Attachment 3.2 –Supporting Documents

Work Plan

Project B – Ash Slough Arundo Eradication and Sand Removal Project

Madera Region – IRWM Implementation Grant Application

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Attachment 3.2, Assessment Engineering Evaluation for Ash Slough

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Flood Hazard Mitigation Program
Madera County, California

Assessment Engineering Evaluation
for
Ash Slough

July 2010

HDR

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Contents

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Tables

1.0 Executive Summary

The following report provides an assessment of Ash Slough in the vicinity of the City of Chowchilla based on best available information. The intent of this Ash Slough assessment is to evaluate existing conditions, identify deficiencies, and apply for grant funding to provide an updated hydrologic and hydraulic evaluation of Ash Slough and a future restoration program.

The sphere of influence for this Ash Slough assessment is located in the vicinity of the City of Chowchilla city limits.

2.0 Purpose of Engineering Assessment

2.1 General

HDR Engineering, Inc. (HDR) has been requested to perform an engineering assessment of Ash Slough near the City of Chowchilla in Madera County, California based on best available information. No updated hydrologic and hydraulic models will be evaluated at this time.

HDR was tasked to provide a report evaluation to assess existing conditions, coordinate with Madera County and local interested parties on the direction of Ash Slough, and to apply for grant funding in the redevelopment of Ash Slough. This proposed evaluation is focusing on approximately 8.0 miles of non-project levees.

HDRs project scope is presented in **Table 1**.

Table 1 - Project Scope Items

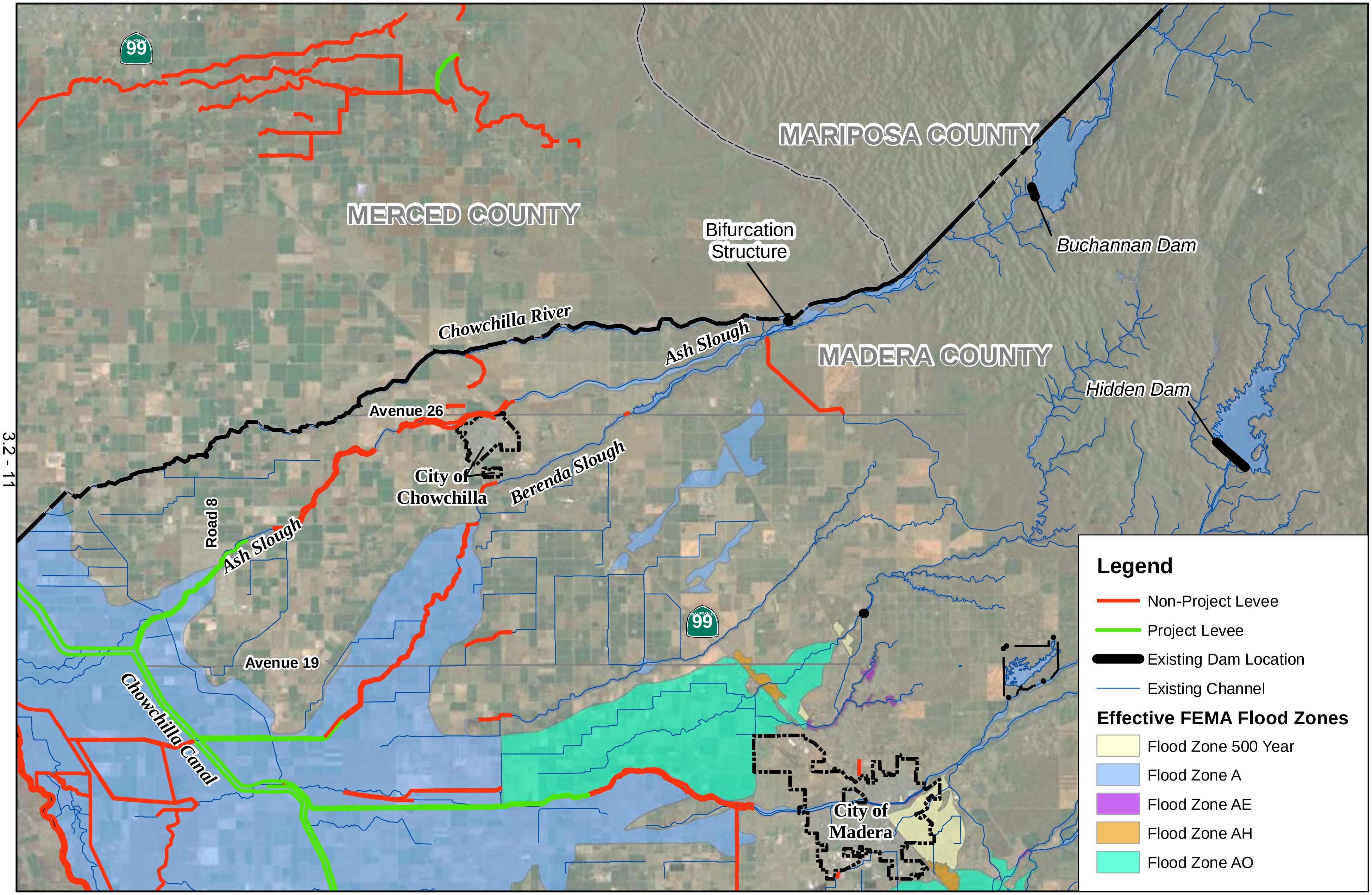
Project Scope	HDR Approach by Task
1. Coordinate up to three Community Meetings	Project Management Task (dated to be determines)
2. Determine potential impacted areas based on 10- year, 100- year and 200- year events	Assessment Using Best Available Data Task
3. Analysis of Impacted Flood Areas	Assessment Using Best Available Data Task
4. Evaluate extent and casualty potential for floods	Assessment Using Best Available Data Task
5. Assessment of the Levee Structure	Assessment Using Best Available Data Task
6. Identification of mitigation measures	To be determined
7. Coordination of final findings	To be determined

2.2 Description of Ash Slough Study Reach

The Chowchilla River discharges from Buchannan Dam and is a tributary of the San Joaquin River. Its drainage basin extends from the San Joaquin River to a ridge on the westerly slope of the Sierra Nevada. The Buchanan Dam (Eastman Lake) is located about 16 miles northeast of the City of Chowchilla. The watershed area above the Buchanan Dam is about 235 square miles of foothill and mountain area. Chowchilla River is the most northern tributary from the Buchanan Dam to San Joaquin River. Ash and Berenda Sloughs are tributary channels of the Chowchilla River, downstream of the first flashboard dam located approximately 8 miles from the Buchanan Dam. Ash Slough and Berenda Slough split at the Ash and Berenda Control Structures about one mile downstream of the first flashboard dam on the Chowchilla River

The Chowchilla River and flows in a southwest direction to the Chowchilla Canal. Ash Slough also flows in a southwest direction adjacent to the City of Chowchilla discharging into the

Chowchilla canal. Ash Slough includes approximately 4.0 miles of State-Federal project levees and 8.0 miles of non-project levees (see **Figure 1**).



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Location Map

FIGURE 1

Source: FEMA DFIRM data; 2008 | \\sac-filsrv2\Projects\136897_Madera_County_Ash_Slough\Map_Docs\TM_figures\Figure1_Location_Map | Last Updated : 07-30-10

2.3 Project Data and Assumptions

2.3.1 General

As previously noted, this assessment is based on best available information and previous studies. The following description is additional project data that may be required with a future evaluation.

- Topographic Data – Per an official request, topography LiDAR data that includes one-foot contour accuracy could be provided by the California Department of Water Resources Central Valley Federal Evaluation Delineation (DWR CVFED) project. This data has sufficient accuracy, quality, and coverage to perform the hydraulic channel analysis, outflanking floodplain and interior drainage analysis. Additional cross-section and profile data maybe needed for the levee to support slope stability and freeboard analysis.

- Bathymetric Surveys – Bathymetric surveying maybe required for the scope of work.

- Geotechnical Data – Geotechnical analysis will be based on existing subsurface data or from related adjacent projects as available. Test borings are not included, but HDR will assist in the selection of a drilling method and establishment of a drilling program if sufficient existing data is not available.

2.3.2 Assumptions

HDR based their evaluation on best available information; therefore, no design and/or modeling assumptions are necessary to list at this time.

3.0 Description and Existing Studies

3.1 General

HDR collected the following information from Madera County for the flood hazard assessment of Ash Slough. Previous engineering studies and other relevant documents were collected from various sources. The following sources were reviewed:

1. USACE Operation and Maintenance Manual for Chowchilla River, Ash and Berenda Sloughs Channel Improvement and Levee Construction (1976)
2. USACE Comprehensive Study - Sacramento and San Joaquin River Basins (2002)
3. USACE Water Control Manual (2006) (under review)
4. FEMA Effective FIS Report (2008)
5. URS Preliminary Engineering Study of Ash Slough (2009)

Each of the studies/references is briefly described in the following sections.

3.1.1 USACE Operation and Maintenance Manual for Chowchilla River, Ash and Berenda Sloughs Channel Improvement and Levee Construction (1976)

Ash Slough was included in the 1976 United States Army Corps of Engineers (USACE) Chowchilla River, Ash and Berenda Sloughs Channel Improvement and Levee Construction project, which were a part of United States Congress-authorized Buchanan Dam and H.V. Eastman Lake Project under the Flood Control Act of 1962, Public Law 87-874. The following summary was extracted from the project Operation and Maintenance (O&M) Manual (USACE, 1976) which provides a background for the flood control project:

"The USACE flood control project for Chowchilla River Basin covered from Buchanan Dam downstream to the Chowchilla Canal, Ash Slough from its bifurcation with the Chowchilla River downstream to the Chowchilla Canal and on Berenda Slough from its bifurcation with Ash Slough downstream to the Chowchilla Canal. The project work on Ash and Berenda Sloughs consisted of levee construction, enlargement, and setback levees along both banks. Channel enlargement was also accomplished upstream from the end of the project levees where existing channel capacities were inadequate to carry project design flow."

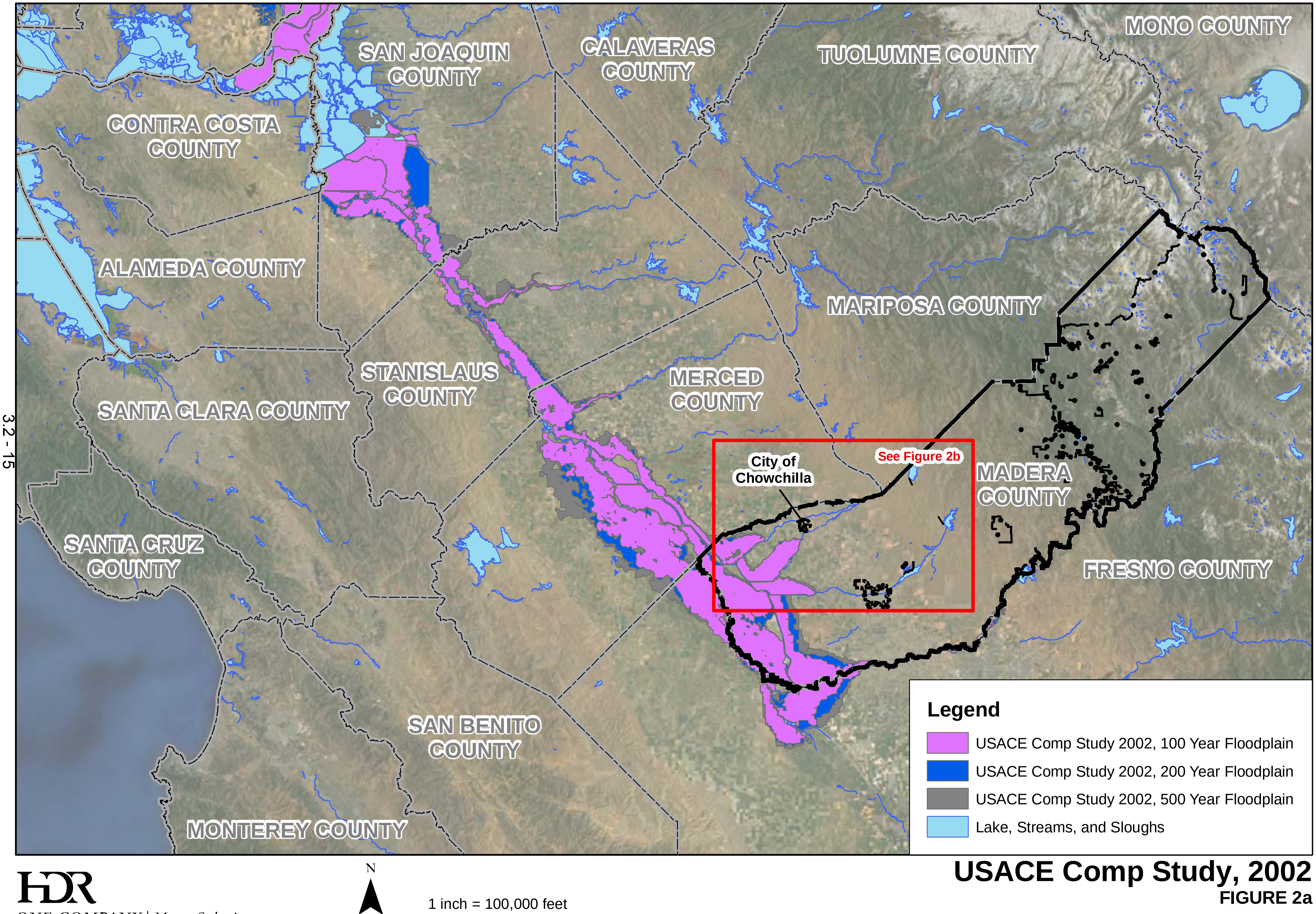
3.1.2 USACE Comprehensive Study (2002)

USACE Comprehensive Study reported the authority and purpose of the study as follows: "*In response to extensive flooding and damages experienced in 1997, the United States Congress authorized the U.S. Army Corps of Engineers, Sacramento District (USACE) to provide a comprehensive analysis of the Sacramento and San Joaquin river basin flood management systems and to partner with the State of California to develop master plans for flood damage reduction. The USACE and the State Reclamation Board of California are leading this Comprehensive Study to improve flood management and integrate ecosystem restoration in the Sacramento and San Joaquin river basins. The authorization for the Comprehensive Study directed the development of hydrologic and hydraulic models for both* *restoration in the Sacramento and San Joaquin river basins. The authorization for the Comprehensive Study directed the development of hydrologic and hydraulic models for both river basins that will allow systematic evaluation. These models incorporate reservoir operations and flow along the major river systems to evaluate the performance of the flood management systems. The models can be used to assess the performance of the current systems or modified systems under a wide range of hydrologic conditions."*

Figure 2a and **2b** provides the study limits for the USACE Comprehensive study which does not include the Ash Slough evaluation are for this report. The hydrologic analysis and floods with 2-, 10-, 25-, 50-, 100-, 200-, and 500-year return frequency were considered. The hydrological analysis involved synthetic hydrologic analysis, and hypothetical storm centering and reservoir operations using HEC-5. For San Joaquin basin hydraulic analysis, floods with 10-, 25-, 50-, 100-, 200-, and 500-year return frequency were modeled. For the hydraulic analysis, computer based UNET and FLO-2D models were used to model riverine and overland portions of the system respectively.

The USACE Comprehensive Study reported the following about the use of study results:

"The synthetic hydrology, levee failure assumptions, and hydraulic models all influence the floodplains developed by the Study, which were delineated specifically for use in basin-wide flood risk analyses. Comprehensive Study floodplains are intended to encompass the full extent of possible flooding, reflecting the influence of multiple storm conditions on the shape and extent of the floodplain. These floodplains may differ from those developed by other studies (including FEMA floodplains that are used for regulatory purposes) due to fundamental differences in the technical approach, assumptions, hydrology, and intended end-use. Comprehensive Study floodplains are not intended to replace or supersede existing regulatory floodplains. Instead, they are an additional resource for studies and local planning efforts."



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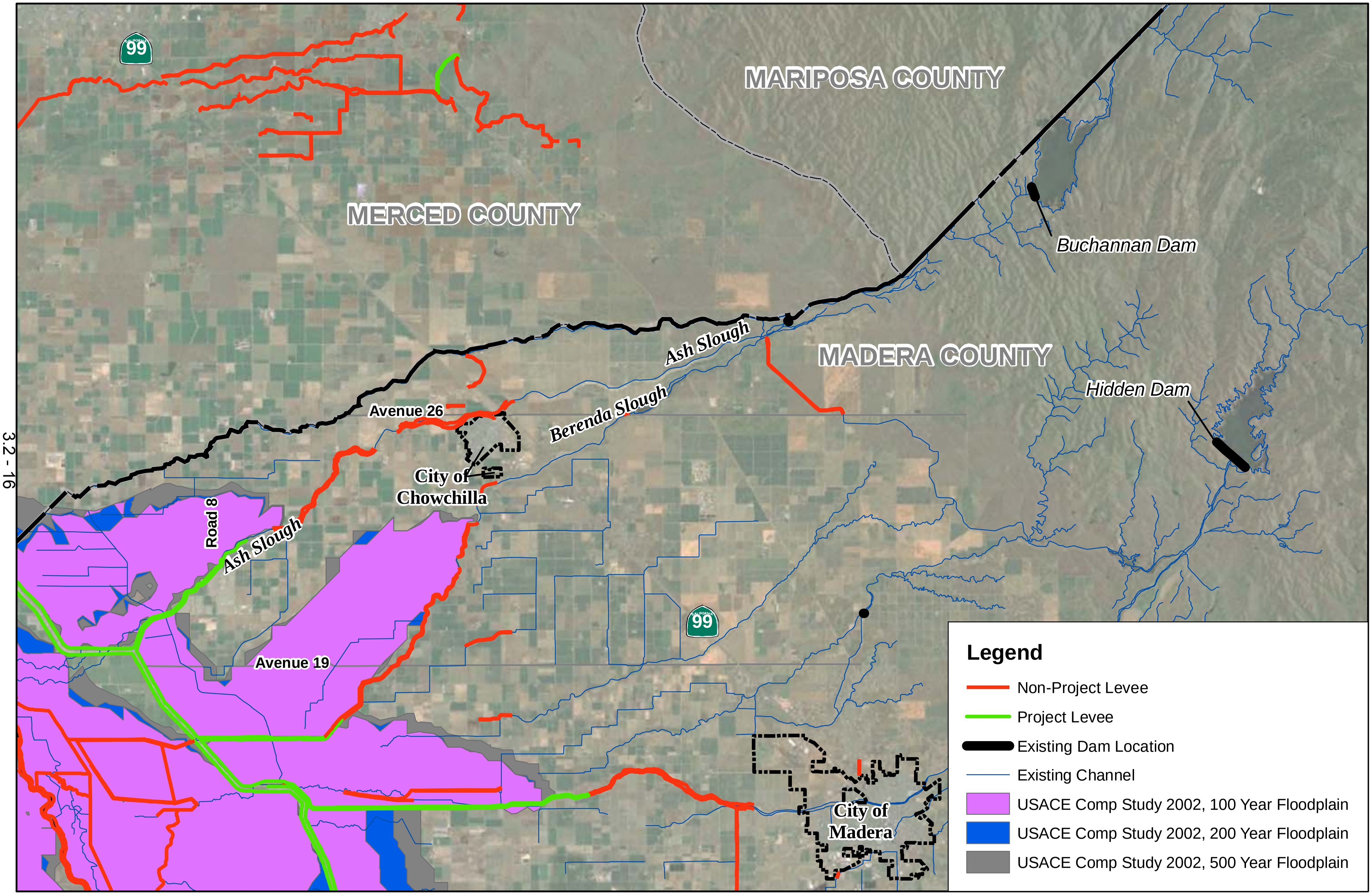
USACE Comp Study, 2002

FIGURE 2a

Source: USACE; 2002 | \\sac-filsrv2\Projects\136897_Madera_County_Ash_Slough\Map_Docs\TM_figures\Figure2a_USACE_Comp_Study | Last Updated : 07-30-10



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1 inch = 20,000 feet

USACE Comp Study, 2002

FIGURE 2b

Source: USACE; 2002 | \\sac-filsrv2\Projects\136897_Madera_County_Ash_Slough\Map_Docs\TM_figures\Figure2b_USACE_Comp_Study | Last Updated : 07-30-10

3.1.3 USACE Water Control Manual (2006)

This report was a reference to the URS 2009 Ash Slough evaluation. The report is still under evaluation by HDR.

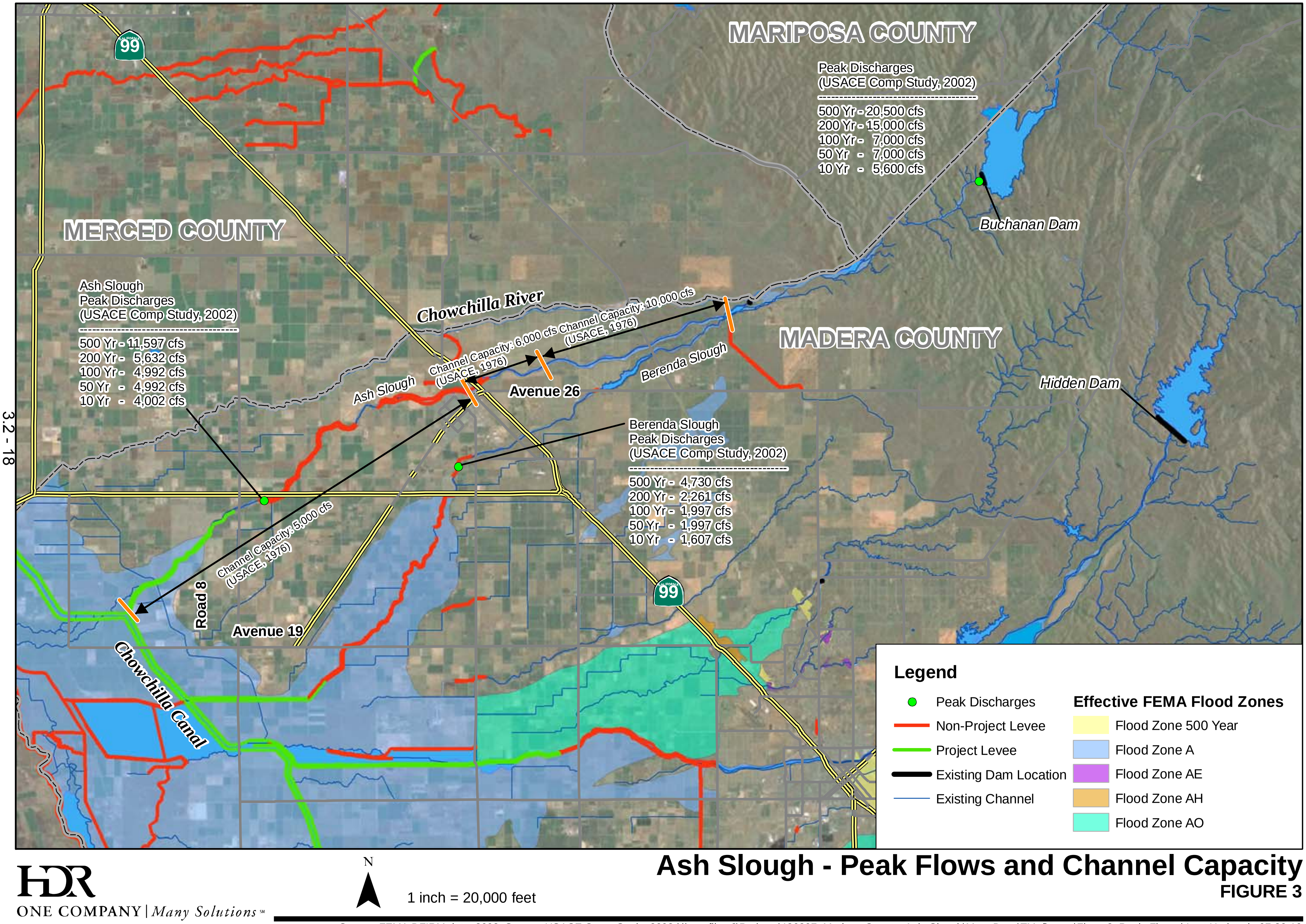
3.1.4 FEMA FIS Report (2008)

3.1.4.1 General

The current FEMA effective countywide flood insurance rate map (FIRM) and flood insurance study (FIS) for Madera County and incorporated areas (including City of Chowchilla) was recently published on September 26, 2008. This report included no updates to the hydrologic or hydraulic analyses performed in the 2008 countywide revision.

Both Chowchilla River and the entire reach of Ash Slough were originally studied by approximate hydrology and hydraulic methods in the previous FIS (August 1987). Hence, no stream discharges for Chowchilla River and Ash Slough were published in the FIS report and the base flood (100 year) elevations were not determined for the floodplain areas and. No floodway analysis was performed in the vicinity of City of Chowchilla. FIRM maps show approximate 100 year (or 1 percent chance) floodplains, designated as Zone A, for entire Ash Slough. **Figure 3** presents the FEMA floodplain for Ash Slough. **Figure 4** presents the floodplain information in the vicinity of City of Chowchilla for clarity.

The FIS report states that levees (unclear on whether project levees or other levees) in Ash Slough were designed for the 50-year (2 percent chance) design flow event. The FIS report also states that levees in Ash Slough were not considered in the hydraulic analysis as they currently do not meet the FEMA requirements to be considered as providing protection against the 100-year flood event.



Ash Slough - Peak Flows and Channel Capacity

FIGURE 3

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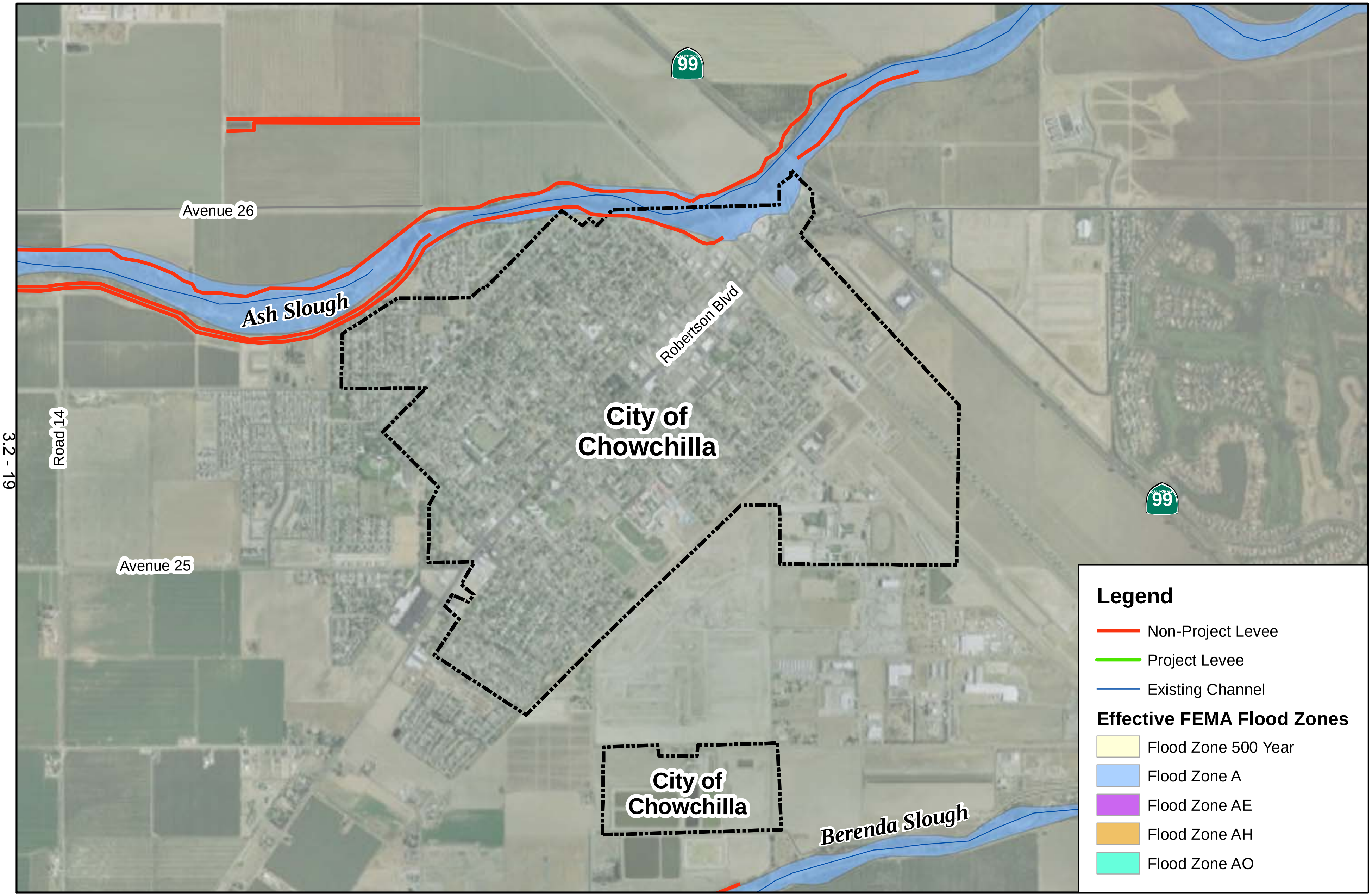
Source: FEMA DFIRM data; 2008, Source: USACE Comp Study; 2002 | \\sac-filsrv2\Projects\136897_Madera_County_Ash_Slough\Map_Docs\TM_figures\Figure3_Peak_Flows | Last Updated : 07-30-10



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1 inch = 2,000 feet

City of Chowchilla Effective Floodplains

FIGURE 4

Source: FEMA DFIRM data; 2008 | \\sac-filsrv2\Projects\136897_Madera_County_Ash_Slough\Map_Docs\TM_figures\Figure4_Chowchilla | Last Updated : 07-30-10

3.1.5 URS Preliminary Engineering Study (2009)

The URS Corporation (URS) conducted a preliminary engineering study of a selected reach of Ash Slough in the vicinity of City of Chowchilla. This report provides the best preliminary hydraulic assessment of Ash Slough; however, this report did not provide a detailed hydraulic floodplain evaluation to assess the outflanking floodplain in the City of Chowchilla or was intended for a FEMA Letter of Map Revision (LOMR) submittal.

The URS evaluation began at the Highway 99 crossing and extended approximately 1.5 miles downstream encompassing most of Ash Slough and the bifurcation structure that controls water, flows to the natural channel and Ash Slough bypass channel.

The preliminary engineering study included literature reviews, field visits, preliminary hydraulic modeling to estimate present channel capacity and assessment of existing conditions. Project flows for the preliminary assessment of Ash Slough were obtained from regulated flows from Buchanan Dam. The design flow for the Ash Slough channel reach was reported at 5000 cubic feet per second (cfs). URS documented significant vegetation and sedimentation problems in the reach. In particular, growth of Arundo (an invasive, non-native, tall perennial cane plant (URS 2009) in the natural channel was noted in the report.

An approximate steady state HEC-RAS model was constructed using County surveyed data. Though the documentation mentioned no specific datum, the elevations seem to suggest that the datum used was National Geodetic Vertical Data (NGVD) 1929. The Ash Slough bypass channel was included in the hydraulic model. The Sand Dam in the natural channel of Ash Slough was not included in the hydraulic model. **Figure 5a** provides the Hydrologic Engineering Center River Analysis System (HEC-RAS) program model cross section layouts.

URS performed the channel capacity analysis by simulating a rating curve of flows from 1000 cubic feet per second (cfs) to 6000 cfs in increments of 1000 cfs for three scenarios/plans.

1. **Plan 1 - Existing Conditions with Arundo.** This plan assumes Arundo growth remains in the natural channel portion.
2. **Plan 2 - Existing Conditions with Arundo Removed.** This plan assumes Arundo growth is cleared in the natural channel portion.
3. **Plan 3 - Channel Modification.** This plan assumes Arundo growth is cleared in the natural channel portion, and up to 3 feet of natural channel bottom is removed starting from cross-section No.3.

Figure 5b provides a water surface profile comparison for plan 1 and 2 along with surveyed ground and levee profiles. The analyses revealed that the existing condition capacity of Ash Slough is approximately 2000 cfs with 3 feet of freeboard in critical sections, or approximately 4000 cfs with no freeboard. In both cases, the capacity improves by another 1000 cfs if vegetation (Arundo growth) is removed. No floodplain delineation was presented in the report.

The following were several key recommendations summarized by URS:

1. More detailed hydraulic modeling is needed to confirm the study findings.

2. Arundo growth significantly impacts the hydraulic capacity of the Ash Slough channel. A consistent annual vegetation management program should be implemented to maintain the channel. The need for removal of large trees in the levee sides should be evaluated to prevent slope stability and other risks.

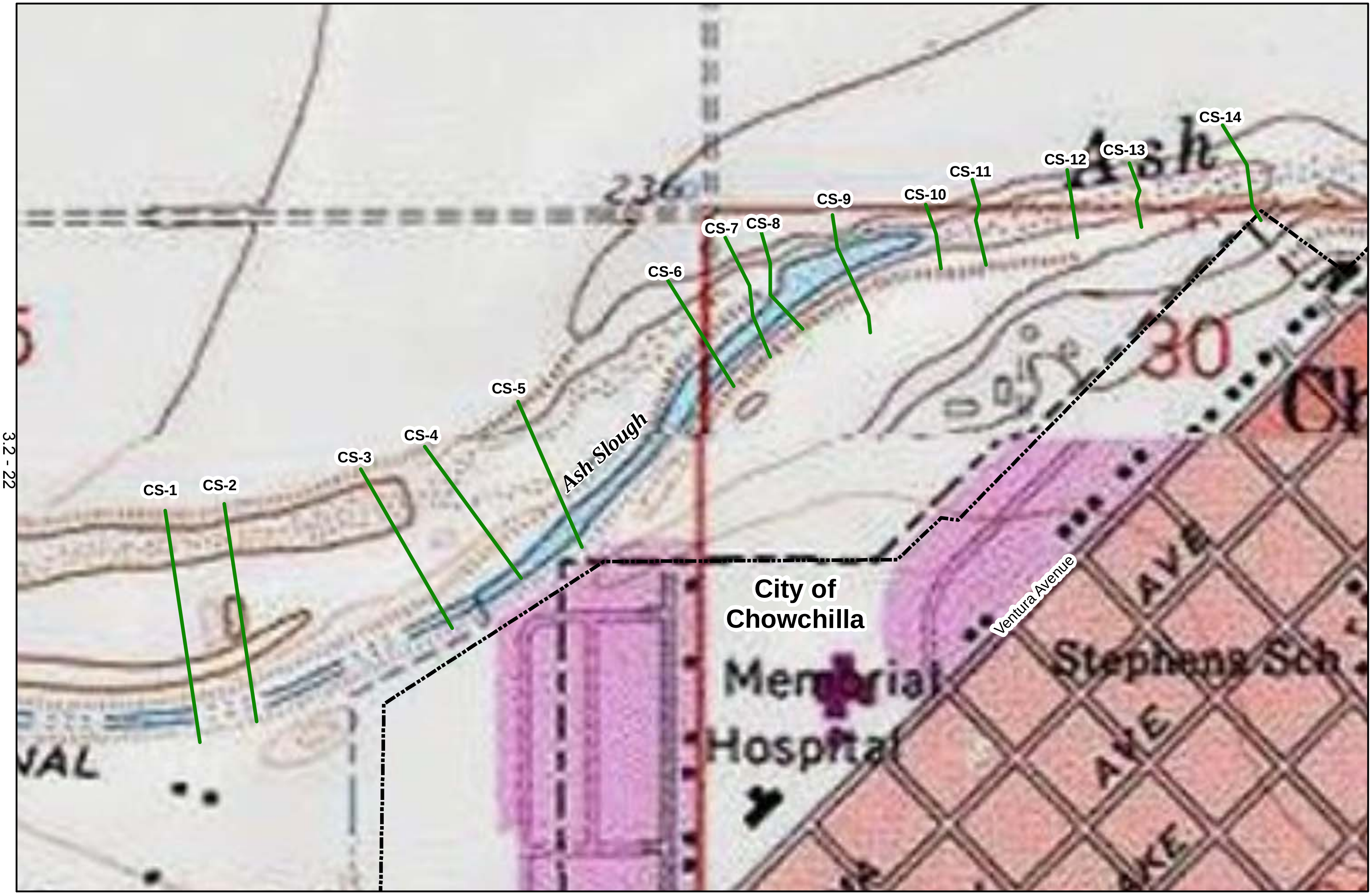
3. The accumulated sediment in the Ash Slough channel needs to be removed to maintain the design capacity of 5000 cfs with acceptable freeboard at critical sections.

4. The road drainage culvert at 1st street which penetrates the embankment currently has a detached flap gate that would not provide positive closure. This drainage culvert should be repaired as soon as possible to meet current levee standards.

5. The areas where the natural grade of landside of Ash slough bypass canal can pose significant seepage problems that could lead to slope instability. Such areas need to be identified and evaluated as part of future studies.

6. Areas with known or potential seepage problems need to be identified and geotechnical investigations should be performed to evaluate seepage and slope stability risks.

7. The issue of replacing the Ash Slough natural channel – Bypass canal bifurcation structure needs to be addressed to improve operation and maintenance and to permit a more rapid response during flood emergency.



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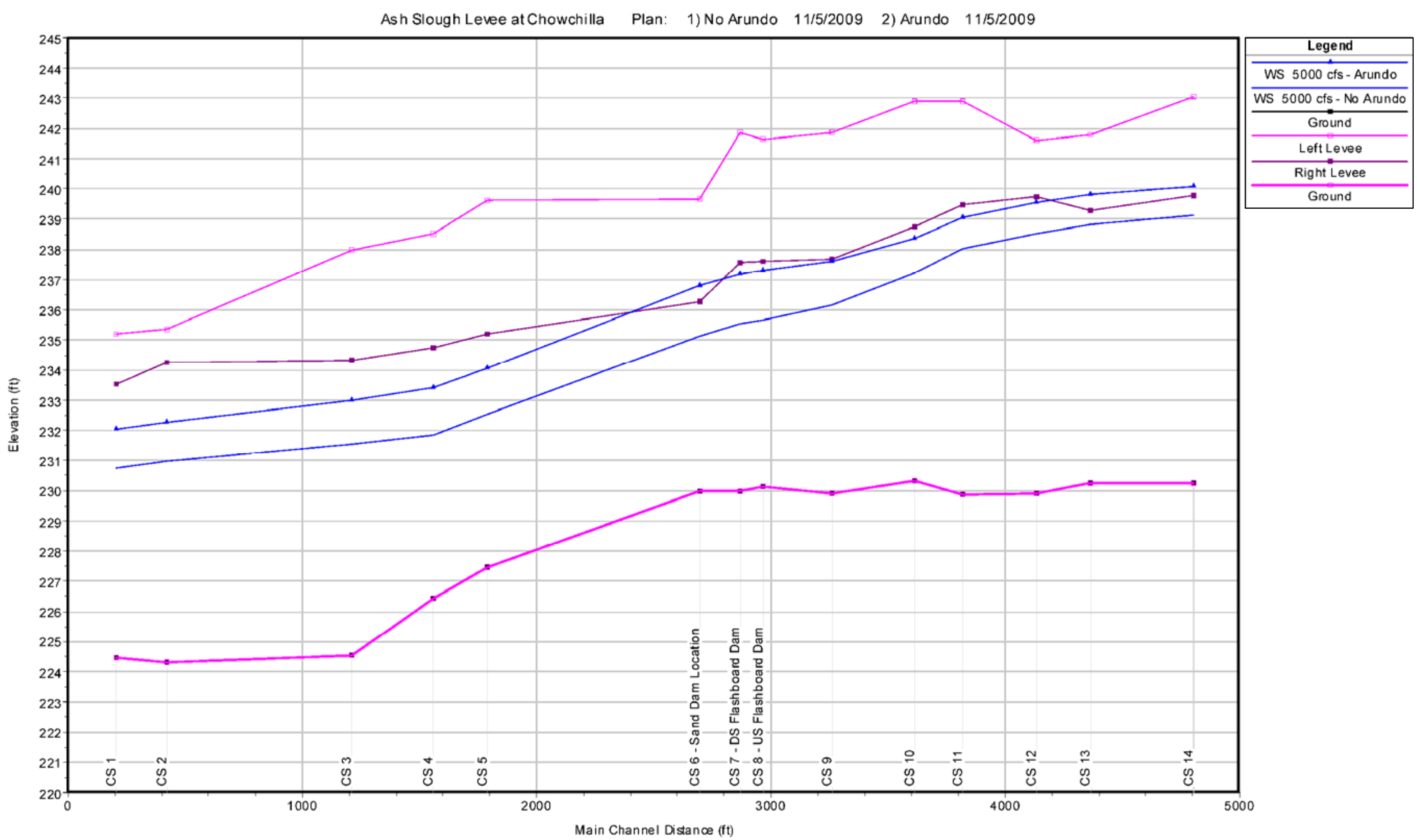
HEC-RAS Model Cross Section Locations

FIGURE 5a

Source: URS Preliminary Study; 2009 | \\sac-filsrv2\Projects\136897_Madera_County_Ash_Slough\Map_Docs\TM_figures\Figure5a_HECRAS_XS | Last Updated : 07-30-10



URS Preliminary Study, Water Surface Profile Comparisons

FIGURE 5b

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Source: URS Preliminary Study; 2009 | \\sac-filsrv2\Projects\136897_Madera_County_Ash_Slough\Map_Docs\TM_figures\Figure5b_Profile | Last Updated : 07-30-10

4.0 Flood Hazard Mitigation Actions

4.1 General

The best available information for a flood hazard assessment of Ash Slough is from the 2009 URS evaluation, but this report only incorporated an approximate channel evaluation with no detailed floodplain. There has been no additional FEMA detailed evaluation in the vicinity of the City of Chowchilla to evaluate the channel capacity of the potential flood hazard to existing residence. The URS evaluation indicated the objective flood control release from Buchanan Dam is approximately 7,000 cfs with approximately 5,000 cfs in Ash Slough and approximately 2,000 cfs in Berenda Slough. The historical record for this estimate was based on the time period of 1976-98 after completion of Buchanan Dam.

4.2 Analysis of Impacted Flood Areas

Figure 6 provides the estimated peak flow assessment for both Ash Slough and Berenda Slough from the Buchanan Dam outfall. Based on field review and best available topographic data, the north side of Ash Slough which is undeveloped agricultural, will be impacted initially since the ground elevation is approximately 3-5 feet lower in elevation than the south side of Ash Slough. However, breakout flows will occur on the south side of Ash Slough west of Highway 99.

Determination of the floodplain extent and the potential floodplain extent will be confirmed with a detailed analysis, but the area of inundation will likely impact a major portion of the City of Chowchilla.

4.3 Findings

The engineering assessment of Ash Slough is based on review of best available studies and data revealed critical issues that need immediate attention for mitigating flood hazard in the Ash Slough affected areas. Summary of findings is as follows:

1. The floodplain information for Ash Slough is provided only by FEMA FIS study and the analysis is at least 25 years old. No recent floodplain analysis is available for Ash Slough except at the project levee section at the most downstream end where USACE Comprehensive study provides composite floodplains for various return periods.

2. The current FEMA FIS does not provide stream discharges used in the floodplain delineations.

3. The design capacity of Ash Slough (as of USACE Channel Improvements activities of 1976) ranges between 15,000 cfs at the bifurcation with Chowchilla River to 5000 cfs at the confluence with Chowchilla canal.

4. The objective flood control release from Buchanan Dam is 7,000 cfs (5,000 cfs in Ash Slough and 2,000 cfs in Berenda Slough). Apparently all flow is diverted to Ash Slough at the Chowchilla River – Ash Slough Bifurcation.

5. USACE Comprehensive study used a regulated peak flow from Buchanan Dam of 5000 cfs for 100 year event. This value is consistent with the design capacity of the Ash Slough downstream of Union Pacific Railroad in the vicinity of City of Chowchilla.

6. No detailed, current hydraulic model is available for Ash Slough. The current FEMA FIS does not provide water surface elevations in the floodplains. No floodway analysis was performed in the vicinity of City of Chowchilla. The UNET model developed by USACE Comprehensive study covers only the project levee section at the most downstream end. The hydraulic model developed by URS is preliminary and covers only 1.5 miles in the vicinity of City of Chowchilla.

7. Existing conditions (without levee failure - topography includes the levees or berms along the channel) suggest that Ash Slough can potentially flood City of Chowchilla. In particular, during high flows, topography suggests that at the bend immediately downstream of Union Pacific Railroad Ash Slough can potentially overflow into the urban areas of City of Chowchilla. This has clearly higher potential for flood damage.

8. Existing conditions (without levee failure - topography includes the levees or berms along the channel) suggest that Ash Slough can potentially flood northern side of the slough in the vicinity of City of Chowchilla as the right bank berms are much lower in elevation than the left bank (City side) levee. However this has lower potential for flood damage as the potential areas of inundation are farm lands.

9. Dense vegetation in natural channel of Ash Slough seems to significantly reduce channel capacity of Ash Slough in the vicinity of City of Chowchilla.

10. Severe sedimentation is of 2-3 feet have been observed in Ash Slough

11. Erosion and seepage problems have been observed in the vicinity of City of Chowchilla.

12. The Ash Slough natural channel – Bypass canal bifurcation structure is currently not used and a sand dam built across Ash Slough natural channel just downstream of the bifurcation structure is used to divert water to Ash Slough bypass canal.

13. California Department of Water Resources (DWR), CVFED Program (Central Valley Floodplain Evaluation and Delineation) is currently developing unsteady HEC-RAS and FLO-2D models for the project levee portion of the Ash Slough for floodplain delineation. Current expected date of completion of the program is July 2012.

4.4 Recommendations

Following are the recommendations or remedial actions for flood mitigation in Ash Slough affected communities.

1. Undertake a detailed hydrological study to determine 10, 50, 100, 200 and 500 year event discharges in Ash Slough.

2. Undertake appropriate hydraulic modeling study to determine the current capacity of Ash Slough from bifurcation with Chowchilla River to upstream end of project levees. Undertake a detailed hydraulic analysis using most current topographic data in the vicinity of City of Chowchilla to determine water surface elevations and perform floodway analysis. Floodway analysis will aid the community in better floodplain management by balancing the economic gain from floodplain development against the resulting increase in flood hazard.

3. Construct new FEMA certified levee system in the vicinity of City of Chowchilla to provide 100 (or 200 for CA) year flood protection to the residents of City of Chowchilla.

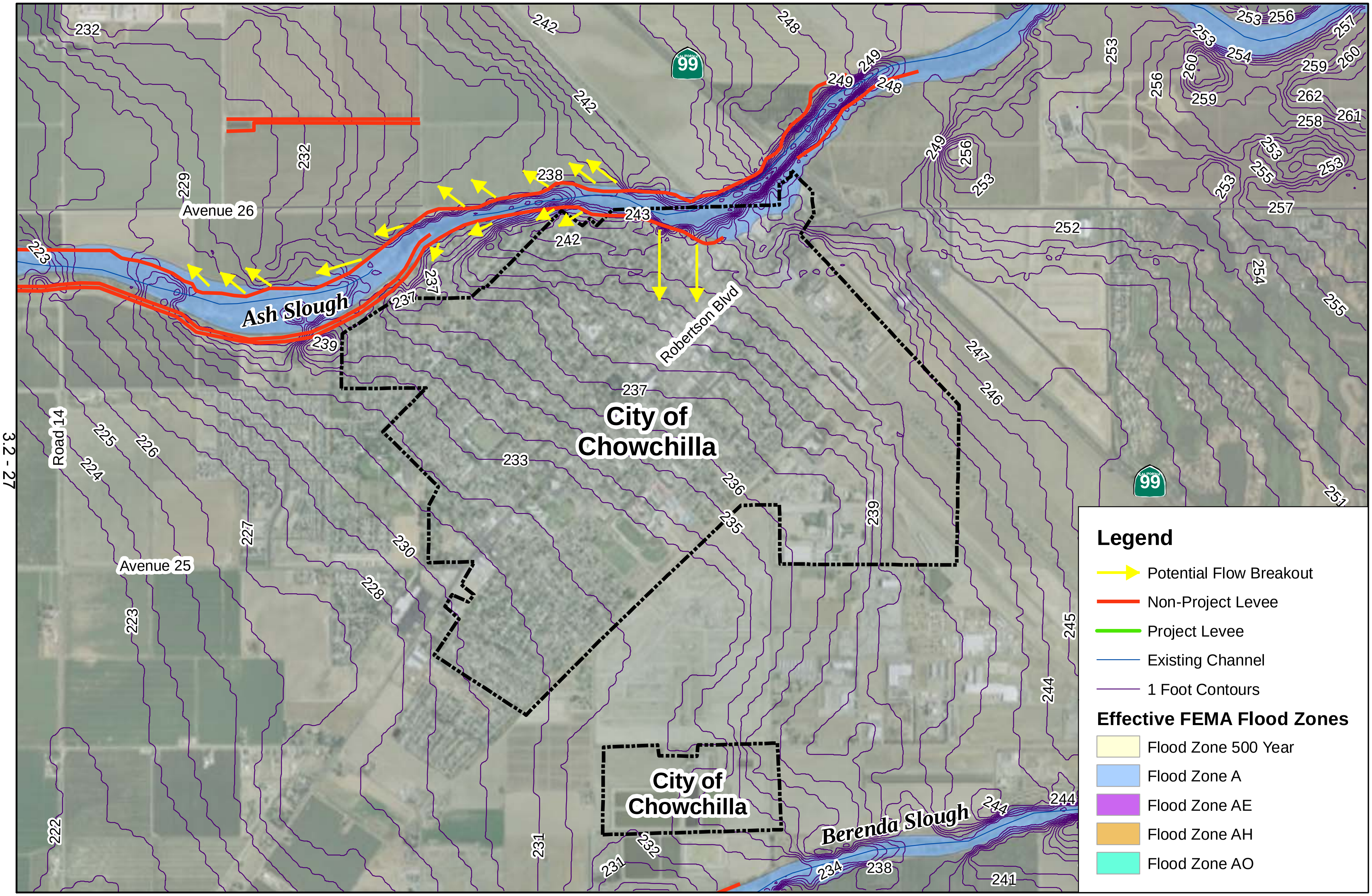
4. Undertake channel improvements and/or levee construction activities along entire Ash Slough to maintain the original design capacity with acceptable freeboard at critical sections.

5. The issue of replacing the Ash Slough natural channel – Bypass canal bifurcation structure should be addressed to improve operation and maintenance and to permit a more rapid response during flood emergency.

6. The areas where the natural ground grade of landside of Ash slough bypass canal is below the canal water level could pose a seepage problem that could lead to slope instability. Such areas need to be identified and evaluated.

7. Areas with known or potential seepage problems need to be identified and geotechnical investigations should be performed to evaluate seepage and slope stability risks.

8. A consistent annual vegetation management program should be implemented to maintain the Ash Slough hydraulic capacity.



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1 inch = 2,000 feet

Ash Slough - Potential Flow Breakout

FIGURE 6

Source: FEMA DFIRM data; 2008 | \\sac-filsrv2\Projects\136897_Madera_County_Ash_Slough\Map_Docs\TM_figures\Figure6_Flow_Breakout | Last Updated : 07-30-10

5.0 Assessment of Existing Levees

5.1 General

A recent field review evaluation dated July 14, 2010 was provided by Klienfelder geotechnical group. Kleinfelder provides a preliminary geotechnical assessment for Ash Slough focusing on the segment near Chowchilla, California (just west of State Route 99 approximately 1.5 miles west of State Route 99. The intent of the memorandum is to review and address geotechnical conditions to aid in the overall assessment and evaluation of Ash Slough. The memorandum is based on review of geotechnical data from nearby projects and readily available historic data for Ash Slough and site reconnaissance by Kleinfelder personnel on July 7, 2010. Significant data used in this assessment was obtained from recent work performed for the Department of Water Resources (DWR) Non-Urban Levee Evaluation (NULE) Program.

This memorandum is organized into two sections:

- Segment Description and History
- General Levee Conditions

5.1.1 Segment Description and History

The Ash Slough Segment is located just north of Chowchilla in Madera County, California. The segment starts on the west side of State Route 99 and runs west (downstream approximately 1.5 levee miles.

Construction History

Initial – Available historical documentation indicates a levee generally resembling the alignment of the segment was constructed under the Chowchilla Ranch Reclamation along the current Ash Slough alignment. Historical documents indicate that Ash Slough was built by 1919.

Historical documents of levee construction details show the criteria to which the proposed eastern alignment would be built. The historical documents indicated Ash Slough levees were to be constructed with a crown width of8 feet and a waterside slope of 2:1 (H:V). A landside slope criterion was not specified. Borrow pits were to be located along the waterside, at least 30 feet from the waterside toe.

Levees were to be constructed by a floating dredge, a drag line excavator, or a horse drawn or tractor drawn excavator and scraper. If constructed by "any form of dredging machinery," the crown and slopes were to be "trimmed" to an "even grade and slope". If constructed by floating dredge, the "top of the levee" was to be built one foot higher than designed to allow for settlement from drying. If constructed with a drag line excavator "working in dry material", the tope of the levee was to be constructed 6 inches higher than design to allow for settlement.

As-built drawings confirmed channel and levee improvements were constructed with a crown width of 8 to 10 feet and landside and waterside slopes at gradients of 2:1 (H:V). Borrow was obtained from Ash Slough channel excavation.

Performance

There are no documented reports of boils, landside slope, or instability. **Table 2** summarizes reported performance during the five high-water events for which performance data are most commonly available (1967, 1969, 1997, 1998, and 2006).

Table 2 - Ash Slough Segment 1.5 Levee Miles, Reported Levee performance Extents

Flood Season	Reported Performance Events	Approximate Location	Mitigation
1966-1967	Unknown	-	-
1968-1969	Overtop and Breach	Near SPRR and Chowchilla Blvd.	Sandfill
1968-1969	200' Erosion Site	End of Dorothy Way	Unknown
1996-1997	Unknown	-	-
1997-1998	Unknown	-	-
2005-2006	Unknown	-	-

Breaches

1969 – During the 1969 high-water event, approximately 3- feet of the right bank of the primary levee was overtopped and breached located near the SPRR and Chowchilla Boulevard. The secondary levee was also breached for a length of approximately 50 feet. Restoration work on the secondary levee was made with a "good sandfill" and was considered adequate at the time.

Erosion

1969 – During the 1969 high-water event, the left bank of the Ash Slough Bypass Canal experienced erosion for about 200 feet located near the end of Dorothy Way. The erosion had progressed to about the landside crown of the levee. Restoration work was completed but was considered temporary.

Improvements

No improvements were identified in documents reviewed or during reconnaissance.

Planned Improvements

No improvements were identified in documents reviewed or during reconnaissance.

5.1.2 Segment general Levee Conditions

This section describes the levee geometry, penetrations, animal activity, maintenance, and other features.

Levee Geometry

The left bank levee height ranges from about 4 to 8 feet above the landside toe. However, the eastern portion near State Route 99 resembles an elevated road that increased from 0 to 2 feet in height. The crest width is approximately 8 feet in most areas, but increased up to 25 feet for a portion f the left bank (about 2000 feet). The waterside slopes on the left bank ranged from approximately 2:1 to 5:1 (H:V), and the landside slopes ranged from 2:1 to 3:1 (H:V).

The eastern portion of the right bank levee resembled mostly a berm without a crown ranging from 1 to 3 feet in height and 1 to 4 feet in width. The west portion (after the bifurcation structure) of the right bank had a height ranging from about 3 to 7 feet and a crown of about 8 to 10 feet in width. The slopes on the right bank ranged from approximately 2:1 to 3:1 (H:V) for the waterside landside.

Penetrations

During the site visit reconnaissance, a 12 inch metal pipe 3 to 4 feet below crown was noted on the left bank. The penetration included a culvert on the waterside slope.

Animal Activity

Animal activity was not reported in reviewed documents; however, some animal activity was noted during the site reconnaissance. The amount and extent of activity was limited due to heavy vegetation on the waterside and landside slopes.

Maintenance

Maintenance was not reported in reviewed documents and during the site reconnaissance.

Other Features

The unlined Chowchilla Canal runs parallel on the south side of Ash Slough starting near Calaveras and Penny Streets. Periodic riprap was observed on the waterside slope of the canal. Most of the 1.5 levee mile segment was covered with vegetation on the waterside landside.

Geotechnical Investigations

Boring logs from a nearby subdivision were advanced to a depth of approximately 21.5 below the landside toe. The soil at the site is comprised of older alluvial sediments of the Pleistocene Age Modesto Formation. The general soil profile depicted by the subsurface exploration consists of silty sand and poorly graded sand with varying silt content to the maximum depth explored, 21.5 feet depth below the ground surface. The soils generally have a relative density of medium dense.

Other Geotechnical Information

Levee (Borrow) – Borrow material for initial and levee construction was obtained from the waterside of the levee. NRCS data indicate soils in probable borrow areas consist primarily of Riverwash sand to sandy loam, and Grangeville sandy loam. The uppermost 5 feet of these soils consist of, silty sand (SM) and sand (SP). The uppermost 5 feet of Riverwash sand and sandy loam consists of poorly graded sand with silt (SP-SM).

5.1.3 Limitations

The findings presented in this memorandum were prepared in accordance with generally accepted geotechnical engineering practice which existed at the time the memo was written. No warranty, either express or implied, is intended or made. The findings and information provided were based on readily available documents and are intended to aid in the overall evaluation of the Ash Slough. Additional geotechnical services will be required to support further evaluation of Ash Slough.

6.0 Levee Certification

6.1 General

The following provides a summary of FEMAs role and requirements of a levee certification. See FEMAs website (www.fema.gov) for complete clarity and accuracy in conveying the intent of FEMA's role and certification requirements on levees. The information and language available from FEMA website is consistent from May 2010.

6.2 FEMA's Role

FEMA is ***not*** responsible for building, maintaining, operating, or certifying levee systems. FEMA does, however, develop and enforce the regulatory and procedural requirements that are used to determine whether a ***completed*** levee system should be credited with providing 1-percent-annual-chance flood protection on a FIRM or DFIRM. These requirements are documented in Section 65.10 of the National Flood Insurance Program NFIP regulations. FEMA relies on Federal, State, and local agencies and private levee owners to provide them with the required data and documentation on levee systems so that the hazards and risks in levee-impacted areas may be presented accurately on the maps and related products.

FEMA also develops and enforces the regulatory and procedural requirements for levee systems that are being constructed for the first time or that are being restored to provide 1-percent-annual-chance flood protection.

6.3 Community, State, and Federal Responsibilities

Communities, State agencies, and Federal agencies may construct new levee systems to address flood hazards and reduce flood risks to structures and people in a particular community or particular area of a state. Likewise, these communities and agencies may undertake a project to restore the flood protection capability of a levee system that had previously been credited with providing a 1-percent-annual-chance level of flood protection to that level of protection, thereby reducing the flood risk to the people and structures located in levee-impacted areas.

6.4 FEMA Requirements

In order for FEMA to recognize a levee system as providing protection from the base (1-percent annual chance) flood, it must meet, and continue to meet minimum design, operation, and maintenance standards established in Section 65.10 of the National Flood Insurance Program regulations. The design criteria include, but may not be limited to, requirements for freeboard, closure devices, embankment protection, embankment and foundation stability, settlement, and interior drainage. Operation and maintenance plans must also be completed. The operation plan for the levee may include, but is not limited to, procedures for closures, interior drainage systems, and emergency measures. The maintenance plan should detail responsibility and frequency of maintenance necessary to ensure the integrity of the levee system. All items necessary for a levee system to be recognized as providing protection from the 1-percent annual chance flood must be certified by a registered professional engineer. The certification requirement is different if a Federal agency has responsibility for the levee.

The FEMA requirements in Section 65.10 are separated into five categories:

1. General criteria;
2. Design criteria;
3. Operations plans and criteria;
4. Maintenance plans and criteria; and
5. Certification requirements.

The requirements for each of these areas are summarized below.

6.4.1 General Criteria

For purposes of the NFIP, FEMA will only recognize in its flood hazard and risk mapping effort those levee systems that meet, and continue to meet, minimum design, operation, and maintenance standards that are consistent with the level of protection sought through the comprehensive floodplain management criteria established by Section 60.3 of the NFIP regulations. Section 65.10 of the NFIP regulations describes the types of information FEMA needs to recognize, on NFIP maps, that a levee system provides protection from the flood that has a 1-percent chance of being equaled or exceeded in any give year (base flood). This information must be supplied to FEMA by the community or other party seeking recognition of a levee system at the time a study or restudy is conducted, when a map revision under the provisions of Part 65 of the NFIP regulations is sought based on a levee system, and upon request by the Administrator during the review of previously recognized structures. The FEMA review is for the sole purpose of establishing appropriate risk zone determinations for NFIP maps and does not constitute a determination by FEMA as to how a structure or system will perform in a flood event.

6.4.2 Design Criteria

For the purposes of the NFIP, FEMA has established levee design criteria for freeboard, closures, embankment protection, embankment and foundation stability, settlement, interior drainage, and other design criteria. These criteria are summarized in subsections below.

6.4.2.1 Freeboard

For riverine levees:

- A minimum freeboard of 3 feet above the water-surface level of the base flood must be provided.
- An additional 1 foot above the minimum is required within 100 feet on either side of structures (e.g., bridges) riverward of the levee or wherever the flow is constricted.

- An additional 0.5 foot above the minimum at the upstream end of the levee, tapering to not less than the minimum at the downstream end of the levee, is also required.

Exceptions to the minimum riverine freeboard requirements above may be approved if the following criteria are met:

- Appropriate engineering analyses demonstrating adequate protection with a lesser freeboard must be submitted
- The material presented must evaluate the uncertainty in the estimated base flood elevation profile and include, but not necessarily be limited to:
  - An assessment of statistical confidence limits of the 1-percent-annual-chance discharge;
  - Changes in stage-discharge relationships; and
  - Sources, potential, and magnitude of debris, sediment, and ice accumulation.
- It must be also shown that the levee will remain structurally stable during the base flood when such additional loading considerations are imposed. Under no circumstances will freeboard of less than 2 feet be accepted.

6.4.2.2 Closures

The levee closure requirement is that all openings must be provided with closure devices that are structural parts of the system during operation and design according to sound engineering practice.

6.4.2.3 Embankment Protection

Engineering analyses must be submitted to demonstrate that no appreciable erosion of the levee embankment can be expected during the base flood, as a result of either currents or waves, and that anticipated erosion will not result in failure of the levee embankment or foundation directly or indirectly through reduction of the seepage path and subsequent instability.

The factors to be addressed in such analyses include, but are not limited to:

- Expected flow velocities (especially in constricted areas);
- Expected wind and wave action;
- Ice loading;
- Impact of debris;
- Slope protection techniques;
- Duration of flooding at various stages and velocities;
- Embankment and foundation materials;
- Levee alignment, bends, and transitions; and

- Levee side slopes.

6.4.2.4 Embankment and Foundation Stability

Engineering analyses that evaluate levee embankment stability must be submitted. The analyses provided shall evaluate expected seepage during loading conditions associated with the base flood and shall demonstrate that seepage into or through the levee foundation and embankment will not jeopardize embankment or foundation stability.

An alternative analysis demonstrating that the levee is designed and constructed for stability against loading conditions for Case IV as defined in U.S. Army Corps of Engineers (USACE) Engineering Manual 1110-2-1913, Chapter 6, Section II, may be used.

The factors that shall be addressed in the analyses include:

- Depth of flooding;
- Duration of flooding;
- Embankment geometry and length of seepage path at critical locations;
- Embankment and foundation materials;
- Embankment compaction;
- Penetrations;
- Other design factors affecting seepage (e.g., drainage layers); and
- Other design factors affecting embankment and foundation stability (e.g., berms).

6.4.2.5 Settlement

Engineering analyses must be submitted that assess the potential and magnitude of future losses of freeboard as a result of levee settlement and demonstrate that freeboard will be maintained within the minimum freeboard standards set forth in B(1).

This analysis must address:

- Embankment loads,
- Compressibility of embankment soils,
- Compressibility of foundation soils,
- Age of the levee system, and
- Construction compaction methods.

A detailed settlement analysis using procedures such as those described in USACE Engineering Manual EM 1110-1-1904 must be submitted.

6.4.2.6 Interior Drainage

An analysis must be submitted that identifies the source(s) of such flooding; the extent of the flooded area; and, if the average depth is greater than 1 foot, the water-surface elevation(s) of the base flood. This analysis must be based on the joint probability of interior and exterior flooding and the capacity of facilities (such as drainage lines and pumps) for evacuating interior floodwaters. Interior drainage systems usually include storage areas, gravity outlets, pumping stations, or a combination thereof. For areas of interior drainage that have average depths greater than 1 foot, mapping must be provided depicting the extents of the interior flooding, along with supporting documentation.

6.4.2.7 Other Design Criteria

In unique situations, such as those where the levee system has relatively high vulnerability, FEMA may require that other design criteria and analyses be submitted to show that the levees provide adequate protection. In such situations, sound engineering practice will be the standard on which FEMA will base its determinations. FEMA also will provide the rationale for requiring this additional information.

6.4.2.8 Operations Plans and Criteria

For a levee system to be recognized, the operational criteria must be as described below. All closure devices or mechanical systems for internal drainage, whether manual or automatic, must be operated in accordance with an officially adopted operation manual, a copy of which must be provided to FEMA by the operator when levee or drainage system recognition is being sought or when the manual for a previously recognized system is revised in any manner. All operations must be under the jurisdiction of a Federal or State agency, an agency created by Federal or State law, or an agency of a community participating in the NFIP.

6.4.2.9 Closures

Operation plans for closures must include the following:

- Documentation of the flood warning system, under the jurisdiction of Federal, State, or community officials, that will be used to trigger emergency operation activities and demonstration that sufficient flood warning time exists for the completed operation of all closure structures, including necessary sealing, before floodwaters reach the base of the closure;
- A formal plan of operation, including specific actions and assignments of responsibility by individual name or title; and • Provisions for periodic operation, at not less than 1-year intervals, of the closure structure(s) for testing and training purposes.

6.4.2.10 Interior Drainage Systems

Interior drainage systems associated with levee systems usually include storage areas, gravity outlets, pumping stations, or a combination thereof. FEMA will recognize these drainage systems on NFIP maps for flood protection purposes only if the following minimum criteria are included in the operation plan:

- Documentation of the flood warning system, under the jurisdiction of Federal, State, or community officials, that will be used to trigger emergency operation activities and demonstration that sufficient flood warning time exists to permit activation of mechanized portions of the drainage system;
- A formal plan of operation, including specific actions and assignments of responsibility by individual name or title;
- Provision for manual backup for the activation of automatic systems; and
- Provisions for periodic inspection of interior drainage systems and periodic operation of any mechanized portions for testing and training purposes; no more than 1 year shall elapse between either the inspections or the operations.

6.4.2.11 Other Operation Plans and Criteria

FEMA may require other operating plans and criteria to ensure that adequate protection is provided in specific situations. In such cases, sound emergency management practice will be the standard upon which FEMA determinations will be based.

6.4.3 Maintenance Plans and Criteria

For levee systems to be recognized as providing protection from the base flood, the following maintenance criteria must be met:

- Levee systems must be maintained in accordance with an officially adopted maintenance plan, and a copy of this plan must be provided to FEMA by the owner of the levee system when recognition is being sought or when the plan for a previously recognized system is revised in any manner.
- All maintenance activities must be under the jurisdiction of a(n):
  - Federal or State agency;
  - Agency created by Federal or State law; or
  - Agency of a community participating in the NFIP that must assume ultimate responsibility for maintenance.
- The maintenance plan must document the formal procedure that ensures that the stability, height, and overall integrity of the levee and its associated structures and systems are maintained.
- At a minimum, the maintenance plan shall specify:
  - Maintenance activities to be performed;
  - Frequency of their performance; and
  - Person by name or title responsible for their performance.

6.4.4 Certification Requirements

Data submitted to support that a given levee system complies with the structural requirements set forth in B(1) through B(7) above must be certified by a Registered Professional Engineer. Also, certified as-built plans of the levee must be submitted. Certifications are subject to the definition given in Section 65.2 of the NFIP regulations. In lieu of these structural requirements, a Federal agency with responsibility for levee design may certify that the levee has been adequately designed and constructed to provide protection against the base flood.

6.5 Useful Resources

The levee resources listed below provide more information on regulatory requirements, procedural requirements, and benefits of adequate progress and flood protection restoration determinations. These and other FEMA, NFIP, and Map Mod resources are located in the FEMA Library:

- Flood Protection Restoration: Zone AR Requirements Summary for State and Local Officials
- Flood Protection Restoration: Frequently Asked Questions Regarding the Zone AR Flood Insurance Risk Zone Designation
- Adequate Progress on Flood Protection Systems: Zone A99 Requirements Summary for State and Local Officials
- Adequate Progress on Flood Protection Systems: Frequently Asked Questions Regarding the Zone A99 Flood Insurance Risk Zone Designation
- Appendix H of *Guidelines and Specifications for Flood Hazard Mapping Partners*
  - NFIP Regulations; Section 59.1, 60.3, 61.12, 65.9, 65.10, 65.14

7.0 Financial Strategy - Project Funding Assistance Summary

7.1 General

This report serves to document the investigation of potential funding sources for the design and/or construction of flood protection improvements to Ash Sough in Madera County, California. This evaluation looks at Ash Slough itself as well as other tributaries and potential facilities that have an impact on Ash Slough. This TM documents the investigation by providing a brief synopsis of each program, applicable opportunities and constraints for these programs, references for additional information, and recommendations intended to improve the client's success in securing grant funds.

7.2 Objective

The primary objective of this report is to document the investigation of potential funding sources for the design and/or construction of flood protection improvements to Ash Slough and other tributaries and potential facilities that impact Ash Slough in Madera County (County). A secondary objective of this TM is to provide a series of recommendations intended to improve the County's success in securing grant funds.

7.3 Program Evaluation Criteria

A successful financial strategy must be equally capable of quickly and efficiently identifying, evaluating, prioritizing, applying, and securing available grant funds. The primary objective of this memorandum is to start building a list of potential funding sources during the feasibility phase of the project. A secondary objective is to initiate the evaluation of these programs to maximize the financial return on a limited investment of available resources. In order to simplify the process of evaluating and comparing a broad variety of grant programs, **Table 3** includes a list of criteria against which each program identified will be evaluated.

Table 3 - Grant Program Evaluation Criteria

Evaluation Criteria	Description
Application Cycle	Month Annual Applications are Due
Maximum Grant	Funding Limit for Various Types of Available Grants
Cost-Sharing Requirements	Maximum Value of Grant in Total Project Cost
Eligibility Requirements	Basis for Consideration

7.4 Potential Funding Sources

7.4.1 State of California – Integrated Regional Water Management Implementation

The Water Security, Clean Drinking Water, Coastal and Beach Protection Act of 2002, commonly referred to as Proposition 50, established an Integrated Regional Water Management

(IRWM) Grant Program. This Program is jointly administered by the California Department of Water Resources (DWR) and the California State Water Resources Control Board and provides funding for projects that protect communities from drought, protect and improve water quality, and reduce the dependence on imported water. This act was subsequently supplemented by the Safe Drinking Water, Water Quality and Supply, Flood Control, River and Coastal Protection Bond Act of 2006, commonly referred to as Proposition 84.

The IRWM Grant Program includes two separate grant types - Planning Grants and Implementation Grants. Our understanding is that Madera County has already developed and submitted an IRWM plan to DWR. The IRWM Program Guidelines include the following description of an eligible project for an Implementation Grant:

- Planning and implementation of multi-purpose flood control programs that protect property; and improve water quality, storm water capture and percolation; and protect or improve wildlife habitat.

IRWM Program Grants are awarded on a competitive basis. **Table 4** includes a list of factors and constraints that should be considered in determining whether to apply for funding under this program.

This funding source is most applicable to the potential detention basin, which would have a positive impact on the hydraulics of Ash Slough and Brenda Slough as well as the downstream sedimentation issues that are impacting the Sloughs.

Table 4 - IRWM Implementation Program Evaluation

Evaluation Criteria	Program Requirement
Application Cycle	Expected applications due Sept. 2010
Maximum Grant	$6.3 million allocated for the San Joaquin River Region
Cost-Sharing Requirements	25% but maybe waived if project addresses critical water supply or water quality
Eligibility Requirements	Must have submitted a IRWM Plan to DWR

They current draft Guidelines and Proposal Solicitation Packages can be found at the following Internet addresses:

http://www.water.ca.gov/irwm/docs/prop84/guidelinepsp/DraftImppsp.pdf

7.4.2 State of California – Integrated Regional Water Management Stormwater Flood management

Another program that is also under the integrated water management funding umbrella is the Stormwater Flood Management Grant Program. In contrast with the traditional IRWM programs, this is a new program that is funded under Proposition 1E instead of Proposition 84.

This program funds projects that are included in the adopted Integrated Regional Water Management Plan and is designed to manage stormwater runoff to reduce flooding and:

- Is consistent with the Regional Water Quality Control Plan
- It is not part of the State Plan of Flood Control
- Yields multiple benefits including
  - Groundwater recharge
  - Water quality improvement
  - Ecosystem restoration and benefits
  - Reduction of instream erosion and sedimentation

Table 5 includes a list of factors and constraints that should be considered in determining whether to apply for funding under this program.

This funding source is most applicable to the potential detention basin, which would have a positive impact on the hydraulics of Ash Slough and Brenda Slough as well as the downstream sedimentation issues that are impacting the Sloughs. The application package for the detention basin could be written to address all four of the main benefits identified above.

Table 5 - IRWM Stormwater Flood Management Program Evaluation

Evaluation Criteria	Program Requirement
Application Cycle	Expected applications due Sept. 2010
Maximum Grant	$30 million per project
Cost-Sharing Requirements	50% non-state cost share
Eligibility Requirements	Project included in IRWMP

They current draft Guidelines and Proposal Solicitation Packages can be found at the following Internet addresses:

http://www.water.ca.gov/irwm/docs/prop1e/guidelinepsp/SWFM_PSP_drft_FINAL.pdf

7.4.3 State of California – Local Groundwater Assistance

The Local Groundwater Management Assistance Act of 2000 (California Water Code [CWC] Section 10795 et seq.) (Act) was enacted to provide grants to local public agencies to conduct groundwater studies or to carry out groundwater monitoring and management activities. The Act gives priority for grant funding to local public agencies that have adopted a groundwater management plan (GWMP) and demonstrate collaboration with other agencies in the management of the affected groundwater basin.

The goal of the Local Groundwater Assistance (LGA) Program is to improve groundwater resource management and the knowledge of various groundwater basins throughout the state by funding projects that will provide long-term benefit to the management of groundwater.

Table 6 includes a list of factors and constraints that should be considered in determining whether to apply for funding under this program.

This funding source is most applicable to the potential detention basin, which would have a positive impact on the hydraulics of Ash Slough and Brenda Slough as well as the downstream sedimentation issues that are impacting the Sloughs. The funds could be used to model and determine potential groundwater recharge benefits of a future upstream detention basin.

Table 6 - Local Groundwater Assistance Program Evaluation

Evaluation Criteria	Program Requirement
Application Cycle	Expected applications due early 2011
Maximum Grant	$250,000
Cost-Sharing Requirements	None
Eligibility Requirements	Must have Groundwater Management Plan or can be used to develop a plan

They current draft Guidelines and Proposal Solicitation Packages can be found at the following Internet addresses:

http://www.water.ca.gov/lgagrant/docs/Draft_GuidelinesPSP_LGA-112309.pdf

7.4.4 State of California – Local Levee Grant Program

The Safe Drinking Water, Water Quality and Supply, Flood Control, River and Coastal Protection Bond Act of 2006, commonly referred to as Proposition 84, established a Local Levee Grant (LLG) Program. This program is administered by the California Department of Water Resources (DWR) and provides funding for the design and construction of repairs or improvement of local flood control facilities, including levees that are not part of the State Plan of Flood Control.

The LLG Program includes two separate components – Local Levee Urgent Repair (LLUR) Grants and Local Levee Evaluation (LOLE) Grants. It appears based upon the previous application process guidelines that only the LOLE grant would be applicable for the non-Project Levee portions of Ash Slough; however, final guidelines have not yet been published by DWR for this program for the upcoming cycle.

LLG Program Grants are awarded on a competitive basis. **Table 7** includes a list of factors and constraints that should be considered in determining whether to apply for funding under this program.

Table 7 - Local Levee Grant Program Evaluation

Evaluation Criteria	Program Requirement
Application Cycle	Expected late 2010 (Final Guideline have not been Published)
Maximum Grant	$1M – LOLE Grants
Cost-Sharing Requirements	Non state cost share 30% Reduced to 10% is annual median household income is less than 60% of the statewide number
Eligibility Requirements	Non-Project Levees

Madera County currently falls into the "Disadvantaged Community" classification which means that the annual household median income is less than 80% of the statewide number. This reduces the local cost share to 30%. Should the county have 2009 data that shows that it is less than 60% of the statewide number, then the local cost share is further reduced to 10%? Additionally 25% of the funds for this grant program are set aside for disadvantaged communities which increase the odds of being successful in the grant application cycle. DWR is currently developing updated guidelines for this program. Additional information regarding this program can be found at the following Internet address:

http://www.water.ca.gov/floodmgmt/fpo/sgb/llap/

7.4.5 State of California – Early Implementation Program

The Disaster Preparedness and Flood Prevention Bond Act of 2006, commonly referred to as Proposition 1E, established a number of new authorities under which the DWR may develop and administer grant programs dedicated to the design and construction of repairs or improvements of flood control facilities across the State.

Table 8 includes a list of factors and constraints that should be considered in determining whether to apply for funding under this program.

Table 8 - Early Implementation Program Evaluation

Evaluation Criteria	Program Requirement
Application Cycle	Expected late 2010
Maximum Grant	$200 million
Cost-Sharing Requirements	Non state cost share max 50%
Eligibility Requirements	Project Levees

It is possible to further reduce the local cost share of the project through a number of different ways including project features which are referenced in the link below. Currently, this program is specifically for Project Levees, therefore only the downstream portions of Ash Slough which is considered to be a Project Levee is applicable. Additional information regarding this program can be found at the following Internet address:

http://www.water.ca.gov/floodsafe/docs/2010EIP-GuidelineAmendmentsClean-2-18-10.pdf

7.4.6 State of California – Urban Streams Restoration Grant Program

The Urban Streams Restoration Program (USRP) funds grants to local communities for projects to reduce flooding and erosion and associated property damages; restore, enhance, or protect the natural ecological values of streams; and promote community involvement, education, and stewardship. There is very limited information for this program since it has been put on hold due to state budget issues and it is not known when this program will be reactivated.

7.4.7 FEMA – Flood Mitigation Assistance Program

The Flood Mitigation Assistance (FMA) Program administered by the Federal Emergency Management Agency (FEMA) provides funds to non-Federal Government agencies for the implementation of cost-effective measures identified to reduce or eliminate the long-term risk of flood damage to buildings, manufactured homes, and other structures insured under the National Flood Insurance Program (NFIP). The objective of the program is to reduce or eliminate claims under the NFIP through mitigation activities.

A review of the FY2007 FEMA FMA Program Guidance indicated that applications generally fall into two categories, flood mitigation planning grants and flood mitigation project grants. The Flood Mitigation Planning activities generally do not appear to apply to the Ash Slough Project; however, a Flood Mitigation Project Grant may be possible depending on the specific scope of the recommended alternative. A brief review of eligible project activities listed in 44 CFR 78.12 includes the following two statements:

1. Other activities that bring an insured structure into compliance with the floodplain management requirement at 44 CFR 60.3…

2. Minor physical flood mitigation projects that reduce localized flooding problems and do not duplicate the flood prevention activities of other Federal agencies.

FMA Program funds are awarded on a competitive basis. **Table 9** includes a list of factors and constraints that should be considered in determining whether to apply for funding under this program.

Table 9 - FEMA FMA Program Evaluation

Evaluation Criteria	Program Requirement
Application Cycle	End of year
Maximum Grant	Based on Amount of Funding Received by State or Community Applying
Cost-Sharing Requirements	Non-Federal cost share 25%
Eligibility Requirements	Approved FEMA Flood Mitigation Plan Active & Acceptable Status in FEMA NFIP

Additional information regarding this program can be found at the following Internet address:

http://www.fema.gov/government/grant/fma/index.shtm

7.4.8 FEMA – Pre-Disaster Mitigation Program

The Pre-Disaster Mitigation (PDM) Program administered by FEMA provides funds to non-Federal Government agencies for hazard mitigation planning and the implementation of mitigation projects prior to a disaster event. The objective of the program is to fund these plans and projects in order to reduce the overall risk to the population and structures while also reducing reliance on funding from a post-event disaster declaration.

A review of the FY2010 FEMA PDM Program Guidance indicated that applications generally fall into two categories, mitigation planning and mitigation projects. Mitigation Planning activities generally do not appear to apply to the Ash Slough Project; however, the following types of Mitigation Projects activities are eligible for grant assistance:

- Hydrologic and hydraulic studies/analysis, engineering studies, and drainage studies for the purpose of project design and feasibility determination;
- Protective measures for utilities, water, and sanitary sewer systems and/or infrastructure;
- Localized flood control projects, such as ring levees, bank stabilization, and floodwall systems that are specifically designed to protect critical facilities, including sewer and wastewater treatment facilities.

PDM Program funds are awarded on a competitive basis. **Table 10** includes a list of factors and constraints that should be considered in determining whether to apply for funding under this program.

Table 10 - FEMA PDM Program Evaluation

Evaluation Criteria	Program Requirement
Application Cycle	End of Year
Maximum Grant	$3M – Mitigation Projects
Cost-Sharing Requirements	Non Federal cost share 25%
Eligibility Requirements	Approved FEMA Hazard Mitigation Plan Active & Acceptable Status in FEMA NFIP

Additional information regarding this program can be found at the following Internet address:

http://www.fema.gov/government/grant/pdm/index.shtm

7.4.9 FEMA – Cooperative Technical Partner (CTP) Program

The CTP program is a partnership between FEMA and local communities. The purpose of this program is to have local communities act as a partner with FEMA and take the lead on developing updated flood maps. This funding source is not a grant program and does not have a cycle. It is about sitting down with a FEMA representative and talking through your plans with them. This funding is again, for development of flood maps which is based upon topography, hydrology and hydraulics. There is no cap to this program or local cost share. Additional information regarding this program can be found at the following internet address:

http://www.fema.gov/plan/prevent/fhm/ctp_main.shtm

7.5 Methods to Cover Cost Share

Many of the programs described above have a cost share component. There are two ways to address this cost share with the first being to match up the state grants with the federal grants. The cost share requirements are typically stated as non-state cost share and non-federal cost share which means that the County may be able to cover the non-state cost share part of a state grant with a federal grant. This is difficult to do since the federal grant programs are extremely competitive. The second way is to raise the local cost share in California communities is through a Prop 218 assessment/election. This process is used to determine the area of benefit for a specific project and how each entity in the area of benefit should be assessed. This process requires a public vote and return of 50% plus one of the voters returning ballots. This places an assessment on each parcel that is paid when property taxes are paid each year.

7.6 Increasing the Odds

Most of the programs discussed above are awarded through a competitive process with a lot of competition. HDR has developed a three step process that increases the success rate. These steps are 1) informing 2) submitting the application 3) following up. 1) The informing step is where we reach out to the appropriate local elected representatives (state assembly and senators for statewide grants and congressional members and senators for federal funds) and inform them about project and the needs as well as discuss what grant programs we will be competing for. We also take this opportunity to inform the staff that will be selecting and ranking the grant applications to visit the site and talk about the project as well as the grant program. 2) We submit a responsive application package. In our response we will use key buzz words that we have learned in step 1 from talking with the staff that will be selecting and administering the grants from the respective agency. 3) Finally, after submitting the application we follow up with the appropriate elected representative and asked for them to submit a letter of support to the head of the agency (for the state it would be the Director of DWR) as well as the agency person leading the ranking of grant applications. We have learned over time that this approach results in very high success in being selected for the grant.

7.7 Conclusion

The funding assistance opportunities and associated strategy described in this TM are intended to complement the other studies underway as part of the contract.

This memorandum is the start to building a list of potential funding sources during the feasibility phase of the project. A secondary objective is to initiate the evaluation of these programs to maximize the financial return on a limited investment of available resources.

Based on the list of grant programs compiled and evaluated in this TM, the following recommendations are intended to improve the client's success in securing grant funds:

- Develop a cost estimate for the project as well as other project components such as the upstream detention basin.
- If the county has not done so already, compete for the Local Groundwater Assistance grant program, which has no cost share, to better determine the potential groundwater recharge benefits that an upstream detention basin would have on the existing groundwater.
- Enter into a CTP agreement with FEMA so the County can use the topography developed by DWR to evaluate the existing hydraulic conditions and flow splits. Potentially there may be reduced flood risks by modifying the flow splits at bifurcation structures.
- Combine both state grant programs with federal grant programs which will limit the amount of cost share the County needs to come up with.

- Initiate a Benefit-Cost Analysis of the recommended project upon completion of the feasibility study. This analysis will establish eligibility in many grant programs (BCR > 1.0) while also potentially reinforcing the value of the investment if the BCR is very high.

- Establish an overall preliminary program schedule for the design and construction of the flood protection improvement project. This schedule will assist in determining the appropriate category of grant and timing for filing grant applications.

- Verify participation through the City or County in the FEMA National Flood Insurance Program (NFIP); and, furthermore, ensure coverage in a current FEMA Hazard and Flood Mitigation Plan.

Attachment 3.2, Valley Floor Groundwater Level Decline

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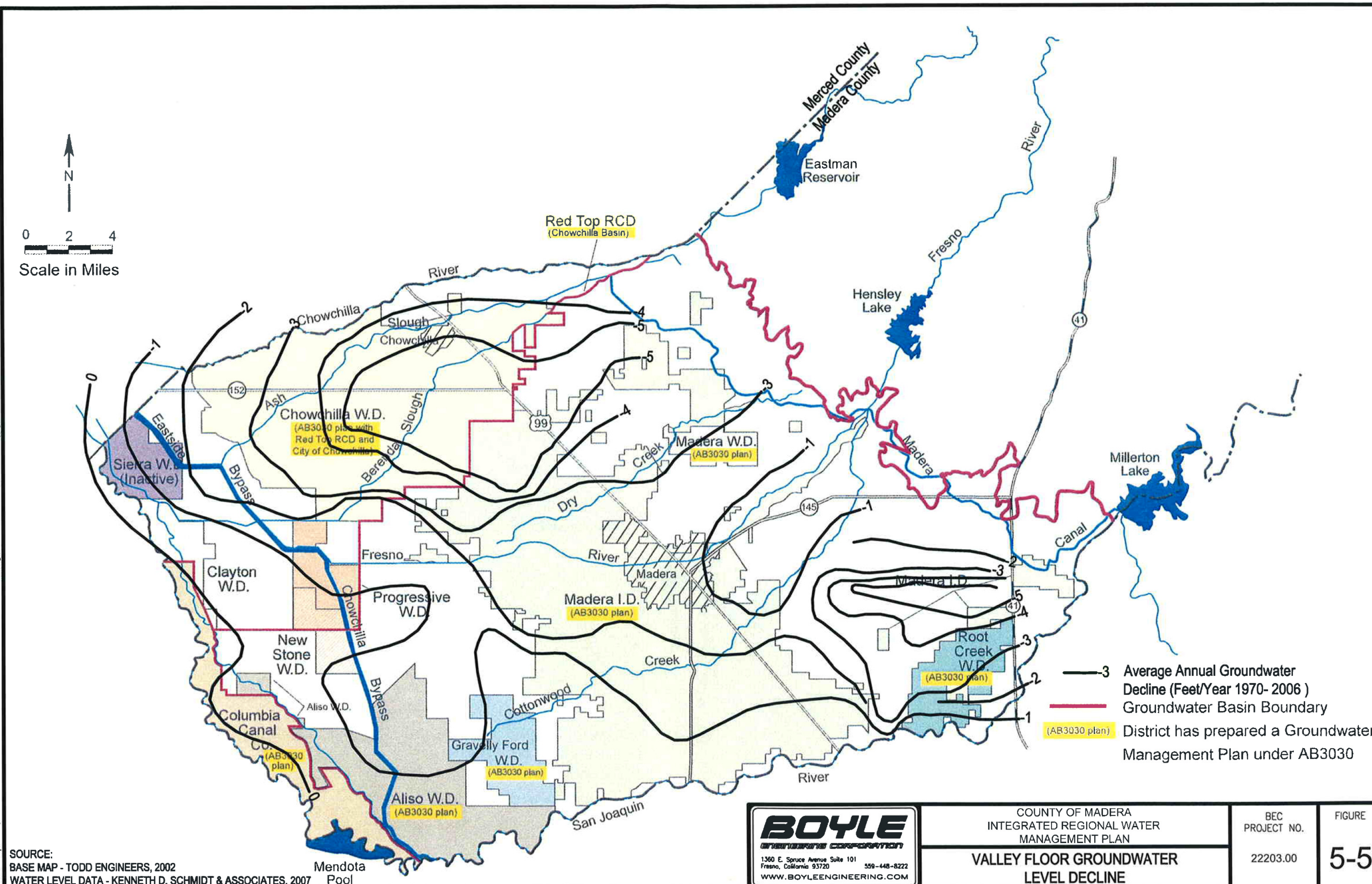

SOURCE:
BASE MAP - TODD ENGINEERS, 2002
WATER LEVEL DATA - KENNETH D. SCHMIDT & ASSOCIATES, 2007

BOYLE ENGINEERING CORPORATION
1360 E. Spruce Avenue Suite 101
Fresno, California 93720 559-448-8222
WWW.BOYLEENGINEERING.COM

COUNTY OF MADERA INTEGRATED REGIONAL WATER MANAGEMENT PLAN	BEC PROJECT NO.	FIGURE
VALLEY FLOOR GROUNDWATER LEVEL DECLINE	22203.00	5-5

DWG: V:\Madera, County of\22203.00 IRWMP\CAD\FIGURES\Chapter 5\FIG 5-5.dwg USER: drodriguez
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Attachment 3.2, Preliminary Comparison of Transpirational Water Use by *Arundo donax* and Replacement Riparian Vegetation Types in California

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Preliminary Comparison of Transpirational Water Use by *Arundo donax* and Replacement Riparian Vegetation Types in California

Report to Madera Co. RCD, Elissa Brown
From: Tom Dudley, Marine Science Institute, U.C. Santa Barbara
& Shelly Cole, Environmental Sciences Program, U.C. Berkeley

Introduction

Arundo donax or giant reed is hypothesized to cause excessive losses of groundwater to the atmosphere, based on an assumption that it has high transpiration rate during photosynthesis relative to other riparian plant types, and that its large leaf surface area facilitates even greater water consumption and transport (Dudley 2000). Some initial comparisons do suggest that it may transpire almost double the amount of water as does a native willow in northern California under some circumstances (Zimmerman 1999, Hendricks et al. 2006). Researchers in Texas indicate that *Arundo* has high transpiration output but associated plant types were not compared in that case (Watt et al. 2008). In semi-arid riparian areas of California and the Southwest excessive transpiration by invasive plants potentially exerts pressure on natural or managed ecosystems by exhausting surface water and depleting groundwater (Shafroth et al. 2005). Documentation of such effects would provide a solid basis for implementing control programs for invasive plants such as *Arundo* if it can be shown that replacement by native or other plants that transpire less water could enhance water availability for wildlife and human uses.

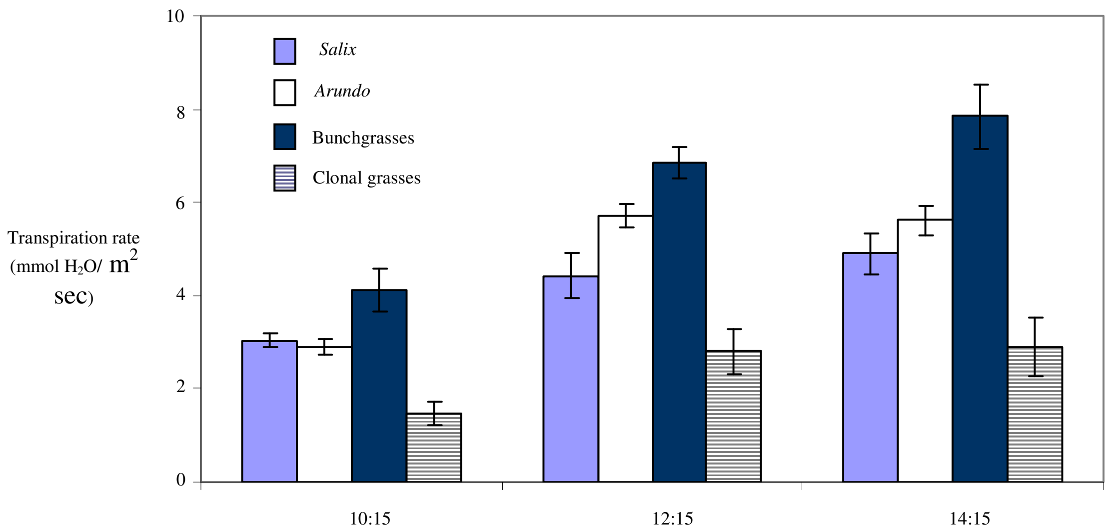
We conducted a comparison of water use by four vegetation types, including *Arundo*, a native willow, large-statured bunch grasses and prostrate, clonal grasses, to determine the relative amount of sub-surface water that are transpired to the atmosphere during the warm season in California. This trial study was conducted at the Hedrick Conservation Area (HCA), a private nature reserve on the Santa Clara River in Ventura County. *Arundo* and red willow (*Salix laevigata*) were plants that we had grown in an experimental 'plantation' for other ecological studies (Coffman 2006); the other plants were either installed in restoration efforts or existed naturally at the HCA within 200 meters of the plantation, and included 'bunch grasses' (*Leymus triticoides* – creeping wildrye, *Elymus condensatus* – giant wildrye) and 'clonal grasses' (*Distichlis spicata, Cynodon dactylon*). Weather data used for calculating moisture dynamics were from the nearby U.C. Coop. Extension Hansen Agricultural Center.

The trials were conducted at the beginning of September and consisted to 4 days for collecting data. Leaf-level moisture flux (transpiration) was measured using Lincoln Corporation portable photosynthesis unit (LiCor 6100) at three times of the day, mid-morning, mid-day and early afternoon, to reflect daily variation in temperature and light intensity. The LiCor test chamber would be used to measure moisture flux from two leaves on each test plant, the leaves chosen to be the uppermost (newest) on a given stem that had fully opened; measurements were replicated on a minimum of five plants for each treatment group (*Arundo*, *Salix*, bunchgrass, clonal grass). Whole plant transpiration was then estimated by extrapolating unit-leaf area moisture flux measurements to whole plant leaf area, which was determined by harvesting sub-portions of the test plants and measuring leaf dimension to calculate whole-plant leaf area.

Results

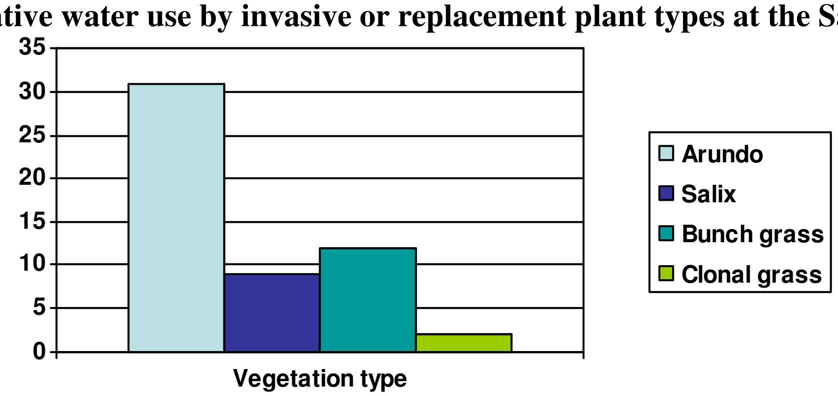
The following table presents values for transpiration (or water loss) through foliage of the experimental plants. These are estimates for a standardized leaf surface area, and indicate that generally willow (*Salix laevigata*) is roughly similar to *Arundo donax* on a leaf-area basis, that our 'bunch grasses' (*Leymus triticoides, Elymus condensatus*) are more water-consumptive, and 'clonal grasses' (*Distichlis spicata, Cynodon dactylon*) use substantially less water when standardized for leaf area. Note, however, that during the high light-intensity mid-day period, *Arundo* transpired approximately 25% more water than did the willow; these differences were statistically significant. This suggests that *Arundo* has an inherent higher capacity to continue transpiration (or photosynthesis) at a high rate when under excessive light conditions, while willows may respond to by reducing photosynthetic rate. Such photo-inhibition is well-documented in many plants, and it is likely that this dichotomy also exists between *Arundo* and willows too. This would translate into substantially larger daily ET rates for *Arundo*, once transpiration values are integrated over the full daylength period.

Transpiration rates for target vegetation types at the Santa Clara River



The more critical comparison, however, is transpiration on a per-unit ground area basis. We calculated the photosynthetic area, or leaf area, for 4 plants of each plant type, as well as the average ground area occupied by that plant (its 'footprint'). The estimated leaf area per m^2 for the four vegetation types at our study site on the Santa Clara River were: willow 1.1 – 2.9 m^2 ; *Arundo* 3.7 – 6.7 m^2 ; Clonal grasses 0.3 – 0.8 m^2; Bunch grasses 1.0 – 2.4 m^2. By using

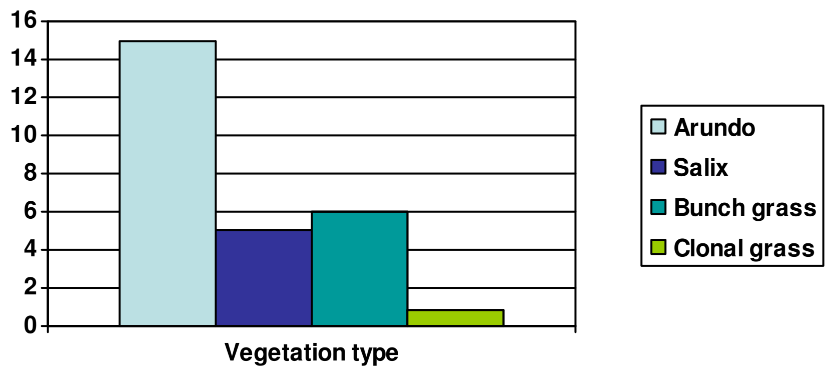
Relative water use by invasive or replacement plant types at the Santa Clara River



the mid-range values for leaf-area, and the mid-day transpiration rates, the relative water use by these 4 vegetation types is: *Salix* – 9 units water (on a relative basis); *Arundo* – 31 units; Bunch grasses – 12 unit; Clonal grasses – 2 units water.

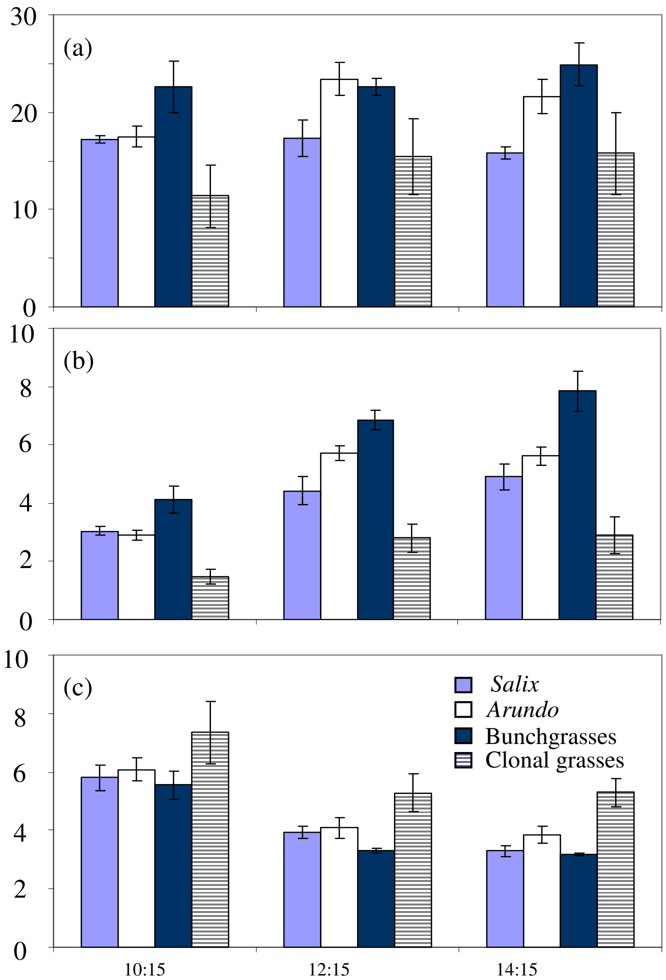
A rough prediction of the actual amount of water transpired to the atmosphere by each vegetation type can subsequently be calculated as the product of the transpiration volume per second over the time period that plants are photosynthetically active, and extrapolating this value to plant leaf area. For the late summer period when measurements were taken, we estimated the period of active photosynthesis as being 10 hours long (discounting morning and evening hours when light incidence is relatively low), and extrapolated interim hourly values between the three measurement points as a curvilinear relationship. This yielded a range of daily water use values from 0.015 m^3 (15 l.) per m^2 ground area with *Arundo* to 0.0008 m^3 (0.8 l.) for *Cynodon* and *Distichlis* clonal grass forms. That would be equivalent to 150 m^3 of water loss per hectare of *Arundo*-infested riparian area per warm, sunny day, or approximately 0.12 acre-feet per day.

Estimate daily mid-summer water use by target plant types (liters per day per m^2)



These values could be further extrapolated to annual water use quantities by estimating the transpiration rates per unit time at different times of the year, but for several reasons this is beyond the scope of the preliminary data we have generated. For purposes of discussion, we might assume that these mid-summer transpiration values are representative of 4 warm months, that 4 spring and fall months produce half as much water use, and during winter there are 4 months of transpiration rates about 15% of summer rates. Based on these conjectures, *Arundo* may remove approx. 3.0 m^3 of groundwater to the atmosphere for every m^2 of infested land area, compared with 1.0 to 1.2 m^3 for native vegetation; 0.16 for groundcover 'clonal' grasses; this would be equivalent to drawing down the groundwater level by the same numerical relationship (e.g. 3 m by *Arundo*) if the whole system was comprised of that vegetation type. We cannot stand by these estimates, however, because transpiration is highly dependent upon air temperature and relative humidity, on water availability, and on the amount of total leaf area and shading that would exist at different times of the year. Although *Arundo* is presumed to be more metabolically active during winter months than are willows and so would certainly be relatively even more water-consumptive at that time of year, we are unable to make a rational evaluation of actual seasonal water use because of the lack of appropriate data needed to make such calculations.

The following graphs of PS rates and Water Use Efficiency expand the relationships described previously (the above Transpiration graph is 'b'), although they are more complex than is easily explained in this preliminary report. WUE suggests that the clonal grasses are most efficient at photosynthesis with respect to water used, while *Arundo* is marginally more efficient than the willows it has displaced.



The (a) photosynthetic rate (µmol/m^2 sec), (b) transpiration rate (mmol/m^2 sec) and (c) water use efficiency (mmol CO_2/molH_2O) of study plants at three time periods. *n*=5 and bars indicate ±1 SE.

Discussion/Preliminary Conclusions

It appears that under warm-season conditions in semi-arid regions *Arundo* uses roughly three times as much water as do moderate sized replacement species (red willow, ryegrasses) that also provide some habitat value for wildlife, and about 15 times more water than does a low-quality grass such as native saltgrass or introduced bermudagrass. This may translate to roughly 0.12 acre-feet of water use by an acre of *Arundo*-infested landscape, one-third that among by willows (0.04 ac-ft) and large grasses (0.05 ac-ft), and somewhat less that 0.01 acre-feet by low-growing native or exotic grasses.

One caveat is that there are certainly areas where *Salix* and other plants have a greater (or less) leaf surface area than we found at this site, so our results are not robust across a larger region without correction for the leaf area present per meter-square of land surface. We did, however, find roughly similar results when the same approach was taken in comparing *Arundo* and *Salix exigua* in northern California (Zimmerman 1999). In that study, transpiration per unit leaf area was more equivalent between the two taxa, but the leaf area of *Arundo* was approximately double that of *Salix* so the water losses through *Arundo* were consequently about double that lost through willow photosynthesis.

It is important to note that these are very preliminary results, and firmer conclusions must wait until we do a longer series of PS/transpiration trials under a full range of environmental conditions, and at different times of the year. The degree of soil saturation greatly influences transpiration, and the plants in this study had ample water supplies available while under other circumstances plants may experience variable degrees of water-stress (and stress may differ among species) when results would be much lower. Also, these measurements were taken under full sunlight, but portions of plants obviously are shaded to different degrees, which will reduce photosynthesis, and thus, transpiration. The shade produced by *Arundo* may, in fact, be greater than that created by the other species which would further influence transpiration estimates. Plant density can further influence the local microenvironment, particularly by creating locally high humidity conditions which would also lead to over-estimates of water use by testing leaf surface transpiration in the open away from the plant under canopy, although the equipment can partially compensate for such humidity effects.

Also, we need to develop more accurate leaf area assessments, which will require much more extensive harvesting and measuring of plant parts. The stomatal surface area should be accurately described as well, because some plants have greater stomatal density on the same leaf surface area (even on one side vs. both sides of the leaf), which should be understood in accurately assessing water use. Some stems have photosynthetic tissue, which should be included in transpiration estimates.

In future studies we will determine how PS differs based on leaf types (new vs. old, sun vs. shade leaves) and at different positions in the plant. In particular, we intend to measure how shading affects leaf metabolic activity, but some very preliminary tests indicated that *Arundo* has higher PS activity in the shade than does *Salix*, which would certainly tend to increase the relative difference in water use by the two. That, in combination with estimates under low water availability levels, I think will certainly show that *Arundo* is very significantly and substantively worse than any of the other plant types, in terms of water loss from regional rivers and groundwater.

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Hendricks, D.A., S. McGaugh, T. Dudley, K. Lyons. *Arundo donax* (Carrizo Grande / Giant Cane) in Cuatro Ciénegas. http://www.desertfishes.org/cuatroc/organisms/non-native/*Arundo*/*Arundo*.html#Literature

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Attachment 3.2, Global Invasive Species Database: Ecology of Arundo

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Arundo donax (grass)

Taxonomic name: *Arundo donax* (L.)
Synonyms: *Aira bengalensis* (Retz.) J.F. Gmel., *Amphidonax bengalensis* (Retz.) Nees ex Steud., *Amphidonax bengalensis* Roxb. ex Nees., *Amphidonax bifaria* (Retz.) Nees ex Steud., *Arundo aegyptiaca* hort. ex Vilm., *Arundo bambusifolia* Hook. f., *Arundo bengalensis* Retz., *Arundo bifaria* Retz., *Arundo coleotricha* (Hack.) Honda., *Arundo donax* var. *angustifolia* Döll., *Arundo donax* var. *coleotricha* Hack., *Arundo donax* var. *lanceolata* Döll., *Arundo donax* var. *procerior* Kunth., *Arundo donax* var. *versicolor* (P. Mill.) Stokes, *Arundo glauca* Bubani., *Arundo latifolia* Salisb., *Arundo longifolia* Salisb. ex Hook. f., *Arundo sativa* Lam., *Arundo scriptoria* L., *Arundo versicolor* P. Mill., *Cynodon donax* (L.) Raspail., *Donax arundinaceus* P. Beauv., *Donax bengalensis* (Retz.) P. Beauv., *Donax bifarius* (Retz.) Trin. ex Spreng., *Donax donax* (L.) Asch. and Graebn.
Common names: arundo grass (English), bamboo reed (English), caña (Spanish), caña común (Spanish), caña de Castilla (Spanish), caña de la reina (Spanish), caña de techar (Spanish), cana- do-reino (Portuguese-Brazil), cana-do-brejo (Portuguese-Brazil), cane (English), canne de Provence (French), canno-do-reino (Portuguese-Brazil), capim-plumoso (Portuguese-Brazil), carrizo (Spanish), carrizo grande (Spanish), cow cane, donax cane (English), fiso palagi (Samoan), giant cane (English), giant reed (English), grand roseau (French), kaho (Tongan-Tonga Islands), kaho folalahi (Tongan-Tonga Islands), la canne de Provence (French- New Caledonia), narkhat (Hindi), ngasau ni vavalangi (Fijian-Fiji Islands), Pfahlrohr (German), reedgrass (English), river cane (English), Spaanse-riet, Spanisches Rohr (German), Spanish cane (English), Spanish reed (English), wild cane (English)
Organism type: grass
Giant reed (Arundo donax) invades riparian areas, altering the hydrology, nutrient cycling and fire regime and displacing native species. Long 'lag times' between introduction and development of negative impacts are documented in some invasive species; the development of giant reed as a serious problem in California may have taken more than 400 years. The opportunity to control this weed before it becomes a problem should be taken as once established it becomes difficult to control.

Description

Arundo donax is a very tall and robust bamboo-like, perennial grass with large, spreading clumps of thick culms to 6.1 m tall. The numerous leaves are about 5 cm wide and 30.5-61 cm long, and arranged conspicuously in two opposing ranks on the culms. The leaves look like those of a corn plant. Their margins are sharp to the touch and can cut careless hands. The inflorescence, appearing in late summer, is a 0.3-0.6 m long purplish, aging to silver, plume that stands above the foliage. Giant reed spreads from thick, knobby rhizomes. Once established, it tends to form large, continuous, clonal root masses, sometimes covering several acres. These root masses can be more than 1 m thick. The foliage dries to light brown in the winter and rattles in the wind. Striped giant reed (*A. donax* var. *versicolor*, has leaves with bold white stripes, and is a smaller plant, to 2.4 m tall (Christman, 2003; McWilliams, 2004).

Occurs in:

agricultural areas, coastland, desert, natural forests, planted forests, range/grasslands, riparian zones, ruderal/disturbed, scrub/shrublands, urban areas

Habitat description

Arundo donax is a hydrophyte, and grows best where water tables are near or at the soil surface. It establishes in moist places such as ditches, streams, and riverbanks, growing best in well drained soils where abundant moisture and sunlight is available. *A. donax* has also been demonstrated to prefer areas with enriched nitrogen levels. It tolerates a wide variety of conditions, including high salinity, and can flourish in many soil types from heavy clays to loose sands. It is well adapted to the high disturbance dynamics of riparian systems. *A. donax* inhabits USDA zones 6-11 (Benton *et al*, 2006; Ambrose & Rundel, 2007).

General impacts

Dense populations of *Arundo donax* affect riversides and stream channels, compete with and displace native plants, interfere with flood control, and is extremely flammable increasing the likelihood and intensity of fires. It may establish a invasive plant-fire regime as it both causes fires and recovers from them 3-4 times faster than native plants. It is also known to displace and reduce habitats for native species including the Federally endangered Least Bell's Vireo (*Vireo bellii*).

Its long, fibrous, interconnecting root mats of giant reed form a framework for debris behind bridges, culverts, and other structures that can effect their function and disturb ecosystems. Its rapid growth rate, estimated 2-5 times faster than native competitors, and vegetative reproduction, it is able to quickly invade new areas and form pure stands. Once established, *A. donax* has the ability to outcompete and completely suppress native vegetation, reduce habitat for wildlife, and inflict drastic ecological change (Benton *et al*, 2006; McWilliams, 2004; Ambrose and Rundel, 2007; Rieger & Keager, 1989).

Uses

Arundo donax is grown as an ornamental for the its striking appearance, purplish stems, and for the huge feather-like panicles of purplish flowers. It is the largest and tallest ornamental grass other than bamboo, and the tallest grass that can be grown outside the tropics. The large, thick and fluffy flower plumes are used in floral arrangements. *A. donax* is also used to make reeds for woodwind instruments and were once used for organ pipes. Giant reed is commonly planted in wet soils to reduce erosion (Christman, 2003).

In folk medecine, the rhizome or rootstock of *Arundo donax* is used for dropsy. Boiled in wine with honey, the root or rhizome has been used for cancer. This or other species of *Arundo* is also reported to be used for condylomata and indurations of the breast. The root infusion is regarded as antigalactagogue, depurative, diaphoretic, diuretic, emollient, hypertensive, hypotensive, and sudorific (Duke, 1997).

Geographical range

Native range: Afghanistan, Algeria, Azerbaijan, China, Cyprus, Egypt, Georgia, India, Indochina, Iran, Iraq, Israel, Japan, Jordan, Lebanon, Libya, Myanmar, Nepal, Pakistan, Saudi Arabia, Syria, Taiwan, Tunisia, Turkey, Turkmenistan, Ukraine, Uzbekistan

Known introduced range: Argentina, Australia, Bangladesh, Bermuda, Bolivia, Brazil, Cayman Islands, Chile, Cook Islands, Costa Rica, Dominican Republic, Ecuador, El Salvador, Fiji, French Polynesia (Polynésie Française), Gibraltar, Guam, Guatemala, Haiti, Indonesia, Italy, Kiribati, Mexico, Micronesia, Namibia, Nauru, New Caledonia (Nouvelle Calédonie), New Zealand, Nicaragua, Norfolk Island, Palau, Peru, Portugal, Samoa, South Africa, Suriname, Swaziland, Tonga, United States (USA), Uruguay, Venezuela

Introduction pathways to new locations

Agriculture:
Floating vegetation/debris:
Landscape/fauna "improvement":
Nursery trade: Canes traditionally cultivated for variety of uses - fencing, thatch, framing, musical instruments and woodwind reeds; carried esp. by Spanish colonists.

Local dispersal methods

Garden escape/garden waste: Available in nursery trade.
Translocation of machinery/equipment (local):
Water currents: Floods break up clumps of *Arundo donax* and spread pieces downstream where they can take root and establish new clones (McWilliams, 2004).
Wind dispersed: The hairy, light-weight disseminules (individual florets with the enclosed grain) are dispersed by wind (McWilliams, 2004).

Management information

Preventative measures: A Risk assessment of *Arundo donax* for Australia was prepared by Pacific Island Ecosystems at Risk (PIER) using the Australian risk assessment system (Pheloung, 1995), resulting in a score of 12 with a recommendation "to reject the plant for import (Australia) or species likely to be of high risk (Pacific)".

Chemical: The use of systemic herbicides such as glyphosate or fluazipop applied after flowering either as a cut stump treatment or foliar spray have been found to control *Arundo donax*. Caution should be taken when using such herbicides around water or in wetlands (Benton *et al*, 2005; PIER, 2008).

Physical: Hand pulling may be effective at removing small infestations of *Arundo donax*, but care must be taken to remove all rhizomes to prevent re-establishment. Cutting is not recomended unless the rhizomes are dug up, as tiny rhizomes can grow into new colonies. Burning is not recomended either as it has been demonstrated to aid the growth of *Arundo donax* because it regrows 3-4 times faster than native plants (PIER, 2008; Ambrose & Rundel, 2007).

Biological control: Native flora and fauna typically do not offer any significant control potential of *Arundo donax*. It is uncertain what natural controlling mechanisms for giant reed are in its countries of origin, although corn borers, spider mites, and aphids have been reported in the Mediterranean. A sugar cane moth-borer in Barbados is reported to attack giant reed, but it is also a major pest of sugar cane and is already found in the United States in Texas, Louisiana, Mississippi, and Florida. A leafhopper in Pakistan utilizes *A. donax* as an alternate host but attacks corn and wheat. In the United States a number of diseases have been reported on giant reed, including root rot, lesions, crown rust, and stem speckle, but none seem to have seriously impacted advance of this weed. Giant reed is not very palatable to cattle, but during the drier seasons they will graze the young shoots, followed by the upper parts of the older plants. However, in many areas of California the use of Angora and Spanish goats is showing promise for controlling *A. donax*. Also an unidentified stem-boring sawfly that appears similar to *Tetramesa romana* has been demonstrated to cuase significant damage to *A. donax*, and it is being tested in quarantine as a candidate biocontrol agent for it (McWilliams, 2004; Dudley *et al*, 2006).

Integrated management: A popular approach to treating giant *Arundo donax* has been to cut the stalks and remove the biomass, wait 3 to 6 weeks for the plants to grow about 1 m tall, then apply a foliar spray of herbicide solution. The chief advantage to this approach is less herbicide is needed to treat fresh growth compared with tall, established plants, and coverage is often better because of the shorter and uniform-height plants. However, cutting the stems may result in plants returning to growth-phase, drawing nutrients from the root mass. As a result there is less translocation of herbicide to the roots and less root-kill. Additionally, cut-stem treatment requires more time and personnel than foliar spraying and requires careful timing. Cut stems must be treated with concentrated herbicide within 1 to 2 minutes of cutting to ensure tissue uptake. This treatment is most effective after flowering. The advantage of this treatment is that it requires less herbicide and the herbicide can be applied more precisely. It is rarely less expensive than foliar spraying except on very small, isolated patches or individual plants (McWilliams, 2004).

Nutrition

Arundo donax photosynthesizes through C3 fixation which requires abundant sunlight and moisture. It has also been demonstrated to prefer areas with enriched nitrogen levels (Lewandowski *et al*, 2003; Benton *et al*, 2006; Ambrose & Rundel, 2007).

Reproduction

Reproduction of *Arundo donax* is primarily vegetative by way of rhizomes which root and sprout readily and layering in which stems touching the ground sprout roots. Layering has been demonstrated to expand *A. donax* as much as 7.4 times faster than spread by rhizomes but is thought to only occur within flood zones. *A. donax* tends to form large, continuous, clonal root masses, sometimes covering several acres. It very rarely produces seeds and very little is known about its sexual reproduction (Benton *et al*, 2006; Boland, 2006; McWilliams, 2004)

This species has been nominated as among 100 of the "World's Worst" invaders

Reviewed by: Tom Dudley Marine Science Institute University of California Santa Barbara & Natural Resource & Environmental Sciences University of Nevada, Reno. United States

Principal sources: McWilliams, John D. 2004. *Arundo donax*. In: Fire Effects Information System, [Online]. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory (Producer).

Pacific Island Ecosystems at Risk (PIER)., 2006. Risk Assessment *Arundo donax* L., Poaceae

Compiled by: Profile revision: National Biological Information Infrastructure (NBII) & IUCN/SSC Invasive Species Specialist Group (ISSG)

To contribute information, please contact Shyama Pagad.

Last Modified: Thursday, 23 March 2006

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Attachment 3.2, Photos of Arundo Infestation in Ash Slough

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Ash Slough Arundo Eradication Project – Photos of Arundo in Ash Slough

Ash Slough adjacent to the City of Chowchilla. Dense greenery is Arundo Infestation

Ash Slough Arundo Eradication Project – Photos of Arundo in Ash Slough

Arundo infestation spreading to adjacent agricultural areas

Un-managed Arundo canes can grow to 20 feet in height. Canes are cut and allowed to re-sprout prior to spraying for more effective eradication.

Attachment 3.2, Current Flora and Fauna and Restoration Plant List – Ash Slough

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Current Flora and Fauna and Restoration Plant List

Current conditions: Based on site visits in October and November 2008, more than 29 species of plants grow on the site, 16 are native to the area.

Existing native plants on the site:

Shrubs and Trees:
Fremont's Cottonwood (*Populus fremontii*)
Valley Oak (*Quercus lobata*)
Arroyo willow (*Salix lasiolepsis*)
Blue Elderberry (*Sambucus mexicana*)

Forbs and Herbs:
Mugwort (*Artemesia douglasiana*)
Wire Lettuce (*Stephanomaria* sp)
Sunflower (*Helianthus annua*)
Cockleburr (*Xanthium strumarium*)
Jimson Weed (*Datura discolor*)
Pale smartweed (*Polygonum* sp.)
Lambs quarters (*Chenopodium album*)
Mullein (*Verbascum thapsis*)

Grasses and Sedges:
Tule (*Scirpus* sp.)
Barnyardgrass (*Echinochloa crus-galli*)
Creeping Wildrye (*Leymus triticoides*)
Sprangletop (*Leptochloa unervia*)

Exotic Species:
Foxtail barley (*Hordeum murinum spp. leporinum*)
Fig (*Ficus* sp.)
Soft chess (*Bromus hordeaceous*)
Russian thistle (*Salsola kali*)
Tree of heaven (*Ailanthus altissima*)
Telegraph weed (*Heterotheca grandiflora*)
Giant reed (*Arundo donax*)
Himalayan blackberry (*Rubus discolor*)
Nut sedge (*Cyperus* sp.)
Milk thistle (*Silybum marinum*)
Wild oats (*Avena fatua*)
Sow thistle (*Sonchas* sp.)

Mammal species observed on the site:
California groundsquirrel (*Spermophilus beechii*)
Audubon cottontail (*Sylvilagus audubonii*)

Bird species observed on the site:
Ruby-crowned kinglet
Anna's Hummingbird
White-crowned sparrow
Common raven
Western scrub jay
Brewer's blackbird
Northern mockingbird
Northern flicker
Yellow-rumped warber
American crow
Bushtit
Nuttall's woodpecker
Red-shouldered hawk

Habitat Enhancement Benefits to Wildlife

In all, at least 9 special status species are likely to benefit from habitat enhancement and *Arundo* control on the site.
Restoration of riparian areas can improve the habitat for the following species:

- Western Yellow-billed cuckoo (*Coccyzus americanus occidentalis*), a federal candidate species
- Southwestern willow flycatcher (*Empidonax traillii extimus*) a state and federally endangered species
- Least Bell's vireo (*Vireo bellii pusillus*), a state and federally endangered species
- Swainson's hawk (*Buteo swainsonii*), a state threatened species.

Because removal of *Arundo* results in higher water yield, removal will result in better habitat for southwestern pond turtle (*Emys (=Clemmys) marmorata pallida*), a State Species of Concern, as well as some species listed below by the US Fish and Wildlife Service as occurring in the project area.

<u>Invertebrates</u>
vernal pool fairy shrimp (T) (*Branchinecta lynchi*), this species may not be directly affected by the project.
valley elderberry longhorn beetle (T) (*Desmocerus californicus dimorphus*)

<u>Fish</u>
Delta smelt (T) (*Hypomesus transpacificus*)
Central Valley steelhead (T) (NMFS) (*Oncorhynchus mykiss*)

<u>Amphibians</u>
California tiger salamander, central population (T) (*Ambystoma californiense*)
California red-legged frog (T) (*Rana aurora draytonii*)

<u>Reptiles</u>

Blunt-nosed leopard lizard (E) (*Gambelia (=Crotaphytus) sila*), this species may not be directly affected by the project.
Giant garter snake (T) (*Thamnophis gigas*)

Mammals
Fresno kangaroo rat (E) (*Dipodomys nitratoides exilis*), this species may not be directly affected by the project.
San Joaquin kit fox (E) (*Vulpes macrotis mutica*)

Key:

(E) *Endangered* - Listed (in the Federal Register) as being in danger of extinction.
(T) *Threatened* - Listed as likely to become endangered within the foreseeable future.
(P) *Proposed* - Officially proposed (in the Federal Register) for listing as endangered or threatened.
(NMFS) Species under the Jurisdiction of the National Marine Fisheries Service. Consult with them directly about these species.
Critical Habitat - Area essential to the conservation of a species.
(PX) *Proposed Critical Habitat* - The species is already listed. Critical habitat is being proposed for it.
(C) *Candidate* - Candidate to become a proposed species.
(X) *Critical Habitat* designated for this species

Restoration Species List

A*. *Riparian Community

1) Over story
   a) Valley oak (*Quercus lobata*)
   b) Blue elderberry (*Sambucus mexicana*)
   c) Western sycamore (alluvial flats) (*Plantanus racemosa*)
   d) Fremont's cottonwood (*Populus fremontii*)
   e) Willow (*Salix spp.*)
   f) Ash (*Fraxinus spp*)
   g) Alder (*Alnus spp*)
2) Under story
   a) Santa Barbara Sedge (*Carex.*)
   b) Creeping wildrye (*Leymus triticoides*)
   c) Mulefat (*Baccaris salicifolia*)
   d) Buttonbush (*Cephalanthus occidentalis*)
   e) California Blackberry (*Rubus ursinus*)
   f) Mugwort (*Artemisia douglansian*)
   g) Oak gooseberry (*Ribes quercetorum*)
   h) California grape (*Vitus californica*)
   i) California rose (*Rosa californica*)
   j) Golden rod (*Solidago spp.*)

B*. *Upland/Grassland Community

1) Salt bush (*Striplex lentiformis*)
2) Salt grass (*Distichlis spicata)*
3) Alkali sacaton (*Sporobolus aeroides*)
4) Alkali barley (*Hordeum deppressum)*
5) Goldfields (*Lasthenia californica*)
6) Milkweed (*Aescapius spp.)*
7) Spikeweed (*Hemazonia pungens*)

Attachment 3.2, Madera Easement Letter

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STATE OF CALIFORNIA – THE RESOURCES AGENCY

ARNOLD SCHWARZENEGGER, GOVERNOR

CENTRAL VALLEY FLOOD PROTECTION BOARD
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SACRAMENTO, CA 95821
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November 6, 2008

To Whom It May Concern:

This letter is regarding the proposal submitted by Madera County to the Urban Streams Restoration Grant program to eradicate the Arundo Donax infestation and replant native grasses within the Ash Slough. The target areas of the work proposed are on the Ash Slough from Road 12 up to Highway 99.

The Central Valley Flood Protection Board confirms that the Madera County Flood Control and Water Conservation Agency is the 'Local Maintaining Agency' for these waterways, which means it has not only the right, but the duty, pursuant to an assurance agreement with the Board, to perform the maintenance activities allowed by the easements which the State holds to operate and maintain the waterways.

For purposes of the proposed grant activities, therefore, The Madera County Flood Control and Water Conservation Agency has legal right of access to perform the proposed tasks for areas in which the State holds easements, which include vegetation removal and replanting of appropriate vegetation.

Sincerely,

Jay S. Punia

Jay S. Punia
Executive Officer

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