Post-Project Appraisal of Arroyo Viejo Improvement Project, Oakland, California

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LA227: Restoration of Rivers and Streams

Jonathan McCall, Eric Garcia, Jill Dressler, Diana Saenz

Abstract

Our team performed a Post-Project Appraisal to evaluate the Arroyo Viejo Creek Improvement Project, located in Oakland, California. We assessed the project's lasting success against two of the initial goals set by the the landscape architects Wolfe Mason Associates: channel stability and enhancement of riparian habitat by planting native vegetation. We performed a site survey and compared current conditions with those documented by a student report in 2005 and Wolfe Mason and Associates' proposed conditions to assess geomorphic channel stability. Additionally, we conducted a vegetation survey to determine the percentage of native vegetation at the site. With respect to these criteria, the Arroyo Viejo Creek Improvement Project has had limited success. Comparing the geomorphology of Arroyo Viejo sixteen years post-construction to both the proposed and 2005 conditions, we see that the channel has experienced severe incision in the upstream reaches while the downstream end has seen slight aggradation. Furthermore, the project has failed to reach the target goal of 70% native vegetation cover after three years, with native plants accounting for 50% of vegetation cover sixteen years post-construction. We propose that further maintenance is required to slow incision at the upstream end of the reach and to establish more native plant cover.

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Introduction

Background

The Arroyo Viejo Creek Improvement Project began in 2000 and was completed in 2002 by the City of Oakland Public Works Agency and the Alameda County Public Works Agency. The original project description called for both the restoration of a specific reach of the Arroyo Viejo Creek and park enhancement projects. Wolfe Mason Associates prepared the creek restoration plan. The restoration project had several key components, ranging from environmental goals such as improved habitat and water quality, to broader, more community focused objectives such as improving neighboring trails and bridges. The project hoped to achieve several environmental benefits such as habitat improvement, sediment transport re-establishment, long term bank stability, and improved water quality. The most critical component of this plan was the removal of the ailing infrastructure containing the creek, which would then lead to the "re-establishment of a stable meander pattern and stream pattern." With this, the plan's ecological, hydrological, geomorphologic, and social objectives would be met.

Arroyo Viejo Creek begins in Anthony Chabot Regional Park, flowing west through Knowland Park and the Oakland Zoo. The Creek then follows Golf Links Road and enters various culverted regions as it approaches Castlemont High School. As the Creek continues through the Eastmont region of Oakland, it transitions out from the culverted section to an engineered channel form, and this continues until Arroyo Viejo Creek Park. The channel remains above ground within an engineered channel, flowing through the Coliseum district of Oakland alongside Hegenberger Expressway, until it discharges into San Leandro Bay. The Arroyo Viejo Creek Watershed includes five creeks including Arroyo Viejo, and covers an area of 6.2 square miles (Flood Control and Water Conservation District, 2018). Figures 1a/1b shows the Arroyo Viejo Creek pathway as of 2018.

The project channel begins in the Northeast corner of the Arroyo Viejo Park, and continues downstream 725 linear feet. Flowing east to west, the creek exits a culvert approximately 400 feet before the project site begins and then enters another culvert downstream, at the end of the project reach (Wolfe Mason Associates, 2001). Prior to restoration, the reach was completely culverted within concrete walls that had been built in the 1930's. In 2000, the concrete structures showed significant deterioration, characterized by "exposed, heavily worn banks" and "eroding banks contained by failing concrete walls," leading to the implementation of the Arroyo Viejo Restoration Project (Wolfe Mason Associates, 2001).

When the project commenced in 2000, there was strong local interest in the health and stability of the Arroyo Viejo Creek. A large portion of the Arroyo Viejo Creek is surrounded by parks, serving East Oakland and neighboring communities as a recreational green space. It is visited very regularly both by school children and visitors to the Arroyo Viejo Recreation Center.

In 2005, students from the University of California, Berkeley conducted a post-project appraisal of the Arroyo Viejo Restoration Project. They found that while native vegetation cover had been improved, the desired level of streambank stability had not been achieved. They also investigated the site's social use alongside the original project's community related objectives. They identified risk areas such as sediment thinning and non-native species growth, including the proliferation of watercress inside the stream channel which contributed to trash accumulation (Cousins & Storesund, 2005).

Problem Statement

The original restoration project was completed in 2001, and a number of Post-Project Appraisals (PPAs) were completed between 2001-2005. However, to our knowledge no further evaluations of the creek have been completed. The ongoing monitoring and maintenance of restoration projects is critical, not only to continue enhancing each individual project, but also to advance the field of river restoration (Kondolf, 2000) . Each river restoration project is unique and requires specific rehabilitation components, and therefore, each completed project can contribute valuable information to the growing database that will inform future decision makers. Analyzing and learning from restoration projects requires that we understand the original objectives of the project and how the project planners intended the river to respond after completion. The 2001 project design had the following seven objectives (Wolfe Mason Associates, 2001):

- Restore native riparian plant species;
- Enhance and restore habitat for terrestrial and aquatic species;
- Restore hydrologic function to Arroyo Viejo Creek for safe storm-water conveyance, sediment transport (dynamic equilibrium), and improved sediment quality;
- Restore a stable channel profile and meander sequence which transitions smoothly and safely between the reaches upstream and downstream of the restoration site;
- Re-establish a stable channel and banks (including removal of sections of existing WPA-era concrete and mortared stone walls);
- Provide long-term erosion control;
- Incorporate appropriate recreational amenities such as trails, footbridges, overlooks, and interpretive signage.

As stated previously, there has been no documentation on the condition of Arroyo Viejo Creek since 2005, adding gaps to the understanding of the health and condition of the Creek in its current state. Thus, with a thirteen year gap in data, it becomes increasingly difficult to comprehensively assess the project's success.

Using the 2005 PPA as a guide, we conducted an appraisal of the Arroyo Viejo Improvement Project. Our appraisal compares the current condition of the creek to those that were reported in 2005, the 2001 original conditions prior to restoration, and the outlined goals from the original design plan. We hope that this appraisal will spark a heightened dedication to monitoring and maintenance of the creek, and that appraisals will be completed on a more regular basis moving forward.

Methods

We collected documents on the planning, design and construction of the project and compared the proposed project goals with post-project conditions established by a student survey in November 2005 and data we collected in October-November 2018. We used the project proposal's goals to evaluate the success of the restoration.

Document Collection

We compiled existing documentation on the planning, design and construction of the restoration project. We acquired the Arroyo Viejo restoration project proposal from the UC Berkeley Environmental Design Library which we used to determine our criteria for evaluating the project's success. We reviewed a student's survey data from November 2005 to inform our field data collection methods and to perform a comparison of the creek's post-project conditions. Below, we summarize our data types and sources of information for each.

Table 1: Data Sources for Post-Project Appraisal

Data Type	Information Source
Long Profile	● Pre-Project and Design: Long profile in project plans (WMA, 2001) ● Post-Project: Student report (Cousins and Storesund, 2005)
Cross Sections	● Pre-Project and Design: 6 cross sections in project plans (WMA, 2001) ● Post-Project: 9 cross sections (Cousins and Storesund, 2005)
Vegetation Survey	● Design: Revegetation plans (WMA, 2001) ● Post-Project: 7 vegetation plots (Cousins and Storesund, 2005)
Pebble Counts	● Post-Project: Pebble Counts at 6 locations (Cousins and Storesund, 2005)
Feature Mapping	● Design: Rock riffles and bank protection (WMA, 2001) ● Post-Project: Gravel bars and cross sections (Cousins and Storesund, 2005)

Survey Methods

We performed cross section surveys, pebble counts, vegetation surveys and feature mapping. We selected these field methods as they are the most appropriate for evaluating the goals stated in the original project proposal. These methods allowed us to compare our results with available historical data for pre-project conditions, proposed conditions and the conditions reported in a student report from 2005.

We surveyed eight channel cross sections using a stadia rod, tripod and 100-foot measuring tape (Figure 5). The cross sections we conducted correspond to eight of the nine cross sections performed in the 2005 PPA to provide data for comparisons to pre and post-restoration conditions. We were only able to perform surveys of eight cross sections due to accessibility issues at the ninth. We collected elevation data at a number of points along each cross section, both in the floodplain and in the channel, and identified the station position in feet. We anchored the elevation of the cross sections to the height of 101 feet indicated in the original site survey at the Southwest corner of the amphitheater (point D'). We recorded the start and endpoints of each cross section using Google Maps on an iPhone. We could not match up each of our cross sections to the permanent landmarks used in the 2005 PPA, so comparisons over time may not be perfectly accurate.

Our pebble count survey consisted of random sampling of pebbles in a designated gravel bar or cross section. Using a grain sieve, we measured the intermediate b-axis of the grains using the Wolman method introduced in class.

We performed a vegetation survey of the restoration project by dividing the channel into seven sections and determining the percent cover by native and non-native plants. We used the iNaturalist app to identify native vegetation.

Our team's feature mapping consisted of

Performance Measures

The performance measures for the Arroyo Viejo restoration project encompass both quantitative and qualitative measures. The quantitative performance measures were determined primarily by the project's permits. For example, the California Department of Fish and Wildlife permit established a goal of 70% native vegetation cover after three years. Furthermore, the U.S. Army Corps of Engineers (USACE) permit required annual reports, erosion control during construction and monitoring of vegetation survival and channel stability for five years after construction. The rest of the project's performance measures are qualitative and no metrics for their evaluation are presented in the project proposal. The performance measures we used to evaluate the project are described below in Table 2.

Table 2: Performance Measures for the Arroyo Viejo Creek Improvement Plan's Objectives

Objectives (WMA, 2001)	Performance Measure
Restore native regional riparian plant species	Percentage cover by native species; survival rate analysis; proposal to achieve 70% native cover after 3 years
Enhance and restore habitat for terrestrial and aquatic species	Qualitative assessment;
Restore hydrologic function to Arroyo Viejo Creek for safe storm-water conveyance, sediment transport, and improved sediment quality	Pebble counts; quantify changes in sediment characteristics at certain locations
Restore a stable channel profile and meander	Evaluate changes in long profile over

sequence which transitions smoothly and safely between the reaches up and downstream of the restoration site	time;
Re-establish a stable channel and banks	Channel width assessment;
Provide long-term erosion control	Long profile and cross section assessments; evaluate change over time
Incorporate appropriate recreational amenities such as trails, footbridges, overlooks, and interpretive signage	Qualitative assessment, user interviews

Results

Cross Sections

Our cross sections indicate that there has been significant downcutting of the stream channel at the upstream end (cross sections A - C) and mild aggradation at the downstream end (cross sections D - E) of the project reach. At cross section A, which is closest to the exit of the upstream culvert, we recorded 4 feet of downcutting at the middle of the stream channel since 2005. At cross section B, we recorded 4.5 feet of downcutting since 2005. These results indicate that high-energy water exiting the upstream culvert may be eroding the stream bed north of the bridge. We recorded significant aggradation at cross section D since 2005. However, our measurements for cross section D differ dramatically in channel shape and width from the measurements made in 2005, indicating that we may not have successfully aligned our measurements with the permanent landmarks used in that study. We recorded aggradation of 1.8 feet at cross section E, indicating that there may be some deposition of sediment south of the bridge.

Pebble Counts

We conducted three pebble counts that correspond to three of the five pebble counts performed by Cousins and Storesund in November 2005. We only performed three of the five pebble counts due to the locations' lack of accessibility. Cross Sections III and V showed significant sediment fining since the 2005 survey, whereas the point bar showed slight coarsening. Sediment fining could have occurred due to the deposition of finer sediment originating from upstream during high flows. Furthermore, coarsening of the sediment at the point bar could have occurred due to mobilization of gravel placed along the upper reaches of the channel.

Vegetation Survey

We estimated that 30% of the site is covered by tree litter, perennial grasses and bare soil, while 70% of the site is fully vegetated. We estimated that 50% of the fully vegetated site is vegetated by non-native species, mainly blackberry and ivy, and 50% by native species. The most common native species along the channel are willow and common dogwood which were planted to stabilize banks and reduce bank erosion. In the riparian zone, fennel and horsetail grow in abundance. We also noted the presence of cattails and california rose, but as described in the 2005 PPA, their survival rate was very low and they amount to a small percentage of the native vegetation. Among the trees in the riparian zone, we identified white alder, sycamore, willow, coast live oak and chinese elm. These trees were fully grown and provided a very large canopy for low-lying plants to grow beneath. The presence of watercress in the creek bed appeared to have diminished compared to the one recorded in the feature map from 2005, but it was still abundant where there was little to no tree cover. Watercress is known to slow streamflows and appeared to capture fine sediment and garbage, contributing to degraded water quality in the creek.

Feature Mapping

While the logs and boulders used for bank stability and protection during restoration work are still present, we observed some undercutting of the banks. This undercutting was no greater than three inches deep and mostly found in places where no stabilizing structures were used. We found gravel bars in similar locations as described in the 2005 PPA, but some of them had shifted over the past 13 years. There was no sign of the erosion control fabric. We also identified fine sediment deposits along the floodplain of the creek, mainly under the pedestrian bridge. The pools and riffles remained undisturbed and had caught woody debris. We failed to note an island of cattails as described in the 2005 PPA due to the overgrowth of vegetation in that region.

Discussion

Our findings indicate that there have been small changes to the channel form, riparian vegetation, and streambed sedimentation within the project reach that may have management implications. The channel form has remained relatively stable over the past sixteen years since restoration work was completed. However, undercutting at the outer edges of meanders, downcutting at the upstream end of the reach and aggradation at the downstream end suggest there may be long term changes to the channel form and meander sequence. Put together with sediment-fining recorded at the downstream end of the reach, these findings indicate that high-energy hungry water exiting the upstream culvert may be eroding the channel bed north of the bridge and depositing fine sediment south of the bridge. If stream channel stability is necessary for public use of the park, it may be necessary to add structures like large woody debri or rock check dams at the upstream end of the project reach to dissipate energy.

We recorded similar native species ground cover and survival rates to the PPA conducted in 2005. Since two of the restoration project were to “restore native riparian plant species” and “enhance and restore habitat for terrestrial and aquatic species,” our findings suggest that the initial planting was not sufficient to establish long-term native species cover and that ongoing maintenance is necessary to remove ivy and blackberry from the riparian zone and watercress from the streambed (Cousins and Storesund, 2005). In addition to increasing native species groundcover and survivability, these efforts may aid in mobilizing fine sediment and garbage currently caught by watercress in the streambed

Conclusion

The first objective of the 2001 Project Plan was to restore native regional riparian plants. We found that the restoration failed to reach target goal of 70% native cover, even though the intent was to reach this goal within three years of project completion in 2001. The 2005 survey also recorded 50% native vegetation, so we can assume that there hasn't been any additional planting since the original project. Additionally, there was well-established invasive communities growing on and around the creek like watercress and blackberry. Although the amount of watercress appears to have decreased since the 2005 survey, the general "overgrown-ness" has progressed. This state of vegetation often contributes to the trash and woody debris build-up in the creek itself, and thus impact the flow capacity.

Four of the restoration objectives focused on geomorphology. Specifically, the project called for the improvement of sediment transport, the re-establishment of a stable channel and banks, and the establishment of long-term erosion control. We found that the upstream end of the channel (sections A-C) saw severe downcutting, and that the downstream end had mild aggradation (sections D-E). Erosion at cross-section A is evident, possibly due to high flow out of the upstream culvert. However, these observations rely on the accuracy of our alignments with the 2005 report and therefore, our conclusions on these objectives focus more on visual observations. We observed undercutting and erosion throughout the channel and it appears as though no action has been taken to prevent scouring since 2005, as seen in the photographic survey in Appendix A. Additionally, the pebble count revealed significant sediment fining, and thus we conclude that these objectives were not met.

The final project objective focused on the social component of park restoration. We were unable to conduct interviews with users, however we did see visitors from the daycare located next to the creek during one site visit. It did not appear that the creek had much recreational purpose; rather, we found that it was a location for informal settlement. The planners intended for the restoration project to encourage more use, and connect users to the neighboring park and recreation center. We suspect that it may have encouraged more use immediately after project completion, but that trend dissipated in the last fifteen years. Additionally, the creek had significant trash build-up, reinforcing our assumption that there has been very little maintenance.

Future Post-Project Appraisals should investigate bank erosion and channel downcutting, as well as the state of native vegetation cover. The City of Oakland should take steps towards improving the current state of the channel bed both with erosion control and vegetation maintenance.

References Cited

2017. Arroyo Viejo Watershed. Alameda County Flood Control and Water Conservation District. Retrieved from https://www.acfloodcontrol.org

Cousins, M. and R. Storesund. 2005. Post-Project Appraisal of Arroyo Viejo Creek Improvement Project, Oakland, California. *UC Berkeley: Water Resources Collections and Archives*. Retrieved from https://escholarship.org/uc/item/5cq6127x

Kondolf, M. 2000. Some Suggested Guidelines for Geomorphic Aspects of Anadromous Salmonid Habitat Restoration Proposals. *Society for Ecological Restoration.* 9pp.

Wolfe Mason Associates Inc (WMA). February 2001. Arroyo Viejo Park Creek Improvement Project, City of Oakland, Alameda County, California. 9pp.

Wolfe Mason Associates Inc (WMA). May 2001. Arroyo Viejo Park Creek Improvement Project. Line K, Oakland, California (design plans). 13pp.

Table : Cumulative Size Distribution for Pebble Counts

Cumulative Size Distribution for Pebble Counts on Arroyo Viejo Creek (% Finer) on November 2, 2018			
Size (mm)	**Pebble Count Location**		
	XS III	**XS V**	**Point Bar Below Pedestrian Bridge**
4	0%	9%	0%
5.7	3%	19%	5%
8	21%	34%	9%
11.3	62%	75%	43%
16	90%	86%	65%
22.5	99%	97%	93%
32	100%	100%	100%
45	100%	100%	100%
64	100%	100%	100%
90	100%	100%	100%

128	100%	100%	100%
180	100%	100%	100%
256	100%	100%	100%
362	100%	100%	100%