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# **Perspectives on Dam Removal: York Creek Dam and the Water Framework Directive**

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**FINAL DRAFT**

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Justin Lawrence, Josh Pollak and Sarah Richmond

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**ABSTRACT**

Many dams built over the last century in California no longer provide their intended benefits and may pose ecological and safety risks. However, a lack of clear regulatory framework, further complicated by a lack of scientific understanding of the impacts of dam removal, has handicapped many efforts to remove such outmoded dams. We investigate these challenges through a case study of York Creek Dam in St. Helena, California and show the need for standard protocols to prioritize and monitor dam removals. As a thought experiment, we explore how dam removal would proceed under the European Union Water Framework Directive (WFD) and argue that California can learn from the WFD's systematic, watershed approach to improve dam removal decision-making. However, the monitoring programs under the WFD are driven by ecology and therefore provide little guidance on monitoring channel changes to evaluate whether dam removal increases the risk of flooding for downstream property, a major concern in California.

**1. Introduction**

California has over 1400 dams with a height greater than 25 feet or capacity greater than 50 acre-feet (California DWR, 2000). These dams were built for purposes such as water supply, flood control, hydropower, and recreation. However, dams are one of the most significant factors contributing to the poor ecological health of California's watersheds (Moyle & Randall, 1998).

Furthermore, dams have a lifespan because of gradual deterioration in structural integrity, and some of California's dams are among the more than 85% of dams in the United States that will approach the end of their useful lifespan by 2020 (FEMA, 1999). Whether the reason to remove dams is to restore California's salmon populations or to eliminate liability concerns associated with aging dams, the rate of dam removal is likely to increase in the coming decades (Poff & Hart, 2002). Since 1922, at least 77 dams have been removed in California and the number of dams removed each year has been increasing (California DWR, 2005).

While the impacts of dam building on river hydrology, geomorphology and ecology are well understood (e.g., Graf, 1999, Ligon *et al.*, 1995), the impacts of dam removal are poorly understood, to some degree because dam removal projects have been poorly documented or analyzed (Shuman, 1995). The fate of sediment stored behind dams remains a key concern for most dam removal projects (ASCE, 1997). This is especially true of the project to remove York Creek Dam, which is scheduled to be removed in 2009 (J. Goldman, CEQA Lead Contact and St. Helena Director of Public Works/City Engineer, personal communication, April 2008). Through our case study on York Creek Dam, we highlight the ad-hoc dam removal process and examine how the WFD addresses the need to better prioritize and monitor dam removals in California.

### *1.1 History of York Creek Dam*

York Creek Dam is a 50 ft high, 140 ft long earthen filled dam built in 1900 to expand the water supply of the City of St. Helena (the City) (Figure 1). The City owns the dam and has not significantly modified it since its construction (Figure 2). The City stopped using it for water storage and supply in the 1980s due to the acquisition of other water sources and to ongoing issues with sedimentation (Prunuske Chatham Inc., 2007). Since 1965, there have been four large, documented fine-grained sediment releases from York Creek Dam into York Creek.

The most recent release in 1992 occurred during maintenance of the reservoir outlet. The silt deposits ranged from 18 inches just below the dam to 0.5 miles downstream to thin coverings at the confluence of the Napa River. The California Department of Fish and Game (CDFG), charged with maintaining fish, wildlife, and the habitats upon which they depend, reported that “dense anaerobic sediments, high in toxic hydrogen sulfide, were released from the dam and deposited in pool and riffle areas downstream, quickly suffocating and burying all fish and aquatic invertebrates within a mile or so of the dam” (DEIR, 2007). CDFG filed a complaint with the Napa County District Attorney's Office, and as a result of this legal action, the City agreed to remove the dam (FPIP, 2002b). The City encountered various permitting issues over the next few years (Table 1).

In 2000, the National Marine Fisheries Service (NMFS) identified York Creek Dam as a “complete barrier to nearly two miles of high quality steelhead habitat” in the upper portion of the watershed (FPIP, 2002b) and designated York Creek as critical habitat for steelhead trout (*Oncorhynchus mykiss*) that belong to the Central California Coast evolutionarily significant unit (ESU) (NMFS, 2000). Critical habitat includes all river reaches and estuarine areas accessible to the threatened species within the ESU's geographic area. Because this ESU was federally listed as threatened under the Endangered Species Act, NMFS law enforcement sent a letter to the City clarifying the City's potential liability if the dam was not removed. This led the City to meet with multiple federal, state, and local agencies in 2001 to discuss details of the dam removal project.

The City hired several consulting firms to characterize the stretch of York Creek that would be affected by the dam removal and to explore potential implications for flood risk downstream. These firms coupled hydrologic models with traditional geomorphology field methods including cross sections, longitudinal profiles, facies maps and pebble counts. The conclusion after

modeling with HEC-RAS is that the removal of York Creek dam is unlikely to have a significant impact on the volume or timing of flood discharges (Prunuske Chatham Inc., 2007). However, the increased sediment load following removal of the dam could cause aggradation of the channel downstream near bridges or along gently sloping portions of the longitudinal profile (Figure 3). Increased flood risk resulting from this augmented aggradation is a concern for local property owners who want to make sure that the City will be liable for any extra risk introduced by the dam removal project.

### *1.2 Water Framework Directive: A Better Process For Dam Removal?*

Adopted by the European Parliament in 2000, the WFD provides a systematic process to decide where to spend limited resources to maximize restoration potential. The WFD aims for all water bodies in the EU to achieve Good Ecological Status (GES) under the guidance of Member States (nations) by the year 2015. GES for rivers is defined in Annex V (1.2.1) of the WFD as a favorable comparison of hydromorphological, biological, and physico-chemical quality elements to reference sites. For instance, the presence of salmon in a creek with suitable habitat would be a factor for evaluating whether a water body achieves GES under the WFD. The WFD presents a process (Figure 4) grounded in scientific data collection and economic analysis to classify water bodies.

Although the goal for all water bodies is GES, the WFD acknowledges that some water bodies may not achieve this objective and therefore permits Member States to classify some water bodies as heavily modified water bodies (HMWBs). Water bodies with dams may be classified as HMWBs because there have been significant hydromorphological changes to a water body, such as changes induced by hydropower, flood control, or water storage, and modifications to achieve GES would cause significant adverse affects to current uses. Water bodies with dams may also

be classified as HMWB because it would be economically infeasible to achieve GES. However, water bodies with small dams are unlikely to be classified as HMWBs and therefore must achieve GES. For HMWBs, Member States are required to achieve Good Ecological Potential (GEP). As defined in Annex V (1.2.5), to achieve GEP, values of hydromorphological, biological, and physico-chemical quality elements are close to comparable water bodies given the physical constraints associated with the HMWB.

An innovative feature of the WFD is the top-down structure that leaves implementation of the Directive completely to the Member States. The individual Member States must designate competent authorities responsible to prepare and implement River Basin Management Plans (Article 3(2)). Each Member State must achieve GES in its river basins by 2015—with the exception of HMWBs, as discussed above—or it will face fines. Member States are also responsible for monitoring within each river basin. The WFD provides ambitious monitoring programs (Annex V (1.3)) of hydromorphological, biological, and physico-chemical quality parameters to track the effectiveness of restoration measures and to ensure that no further degradation occurs. Operational monitoring (Annex V (1.3.2)) must occur at monitoring sites for pollutant discharge as well as for other parameters that indicate ecological health. The frequency of monitoring is also specifically established in the WFD (Annex V (1.3.4)) for each of the quality elements.

Although it does not explicitly discuss dam removal, the WFD has important implications for dam removal because of its watershed-scale assessment to prioritize restoration projects. Dam removal is only one of a wide range of possible restoration measures to achieve GES. Under the classification scheme prescribed by the WFD, anthropogenic modifications to water bodies that impair the biological or physico-chemical quality are ranked according to their relative impact. After cost-benefit analysis, the most effective measures of restoration should be implemented. If a

dam provides little benefit and its removal is the most cost-effective measure to restore a fish population, then under the structure provided by the WFD, the dam should be removed. The rigorous monitoring program proposed under the WFD can also be useful to document the effects of dam removal. However, the WFD does not adequately address flooding issues, and flooding due to channel aggradation is a concern post-dam removal. Despite this shortcoming, the WFD can still provide valuable insight to overcome the challenges that restrain the progress of dam removal in California.

Although the WFD is still in its nascent stages, it has already had an impact in dam removal decision-making and monitoring in France. The French government adopted a watershed approach under the WFD during the relicensing process for the Poutés Dam on the Allier River, a hydroelectric plant in France. The operation of the dam was granted to Électricité de France (EDF) in 1956, and its concession ended in 2007. The French government weighed the economic benefit of the dam generating hydroelectric power versus the ecological costs of the dam being the worst fish barrier on the Allier River (ENGREF, 2006). Normally, the shortest concession granted during a relicensing process is 30 years; however, the French government decided to grant only a 10-year concession to EDF based on comprehensive watershed analysis. While France ultimately did not decide to remove the dam, this example illustrates how the WFD provides criteria for evaluating and prioritizing dam removal projects. France has also launched a research effort to learn from three dam removals on the Loire River completed prior to the WFD. Little data exists on the economic and ecological effects of these dam removals and France plans on integrating this information into its monitoring programs for future dam removals (ENGREF, 2005). We suggest that California can learn from the WFD's holistic watershed analysis to prioritize dam removals.



## 2. Methods

To investigate the York Creek Dam removal project, we analyzed documents, interviewed experts and conducted fieldwork. As part of our effort, we reviewed the WFD and interviewed an expert, Gabrielle Bouleau, to understand how the WFD might apply to York Creek Dam. We also interviewed the lead contact for the *Draft Environmental Impact Report, Upper York Creek Ecosystem Restoration Project* on April 8, 2008 to learn more about the history of York Creek Dam and the current status of the dam removal project. Our main questions were:

1. What consequences did the City face after the sediment releases prior to 1992?
2. Why did the dam removal project move so slowly during the 1990s?
3. What DEIR alternative has the City endorsed?
4. How is the dam removal funded?
5. How has the City addressed the flooding concerns by property owners downstream?

Following the interviews, we visited York Creek Dam to improve our understanding of the situation and to implement some methods that may be useful monitoring streams. To examine the impact of the dam on channel form, we selected a reach 100 ft downstream of the dam and drew a facies map, surveyed a cross-section and did two pebble counts. A facies map is an interpretive sketch of the channel that includes geomorphic features such as riffles, pools, large wood and boulders; the word facies refers to a distinctive patch of sediment. We selected a location for the cross section by identifying a position below the dam where the banks were accessible and a clear line of sight was available across the entire channel. An auto-level attached to a tripod was used to read measurements from a stadia rod positioned at key locations along the cross-section. Pebble counts were done on two bars that were selected to be representative of the average grain size for this reach of the creek; the procedure involved measuring the intermediate axes (in mm)

of 100 randomly selected pebbles and calculating from this the median grain size (Wolman, 1954). These methods are all standard techniques of geomorphology.

### **3. Results and Discussions**

#### *3.1 Dam Removal Process in California*

Dam removal projects in California proceed on case-by-case basis. There is no single agency that decides whether or not to remove a dam and, once the decision has been made to remove a dam, has responsibility to complete the project (Bowman, 2002). While the Endangered Species Act and public safety concerns motivate most dam removals in California, this decision-making process is not proactive. For example, the Endangered Species Act is fundamentally designed to maintain the status quo by preventing further decline of an endangered species, whereas dam removal is fundamentally designed to change the status quo by restoring ecological processes (Bowman, 2002). The decision to remove a dam should attempt to balance different interests and deviations from the status quo, similar to the Federal Energy Regulatory Commission (FERC) relicensing process. FERC requires private hydropower dams to provide “equal consideration” to power and non-power uses of the river, e.g., hydropower and fish habitat, in order to renew their 30 to 50 year licenses. FERC regulates over 300 hydropower dams in California and over half of these projects will come up for renewal by 2020 (Friends of the River, 1999).

However, for the remainder of dams in California, there is no legal requirement to evaluate the costs and benefits of the maintaining dams on a periodic basis. Without an inventory to identify abandoned, obsolete, or poorly functioning dams in California (Pejchar & Warner, 2001), it is difficult to prioritize dam removal projects. Furthermore, dam removal decisions should be based on comprehensive criteria at the watershed scale (e.g., Doyle *et al.*, 2003). At this scale, agencies

can pursue projects more strategically, which is crucial given their limited resources.

Even after a dam has been identified for removal in California, there is no formal agency coordination to permit, plan, and fund the project. Dam removal projects require different permits from different agencies and the York Creek Dam removal project is no exception (Table 2). Various agencies have been involved at various stages of the dam removal process. From 2001 to 2003, the Department of Water Resources Fish Passage Improvement Program helped the City prepare engineering and environmental documentation necessary to begin the dam removal. In 2003, U.S. Army Corps of Engineers sought funding for the City under its Continuing Authorities Program, but the project has been on hold until very recently because this funding did not materialize.

### *3.2 Dam Removal Process Under The WFD*

In order to understand how the WFD can provide guidance for dam removals, we performed a thought experiment by applying the WFD on York Creek. The York Creek watershed is 4.4 mi<sup>2</sup> (11.4 km<sup>2</sup>), considered on the lower end of small-scale watersheds under the WFD (Annex II (1.2.1)), and therefore would not be considered separately, but in concert with the other tributaries and the entire Napa River watershed. It is highly unlikely that York Creek would be considered a HMWB considering that the dam removal is not projected to significantly alter the volume or timing of flood discharges (Prunuske Chatham Inc., 2007). If York Creek is to achieve GES, the presence and abundance of steelhead trout and other species would be assessed and compared to reference conditions. York Creek Dam was declared a barrier to steelhead trout spawning habitat by NMFS (FPIP, 2002b). The removal of the dam would open up this habitat and may make a significant change in salmon abundance. In general, studies of York Creek (e.g., FPIP, 2002a) have shown that dam removal would bring the creek closer to reference conditions. Since the

York Creek Reservoir is unlikely to be a HMWB and dam removal is economically feasible, then the agency responsible for developing a River Basin Management Plan must ensure that the creek achieves GES by 2015. Given the ecological problems with the dam and the lack of beneficial use of the dam, removal of the York Creek Dam would be encouraged under the WFD.

### *3.3 Dam Removal Monitoring*

There is no established technical protocol in California for predicting changes to channels before, during and following the dam removal process (e.g., Pizzuto, 2002; Poff & Hart 2002). However, a monitoring program for York Creek would be useful to manage floods and map habitat quality for steelhead trout and other aquatic organisms. Ideally, this program would monitor the capacity of the channel to convey high flows on a regular, predetermined schedule by using well marked, strategically placed cross-sections. The City could use these records to identify aggradation-prone areas that might warrant flood prevention measures such as dredging, vegetation removal or levee construction. In addition, bed material size would be useful to monitor because it relates to salmonid spawning habitat (e.g., Kondolf, 2000) and to the health of benthic macroinvertebrates (e.g., Rempel et al., 2000).

Our fieldwork models techniques that would support a monitoring program. We observed that the channel bed was finer upstream of the dam than downstream because the dam traps most of the fine sediment in its reservoir and prevents it from being delivered to the reaches below the dam. The facies map depicts qualitatively the highly eroded banks and the patches of cobbles and boulders (Figure 5). The cross-section depicts quantitatively the steepness of the banks (Figure 6). The highly eroded, steep banks are consistent with a record of incision. Our measure of surficial bed material size downstream of the dam, a  $D_{50}$  (median size) of about 25mm (Figure 7), contrasts with a range from 20 to 50mm reported by Entrix (2002) and a  $D_{50}$  of 64mm derived by

averaging pebble counts from four sites (Prunuske Chatham, 2007). The high spatial variability of distributions along lower York Creek suggest that monitoring programs should tie grain size measurements to specific geomorphic features, and not average from multiple locations.

Systematic monitoring of stream biology as it is imposed in the EU under the WFD would be useful for York Creek to map habitat quality for steelhead trout and other aquatic organisms. For example, this monitoring program could be used to evaluate conditions both pre- and post-dam removal to increase scientific understanding of the processes that accompany dam removal projects. However, the monitoring programs under the WFD are designed to address ecological parameters, not changes in channel morphology related to flooding and flood liability. We suggest that the WFD could benefit by incorporating monitoring of bed material size and including a goal to minimize flood damage from dam removals. The  $D_{50}$  would be useful to assess habitat quality and cross-sections would be useful to assess flood risk.

#### **4. Conclusions**

The case study on York Creek Dam illustrates the lack of a clear process for prioritizing and monitoring dam removals in California. After sixteen years of bureaucratic shuffling, York Creek Dam is finally expected to come down in 2009. Unlike the current ad-hoc dam removal process in California, the WFD offers a top-down approach that places responsibility of implementing restoration measures in the hands of each Member State. The WFD prioritizes measures to achieve GES, such as dam removal, using a systematic process. However, prioritizing measures does not necessarily mean that dam removals will be any easier to implement. Monitoring under the WFD would focus on ecological health and would not necessarily address flood problems post-dam removal. Despite its limitations, a WFD-type approach could be a valuable process that places the onus for ecological improvement on

governments under penalty of fines. Given the convoluted nature and slow pace of dam removals in California, it is essential to adopt a more logical and efficient process. The WFD offers an alternative framework that shows great potential to motivate dam removal projects by making governments financially liable for ecologically poor conditions.

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York Creek Physical Baseline Assessment Report, 27 November 2002, Technical report Prepared by Entrix, Inc., 7919 Folsom Boulevard, Suite 100, Sacramento, CA 95826.



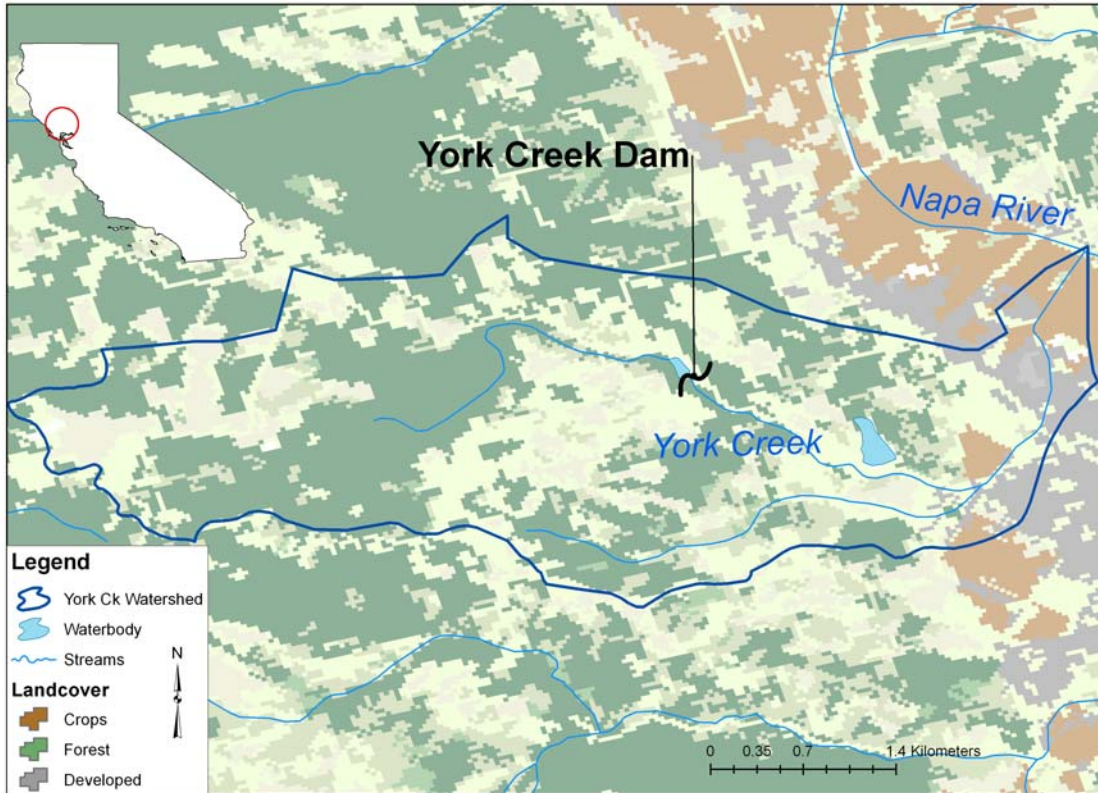


Figure 1. Location map for York Creek Dam, showing the City of St. Helena and the confluence of York Creek and Napa River.



Figure 2. Photo of earthen filled York Creek Dam (looking downstream) (April 8, 2008).

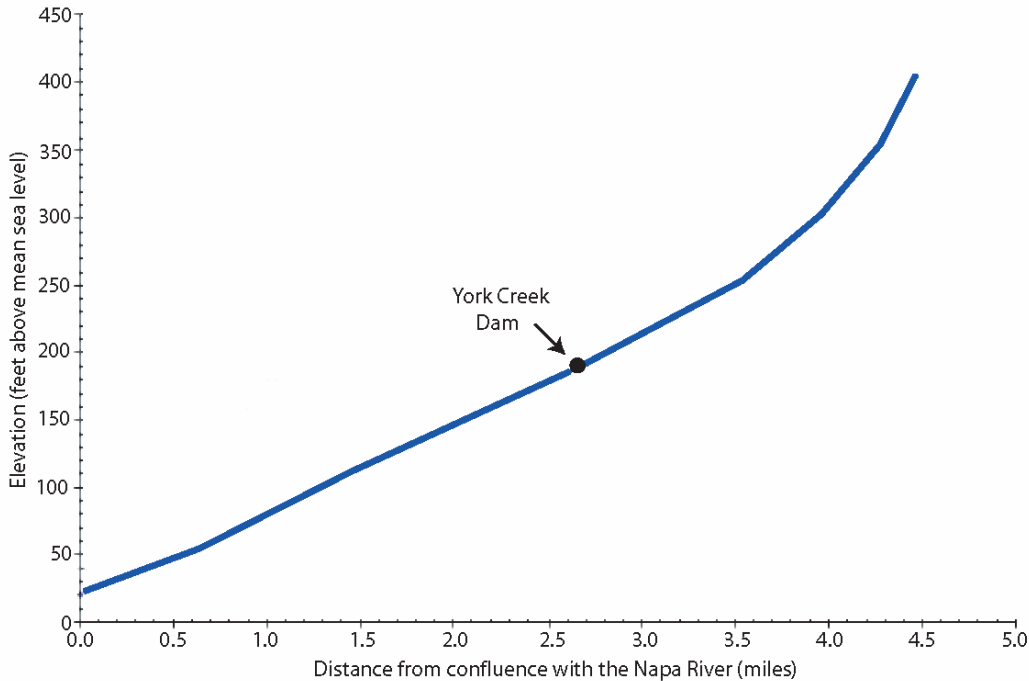


Figure 3. Long-profile of York Creek (figure adapted from report by Entrix, Inc., 2002).

# Characterizing a Water Body Under the Water Framework Directive

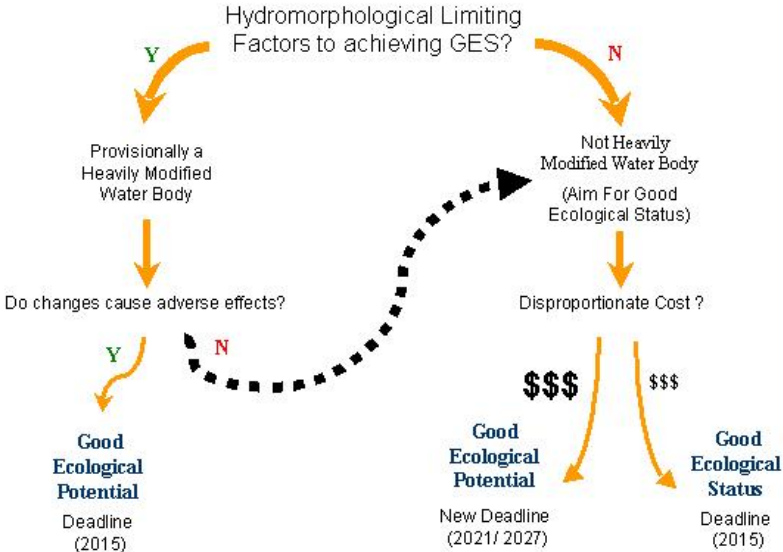


Figure 4. Water Framework Directive decision-making process to characterize a water body.

### FACIES MAP:

BELOW SPILLWAY OF  
YORK CK. DAM  
4/8/08 J. POLLAK

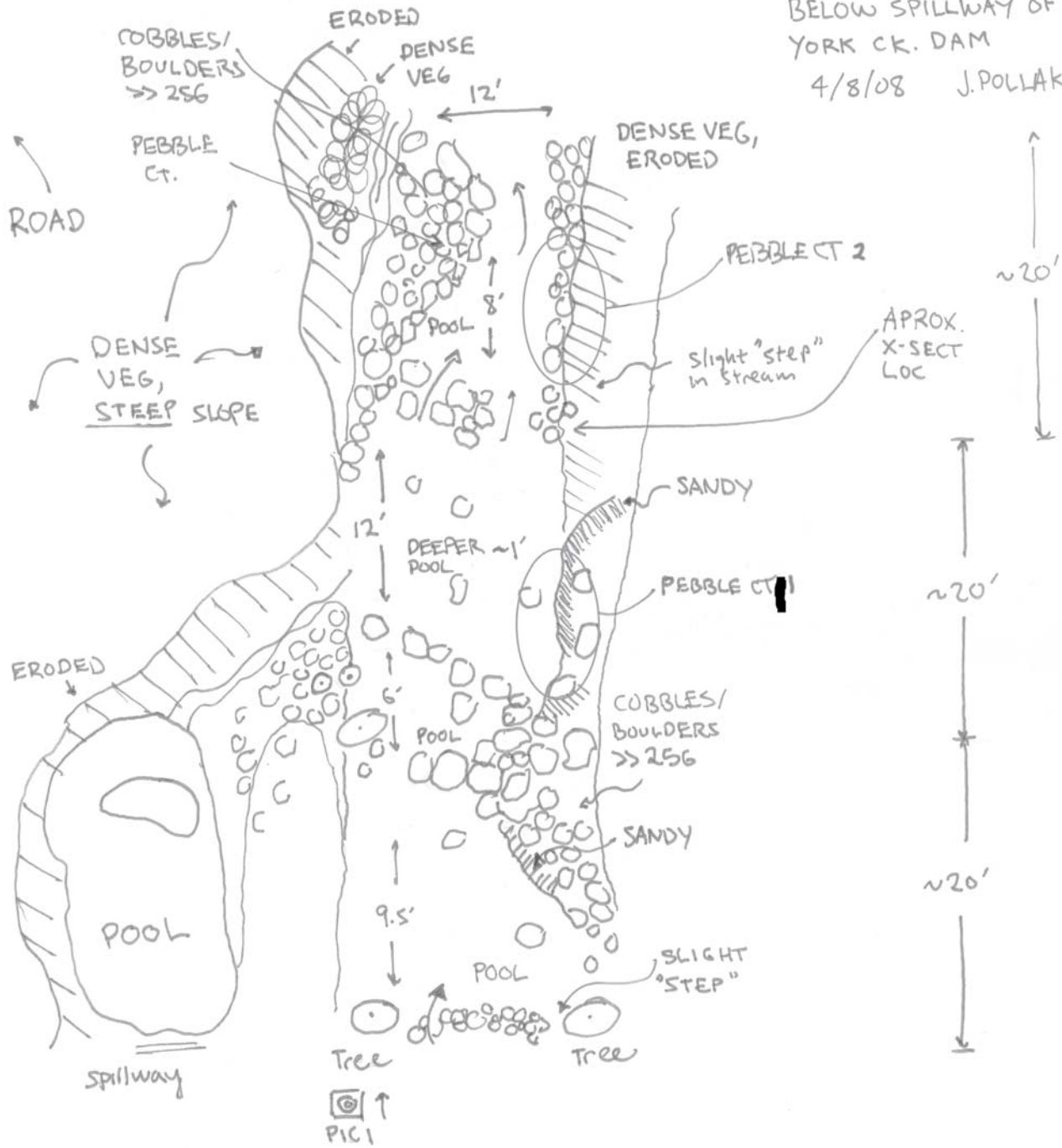


Figure 5. Facies map for York Creek about 100 ft downstream of the dam.

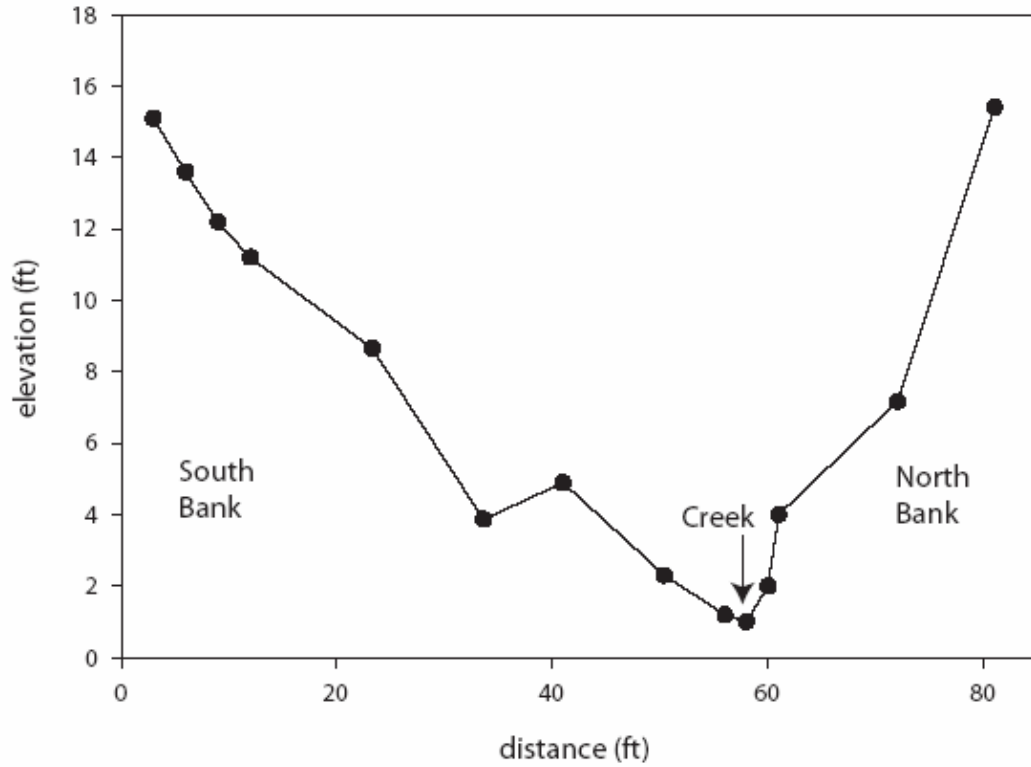


Figure 6. Cross-section downstream of the dam, elevation based off an arbitrary datum.

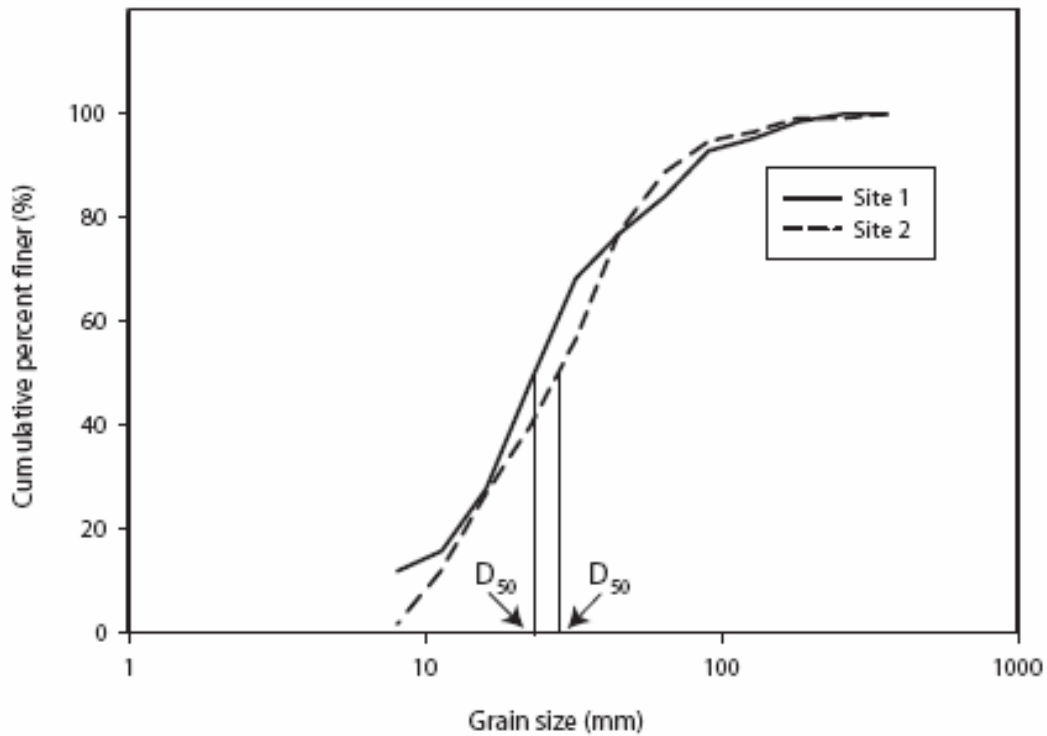


Figure 7. Pebble counts performed at sites marked on the facies map.

Table 1. York Creek Dam Removal Project Timeline

| <b>Date</b>   | <b>Event</b>  |
|---------------|---|
| July 28, 1992 | Accidental sediment discharge during routine maintenance of the reservoir outlet. The depth of the silt varied from heavy deposits (up to 18 inches) just below the dam and downstream for 0.5 miles to a light covering of fine silt deposited at convergence with Napa River, "burying all fish and aquatic invertebrates within a mile or more of the dam" according to the California Department of Fish and Game (CDFG). |
| July 30, 1992 | CDFG filed a complaint with Napa County District Attorney   |
| 1993          | CDFG and the Napa County District Attorney obtained an injunction in State Superior Court of Napa County ordering the City to remove York Creek Dam. The City agreed to a settlement to remove the dam.   |
| 1993-2000     | Permitting delays, primarily related to required federal Clean Water Act Section 404 "Dredge and Fill" permit.  |
| 2000          | York Creek designated as critical habitat for federally listed threatened Central California Coast (CCC) steelhead trout. National Marine Fisheries Service (NMFS) sent a letter to the City clarifying the City's potential liability under the Endangered Species Act if the dam was not removed.   |
| 2001          | Representatives from City of St. Helena, Napa County District Attorney's Office, CDFG, Army Corps of Engineers, NMFS and Department of Water Resources discussed the dam removal project. The 1993 injunction against the City was dropped.   |

Based on information from Fish Passage Improvement Program, 2002b, DEIR, 2007, and Prunuske Chatham Inc., 2007.

Table 2. Regulatory Framework for York Creek Dam

| <b>Agency</b>                                 | <b>Potentially Required Permit</b>  |
|---|---|
| <i>Federal</i>                                |   |
| U.S. Army Corps of Engineers                  | Clean Water Act Section 404 "Dredge and Fill" Permit  |
| U.S. Fish and Wildlife                        | Federal Endangered Species Act Section 7 consultation and Section 10 "take" enforcement                         |
| NOAA National Marine Fisheries Service        |   |
| Advisory Council on Historic Preservation     | National Historic Preservation Act of 1966 requires consultation with SHPO                                      |
| <i>State</i>                                  |   |
| California Department of Fish and Game (CDFG) | California Endangered Species Act informal consultation   |
| California Department of Fish and Game (CDFG) | CDFG Code Section 1600 Streambed Alteration Permit  |
| Regional Water Quality Control Board          | Clean Water Act Section 401 "Water Quality Certification" Permit (in conjunction with Section 404 Permit)       |
| State Regional Water Quality Control Board    | Storm Water Pollution Prevention Plan for construction greater than 1 acre                                      |
| State Historic Preservation Officer (SHPO)    | National Historic Preservation Act of 1966 requires consultation with Advisory Council on Historic Preservation |
| Bay Area Quality Management District Permit   | Asbestos Airborne Toxic Control Measure for Construction provides guidelines for controlling airborne asbestos  |
| <i>Local</i>                                  |   |
| City of St. Helena                            | Flood Damage Prevention Provisions (Municipal Code)   |

Based on information from DEIR, 2007.