr: 83,600 ft³/s
- 100-yr: 50,100 ft³/s
- 50-yr: 37,700 ft³/s
- 20-yr: 23,600 ft³/s
- 10-yr: 15,000 ft³/s
- 5-yr: 8,140 ft³/s
- 2-yr: 2,120 ft³/s

Post-fire discharge estimates:
Using FEMA simplified method to provide a quick approximation of peak discharges
source: "The Hydrologic and Hydraulic Methodology Used To Estimate Post-Burn Floodplain Hazards"; (FEMA-1498-DR-CA)
- 100-yr: 78,300 ft³/s (+36%)
- 5-yr: 13,900 ft³/s (+41%)

Debris Yield estimates:
Using LAD Debris Method
- pre-fire: 100-yr: 1,000 af
- post-fire: 100-yr: 1,260 af (+21%)
- pre-fire: 5-yr: 160 af
- post-fire: 5-yr: 200 af (+20%)
MEMORANDUM FOR RECORD

SUBJECT: Santa Maria Levees – Site Visit for Technical Assistance

1. On 30 August 2007, engineering staff from the Los Angeles District office of the Corps of Engineers participated in a coordination meeting and site visit to the Santa Maria Levees. The objective of the meeting and visit were to provide technical assistance to local officials on advance measures to protect the city of Santa Maria from flooding caused by a levee breach resulting from impinging low flows. Flows that impinge upon the levee at a sharp angle not only greatly increase the likelihood of directly eroding the riprap revetment, but also create a high potential for local scour that undermines and destabilizes the riprap. Attending the meeting and site visit were Messrs. Doug Chitwood of the Soils Design and Materials Section, Greg Peacock of the Reservoir Regulation Section, and David Cozakos of the Hydrology and Hydraulics Section. The meeting and site visit were led by Mr. Tom Fayram, Deputy Public Works Director of the Santa Barbara County Flood Control and Water Conservation District, with assistance from Messrs. Rick Tomasini and Larry Fausett. Attending as an observer was Mr. Chang Lee of the California Department of Water Resources, Division of Planning and Local Assistance. Before the site visit Mr. Fayram gave a presentation in the county’s local office in Santa Maria to explain the measures the county has already put into place, as well as other measures currently being considered. Summarized herein are notable aspects of the presentation and subsequent discussion, as well as observations from the site visit.

2. A recent incident that has prompted the planning of advance measures at the present time is the so-called Zaca wildfire that has burned a very large area in the watershed tributary to the project and has still not been extinguished. Local officials are concerned that the fire will increase runoff and sediment into the project reach during this upcoming flood season. These concerns are well-founded and will be addressed by the Corps team in the project information report that will accompany the request for advance measures.

3. Mr. Fayram began the meeting by pointing out that the Santa Maria Levees project has suffered from localized erosion of the toe of the levee revetment from impinging cross-channel flows several times since the project was completed in the mid 1960’s. Aggressive floodfighting by the county has been required more than once to prevent a breach. However, a breach occurred in the right (north) levee just downstream of the Bonita School Road crossing on 4 February 1998 before floodfighting forces could be mobilized. Presently, the most problematic location for a breach that could cause wide-spread flooding in the city of Santa Maria is roughly a mile upstream of the U.S. Highway 101 crossing. The existing natural low flow path crosses from the right to the left side of the river and impinges upon the levee at a sharp angle.

4. The next most problematic area extends for a considerable distance upstream of Suey Road, where the existing low flow path either impinges upon the levee or is concentrated parallel against it. However, a sizable landfill is located immediately adjacent to the levee in this reach. For about a mile downstream of the Bradley Canyon
confluence, the landfill is roughly a thousand feet wide and at least 30 feet high. The massive volume of material in the landfill provides considerable protection against a breakout onto the floodplain should the levee itself be breached. The downstream end of the landfill, extending about a mile upstream of Suey Road, is considerably narrower and shorter, and therefore will not provide nearly as much protection against a breakout in the event of a breach. Mr. Fayram point out that a sand and gravel mining operation in this reach has recently trained much of the along the right side of the river, significantly reducing the threat of flows impinging upon the levee. Downstream of U. S. Highway 101, the low flow pattern is presently concentrated along the right side of the river essentially parallel to the levee. No immediate threat of impinging low flows causing a levee breach is apparent throughout the entire reach the levee from the highway to the downstream city limits, where existing development ends.

5. To redirect low flows away from the levee at the location of most concern, the county excavated a pilot channel in 2006 along the right side of the river for a distance of roughly mile. The pilot channel is about 300 feet wide and 4 feet deep, and essentially cuts off the low flow meander. The county has also placed a pole and wire retarding fence for several hundred feet long along the toe of the levee at the impinging flow location. The county proposes augmenting these advance measures by extending the pilot channel about two-thirds of a mile further upstream to connect to the Suey Road low flow crossing.

6. As additional advance measures, the county proposes to stockpile large rock for floodfighting at key locations immediately adjacent to the levee that are readily accessible. The county already has stockpile sites prepared at the Broadway offramp to the U.S. Highway 101 freeway, and two additional sites just upstream and downstream of the Suey Road crossing. The county also has a fourth site at Blosser Road, which is at the very downstream end of the Santa Maria city limits. A large stockpile of rock from the 1998 floodfighting is presently located adjacent to the right levee just downstream of Bonita School Road. The county proposes hauling this rock to one of the aforementioned other stockpile locations. As an alternative, additional rock suitable for floodfighting can be acquired in large quantities from a quarry located in Santa Margarita, roughly 40 miles from the project site. Mr. Fayram pointed out that in addition to the county’s own operation and maintenance staff and equipment, the agency has already contracted with local construction companies to provide additional floodfighting services on short notice.

7. The Corps staff believes the advance measures constructed and proposed by the county are prudent and appropriate given the extremely limited funding and time available. The only notable recommendation that the Corps staff can offer is to place at least as much emphasis, if not more, on stockpiling sufficient quantities of rock suitable for floodfighting. The length of time that a pilot channel will provide protection against impinging or concentrated flows is relatively limited. If low flows persist long enough, the pilot channel will be reshaped by scour and deposition of sediment, and the river will once again naturally establish typical impinging or concentrated flow patterns. A much more reliable and longer-lasting method of preventing a levee breach is timely and aggressive floodfighting with sufficient quantities of large rock. Strategically placing stockpiles of rock has the additional advantage of providing flexibility for floodfighting at new locations of flow concentration or impingement that may develop during a particular flood season, or even during a single flood. It also has another advantage of being potentially useful for larger floods that tend to flow more parallel to the levee rather than impinge upon it at an angle. In particular, the original riprap revetment on the levee has
deteriorated significantly since the project construction was completed, in that much of
the rock has fractured and broken down into smaller pieces. Relatively recent
geotechnical explorations and hydraulic calculations by the Corps have concluded that
the existing revetment does not meet current Corps design standards for parallel flow
conditions for larger floods.

8. On a related note, county staff pointed out significant scour immediately adjacent two
of the project groins constructed to protect the levee from undermining. These groins
are located in the general area of the impinging flow pattern about a mile upstream of U.
S. Highway 101. Low flows in 2005 scoured the riverbed adjacent to the groins and
levee toe, requiring a floodfighting response by the county. Groins and other similar
training structures have long been demonstrated to be reliable in protecting from erosion
caused by concentration of flows parallel to a levee or a streambank. However, it
appears from this observation that their effectiveness may be limited in providing similar
protection against cross-channel flows that impinge upon a levee between the groins.
This apparent performance problem should be carefully considered when evaluating
various alternatives of permanent project modifications to protect against levee
undermining.

DAVID P. COZAKOS, P.E.
Hydraulic Engineer
MEMORANDUM FOR RECORD

Subject: Support for Request for Advanced Technical Assistance and Annual Levee Inspection, Santa Maria River, 30 August 2007

1. On 30 August 2007, Engineering Division staff Dave Cozakos, Greg Peacock and the undersigned met with Santa Barbara County Flood Control and Water Conservation District (FCWCD) staff. The primary purpose was to provide technical support for FCWCD’s request for advanced technical assistance resulting from concerns over the vulnerability of the Santa Maria River levees to erosion. In addition, the annual inspection of the levees was conducted as a part of the same trip. The FCWCD participants were Tom Fayram, Larry Fausett, and Rick Tomasini. In addition, the California Department of Water Resources was represented, as was the City of Santa Maria Fire Department. Further detail on the technical assistance request is summarized in the MFR prepared by Mr. Cozakos.

2. While the focus of the advanced technical assistance request was on that portion of the south levee adjacent to Santa Maria (between Suey and Blosser Roads), the entire south levee west of Suey Road and portion of the north levee east of Bonita School Road were also inspected for the annual inspection. The inspection was made from a vehicle driving along the top of the levees. Stops were requested by the undersigned at both random locations and those of particular interest or concern. There was no significant flow in the river during the time of the inspection.

3. Based upon this inspection, the undersigned is of the opinion that the levees are well-maintained. Bullet items identified in last year’s inspection have been addressed. In all areas, trimming of the willows adjacent to the levees had been completed prior to the inspection. There was no significant vegetation on the levees, the access roads and landside toes were in very good condition, and there was no rilling (surface erosion) on the slopes. Stockpiles of rock are maintained just east of Suey Road and adjacent to the levee at the location of the 1998 flood fight (north levee, west of Bonita Canyon School Road).

4. With respect to the request for advanced measures, the 1996 investigation report summarizes the results of test trenches and large scale gradations that were conducted along the SMR levees to quantify the size and thickness of the riprap. The report shows that the rock failed to meet the size criteria under which it was designed 60 percent of the time, and the existing criteria 90 percent of the time. In addition, a frequent concern is the ongoing disintegration of the riprap stone. One of the conclusions of the 1996 report is that, though the stone is breaking down on surface, it has maintained its original size at depth. While that is true, the extent of the degraded stone and the impact that it has on the effective thickness of the section, continues to be a concern for the undersigned. Figures 1 through 4 below provide examples of the stone in typical areas.
5. During the 30 August meeting, the FCWCD identified two possible advanced measures, the excavation of a low channel at a critical area and the advanced stockpiling of riprap at designated areas. I will defer to the expertise of Mr. Cozakos and others as to which is the more appropriate measure. However, due its proven effectiveness and the ability to deliver to specific sites as needed, I would suggest that rock is preferable for the larger events. In addition, funding should require the development of an emergency action (flood fighting) plan which will address at least the following critical items: inspection mobilization, execution of inspections, mobilization of flood fighting crews, methods to determine where rock is needed to prevent a breach, and coordination with the Corps and other agencies.

6. If there are any questions, please feel free to give me a call.

Douglas E. Chitwood, P.E., G.E.
District Geotechnical Specialist
Geotechnical Branch
The largest stone in Figure 1, located in the lower left corner, weighs less than 1500 lbs (about a 30-inch diameter, assuming spherical shape). Note the split faces.
Figure 6 - Station 870+00

Note that the 200-lbs stone is possibly the largest in the photo. Note also that on examination of this picture, multiple likely split faces can be identified, illustrating the disintegration of the rock.

Figure 7 - Station 1070+00 – badly disintegrated sandstone riprap. Largest stone less than 500 lbs.
Section B-4: Damage and Flood Fight Photographs

Figure B-4 (1): Two Crescent Shape Failures – Dec 1966

Figure B-4 (2): 1969 Flood Fight
Figure B-4 (3): 1969 Flood Fight

Figure B-4 (4): 1998 North Levee Breach
APPENDIX C

Economic Data
Flood Damage Analysis
Santa Maria Levee Project

Prepared By:
USACE Los Angeles District, Economics Section
Purpose
This Economic Analysis will present the methods and results of a flood damage analysis conducted for the Santa Maria Levee Project. The analysis is intended to determine whether there is a Federal interest in making emergency improvements to portions of the Santa Maria Levee that would be expected to reduce the risk of levee failure, thus reducing the risk of economic damages from flooding in the surrounding area.

Methodology & Delimitation
The principal guidance of the analysis comes from the U. S. Army Corps of Engineer’s (USACE) “Planning Guidance Notebook”, ER 1105-2-100, with specific guidance from Appendix D – Economic and Social Considerations. Guidance on the use of emergency resources comes from ER 500-1-1, Emergency Employment of Army and Other Resources. Benefits and costs are expressed in average annual terms at 2007 price levels using the fiscal year 2007 federal discount rate of 4.875%. Importantly, for purposes of this Economic Analysis, the period of analysis is limited to five years because that is the length of time that roughly corresponds with the expected effective life of the emergency measures. However, the effectiveness of the emergency measures in preventing a levee breach in this location could, in reality, last much longer than this. While the actual effective life of the emergency measures (assuming no other actions are taken) is uncertain, it is expected that the effective life is much more likely to be greater than five years than it is to be less than five years. Since project benefits are positively correlated with project life, this project life assumption means that overall benefits are likely greater (or much greater) than shown here. Also, the Corps is currently pursuing options for making improvements to the levees that will address existing deficiencies that are resulting in a level of protection that is less than the authorized level. However, beyond the emergency measures, it is uncertain what type of longer-term improvements will be made and when they will be implemented. It is hoped that such long-term improvements can be completed prior to the end of the useful life of the advanced protective measures recommended in this report.

Given the urgency associated with this analysis and potential repair work, and given the limited funding and time available for this analysis, it was necessary to simplify the analysis in numerous ways. First, the damage estimate was limited to structures and their contents. In a flooding analysis for highly developed, urbanized floodplains such as this, damage to structures and contents is expected to constitute the vast majority of economic damages from flooding. Second, as opposed to collecting a detailed, updated floodplain property inventory, the analysis relied on aerial photography, real estate records, and conversations with local officials. As described in more detail below, this information was combined with local construction cost data in order to value the total property at risk in the floodplain. Third, event-based damages were calculated for three events, using adjusted overflow depth data from a prior USACE report from 1980. Given that significant urbanization and development has occurred in the floodplain since 1980, it is assumed for purposes of this analysis that the average flood depths for a given frequency have increased by 25%. Damages to structures were calculated using structure and content depth-damage curves developed by either the Institute for Water Resources or FEMA. Expected Annual Damages (EAD) were calculated in a Microsoft Excel spreadsheet given the estimated damages per event and the corresponding probability of flooding.

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1 Supplement to Design Memorandum No. 1 for Santa Maria Valley Levees and Channel Improvements, USACE Los Angeles District, March 1980.
2 Source: USACE Hydrology and Hydraulics Branch
The Study Area and the Current Flooding Threat
The Santa Maria River Levee is located 160 miles north of Los Angeles in Santa Barbara County, CA. The City of Santa Maria has approximately 85,000 residents, 28,000 housing units, and over 1,500 business establishments. Since 1980, the population has more than doubled – from 32,000 to 84,000 residents.

Figure 1 below shows the approximate floodplain\(^3\). The floodplain is approximately 2,600 acres in size (4 square miles). This floodplain encompasses approximately one-fifth of the City of Santa Maria, but approximately one-third of the developed land in the city. According to USACE engineers, the floodplain outlined in Figure 1 is the most likely area of inundation in the event of a levee breach. Under the existing conditions, it is expected that the non-damaging frequency event is the ten-year storm, which is a storm that has a 10% probability of occurring in any given year. According to USACE Engineers, it is reasonable to assume that, while the depths differ, the extent of the floodplain is roughly equivalent for the 100-, 50-, and 25-year frequency events.

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\(^3\) Approximates the Breach No. 3 floodplain boundary delineated in the 1980 design memorandum
Floodplain Inventory
In order to estimate the economic impact of potential future flood damages to the residences and businesses in the study area’s floodplain, it is necessary to estimate the total value of these structures and their contents. As a result of funding and time constraints, no detailed structure inventory was completed. Instead, this estimate was made by using a combination of previous USACE studies, aerial photography, real estate records, and telephone interviews with local officials. This information was combined with data from the Marshall & Swift (M&S) valuation service, which provides the relevant cost components that serve as the basis for the value calculations, to arrive at a rough approximation for the value of property in the floodplain.

As stated above, the floodplain encompasses approximately one-third of the developed land in the city. Compared to the overall land use in the City of Santa Maria, the land use in the floodplain is to a greater extent comprised of residential use, and less of industrial and manufacturing use. For purposes of this analysis, however, it is assumed that the land use pattern in the floodplain is consistent with the land use in the broader city. Using one-third as an approximation of the proportion of the city’s structures that are contained in the floodplain, it is possible to make a rough estimate the number of the various types of structures at risk in the floodplain. The results of this inventory are shown below.

<table>
<thead>
<tr>
<th>Table 1: Structure Inventory - Units in Floodplain</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Structure Type</strong></td>
</tr>
<tr>
<td>SFR</td>
</tr>
<tr>
<td>MFR</td>
</tr>
<tr>
<td>MH</td>
</tr>
<tr>
<td>Office</td>
</tr>
<tr>
<td>Retail</td>
</tr>
<tr>
<td>Other Commercial</td>
</tr>
<tr>
<td>Manuf./Ind.</td>
</tr>
<tr>
<td>Restaurant</td>
</tr>
<tr>
<td>Churches*</td>
</tr>
<tr>
<td>Schools*</td>
</tr>
</tbody>
</table>

*Estimated directly from aerial photography.

^Source: U.S. Census Bureau. Commercial - includes retail and wholesale trade; Offices - includes professional services and healthcare facilities; Manufacturing & Industrial - those classified as manufacturing by the U.S. Census Bureau.

The value of the structures was calculated by multiplying the square footage of the structure by an estimate of the per square foot value of the structure, which depends on the structure use type (residential, commercial, etc.). The per square foot values were taken from Marshall & Swift, which are based on the following factors: the type of structure, the quality of the construction, the condition of the structures, a locality multiplier (Santa Barbara County in this case), and a cost multiplier (western region). The aerial photographs in Figure 2 below are examples of the type of residential and commercial structures that are found in the floodplain.
Given the funding and time restrictions of this analysis, it was necessary to make several assumptions regarding the characteristics of the property in the floodplain. For the single-family residential structure valuation, an examination of aerial photographs and real estate records indicates that it is reasonable to assume for purposes of this analysis that the average single-family residence is 1,700 square feet. For USACE economic analyses, the appropriate structure value to use is the depreciated replacement value. Date of construction, which is used here as a partial indication of structure condition was estimated from real estate data collected via an internet site specializing in real estate information. According to this source, most of the residences in the floodplain were constructed between thirty and fifty years ago. As such, it is assumed for this analysis that, according to the M&S classification system for Class D (wood frame) structures, the structures are of “average” construction quality and in “average” condition. Given this, a per square foot construction cost of $63 is assumed, which incorporates a regional adjustment and depreciation percentage. Combining this value with the average square footage of the structures and multiplying this value by the total number of structures in the floodplain gives a rough estimate of the total structure value of single-family residences in the 100-yr floodplain. The same methodology was followed to estimate the total structure value of multi-family residences, mobile homes, and commercial structures.

Another important component of this preliminary evaluation is an estimation of the content value of those structures in the floodplain. For the purpose of this assessment, it is assumed that the content to structure value of the all residential structures is one-half. That is, the total value of the contents is assumed to be half of the depreciated replacement value of the structure. Value ratios for other structure types were assumed based on USACE guidance documents and previous empirical studies. Table 2 below shows the per-square-foot and content to structure ratio values used for each of the structure types included in the analysis.

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4 www.zillow.com
Table 2: Structure & Content Value Assumptions

<table>
<thead>
<tr>
<th>Structure Type</th>
<th>$/SF, Including Depreciation*</th>
<th>Square Footage Per Unit</th>
<th>Content to Structure Value Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>SFR</td>
<td>63</td>
<td>1,700</td>
<td>0.5</td>
</tr>
<tr>
<td>MFR</td>
<td>55</td>
<td>800</td>
<td>0.5</td>
</tr>
<tr>
<td>MH</td>
<td>37</td>
<td>800</td>
<td>0.5</td>
</tr>
<tr>
<td>Office</td>
<td>79</td>
<td>2,500</td>
<td>0.8</td>
</tr>
<tr>
<td>Retail</td>
<td>58</td>
<td>2,500</td>
<td>1.4</td>
</tr>
<tr>
<td>Other Commercial</td>
<td>58</td>
<td>2,500</td>
<td>1.4</td>
</tr>
<tr>
<td>Manuf./Ind.</td>
<td>37</td>
<td>5,000</td>
<td>1.7</td>
</tr>
<tr>
<td>Restaurant</td>
<td>91</td>
<td>2,500</td>
<td>0.4</td>
</tr>
<tr>
<td>Churches</td>
<td>55</td>
<td>5,000</td>
<td>0.3</td>
</tr>
<tr>
<td>Schools</td>
<td>103</td>
<td>40,000</td>
<td>0.3</td>
</tr>
</tbody>
</table>

*Depreciated Replacement Cost - In accordance with Marshall & Swift

Table 3 below shows the estimated values of the depreciated replacement cost of the structures and contents in the 100-year floodplain.

Table 3: Depreciated Structure & Content Value, 100-Year Floodplain

<table>
<thead>
<tr>
<th>Structure Type</th>
<th>Units in 100-Year Floodplain</th>
<th>Total Depreciated Structure Value*</th>
<th>Total Depreciated Content Value</th>
<th>Total Structure and Content Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>SFR</td>
<td>6,333</td>
<td>$683,401</td>
<td>$341,700</td>
<td>$1,025,101</td>
</tr>
<tr>
<td>MFR</td>
<td>2,333</td>
<td>$102,522</td>
<td>$51,261</td>
<td>$153,782</td>
</tr>
<tr>
<td>MH</td>
<td>567</td>
<td>$16,926</td>
<td>$8,463</td>
<td>$25,390</td>
</tr>
<tr>
<td>Office</td>
<td>147</td>
<td>$29,084</td>
<td>$23,267</td>
<td>$52,350</td>
</tr>
<tr>
<td>Retail</td>
<td>116</td>
<td>$16,860</td>
<td>$23,604</td>
<td>$40,465</td>
</tr>
<tr>
<td>Other Commercial</td>
<td>157</td>
<td>$22,834</td>
<td>$31,968</td>
<td>$54,802</td>
</tr>
<tr>
<td>Manuf./Ind.</td>
<td>27</td>
<td>$4,970</td>
<td>$8,450</td>
<td>$13,420</td>
</tr>
<tr>
<td>Restaurant</td>
<td>55</td>
<td>$12,548</td>
<td>$5,019</td>
<td>$17,567</td>
</tr>
<tr>
<td>Churches</td>
<td>6</td>
<td>$1,658</td>
<td>$497</td>
<td>$2,156</td>
</tr>
<tr>
<td>Schools</td>
<td>6</td>
<td>$24,774</td>
<td>$8,175</td>
<td>$32,949</td>
</tr>
<tr>
<td>TOTAL</td>
<td>9,746</td>
<td>915,577</td>
<td>502,405</td>
<td>1,417,981</td>
</tr>
</tbody>
</table>

*In accordance with Marshall & Swift, Depreciation Index. All dollars in thousands.

Without-Project Damage to Property from Flooding

Damage to property from flooding is of course to a large extent a function of the depth of flooding. For this analysis, because of funding, time, and informational constraints, the flood depths at each structure type were derived from a previous USACE report, Supplement to Design Memorandum No. 1, for Santa Maria Valley Levees and Channel Improvements, from March of 1980. The depths associated with the 1980 report’s Breach No. 3 were utilized here because, according to USACE engineers, that is currently the location at greatest risk of levee failure. USACE Hydrology and Hydraulics (H&H) division have
stated that, given the urbanization and growth in the floodplain since 1980, it is reasonable to assume that the flood depths in the floodplain as a result of a levee breach in this area would be twenty-five percent greater as compared to the 1980 data. Also, the 1980 report does not include an estimate of 25-year flood depths. USACE H&H states that it is reasonable to assume that the 25-year depth is two-thirds of the 50-year depth. The adjusted internal structure depth data is shown in the table below. Depth-damage curves are not available for as many structure categories as is shown in the structure valuation tables. As a result, the ten structure categories shown above were condensed into six broader categories as shown in the table below.

<table>
<thead>
<tr>
<th>Structure Type</th>
<th>100-Year Depth (ft)</th>
<th>50-Year Depth</th>
<th>25-Year Depth</th>
</tr>
</thead>
<tbody>
<tr>
<td>SFR</td>
<td>1.13</td>
<td>0.63</td>
<td>0.41</td>
</tr>
<tr>
<td>MFR</td>
<td>1.75</td>
<td>1.00</td>
<td>0.66</td>
</tr>
<tr>
<td>MH</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Commercial</td>
<td>2.38</td>
<td>1.63</td>
<td>1.07</td>
</tr>
<tr>
<td>Manuf./Ind.</td>
<td>5.63</td>
<td>4.25</td>
<td>2.81</td>
</tr>
<tr>
<td>Public</td>
<td>2.00</td>
<td>1.13</td>
<td>0.74</td>
</tr>
</tbody>
</table>

Source: Santa Maria Valley Levees and Channel Improvements, USACE Los Angeles, 1980. See document text for an explanation of adjustments and assumptions.

Tables 5 and 6 below show the estimate of percent damage to structures and structure contents in the floodplain for three storm events. It should be noted that Table 6 shows the damage to contents of residential structures as a percentage of the total depreciated content value, and not as a percentage of structure value, which is sometimes the convention in USACE flood damage analyses.

<table>
<thead>
<tr>
<th>Structure Type</th>
<th>100-Year Depth (ft)</th>
<th>% Damage</th>
<th>50-Year Depth</th>
<th>% Damage</th>
<th>25-Year Depth</th>
<th>% Damage</th>
</tr>
</thead>
<tbody>
<tr>
<td>SFR</td>
<td>1.13</td>
<td>24.2</td>
<td>0.63</td>
<td>19.3</td>
<td>0.41</td>
<td>17.4</td>
</tr>
<tr>
<td>MFR</td>
<td>1.75</td>
<td>12.7</td>
<td>1.00</td>
<td>9.9</td>
<td>0.66</td>
<td>8.4</td>
</tr>
<tr>
<td>MH</td>
<td>0.00</td>
<td>0</td>
<td>0.00</td>
<td>0</td>
<td>0.00</td>
<td>0</td>
</tr>
<tr>
<td>Commercial</td>
<td>2.38</td>
<td>26.2</td>
<td>1.63</td>
<td>21.3</td>
<td>1.07</td>
<td>17.2</td>
</tr>
<tr>
<td>Manuf./Ind.</td>
<td>5.63</td>
<td>41.3</td>
<td>4.25</td>
<td>30</td>
<td>2.81</td>
<td>27.1</td>
</tr>
<tr>
<td>Public</td>
<td>2.00</td>
<td>24.7</td>
<td>1.13</td>
<td>17.2</td>
<td>0.74</td>
<td>13.5</td>
</tr>
</tbody>
</table>

Source: Damage Percent from FEMA and USACE Economic Guidance Memorandum 03-01

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5 This is the calculated as the difference between total flood depth at the structure and the first floor elevation of the structure. Taken from the 1980 report.
Table 6: Percent Damage to Contents by Structure Type and Frequency

<table>
<thead>
<tr>
<th>Structure Type</th>
<th>Depth (ft)</th>
<th>100-Year</th>
<th>50-Year</th>
<th>25-Year</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Depth</td>
<td>% Damage</td>
<td>Depth</td>
<td>% Damage</td>
</tr>
<tr>
<td>SFR</td>
<td>1.13</td>
<td>27.5</td>
<td>0.63</td>
<td>22.4</td>
</tr>
<tr>
<td>MFR</td>
<td>1.75</td>
<td>16.1</td>
<td>1.00</td>
<td>9.8</td>
</tr>
<tr>
<td>MH</td>
<td>0.00</td>
<td>0</td>
<td>0.00</td>
<td>0</td>
</tr>
<tr>
<td>Commercial</td>
<td>2.38</td>
<td>26</td>
<td>1.63</td>
<td>21.3</td>
</tr>
<tr>
<td>Manuf./Ind.</td>
<td>5.63</td>
<td>76.5</td>
<td>4.25</td>
<td>61.3</td>
</tr>
<tr>
<td>Public</td>
<td>2.00</td>
<td>23.7</td>
<td>1.13</td>
<td>18.2</td>
</tr>
</tbody>
</table>

Source: Damage Percent from FEMA and USACE Economic Guidance Memorandum 03-01

Table 7 below shows the estimated structure and content damages by frequency event. The total structure and content damages from a levee breach in this area associated with the 100-year event are estimated to be just under $341 million.

Table 7: Structure & Content Damages by Event

<table>
<thead>
<tr>
<th>Structure Type</th>
<th>100-Year</th>
<th>50-Year</th>
<th>25-Year</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Structure Damage</td>
<td>Content Damage</td>
<td>Total</td>
</tr>
<tr>
<td>SFR</td>
<td>$165,383</td>
<td>$93,968</td>
<td>$259,351</td>
</tr>
<tr>
<td>MFR</td>
<td>$13,020</td>
<td>$8,253</td>
<td>$21,273</td>
</tr>
<tr>
<td>MH</td>
<td>$0</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td>Commercial</td>
<td>$21,307</td>
<td>$21,803</td>
<td>$43,110</td>
</tr>
<tr>
<td>Manuf./Ind.</td>
<td>$2,053</td>
<td>$6,464</td>
<td>$8,517</td>
</tr>
<tr>
<td>Public</td>
<td>$6,529</td>
<td>$2,055</td>
<td>$8,584</td>
</tr>
<tr>
<td>TOTAL</td>
<td>$208,292</td>
<td>$132,543</td>
<td>$340,835</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Structure Type</th>
<th>50-Year</th>
<th>25-Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>SFR</td>
<td>$131,896</td>
<td>$76,541</td>
</tr>
<tr>
<td>MFR</td>
<td>$10,150</td>
<td>$5,024</td>
</tr>
<tr>
<td>MH</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td>Commercial</td>
<td>$17,322</td>
<td>$17,862</td>
</tr>
<tr>
<td>Manuf./Ind.</td>
<td>$1,491</td>
<td>$5,180</td>
</tr>
<tr>
<td>Public</td>
<td>$4,546</td>
<td>$6,389</td>
</tr>
<tr>
<td>TOTAL</td>
<td>$165,406</td>
<td>$110,995</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Structure Type</th>
<th>25-Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>SFR</td>
<td>$118,912</td>
</tr>
<tr>
<td>MFR</td>
<td>$8,612</td>
</tr>
<tr>
<td>MH</td>
<td>$0</td>
</tr>
<tr>
<td>Commercial</td>
<td>$13,988</td>
</tr>
<tr>
<td>Manuf./Ind.</td>
<td>$1,347</td>
</tr>
<tr>
<td>Public</td>
<td>$3,568</td>
</tr>
<tr>
<td>TOTAL</td>
<td>$146,427</td>
</tr>
</tbody>
</table>

All dollars in thousands.
Figure 3 below graphically depicts the without-project damages to structures and contents by frequency event. The total without-project expected annual damages (EAD), which is the sum of the area below the damage curve in the figure below, is $18.2 million.

\[
\begin{align*}
\text{Damages Not Estimated} \\
\text{As stated previously, damage to structures and their contents is expected to constitute the vast majority of total economic damages from flooding as a result of a levee breach in this area. For this reason, and because they are two damage categories that are most readily quantifiable, the damage estimate was limited to these two categories. There are numerous other damage categories that were not included in the analysis however. These include both physical and non-physical costs, for which in many cases there are few commonly accepted generalized functions similar to what exists for structure and content damages. These other categories include structure dewatering and cleanup costs, temporary relocation costs incurred on residents, vehicle damage, emergency costs associated with the flooding, traffic delay and detour costs, and non-recoverable income losses to businesses (such as the destruction of perishable items such as food).}
\end{align*}
\]

\[
\begin{align*}
\text{With-Project Damage to Property from Flooding} \\
\text{The proposed plan includes stockpiling sufficient quantities of rock suitable for flood fighting and protecting a 1,000’ foot long section of the levee, extending an existing pilot channel to redirect low flows from critical areas where flow impingement is an ongoing problem, and developing a detailed flood fighting plan to address mobilization and execution of flood fighting. It is estimated that the implementation of these measures will reduce the probability of a levee breach in the study area, and that over the course of the project's life the measures would enable the levee to withstand a storm corresponding to a range of between a 25-year and 50-year magnitude,}
\end{align*}
\]
which are storms that have a four percent and two percent chance of occurring in any one year, respectively.

Figures 4 and 5 below show the frequency-damage curves for a 25-year and 50-year level of protection, respectively. The EAD associated with each of these protection levels is $8.6 million and $4.3 million, respectively. This EAD can be considered the residual damages associated with the implementation of the emergency measures, depending on the actual level of protection provided by the project.
Averaging the damage reduction that is associated with these two protection levels, the reduction in EAD totals just over $11.7 million. The table below shows the difference in damages between the without- and with-project conditions, and shows the reduced and residual EAD associated with the project. As the table shows, the project is expected to provide benefits at the 25- and 50-year event frequency, but is assumed to provide no benefits for events larger than the 50-year event. Again, because the project is expected to be effective for frequency events between the 25- and 50-year, the final with-project damage reduction incorporates the average of the damage reduction between these two protection levels.

Table 8: With-Project Damages & Damages Reduced

<table>
<thead>
<tr>
<th>Frequency Event</th>
<th>Without-Project Damages</th>
<th>With-Project Damages</th>
<th>With-Project Damage Reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>25-Year Protection</td>
<td>50-Year Protection</td>
</tr>
<tr>
<td>0.1</td>
<td>$0</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td>0.04</td>
<td>$241,000</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td>0.02</td>
<td>$276,000</td>
<td>$276,000</td>
<td>$0</td>
</tr>
<tr>
<td>0.01</td>
<td>$341,000</td>
<td>$341,000</td>
<td>$341,000</td>
</tr>
<tr>
<td>0.005</td>
<td>$341,000</td>
<td>$341,000</td>
<td>$341,000</td>
</tr>
<tr>
<td>EAD</td>
<td>$18,213</td>
<td>$8,573</td>
<td>$4,433</td>
</tr>
</tbody>
</table>

All damages in thousands.
Net Benefits of the Emergency Measures
As stated previously, it is estimated that the completion of these features will reduce the probability of a levee breach in the study area, and that over the effective life of the project the non-damaging storm event will be increased to a level between the 25 and 50-year event. As explained previously, the emergency measures are assumed to have an effective life of five years, and are expected to cost $730,000 to implement. Using a five-year period of analysis and an interest rate of 4.875%, the annualized cost of the project is $168,000. The annual benefits are $11.7 million, which results in annual net benefits of over $11.5 million and a benefit to cost ratio of 70. According to this analysis, there is strong economic justification for implementation of the emergency measures to reduce the risk of flood damages in the project area.

<table>
<thead>
<tr>
<th>Average Annual Benefits</th>
<th>Annualized Cost</th>
<th>Annual Net Benefits</th>
<th>B/C</th>
</tr>
</thead>
<tbody>
<tr>
<td>$11,710,000</td>
<td>$168,029</td>
<td>$11,541,971</td>
<td>70</td>
</tr>
</tbody>
</table>
APPENDIX D

Documentation of Public Sponsor’s Contribution
Figure D-1: Santa Barbara County Installs Pipe & Wire Groins in 2003

Figure D-2: County Begins Planting of Willows in 2003
Figure D-3: County Places Heavy Rock Reinforcement in Spring 2006

2006 Pilot Channel Work

Figure D-4: County Constructs Pilot Channel in Fall 2006
Pipe & Wire Retarding Fence

Figure D-5: Cooperative Project between County and State of California
Winter 2006/2007

Heavy Toe Rock Placement

Figure D-6: Cooperative Project between County and State of California
Winter 2006/2007
Figure D-7: City of Santa Maria Stockpiles Large Rock
APPENDIX E

Environmental and Permit Data
Memorandum for the Record

September 14, 2007

Subject: Santa Maria Levee Protection, Advance Measures

Project Description:

The County of Santa Barbara Flood Control Department proposes to implement the following measures within the Santa Maria River in order to reduce the likelihood of catastrophic flooding within the City of Santa Maria: 1) the construction of a 100-foot-wide, 4-foot-deep pilot channel, beginning at the Suyey Road River crossing and extending 3,650 feet downstream; 2) the re-use of the pilot channel material to build a berm upon a historic flood terrace along the south side of the floodplain, running the length of the pilot channel; 3) the stockpiling of large riprap at several (3) locations behind the existing Levee; and, 4) the discharge of the stockpiled riprap at (future) locations where the Levee has been damaged or breached.

Environmental Conditions:

The proposed pilot channel location is in a low gradient reach of the lower Santa Maria River. Surface flow is absent, which is typical of this reach at this time of year. There are two channels identified in the project reach, a “low-flow” dominant channel on the north edge of the floodplain and a secondary channel in the middle of the floodplain that appeared to be activated regularly. With the exception of a narrow (10-foot-wide) band of vegetation that meanders through the dominant channel, both channels are predominantly devoid of vegetation. Vegetation present is characterized by a relatively limited number of young alluvial scrub species, consisting of mulefat (Baccharis salicifolia), Spanish broom (Spartium junceum), and sandbar willow (Salix exigua), as well as introduced grasses, including ripgut brome (Bromus diandrus) and soft chess (Bromus mollis).

The pilot channel material is proposed for re-use at an adjacent location, to the south of the pilot channel, in order to further protect the levee. Material would be removed from the pilot channel and then dumped onto a historic terrace, creating a low berm that would run approximately the length of the pilot channel. Actual dimensions of the berm are to be determined. The vegetation upon the terrace is dense scrub and is well established, comprised predominantly of coastal sage scrub species and a few alluvial scrub species. Dominant species include coyote brush, chamise (Adenostoma fasciculatum), coast goldenbush (Isocoma menziesii), spanish broom, sandbar willow, and mulefat, as well as introduced grasses. Adverse effects to wildlife are expected to be minor to moderate, as the area covered could be up to 4 acres (3,500 feet-long x 50-feet-wide). Impacts would likely be restricted to several species of small burrowing mammals and reptiles. However, the County intends to conduct pre-construction surveys for sensitive species within the berm footprint and its vicinity, seeking to reduce wildlife impacts as much as possible.

There are currently three designated rock storage locations, spread over a three mile reach of the Santa Maria River. These locations have been chosen because of their immediate proximity to a three-mile-long stretch of residential developments that back up to the Levee. The storage areas are used regularly by various entities (i.e., City of SM,
County FC, USACE) for staging and stockpiling, and are entirely absent of vegetation and wildlife habitat.

The Corps staff biologist also visited several locations along the north and south Levee where damage or breaching has occurred in the recent past (i.e., last 10 years). The Levee has been repaired or rebuilt in these locations, and at one location (terminus of Carlotti Drive) was further protected by additional, large toe rock and pipe and wire revetment. These areas continue to remain in the path of the dominant “low-flow” channel and therefore are predominantly devoid of vegetation and wildlife habitat. For the same reason, these areas may be at greater risk during future large flow events. In the areas visited, a low, narrow (10-foot-wide) bench occurs along the levee toe, vegetated by a strip of maturing alluvial scrub and drier species, including sandbar willow, mulefat, coyote brush (Baccharis pilularis) and tree tobacco (Nicotiana glauca).

Corps Regulatory had previously determined that the pilot channel project would have no effect on the Federally-endangered southern steelhead or its designated critical habitat. This determination was based upon the absence of the species and its suitable rearing/spawning habitat within the project area or its vicinity, the timing of the project (late summer/fall), and the implementation of several additional avoidance and minimization measures, including pre-project biological surveys.

Permit Requirements:
Santa Barbara County has obtained approval of the pilot channel project from the following Regulatory agencies:
- USACE Regulatory, nationwide permit (NWP) authorization (NWP31, maintenance of existing flood control facilities), (August 8, 2007).
- Central Coast Regional Water Quality Control Board, conditioned water quality (section 401) certification (dated August 10, 2007).
- California Department of Fish and Game, Streambed Alteration Agreement (dated August 1, 2007).

Santa Barbara County is seeking approval of the berm project from the following Regulatory agencies*:
- California Department of Fish and Game, amendment to existing Streambed Alteration Agreement.

*The County will be placing this material in “uplands”, located landward of the Ordinary High Water Mark (limit of USACE Regulatory jurisdiction), and will therefore not need permit authorization from USACE Regulatory, and likely not from the Regional Board as well. With the exception of a 900-linear-foot section at the downstream end of the project area, USACE Regulatory staff designated the OHWM boundary in the field (see attachment). Regulatory staff will coordinate with the County to ensure that the entire berm will be located outside of Regulatory’s jurisdiction.

As the stockpile locations are located on the backside of the Levee, upon either City or County property, there are no permit requirements for this element of the project. Should the County need to utilize adjacent private lands to stockpile additional material or equipment, the County will obtain the appropriate permissions.
Should the County need to place/dump rock on the River-side of the levee (e.g., to replace eroded toe), the abovementioned agencies (including USACE Regulatory) should be notified. If threat to life, property, and/or public services has occurred or appears imminent, USACE Regulatory is able to authorize such activities under an emergency general permit (i.e., Regional General Permit No. 63), provided that the actions are the “minimum necessary to alleviate the existing emergency.”

Prepared by:

John W. Markham, M.P.H.
Project Manager
North Coast Branch
Regulatory Division

Enclosures

Cc: Larry Fausett and Maureen Spencer (Santa Barbara County Flood Control)