Executive Summary
El Corte De Madera Creek Open Space Preserve
Watershed Protection Program Effectiveness Monitoring

July, 2020

Summary:

In 2004, the Midpeninsula Regional Open Space District (Midpen) adopted the El Corte de Madera Creek Open Space Preserve Watershed Protection Program (WPP). The goal of the WPP was to reduce the amount of sediment entering El Corte de Madera Creek and to improve spawning habitat for salmonids (steelhead trout and coho salmon) over 12 years of sustained construction to re-route trails, decommission roads, improve roads, install bridges, and more. Midpen construction staff performed most of the work and Midpen invested roughly $1.25M in the project through equipment, materials, and contractors. To monitor the effectiveness of the WPP, Midpen contracted with Balance Hydrologics, Inc. (Balance) in 2004. Initial monitoring focused on measuring sediment in the creeks and the data indicated more study and ways of measuring sediment were necessary. Ultimately, Balance's monitoring work from 2004-08 formed a 'baseline' condition as the WPP implementation proceeded from 2009-2016, and which continues in part today through ongoing maintenance. Upon completion of the majority of WPP work, Midpen returned to Balance with the idea of capturing the 'after' condition in the stream systems of ECDM. The enclosed report summarizes the recent monitoring efforts from 2018-2020, draws conclusions about the effectiveness of the WPP in reducing sedimentation instream and offers insights into the monitoring methods employed for the benefit of the scientific and resource management community. All of the evidence gathered in this study points in a positive direction. The significance of each line of evidence is evaluated in the context of the natural variation in sedimentation that is caused by drier and wetter winters. The clear outcome of the monitoring is that less sediment is entering the San Gregorio watershed than before the WPP was implemented.

Background 2004-2007:

In 2001, in response to citizen complaint, Midpen worked to develop a plan to reduce sedimentation with state environmental agencies including the California Department of Fish and Wildlife and the San Francisco Water Quality Control Board). The San Gregorio watershed was listed as impaired for sediment in 1998 and remains so today. Additionally, steelhead trout and coho salmon had seen declines in populations over the proceeding decades, in part due to sediment harming salmonid eggs in the creek. Out of this grew a process to change the roads and trails in the preserve to improve the water quality and the native fish habitat, while continuing to provide an enjoyable experience for visitors. The WPP tried to balance the experience preserve visitors, particularly mountain bicyclists, would have with the environmental goals of the project and the challenges facing salmonids.

The WPP used best management practices developed throughout California to identify and prioritize construction activities that would reduce sedimentation. Particular attention was paid to steep slopes, roads as they approached creeks and places where preserve visitors were likely to cause erosion. Achieving the WPP goals of reducing sedimentation also entailed changing the preserve visitor experience and the trail system as a whole. New or retrofitted trails allowed for trail designs that were less likely to have ruts, were muddy for a shorter period of the year, and, by installing drainage structures in a rolling pattern, created a varied riding experience for mountain bikers. Some mountain bikers miss the steeper trail system that was legacy of logging and motorcycle riding in the 1980s. Nonetheless, ECDM is more popular than ever and offers some of the best mountain biking in the Bay Area.

The WPP reduced chronic erosion (i.e. erosion that occurs in typical year of average rainfall) and episodic erosion (i.e. erosion during rare and large storm events). Reshaping roads, rocking roads, and eliminating ruts and gullies helped reduced chronic erosion. Making larger stream crossings with bridges and bigger culverts helped reduce episodic erosion by allowing big storm flows to pass through the roads. The condition of these sites after improvement is monitored visually and qualitatively for loss of soil or erosion near the creek. These efforts are estimated to have prevented thousands of cubic yards of sediment from entering the creek over the study period of 2004-2020 (a typical dump truck carries 10 cubic yards). The Santa Cruz Mountains have naturally high rates of sedimentation compared to other regions, due to steep slopes, erosive soils, and the underlying geology. The central challenge of this study was to develop a monitoring method that is sensitive enough to measure the relatively smaller sedimentation caused by roads and trails.

The monitoring efforts have been a collaboration between Midpen and Balance, spanning over 16 years. Both organizations have many of the same people working on the past and present projects. In response to Midpen in 2004, Balance recommended an approach to monitor sediment in the creek called the "V-Star" method (V*). V* monitors change in creek sediments by probing the streambed with a metal rod marked like a ruler. Typically, one person takes the measurement and another records the data point in an unbiased grid across the stream. V* sites are all 'pools', which are natural depressions in the creek (visualize a small swimming hole). Anywhere from 50-200 data points at each pool may be gathered depending on the size of the pool. The average depth of the sediment and the depth of water is used to estimate how full of sediment the pool is. The V* value is a percentage of how much sediment is in the pool (0 = free of sediment and 100 = full). The V* method monitors the change in V* values year over year by remeasuring these pools. The majority of these pools are located in the very bottom of the watershed, towards the southern boundary of ECDM near the Virginia Mill Trail bridge. By locating the measurement sites lower in the watershed, Balance and Midpen aimed to better measure the effects of the WPP, which occurred upstream throughout the entire preserve. Balance trained Midpen staff to collect this data in 2004 and then Midpen collected the data in 2005 and 2006. To set up a point of comparison, Balance recommended Midpen also monitor six pool locations in nearby La Honda Creek Open Space Preserve, in the same watershed with the same geology at a similar elevation with similar rainfall, to act as a control group.

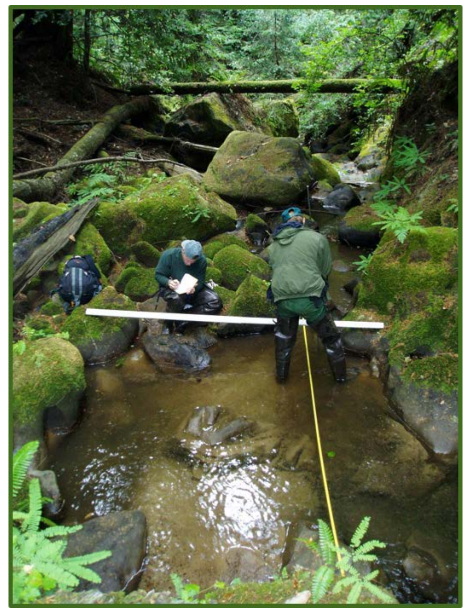

Figure 1 Midpen staff gathering V data, 2005*

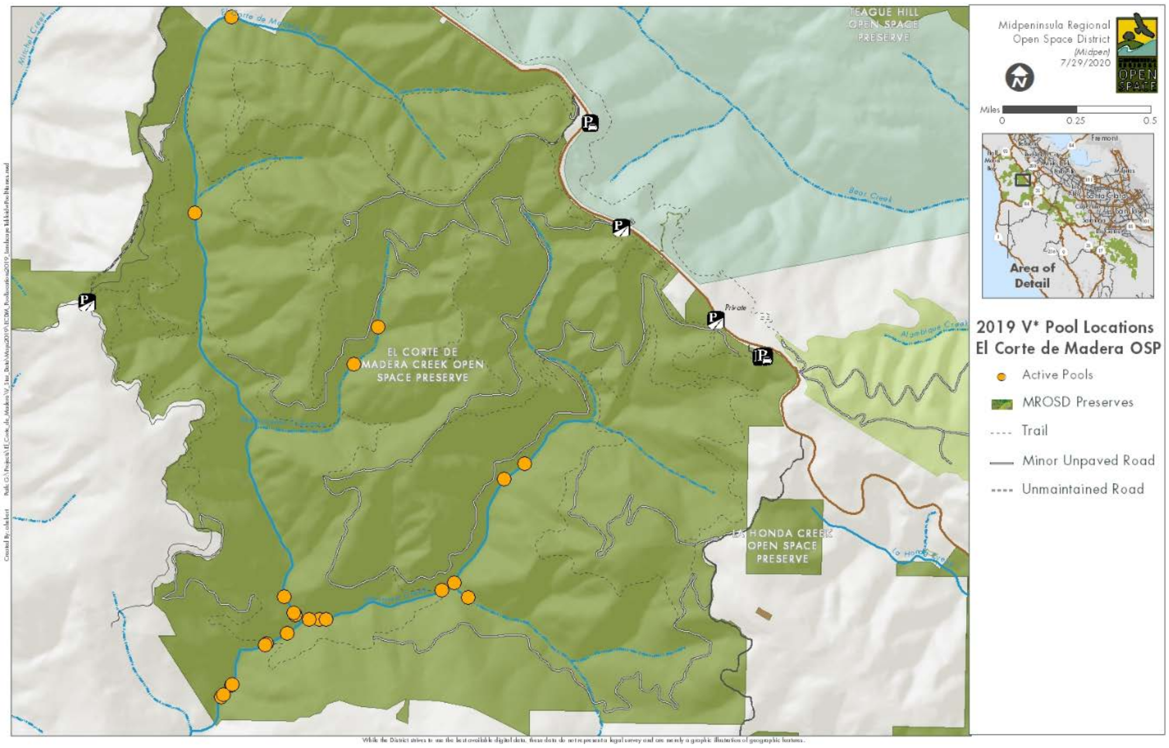

Figure 2 V Pool Locations in ECDM*

It was important to separate background rates of sedimentation from that created from human activity and to "normalize" V* measurements in order to provide context for the results. To do this, Balance staff surveyed large landslides that had entered the creeks throughout most of the ECDM and estimated the volume of those landslides. Most of these landslides appear to have originated or been remobilized by the 1998 El Nino event. Additionally, Balance estimated a potential range of sediment that could be coming from roads and trails. Together, these data suggested in the 2004-07 period that 80% of sediment is attributable to large landslides and 20% may have come from roads and trails.

By 2006, the long-term nature of the WPP was apparent. Balance recommended an additional independent line of evidence, separate from V*, that would be necessary to effectively measure change over time. Midpen contracted with Balance to conduct a stream gaging and sediment sampling program to compliment the V* data. Balance established a stream gage at the bottom of ECDM that measures the height of stream ("stage"). Using an electronic sensor, these data were recorded every 15 minutes. The gage data are also used to measure the volume of water that is leaving ECDM. By measuring the depth of water along the stream across from the gage, Balance could relate the stream height on the gage and the depth to create an area of water. With a velocity meter (visualize a little propeller), Balance gathered stream velocity. Multiplied by the area, velocity provides the volume of water leaving ECDM ("discharge") in cubic feet per second. Monitoring discharge allowed Balance to describe how and when water and sediment moved through the creek system.

Figure 3 At left, El Corte De Madera Creek Gage at High Flow Conditions 2019. At right, Midpen staff at Stream Gage 2006.

When large storms come into the Santa Cruz Mountains, rain quickly mobilizes fine sediment particles into the creek, causing a muddy appearance. This is a natural process, but the degree to which the water is cloudy or muddy ("turbid") reflects how much sediment is in the creek, naturally or because of human activity. During large storms, Balance collected water samples from the creek and then sent them to a laboratory to precisely weigh and describe the sediments in the creek from that exact moment it was collected. This turbidity data could then be connected to the discharge data, relating the magnitude of the storm (e.g. a 1-2 year storm event at ~200cfs, which is a storm that is likely to occur every year to every other year) to the quantity of sediment leaving ECDM. This relationship between storm events and sedimentation (bigger storms move more sediment and the inverse) established another 'baseline' and speaks to how sedimentation in ECDM might affect downstream salmonid habitat.

Figure 4 Balance staff collecting sediment during a storm. Sample at right.

During the V* data gathering, Balance staff recommended at each data point Midpen record what size of rock is found on the pool surface (e.g. sediment, gravels, cobbles, boulders), called streambed texture. The V* values speak to the volume of sediment reduced by the WPP but does not describe directly how that might affect fish habitat on the surface of the streambed. Coho and steelhead spawn in gravels and without gravels, they cannot reproduce as well. Their eggs also get smothered in sediments, reducing oxygen at a critical time. ECDM is too high up in the watershed for salmonids, past natural waterfalls that prevent migration, but the sediments, gravels and wood that leave the preserve directly affect downstream habitats. The streambed texture data gathered alongside the V* data measures how pools in the preserve have changed in response to reduced sedimentation and suggests how downstream pools might have also changed.

Figure 5 Diagram Highlighting Stream Texture at a V pool*

These three lines of evidence (V*, discharge/turbidity, and streambed texture) collectively measure the changes over time in sedimentation.

2018-2020 Study

The first phase of the Balance's efforts was to make sure the streamgage installed in 2006 was in working order to continue and repeat the discharge and turbidity data gathering. The remoteness of the site (an hour fifteen minutes from the urban San Francisco Peninsula) makes very frequent monitoring or sampling cost prohibitive. New and cheaper technology allowed for a turbidity probe to be installed to gather a measurement of the visual clarity of the water (muddiness) every 15 minutes, allowing a year-round record without frequent fieldwork. This continuous data would then be calibrated with the same sediment sampling sent to the lab to ensure accurate recording. Having continuous streamflow data and turbidity data provided a record that could be compared against the San Gregorio gage at the bottom of the watershed, operated by USGS (and partly funded by Midpen).

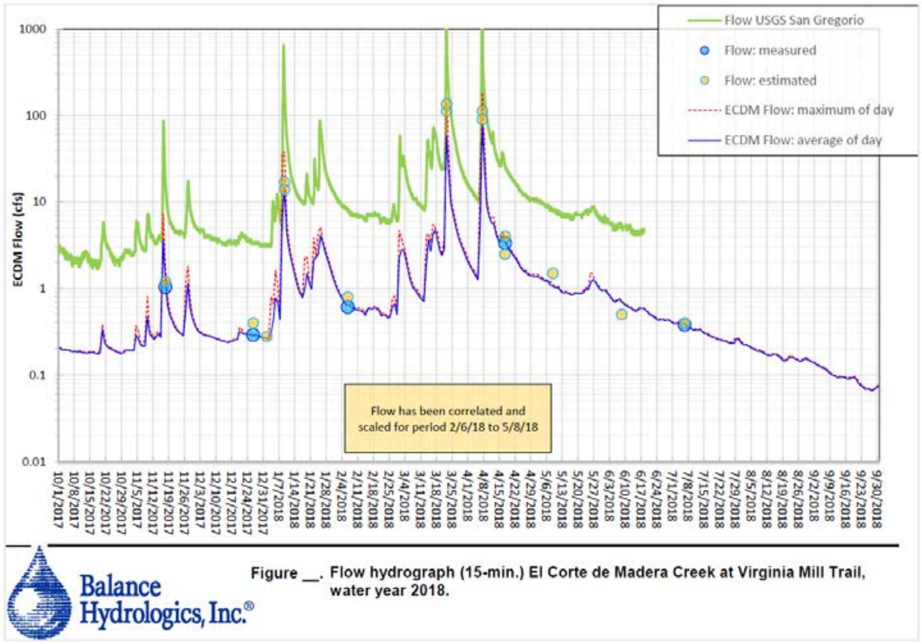

Figure 6 Stream Flow at ECDM and San Gregorio in 2018, log scale

Additionally, Balance and Midpen walked the majority of the creek system to reevaluate how large landslides might be affecting sedimentation. How the very wet winter of 2017 may have changed the stream was an important question (many highways had closed for part of the winter due to landslides). The surprising conclusion was that relatively few new landslides had occurred. This may reflect that the historic rainfall was spread out over the winter and not highly concentrated in fewer, larger storms.

In the fall of 2018, Balance and Midpen staff re-learned the complexities and technicalities of the V* method and began resurveying the same pools as studied before. Balance and Midpen staff compared past photos, sketches and GPS data to reassess the pools. 4 of the La Honda Preserve V* sites were substantially different, due to streambank/road failures and Sudden Oak Death causing tan oak die off into the pools, altering how sediment was stored. Alternatively, only 2 of the ECDM pools were significantly changed, reflecting the stability of the boulders that define most of pools. Midpen hired a Water Resources intern to carry out the bulk of the labor for the V*. The dedicated labor allowed for additional data gathering. Balance and Midpen added 7 new pools to ECDM and selected 2 new replacement pools to La Honda Preserve. An average water year followed the fall of 2018 and another year of V* data gathering continued with another Water Resources intern in fall 2019. Midpen and Balance kept the stream gage in operation through winter 2019-20 in the event large storms would add to the data set (no such large storms occurred).

Results and Interpretation:

All of the data gathered show a decline in sedimentation. The strongest evidence comes from the turbidity-discharge data, comparing 2006-08 to 2018-20. For example, when a 1-2 year storm moves through ECDM, less sediment leaves the system today than before and this is true of every type of storm event. Finer sediments have decreased by 2.4x and coarser sediments of 4.3x from 2006-08 to 2018-19.

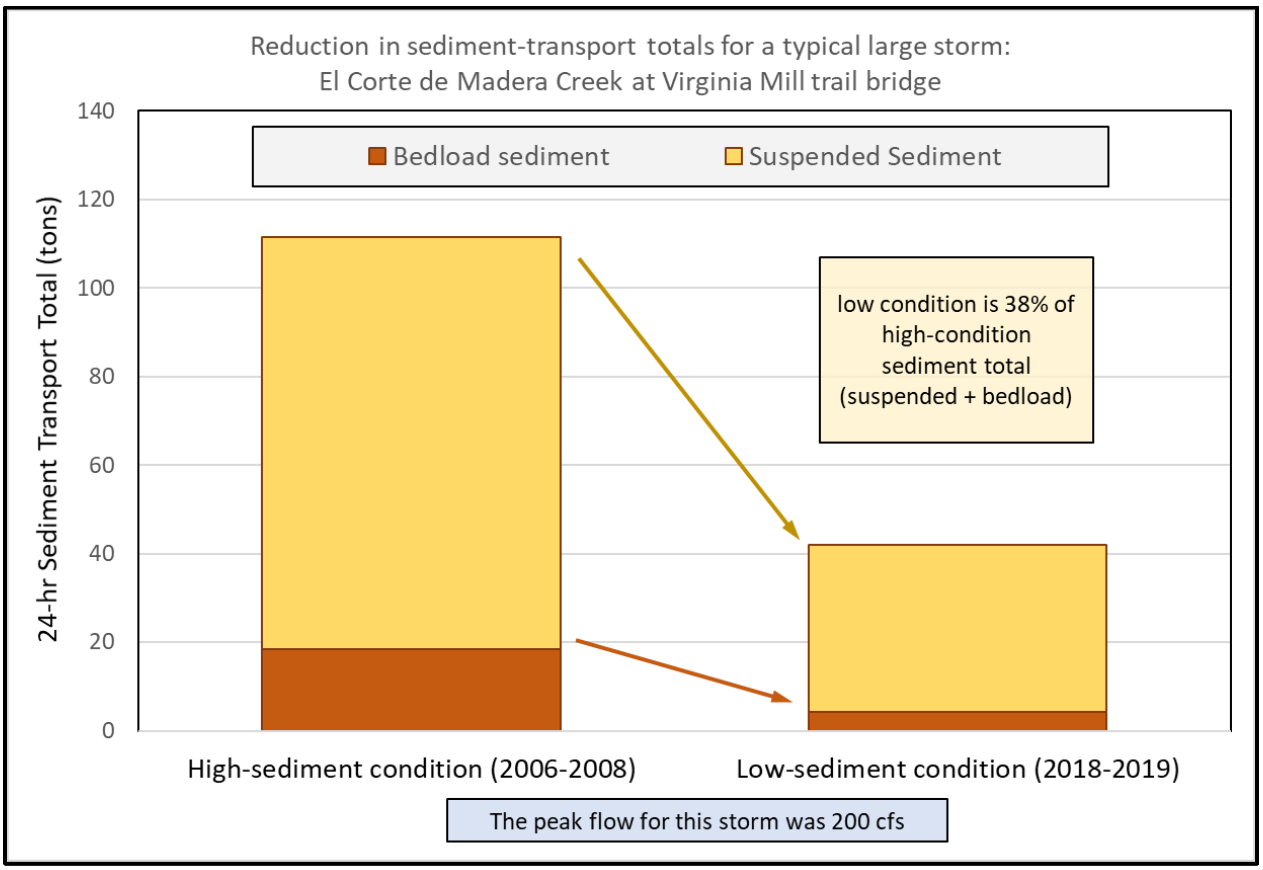

Figure 7 A 1.6-year storm event transporting sediment out of ECDM, comparing the before and after conditions.

Less sediment is affecting downstream fish habitat. The V* data show a 15% decline between the 'before' and 'after' data sets, but the relative volume of sediment stored in the pools compared against the volume of sediment moving within and leaving the preserves suggests this a relatively weaker line of evidence. The La Honda Preserve V* pools track in a similar way to the ECDM pools, though no restoration occurred upstream in La Honda. The streambed texture data shows a 24% decrease in sediment and an increase 3% and 8% in gravels and cobbles respectively. The pools are covered with less sediment. This is the type of change that would better support salmonids downstream.

Every year since El Nino 1998 would be expected to have less sediment as those landslides are flushed down the watershed. The drought of 2012-17 would also be expected to reduce sedimentation in the creek, because fewer storms occurred. The quantitative relationship between the WPP work on the roads and trails and what can be measured in the stream is complex. But the lack of erosion at the WPP sites combined with the three lines of evidence all pointing in the same direction (and no evidence to the contrary) suggests the work has been effective in reaching its goals. The enclosed report expands on this nuance and dives much deeper into the waters of ECDM.

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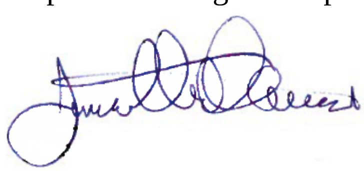

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