Historic Drainage Patterns of the Alameda Watershed

Alameda Creek Flows Workshop #1: Understanding the Issues
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Introduction (Andy Gunther)

Dr. Josh Collins represents the type of interdisciplinary scientists we need to address large environmental issues. Josh received his doctorate in entomological science from U.C. Berkeley, and then he undertook post-doctoral studies in geology/geophysics at U.C. Berkeley and ecology and U.C. Davis. He is presently the Manager of the Wetlands Science Program at the San Francisco Estuary Institute. Josh will speak today about the Alameda Creek watershed historical drainage patterns.

Remarks (Josh Collins)

The purpose of the talk is to provide you with a basic overview of the historical drainage patterns of the watershed. We will use old maps to visualize the network of streams and wetlands that comprised the historical drainage system. As viewed from above, the twists and turns of the channels large and small, and the various wetlands and ponds form a unique signature for the watershed. This signature allows us to distinguish this watershed from other watersheds in the region. In my short talk, we will use this unique signature of the Alameda Creek Watershed, its drainage system of channels and wetlands, to infer some general information about its historical nature.

When we discuss restoration (I have heard the term a couple of times already this morning), there is a sense of returning to the past. As an ecologist, I should remind us that we cannot reach the past, that ecosystems don't run backward. Things continue to change. So why bother looking back to the past? Why do we care about the historical condition? Looking back helps us understand how we got to where we are today. The comparison of past and present conditions gives us some sense of the trends in change, how the watershed tends to adjust to changes in climate and land use, and this gives us a way to plan for the future. We can discover the watershed as a dynamic physical template for successful communities of plants and animals, including people. Land use, such as housing developments or ecological restoration, can either accommodate the natural tendencies of the landscape or fail expensively. The historical view is essential to understand these tendencies and forecast the future.

Sandy gave you cross-sectional pictures of the watershed. I am going to bring you to the surface, the veneer of surface hydrology and life as it existed some 200 years ago, with the emphasis on the drainage patterns. I am suggesting that the surface drainage is an expression of processes driven by topography and climate that still largely exist today as they did before. The topography is basically the same as it was 200 years ago. The climate varies, as we know, from decade to decade and from year to year, but the general climatic regime is about the same now as it was back then. It may in the future change faster than before. There are plenty of models suggesting that the pattern of wetness from season to season, the intensity of storms and the total amount of water coming to the Bay Area may change significantly over the next 100 years, or even sooner, as a part of global climate change. But right now we can look to the past as a picture of how the landscape has tended to behave, given the climate we still have today. This begins to tell us what kinds of habitats might be restored in different parts of the watershed, or how restoration might be supported by natural processes.

I'd like to offer another word or two about drainage. We can go back through time and look at how engineers have historically used the term. It was mostly about getting water off the land as quickly and thoroughly as possible. For land developments, drainage still mostly means getting water off the land. But the idea of drainage is changing in some of the modern schools of landscape ecology and landscape architecture. There is a growing sense that water should have longer residence in watersheds, that it should linger on the land surface. Fast drainage may not be as good as slow drainage. There is a growing concern that using natural features, like wetlands and valley bottoms, or artificial features like carved swales between neighborhoods of houses, should be used to hold the water longer on the land. Slow drainage provides recharge to the water table, diverse habitats, and a desired aesthetic. It can also cause problems with mosquitoes and odors and a deafening chorus of tree frogs at 2 AM. Slow drainage is not without costs. But it's gaining acceptance.

The final point I will make before we turn to the maps is that drainage is not just about water; it's also about sediment. The natural drainage system of the watershed conveys sediment as well as water. And this aspect of drainage also changes over time. One of my reasons for asking Sandy about the origins of the deep valley gravels is that he gives me a chance to point out that these gravels are not coming from present-day or even historical processes. They do not represent erosion of this landscape. These are ancient gravels from a different landscape. But they control drainage in the valleys by giving the surface water a way to penetrate the valley and recharge the ground water. The permeable gravels from an ancient landscape influence the present-day distribution of surface water and the height of the water table. Yes, there is gravel moving along the steeper streambeds in the watershed, but most of these gravels are stored in the streams or reservoirs that have been constructed above the valley floor. What the channels are delivering further downstream are mostly silts and clays suspended in the water. The relative proportions of sediment sizes, from silts and clays to gravels and cobbles, have important implications for habitat restoration, and they are often indicative of geology, climate, topography, and land use. And they help shape the signature drainage system. So, sediment is an important aspect of drainage.

Now let's look at some of the evidence of the natural tendencies of this landscape. Here we see some local detail of a regional map of historical conditions produced by Whitney, the first state geologist in California (Figure 1). The map was published in 1873, but most of the surveys were conducted a few years before that. This map provides a detailed picture of topography and surface hydrology compiled from many sources. It's a pretty good synthesis of the earliest information.

We will start at the top of the watershed, looking at the surface drainage, the channels, that existed at that time. Of course the watershed is much larger than shown here; we are focusing on the Livermore Valley. We can see numerous channels draining the upper part of the watershed and emptying into the ancient gravels on the edges of the valley bottom. Notice that the channels do not cross the valley floor. They feed the aquifer of the valley gravels, raising the watertable above the ground at the broad valley bottom, where there were large freshwater marshes and willow groves. Other channels emerged downstream of the wetlands and led away from the Livermore Valley toward Sunol. The channels that drained the upper watershed around the Livermore Valley dissipated into the valley gravels, maintaining the high water table for which the valley was well known.

Very near to where we are today, near this convention center, there used to be a very large pond surrounded by marsh and willows. It was historically called a lagoon. It is why the main channel that led from Livermore Valley to Sunol was called Arroyo Del Laguna. The term, arroyo, does not always mean a dry creek bed. Arroyo is a general term for a channel having periods of abundant flow and occasionally no flow. Arroyo Del Laguna was fed by the large wetlands, or lagoon. It was 500 to 3,000 acres large, varying in size from season to season and year to year, depending on rainfall. Here the watertable rose above the ground at a topographic low in the bottom of the valley. Around this lagoon were thousands of acres of willows. These willow stands were called sausals by the early Spanish explorers. This arrangement of channels and lagoons and willows was well understood and appreciated by the indigenous Indians that lived here. The Indian habitation was quite large at this location, near the lagoon.

I want to step aside from the main story line of this talk for a moment and address another line of investigation. The Indians were here for thousands of years, successfully using the natural resources, and dealing with year-to-year variability. They somehow managed to survive drought and deluge, and shifts in resources. Would it be useful to know their management practices? The recovery of traditional ecological knowledge is a new initiative in ecological research that may yield tried and true (but forgotten) ways to manage our natural resources.

Now, back to the main story. As Sandy also pointed out, at the bottom of the drainage system in Livermore Valley, downstream from the largest lagoon, another channel emerged, named Arroyo Dell Laguna, that led through a canyon to Sunol. So we had one part of the watershed consisting of channels draining into Livermore Valley, where water and sediment were stored in a large aquifer topped with wetlands and willows, and there was a similar arrangement of channels and storage places in the next valley downstream, called Sunol. In both valleys, the channels did not simply cross the valley floors, but instead they dissipated into permeable gravels, feeding into a watertable that emerged in the middle and lower reaches of the valleys, as evidenced by the lagunas and sausals, and broad areas of seasonally wet meadows. Further downstream, near the ends of the valleys, other channels emerged.

Let's look closer at Sunol (Figure 2). It's drainage system looks like that of Livermore, just smaller. Here in Sunol there were channels entering the upstream margins of the valley, diving into ancient gravels, and charging a watertable that emerged downstream, supporting willows and at least one small lagoon. It is the same kind of discontinuous drainage system as we saw in Livermore Valley. Below the willows and wetlands of Sunol, another channel emerges and it leads through Niles Canyon to the Bay.

Now let's look at the downstream reaches of the watershed, between the Bay and Niles Canyon (Figure 3). This is the area called Niles Cone. It is the large alluvial fan that extends from the mouth of Niles Canyon to the Portrero, the island of hills by the Bay now called Coyote Hills. Niles Cone is actually the name of the aquifer that exists beneath the alluvial fan. The Portrero blocks the downstream distribution of water and sediment coming out of Niles Canyon. The fan is building up behind the Portrero. The stream channel must flow around the Hills to reach the Bay. It has variously flowed to the south and to the north, as evidenced by abandoned channels and remnants of riparian forest.

Even in 1860 and up until the 1900s there were two active channels, one on the south side of the fan, and one on the north side. There are Indian shell mounds along both of these channels, which suggests that either or both of these channels historically carried water all year long, at least during some years.

But the old maps always portray the north channel as being larger than the south channel, and there is evidence of natural levee building in the tidal marshlands at the ends of both channels. The volume of water and sediment probably varied from one channel to the other, and therefore from one side of the fan and hills to the other. Sometimes it went one way, and sometimes it went the other. Why? Well, it's interesting to note that the main channel coming out of the Canyon crosses the Hayward fault at the apex or head of the alluvial fan, at the Canyon mouth. A slight shift in stream course along the fault line could cause the water to move from one side of the fan to the other. Earthquakes and fault creep could redirect the creek flows.

No matter which way the water flowed, it probably did not always reach the Bay. There is evidence of both channels feeding into large sausals and seasonal freshwater wetlands, from which smaller channels led into tidal marshes. As in the Livermore and Sunol Valleys further upstream, local Indian populations were centered on this arrangement of stream channels and wetlands and sausals.

Stated most simply, if we walk through the watershed from top to bottom, we see perennial and seasonal flow in well-defined channels interrupted by broad wet valleys with ponds and emergent wetlands. The watershed signature might be read as channel-pond-sausal-channel-pond-sausal-channel-pond-sausal-saltmarsh-bay.

There's nothing quite like this anywhere else in the region. It is unique to Alameda Creek. The signature is readable. It shows up in historical maps, settlers' accounts, and aerial photography. It is faint in places, but water continues to try to trace the signature through the landscape. The drainage pattern is still evident. Water continues to flow downhill, as directed by topography and geology. The historical topography is mostly still here, the deep gravels have not all been mined away, and the rainfall patterns are about the same. I expect that the gardens and basements on the old lagoon near where we are today tend to get wetter or stay wet longer than gardens and basements in higher places. I suspect that part of the reason that this convention center and the surrounding fairgrounds sit here and not elsewhere is that this area was "poorly drained" and therefore less suitable for housing or industrial development. This place was hard to drain, and places like this have tended to become part of the public domain. Many public schools and city parks in the Bay Area sit on historical flood plains and wetlands. They occupy the places where wetlands tend to be, and where there shouldn't be buildings.

And the wet places may get wetter. There is less agriculture and fewer gravel mines to artificially depress the water table. It will rebound. And we might consider the increase in rainfall for this region that is forecasted by climate change models. There could be more local water. The result could be the restoration of historical drainage patterns, with larger stream volumes and perhaps more wetlands. The historical information gives us a view of where the water will tend to go, and what it will tend to do.

How has this system of drainage, with discontinuous channels, ancient gravels supporting high watertables with lagunas and willows, been impacted by urbanization? We only have time this morning to skim the surface of urban hydrology. Here are some talking points. We have dug ditches through the lagoons so the channel ends meet. We made drainage faster where we could to reduce flooding. We've lessened recharge by routing some streams around the recharge zones, and by extracting and consuming local groundwater. On the upper watersheds, the whole drainage system has extended upslope. Where the creek began a hundred years ago is downstream from where it begins now. This is largely the result of intensive grazing that increases runoff. More water is therefore flowing from the hillsides than before. To accommodate this increase in runoff, the channels have cut down; they have incised. The stream incision in the steeper parts of the watershed weakens the hillsides. Although the landslides that Sandy talked about are in large part natural, their activity is increased by stream incision. In general, there is more landslide activity now than before. Under natural conditions, the sediment from the landslides moved down the headward channels to the alluvial fans near the valley floors, upstream of the lagoons and willows. But now the channels either feed into reservoirs that trap much of the sediment, or they have been artificially extended through their fans as drainage ditches, and are connected across the valleys. The sediment from landslides and local stream banks can now travel far beyond the historical alluvial fans and local wetlands. I suspect that there is more sediment reaching the Bay through Alameda Creek now then before the advent of modern land use. This is part of the reason for maintenance dredging in the Alameda Creek flood control channel. We have increased its supply of sediment by "improving" the upstream drainage system.

In this short talk, I have not gone into much detail. I have tried to provide a basic picture of the natural drainage patterns of the watershed at the landscape scale. The premise has been that these patterns indicate natural processes of water and sediment movement that account for the physical form and ecological function of the landscape, and that the important work of ecological restoration needs to be done in the context of an understanding of these processes. In fact, the comparison between past and present conditions provides the best information about restoration needs and opportunities. If we look backward and forward through history, we see that dams and roads and buildings come and go. There is a cycle of infrastructure repair and replacement. We can successfully build ecological restoration into the history of land use change, if the restoration is consistent with the natural tendencies of the landscape.

Figure 1. Detail of Whitney map ca 1863 showing perennial streams (red lines) leading into and from wetlands (blue polygons) and willow groves (green polygons) in Livermore Valley. Note that none of the streams cross the valley floor.

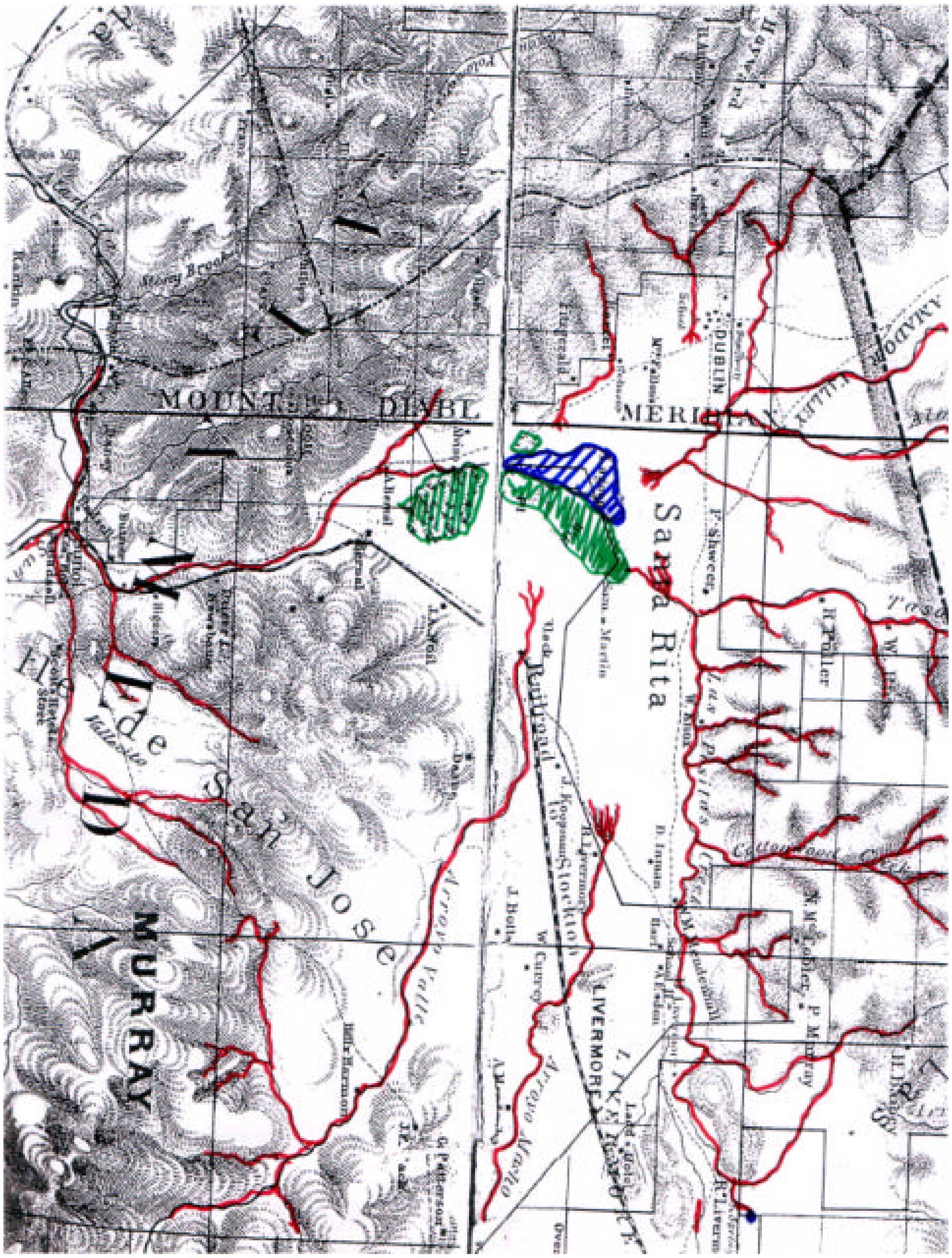

Figure 2. Detail of Whitney map ca 1863 showing seasonal streams (dotted red lines), and perennial streams (red lines) leading into and from wetlands (blue polygons) in Sunol Valley. Note that few of the streams cross the valley floor.

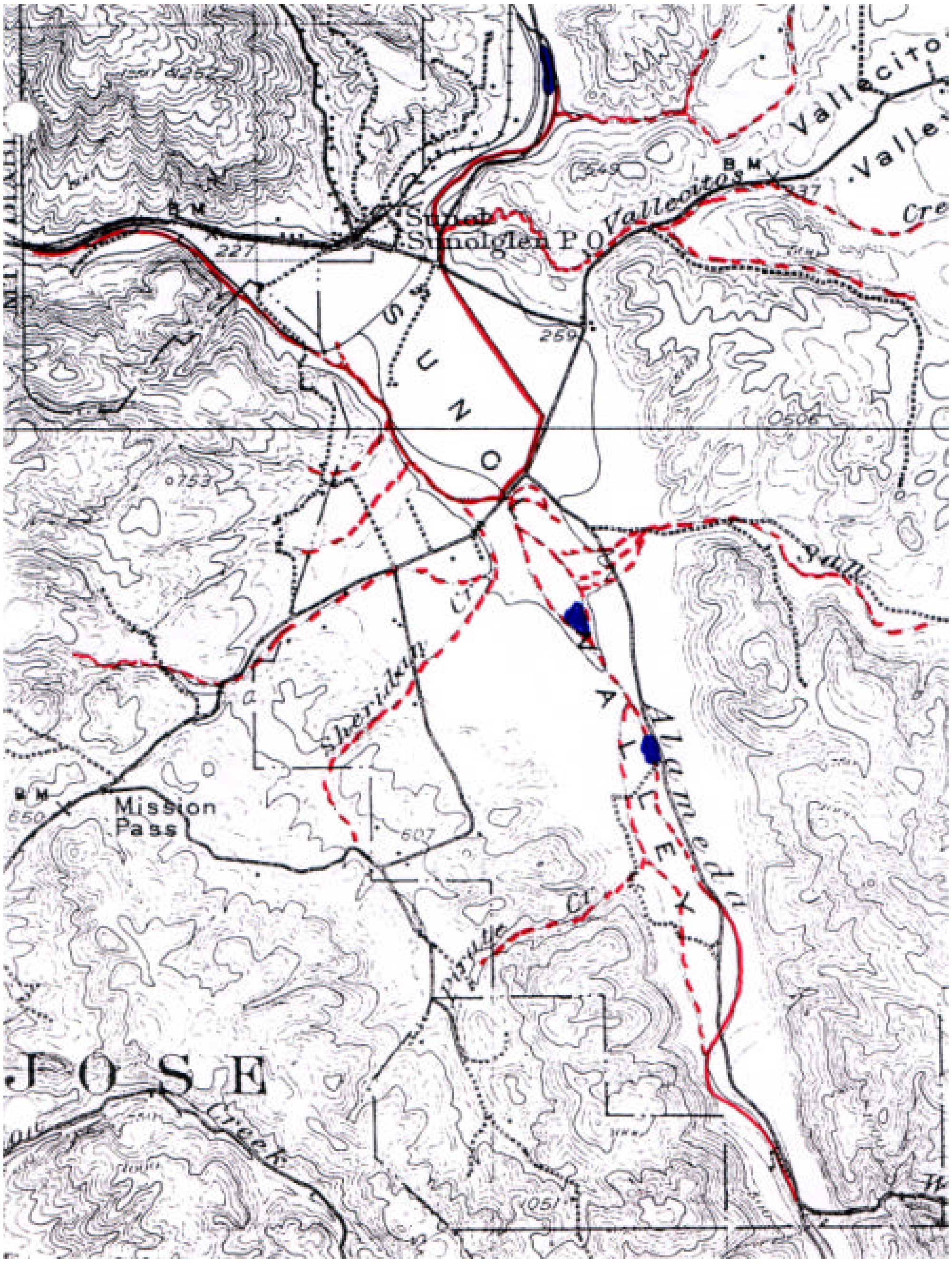

Figure 3. Map of the historical conditions of the South Bay including the Alameda Creek Watershed near Niles Cone, in the region historically occupied by the Tuibun Ohlone people, showing perennial streams (green lines), ponds (dark blue polygons), willow groves (dark green polygons), vernal pool areas (pink), wet meadow (light green), tidal marsh (orange), and mudflat (dark brown). based on the historical baylands maps of the Bay Area EcoAtlas. Note that active channels existed on both sides of the large alluvial fan extending from the mouth of Niles Canyon to the east side of the Coyote Hills.