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Appendix A

DRY CREEK, WINTERS, CA

Study Area

This analysis concerns flooding and erosion problems along Dry Creek in Winters, California. Winters is located in the southwest corner of Yolo County about 30 miles west of Sacramento, California. Dry Creek is a tributary to Putah Creek with their confluence located in Winters. The stream study reach extends from its confluence with Putah Creek to a point 3,000 feet north of Highway 128, approximately 2.6 miles of stream.

Existing Conditions

Dry Creek has a drainage area of 23 square miles with its headwaters in the Vaca Mountains west of Winters. The watershed divide is at elevation 2,610 and drops to elevation 105 at the outlet. The climate is characterized by hot, dry summers and wet, cool winters with an average annual rainfall of 17 inches. Sixty percent of this falls during the winter months of December, January, and February with only 0.2 percent occurring in the summer months. Flows occur in the stream only after storms and last for a short period of time. With no storage in the watershed, the creek is dry for most of the year. Some water enters the stream in the study reach at storm drain outlets during the summer due to urban runoff and is stored in depressions in the stream bed.

Most of the watershed is undeveloped and used as range lands or for agriculture. The upper watershed is steep with the stream contained in steep walled canyons. The stream traverses a foothill region and finally flows across an alluvial region before joining Putah Creek. The study reach is located in this alluvial region. This is also where the City of Winters is located and where the urban development occurs. In the study reach development has extensively taken place along the left bank of the creek and future development is proposed. The right bank remains as mostly orchards.

Soils in the study reach are composed of silty clay loams and are susceptible to erosion by high velocity flows. For this reason the stream has incised deeply into the flood plain and developed a definite meander pattern with many sharp bends. Stream terrace top widths range from 100 to 350 feet and channel depths are 17 to 29 feet with the average channel depth being about 20 feet. The outside of the natural bends have almost vertical banks with erosion occurring by toe cutting and then bank shear failure. Where bend erosion threatens structures, erosion protection has been provided by placing riprap and grouted riprap on the left side of the channel.

Because of the mountainous nature of most of the watershed, flood flows are sharp peaked with little volume and short duration. A flood hazard analyses (1)[1] was done for the

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[1]Numbers in parenthesis refer to references at the end of this report.

area in 1976. Frequency discharges used for this analysis are given in Table 1.

TABLE 1

FREQUENCY DISCHARGES FOR DRY CREEK		
FREQUENCY	DISCHARGE (CFS)	AVERAGE VELOCITY (FT/SEC)
2-Year	1,150	6.3
5-Year	2,020	7.6
10-Year	2,670	8.1
25-Year	3,450	8.4
50-Year	4,160	7.8
100-Year	4,780	7.3
500-Year	6,500	6.1

Problem Identification

Flooding along Dry Creek was not thought to be a problem. Based on the study done in 1974 (1), the channel was thought to have capacity to confine the 500-year flood in the study reach. However heavy rains occurred in January and March of 1995. Both of these storms produced flows which came close to the top of bank for Dry Creek. Time nor funds were available to further investigate the frequency discharges or hydraulics of Dry Creek. However it is possible that Dry Creek could present a flood threat. Further analysis of discharges and flood flows in Dry Creek will be done during the feasibility study.

The main concern is with the erosion occurring along the creek. Development has occurred with some structures located very close to the top of the stream bank. A bridge crossing was washed out during the 1986 floods at Russel Street. Locals report one to two feet of bank erosion during 1992-93 in the Russel Street area. Land owners are concerned with the land lost to erosion and with the possible loss of structures. Though flow in the creek only occurs during flood periods, these flows have high velocities. Table 1 gives the average velocities for the flood flows in the study reach. Non-erosive velocities for the bank soils in this area are considered to be in the range of 5 ft/sec or less. Velocities are concentrated in bends and are thus higher than the average velocities given in Table 1.

Comparison of aerials taken over the last 20 years do not show significant changes in the stream course. As stated significant flows occurred in January and March 1995 and additional erosion occurred along the stream. Significant erosion occurred just downstream of the Highway 128 Bridge. The whole study reach has not been investigated since flows have subsided and it is not possible to characterize the new erosion for the rest of the study reach.

System Change Impacts to Stream Stability

There have been questions and discussions about changes in the watershed and to Putah Creek and their impacts on erosion in the study reach. Table 2 gives a watershed chronology for Dry Creek. The character and stability of the stream today is somewhat based on changes to the watershed from past human actions. To try and identify any one recent action which may have changed the stability and thus increased the meandering of Dry Creek or to identify the magnitude of any impact is difficult or impossible. A stream in a flat alluvial plain will meander to search for a stable condition. Changes to watershed flows or stream gradient can upset this stability and cause the stream to increase its meander movement to achieve a new stability.

Watershed flows can be modified by upstream channel modifications, changes in watershed cover, construction of water storage projects, and urbanization. No significant channel modifications have been done to Dry Creek nor or there any water storage projects. While the establishment of agriculture has changed the ground cover somewhat, it has not been of the kind or to the degree to significantly increase flows. There has not been extensive logging to reduce the tree cover in the range canyons. The conversion of natural grass lands to either wheat fields or orchards would not cause an extensive increase in watershed runoff. Urbanization can cause significant alterations to the amount of flow from a watershed. However, the urbanization in the Dry Creek watershed has occurred on only a small percentage (0.3%) of the watershed and has occurred in the bottom end of the watershed. Development in the lower portion of a watershed has a much less significant impact to flood flows. Future urbanization impacts are being minimized by city requirements that runoff from developed areas not be greater than predevelopment conditions. Future planned development is on a small portion of the watershed and in the lower portion of the watershed. Flood flows are probably not much different than they were 150 years ago. There are no gage records to verify this conclusion, but changes in the watershed are not of the kind to significantly alter flood flows.

Stream gradient changes can be caused by downstream channel modifications, cutoffs through channel meanders, downstream channel degradation, or lowered downstream water surface elevations. The only significant channel modifications have been those associated with the lower Putah Creek work into the Yolo Bypass. This work is 11 miles downstream of the mouth of Dry Creek with an invert elevation approximately 60 feet below the invert of the mouth of Dry Creek. Any changes to water surface elevations associated with this modification would not propagate upstream to Dry Creek. It appears from the topographic maps of the study reach that a cut off of a meander has occurred just upstream of Highway 128 (Grant Road). Though not certain when this cut off occurred, the 1953 quadrangle already shows the cut off.

TABLE 2

Dry Creek Watershed Chronology	
? - 1820's	Patwin villages in the area of Winters and Putah Creek
1842	First land grant recorded for Winters area (Rancho de Los Putos) - cattle and agriculture introduced to the area
1842-1870's	Wheat crops become mainstay of local economy
1867	First fruit ranch north of Putah Creek in foothills - 2.5 miles NW of Winters
1871-1872	South fork channel of Putah Creek excavated
1886-1900	Conversion of grain field to vineyards, and fruit and nut trees
1936	Construction of 15-ft. concrete percolation dam to increase ground water recharge
1943-1949	Army Corps of Engineers close off the North fork of Putah Creek, and deepen and construct levees along the South fork (the Putah Creek Project)
1953	Ground breaking ceremonies on Monticello Dam
1956	Annexation of all the land south of Grant Avenue and east of Dry Creek led to the construction of homes in the western part of the city - Winters Mobile Home Park and the Major Vista subdivision north of Grant Avenue built west of the city limits (annexed 1961)
1957	Monticello Dam completed, construction of diversion dam, the 125 acre Lake Solano reservoir and the Putah South canal begins
1963	Lake Berryessa reaches full storage capacity
? - 1960's	Gravel mining in Putah Creek above Winters

A cut off of this type could cause channel instability and be the reason for increased meander activity. However the stream has had 40 years to adjust. In addition the bridge for the Highway 128 crossing serves as a constriction and control. This crossing is a concrete arch with concrete training walls extending along both banks upstream and downstream. Water surface studies indicate that the crossing is a control for profiles in this section and would serve to offset any increase in stream gradient caused by the cutoff upstream. It appears that this crossing creates backwater effects for 1,300 feet upstream. Any channel instability created by the cutoff would appear to have been significantly reduced by channel adjustment over the years and by the hydraulic control created by the Highway 128 crossing. Channel degradation has not been shown or verified. There has been gravel pit mining in the Putah Creek channel, but the amount of material removed is unknown. Channel surveys of Putah Creek were done in 1974 with additional surveys being done this year. These surveys can be compared to determine if significant channel changes have occurred due to mining or degradation. Regardless of the results of this analysis, changes in channel configuration will have minimal impact on water surface elevations due to downstream controls. The concrete percolation dam built in 1936 as well as the SPRR trestle and the Railroad Street bridge are hydraulic controls in the Putah Creek channel. They influence water surface profiles at Dry Creek much more than any changes in channel configuration. In fact any potential lowering of profiles due to channel degradation would be erased by these hydraulic controls. The biggest change in stream gradient is the impact on water surface profiles at the mouth of Dry Creek due to the flood control storage in Lake Berryessa. Table 3 shows the changes in flood flows and elevations due to Lake Berryessa flood attenuation.

TABLE 3

PUTAH CREEK FLOOD FLOWS AT WINTERS					
Flood Frequency	Flows Prior to Lake Berryessa [1/]	Putah Cr Elev at Dry Creek [2/] (A)	Flows After Lake Berryessa [1/]	Putah Cr Elev at Dry Creek [2/] (B)	(A-B)
5-Year	53,000	126			
10-Year	71,000	132	8,900	111	21
25-Year	93,000	135	16,400	113	22
50-Year	107,000	137	25,100	117	20
100-Year	122,000	137	32,200	120	17
500-Year	153,000	137	41,900	123	14

1/ Flows from 1994 COE Hydrology Report (2)
2/ Elevations from rating curve developed from 1974 flood plain analyses (1)

The 50-, 100-, and 500-year floods prior to Lake Berryessa all have the same elevation because this is the right bank high elevation. Once flows exceed this elevation, they flow out of Putah Creek and across the landscape in a sheet flow pattern to points undetermined. As can be seen from Table 3, the impact of Lake Berryessa on water surface elevations at the mouth of Dry Creek is rather dramatic. If it is assumed that there is most likely a peak on peak occurrence of flood flows in Putah Creek and in Dry Creek, the starting water surface elevations for Dry Creek have been drastically lowered. This would steepen the stream gradient and increase the erosive action of flood flows in the lower portion of Dry Creek. Field observations have seen indications of degradation in the channel bottom of Dry Creek in the lower reaches. This degradation appears to extend as far as Highway 128. A concrete sill and other erosion protection works in the bottom of the Highway 128 crossing have served to prevent the headcutting from propagating upstream. The action of this crossing as a hydraulic control eliminates the impacts of the lower starting water surface elevations upstream of this point.

One stretch of the stream reach has been recently developed. The Valley Oaks Addition was constructed in 1987-89. It appears that a portion of the stream upstream of Highway 128 had fill placed along the left bank. The development has placed back yards right at the top of the bank and some structures are very close to the bank. To prevent erosion loss, erosion protection was placed along the left bank of the stream when the development was built. This erosion protection is in the form of loose riprap rock and grouted riprap rock. The riprap extends from the bottom of the channel to 2-3 feet below the top of the bank. Field inspection determined that this riprap appears to be doing an adequate job for the more frequent storms. There is no evidence of erosion in the areas where the riprap has been placed other than at the toe as discussed later. It does not appear that much if any riprap toe protection was provided. Consequently, there are areas of erosion at the toe. In some instances the toe has eroded 2-3 feet below the grouted portions of the riprap. There are also reports of extensive erosion behind some of the grouted riprap. With much additional erosion at the toe, it would be expected that these sections will suffer failure of the grouted slope and possible extensive erosion of the bank. For flows which exceed the top of the riprap, it would be expected that significant erosion could occur in the unprotected portion. The elevation of the top of the riprap should be compared to flood profiles to determine what frequency floods would exceed the top of the riprap. Again no field inspection of the riprap area has been done since the Spring 95 floods to determine impacts of the high flows.

Erosion is a major problem in the Russell Street area. Residents report 1 to 2 feet of loss yearly. A bridge crossing was washed out in 1986. This is the most unstable area, see above discussion. This is the area of older development and there are some areas of erosion protection. However the locals are looking for a comprehensive plan before implementing any significant erosion protection plan.

Recommendations

Increase Erosion Protection - The existing riprap should be modified by providing better toe protection. In addition erosion protection should be provided in those bends which immediately threaten structures. Attached is a description of common erosion protection methods used in the United States. These methods run from the more conservative and historic rock protection to more recent and less experience methods of biological protection. No attempt has been done in this report to analyze specific erosion areas and select appropriate erosion measures. This report does not provide a comprehensive erosion protection plan. However the information in the attachment can be used by locals to try different erosion protection methods in those areas where they wish to try and maintain a more natural look.

Channel Set Backs for Future Development - Future development should be aware of the tendency of the channel to erode in the bends. All structures should be set back from the top of bank. The City of Winters is aware of this and the General Plan Policy Document requires set backs from the channel bank for new development. It should be understood that this set back should apply to property lines as well as structures or the property owners should be made aware that the set back area is subject to future erosion and could disappear in the future. Set backs should be in the range of 75 - 125 feet.

Section 14 Assistance - Two locations along the stream have been proposed for Section 14 evaluation. Section 14 is a part of the Corps of Engineers Continuing Authorities Program and its purpose is to provide emergency protection to public works which are in danger of being damaged by stream bank or shoreline erosion. The two public work structures under consideration are the Highway 128 bridge over Dry Creek and the city wells located just upstream of Highway 128.

As described earlier, the Highway 128 crossing is a constriction and velocities through the opening are very high with very significant head loss. During a November 1994 field trip it appeared that the bridge abutments and footings were well protected with concrete walls and large riprap. Field inspection did not note any serious erosion problems at the bridge itself. No footings were exposed nor were the abutments endangered. There was evidence of channel bottom degradation downstream of the bridge but a concrete sill constructed downstream of the crossing appeared to be serving its purpose of preventing the headcutting from progressing any further upstream. Large rocks had been placed in the bottom of the crossing and appeared to prevent erosion from undermining the abutment foundations. A field inspection after the January 95 flood showed just how high velocities are through the bridge opening. All of the large rock which had not been grouted had been washed from the opening and deposited downstream of the concrete weir. These rocks were 2 - 3 feet in diameter. The abutments appeared to be safe but large eddy erosion had occurred in the banks of the channel just downstream from where the wingwalls ended. This bridge was visited during the flood of March 95 and the eddy erosion was again occurring and had begun to threaten the road embankment. Pilings underneath the east side abutment were visible. Guard rail along the roadway was suspended in air due to loss of embankment material. CALTRANS was in the process of dumping rock into the eddy hole with the hope of saving the roadway. It is assumed they were successful as no reports of Highway 128 being shut down were received. Winters has a request in for Section 14 assistance for this crossing. it would appear that the Section 14 Program would be appropriate for investigating ways of protecting this vital link from future erosion.

The city wells are located approximately 490 feet from the left stream bank and 270 feet upstream of the Highway 128 constriction. This is an area of backwater from the bridge crossing and velocities are much lower than elsewhere in the study reach. Field inspection did not identify any significant erosion in this area. The wells are sited a sufficient distance from the stream bank that damage from erosion is not expected any time in the future. The wells are not in danger of damage from erosion and do not qualify for Section 14 assistance.

REFERENCES

1. U.S. Department of Agriculture: Soil Conservation Service. In Cooperation with City of Winters, Western Yolo Resource Conservation District, and California Department of Water Resources. July 1976. Flood Hazard Analyses, City of Winters including portions of Putah Creek, Dry Creek, and Moody (Dry) Slough, Yolo County, California.

2. U.S. Army Corps of Engineers, Sacramento District, Office Report, Hydrology of the City of Winters, California and Lower Putah Creek, Reconnaissance Study, November 1994.