Natural Resource Damage Assessment

Clover Flat Landfill Waste Discharges
(Riparian Destruction, Leachate, Sediment, and Low pH)

Napa County

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INTRODUCTION

The California Department of Fish and Wildlife (CDFW) estimates damages to natural resources based upon the following components: 1) primary restoration and monitoring costs of the impacted area; 2) compensatory damages; and 3) the costs of assessment. Primary restoration refers to actions taken at the impacted site to repair and speed the natural recovery of the site (see Appendix A). Compensatory restoration refers to additional restoration projects, either on-site or off-site, to compensate the public for the lost natural resources between the time of the incident and full recovery. Compensatory damages are based upon the cost to implement restoration projects that would benefit habitats similar to those injured. The analysis in this report focuses on compensatory damages, under the assumption that primary restoration is performed on-site to facilitate recovery of the impacted areas.

SITE DESCRIPTION

Clover Flat Landfill (CFL) is located at 4380 Clover Flat Road, Calistoga, CA 94515. CFL is owned by Vista Corporation and operated by Clover Flat Landfill, Incorporated. CFL is situated along the western slope of Clover Flat Canyon in Napa County, California (Figure 1). The landfill is accessed by Clover Flat Road, which extends northward from the Silverado Trail (road) up the western side of the canyon to the landfill site. The landfill site consists of previously capped landfill basins, the active landfill basin, and the capping material mining operation adjacent to the uphill section of the active basin. Clover Flat Canyon runs primarily north to south, with the canyon floor elevation ranging from approximately 300 feet at the Napa River to about 800 feet at the landfill site. The canyon topography is characterized by moderately steep slopes with scattered rocky outcrops, arising from a narrow, rock-bound stream channel with limited flood benching. The canyon supports an oak woodland/chaparral vegetation community. (Memorandum by CDFW Senior Environmental Scientist Glenn Sibbald (October 30, 2019) (Sibbald 2019), Memorandum by Environmental Scientist Garrett Allen (May 10, 2019) (Allen 2019).)

This estimate of compensatory damages is based on injuries quantified in two streams: Streams 1 and 2 (see Figure 1). These streams are located on the site and each one is a tributary to the Napa River. Stream 1 is a small, intermittent stream that flows along the bottom of Clover Flat Canyon, draining southward to eventually leave the canyon and enters the Napa Valley. Stream 1 flows under Silverado Trail North Road, after which it is channelized for most of its remaining length before entering the Napa River. Stream 2, which occurs along the north boundary of the landfill, is a small, intermittent stream that drains a short, steep offshoot of the Clover Flat Canyon on the canyon's western edge. Stream 2 flows along the northeast edge of the landfill capping material mining operation before it joins Stream 1 (Sibbald 2019).

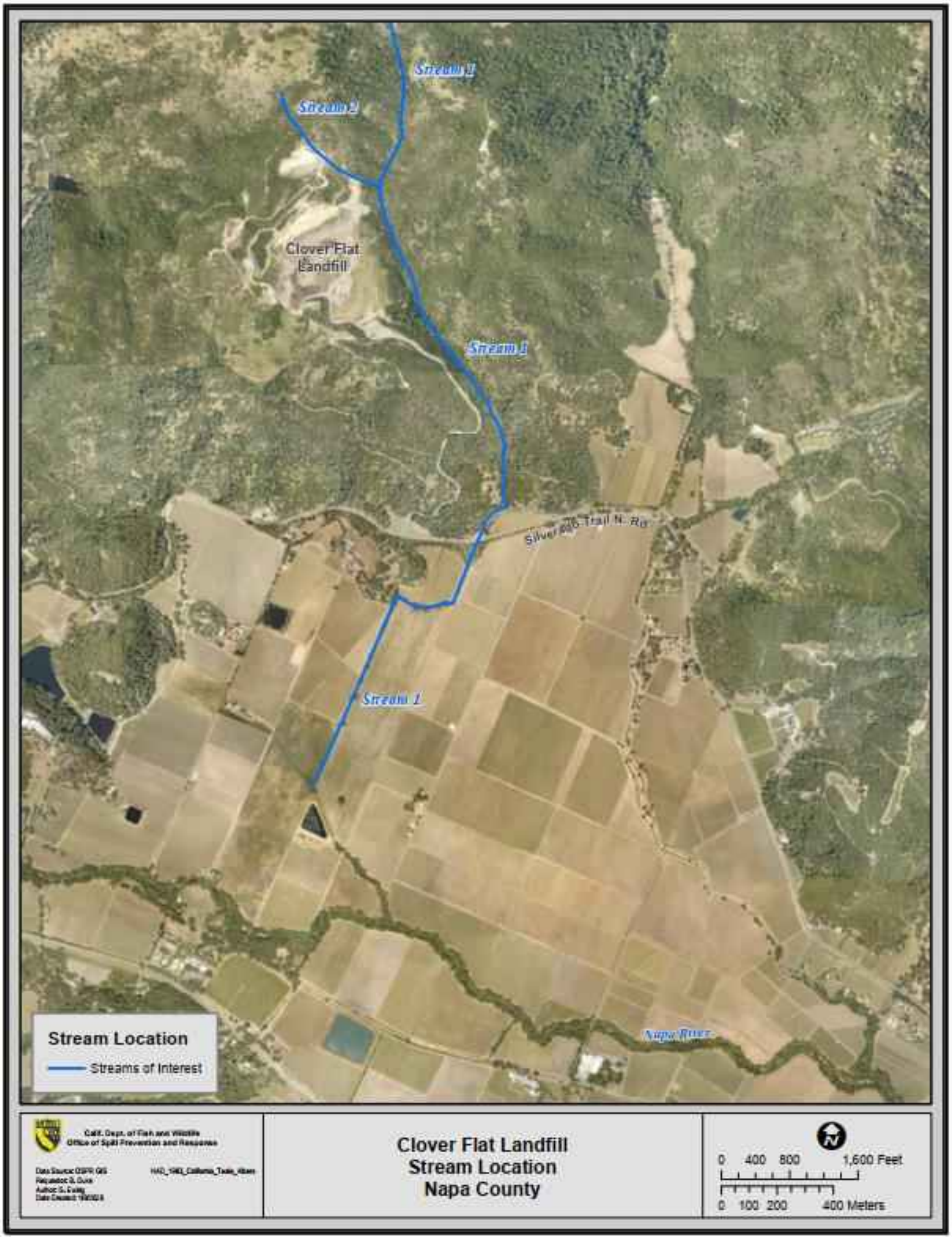

Figure 1. Location of CFL (upper left side), and Streams 1 and 2.

VIOLATIONS OF FISH AND GAME CODE

On March 28, 2019, California Department of Fish and Wildlife Officer Mark White visited CFL. Officer White noted that CFL had severely polluted the unnamed tributaries (Streams 1 and 2) that flow through the landfill property (Arrest/Investigation Report by Wildlife Officer Mark White (March 29, 2019) (White 2019)). Officer White observed large amounts of earth waste spoils, leachate, litter, and sediment that were allowed to enter the streams. (See Figures 2a, 2b. Figure 2b is the reference site.) CDFW staff also observed several hundred linear feet of stream covered in side-cast rock, boulder, and mineral earth waste spoils (White 2019). Stream 2 had been severely altered without any notification to CDFW and there was essentially no aquatic life present in sections of Stream 1 (White 2019). Officer White documented evidence of violations of Fish and Game Code sections 1602(a)(1), 5650(a)(6), and 5652(a) (White 2019).

Figure 2a. Photo of Stream 2.

Figure 2b Photo of Reference Site.

PREVIOUS NOTICE OF VIOLATIONS AND ORDERS TO COMPLY

CFL has received notices from the Napa County Planning, Building, and Environmental Services and the San Francisco Bay Regional Water Quality Control Board alleging violations outside the Fish and Game Code. However, the focus of this report is compensatory damages arising from Fish and Game Code violations include in Wildlife Officer Mark White's Arrest/Investigation Report (White 2019) only.

GENERAL SPECIES AND HABITAT

Stream 1 and Stream 2 are tributaries of the Napa River. The Napa River provides habitat for a diverse array of species including several special-status species. California freshwater shrimp (*Syncaris pacifica*), foothill yellow-legged frog (*Rana boylii*), longfin smelt (*Spirinchus thaleichthys*), and delta smelt (*Hypomesus transpacificus*) are all protected under the California Endangered Species Act and are found in the Napa River system. Additionally, the Napa River is designated critical habitat for Central California Coast steelhead (*Oncorhynchus mykiss*), and California red-legged frog (CRLF) (*Rana draytonii*), both of which are protected under the federal Endangered Species Act (Allen 2019). Chinook salmon (*Oncorhynchus tshawytscha*) and western pond turtle (*Emys marmorata*) are Species of Special Concern that are also known to exist nearby.

The impacted streams on the CFL site provided habitat for a variety of fish and wildlife species prior to impacts. Both streams on the site contained potentially suitable habitat for the foothill yellow-legged frog, and therefore could have been adversely affected as a result of long-term stream pollution and deposition of fine sediment from CFL (Allen 2019). Birds like acorn woodpeckers (*Melanerpes formicivorus*), western scrub-jays (*Aphelocoma californica*), and yellow-billed magpies (*Pica nuttalli*) store acorns from the oak trees that line the stream to eat later. Oak trees also provide shelter for cavity-nesting birds, such as woodpeckers and bluebirds (Zack 2005). The following butterflies also use oaks as host plants: California sister (*Adelpha californica*), Propertius duskywing (*Erynnis propertius*), Mournful duskywing (*Erynnis tristis*), California oak moth (*Phryganidia californica*), and at least 41 other butterflies and moths (CNPS 2020). Trees also control temperatures of streams by providing shade which benefits several in-stream species, such as Central California Coast steelhead (APMS 2019).

INJURY QUANTIFICATION

Injury Zones

The spill is detailed in a memorandum by CDFW Environmental Scientist Garrett Allen (Allen 2019), a memorandum by CDFW Senior Environmental Scientist Glenn Sibbald (Sibbald 2019), and an Arrest/Investigation Report by CDFW Wildlife Officer Mark White (White 2019). These reports provide information concerning leachate, low pH water, and sediment inputs to Streams 1 and 2. To quantify stream injury (see Appendix A), Streams 1 and 2 were divided into four zones (Zones 1-4; see Figure 3). Zones 1-3 are located above Silverado Trail North Road (STNR) and one Zone 4 is located below STNR.

Types of Injury

CDFW staff documented two different types of impacts to Stream 1 and Stream 2 at CFL. These impacts were 1) the removal of riparian oak woodland and 2) in-stream impacts due to low pH, leachate, and fine sediment. Riparian oak woodland removal occurred near Zone 1 (Stream 2) and in-stream impacts were documented on Zones 2-4 (Stream 1).

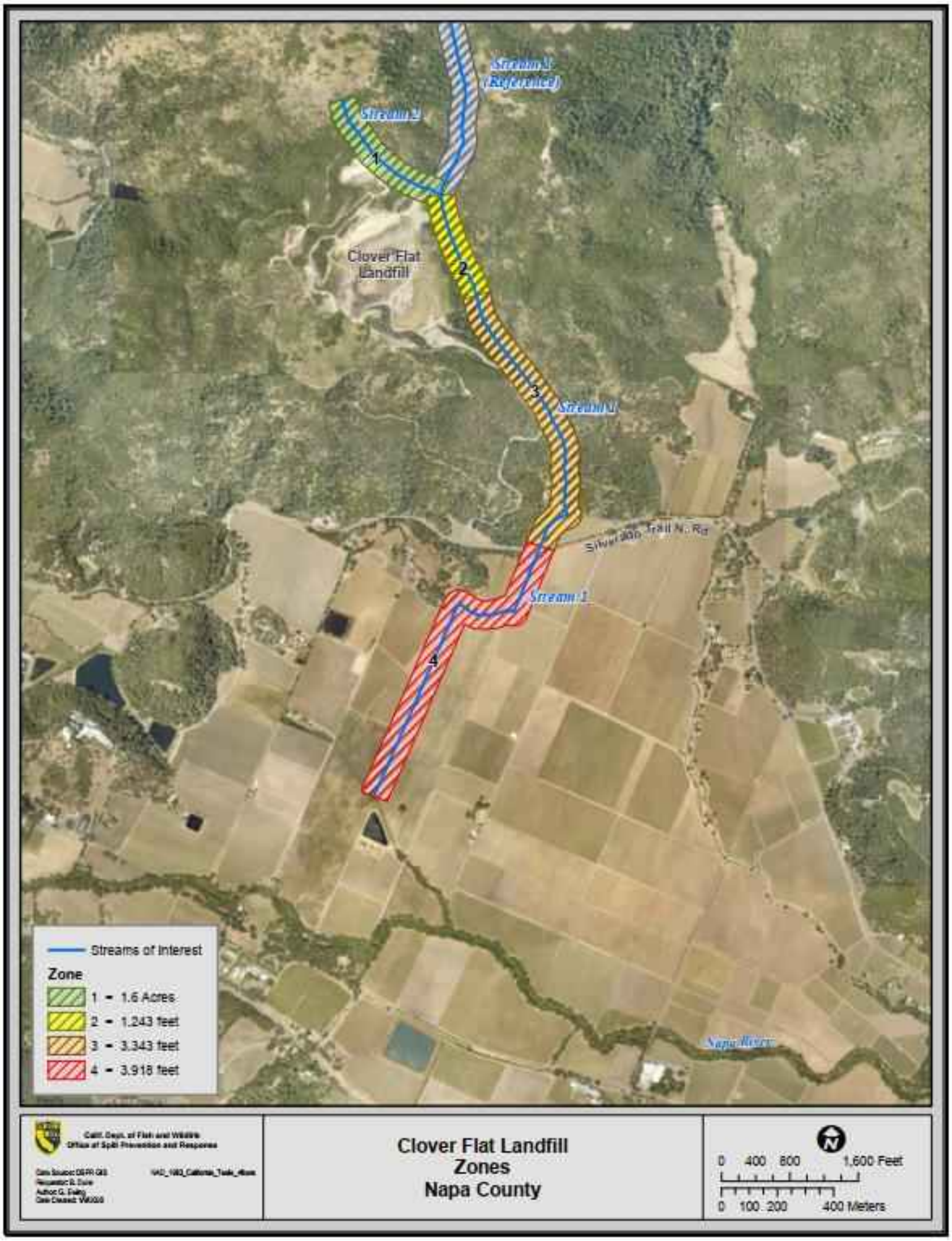

Figure 3. Clover Flat Landfill Zones 1-4.

Parameters Used to Estimate Baseline Impacts and Recovery Times

To assess injury and baseline levels (see Appendix A), chemical analysis, toxicity bioassays, bioassessment, and in-stream observations were used. Additionally, chemical and biological measurements, and species life histories were used to estimate recovery time. Water chemistry (e.g. pH) was measured on three zones of Stream 1 during an initial site visit on May 21, 2019. Samples were analyzed for pH, metals, ammonia, orthophosphate, nitrate and nitrite and volatile organic compounds (Alpha Analytical Laboratories 2019). Toxicity testing was conducted by exposing fathead minnows (*Pimephales promelas*) to water from the CFL site (Nautilus Environmental 2019). Aquatic bioassessment sampling was performed to access species abundance, taxonomic diversity, and percent cover (Sibbald 2019). Baseline, injury, and recovery estimates were included for each zone (i.e., Zones 1-4). These estimates were combined with either the area or length impacted in each zone to develop measures of overall injury.

INJURY IN ZONES 1-4

Zone 1 (Stream 2)

Zone 1 (Stream 2) consisted primarily of mixed oak habitat, and the predominant oak species was coast live oak (*Quercus agrifolia*). These trees are evergreen oaks that grow west of the central valleys of California, as far north as Mendocino County, and as far south as northern Baja California in Mexico. This tree typically reaches a mature height of 10-25 meters in approximately 75 years (APMS 2019*).* Many birds, mammals, reptiles, and invertebrates utilize oak trees which are among the most important wildlife plants (APMS 2019). These trees are typically found on well drained soils of coastal hills and plains, and usually near year-round or perennial streams. Coast live oaks stabilize soil on slopes, provide an organic-rich litter and contribute to a habitat for a diversity of insects, birds, and mammals and acorns are an important food source for birds, small mammals, and deer.

Riparian Canopy Removal

A substantial amount of riparian canopy was removed from the Stream 2 riparian area (Figure 4) and the Stream 1 riparian area (Figure 5, Appendix C) at the CFL location between May 2014 and August 2014 (Allen 2019). This removal resulted in the loss of riparian function for terrestrial and aquatic species on-site. Mature riparian trees and mid-canopy vegetation will take considerable time to reestablish, grow and function (Allen 2019). The temporal loss of riparian habitat reduces shading, which will increase water temperature, and results in deleterious impacts to aquatic organisms. Reduction of riparian vegetation also can result in decreased stream bank stability. Riparian areas are of critical importance to protect and conserve the biotic and abiotic integrity of a watershed (Allen 2019). Riparian buffers provide a microclimate, a source of large woody debris, and act as filter strips (Allen 2019). As a filter strip, riparian buffers also aide in keeping pollutants from entering adjacent waters through a combination of processes including dilution, sequestration by plants and microbes, biodegradation, chemical degradation, volatilization, and entrapment within soil particles.

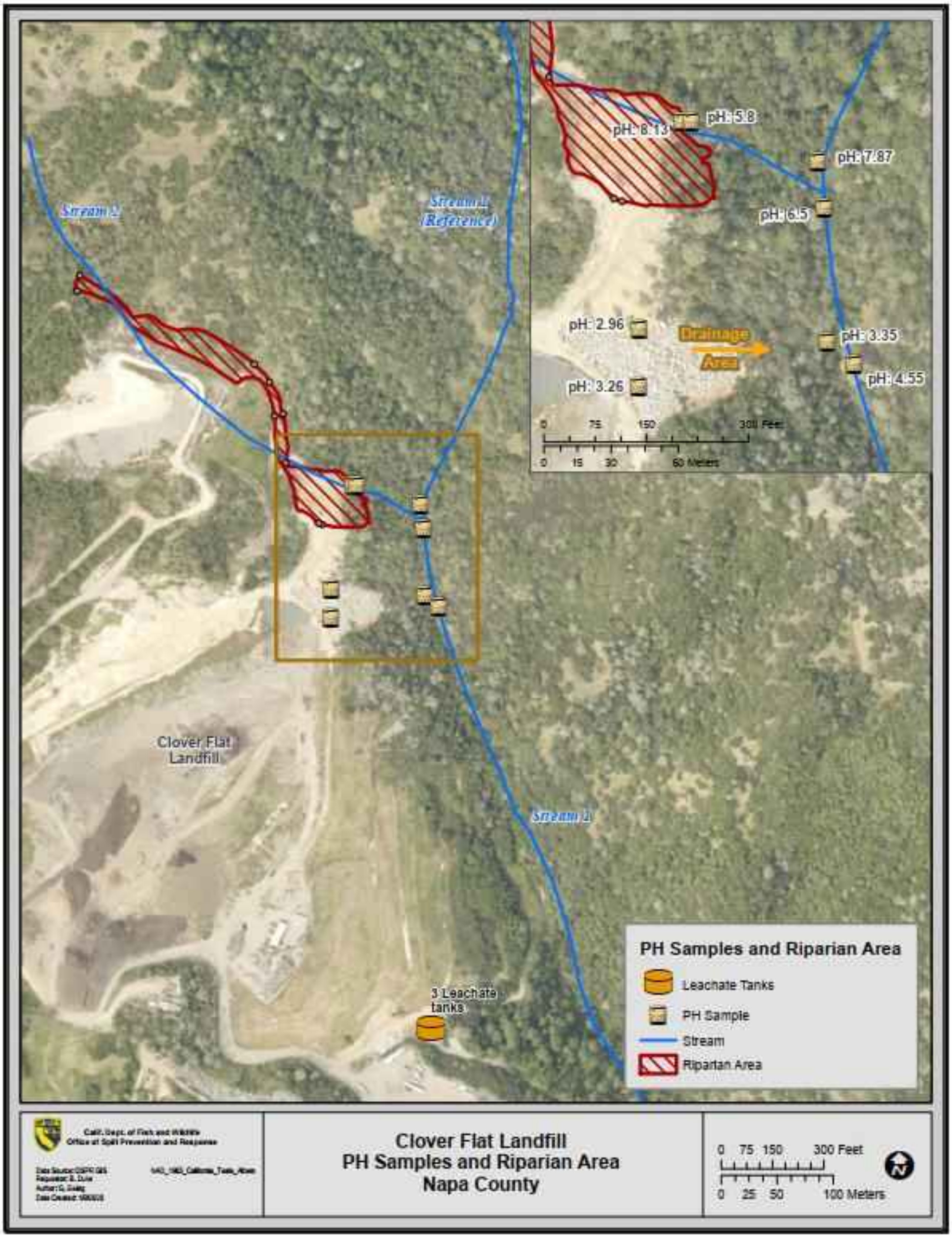

Figure 4. Clover Flat Landfill pH Samples and Riparian Destruction.

Injury and Recovery

Prior to removal, the oak riparian complex was considered to have 90% of the baseline services of an unimpaired stream due to background operations of the landfill. According to field measurements, 1.57 acres of oak riparian woodland habitat were determined to be removed. The complete removal of oak riparian woodland was quantified as the complete loss of the 90% baseline services. Recovery of Zone 1 is estimated to start in March of 2021, and recovery is expected to last 30 years (personal communication with Wildlife Officer Mark White and Environmental Scientist Garrett Allen, September 11, 2019).

ZONE 2 (STREAM 1)

Effects of Sediment and Turbidity on Aquatic Species

Uncontained sediment and erosion discharged from the CFL site into the downstream receiving waters, resulting in substantial adverse impacts to fish and wildlife (Figure 5). Increased sediment delivery from the CFL is deleterious to aquatic species and their habitat. Excess fine sediment (i.e., fines) deposited into waterways can have significant effects on fish and wildlife species. Fines that stay suspended in the stream can be deleterious to fish because it significantly increases the water's cloudiness or turbidity, and many fish species are sight feeders, and therefore, rely on water clarity for foraging success. In addition, turbid waters can also cause fish to spend energy to rid their gills of sediment by coughing, which erodes sensitive gill tissues, thereby inhibiting growth or even resulting in fish mortality (Allen 2019; Berg and Northcote, 1985).

Figure 5. Confluence of Stream 2 (left) and Stream 1 (right). Orange coloration can be observed in Stream 2 and no orange coloration was observed in Stream 1. Likewise, moss was not observed on rocks in Stream 2, however, moss was observed on the rocks in Stream 1 (Allen 2019).

Water Chemistry

Measurements of pH in Zone 2 (Stream 1) ranged from 3.35 to 6.50. It is important to note that the pH of 3.35 is lower than the U.S. Environmental Protection Agency (USEPA) National Recommended Water Quality Criteria. Healthy, diverse and productive fish and macroinvertebrate populations typically live in waters that have a pH between approximately 6.5 and 8.5 (USEPA National Recommended Water Quality Criteria 2019). The pH 3.35 measurement is also lower than the pH of 7.87 that was measured at the reference site (Sibbald 2019).

It is important to note that Zone 2 also contains a drainage that flows directly into Stream 1. The pH of the water in pipes that drain into a drainage area in Zone 2 were measured and determined to be very acidic at pH 2.96 and 3.26 (Figure 3; Sibbald 2019).

Orange coloration (Zone 2; Figure 5) on sediment was also observed in Stream 1 after the confluence of Stream 2. No orange coloration was observed at the reference site (Figure 5; Sibbald 2019).

The specific conductivity was 1,278 µS/cm at Zone 2. This is indicative of a source of ion rich water in the upstream area of the impact zone (Sibbald 2019). The specific conductivity measured at the reference site was 76.3 µS/cm. The specific conductivity in Zone 2 (which was alongside of the landfill) was 17 times higher (1,278 µS/cm) than at the reference site (76.3 µS/cm).

Toxicity Bioassay

Within 72 hours, 100% of all fathead minnows (*Pimephales promelas*) died after being placed in a water sample from Zone 2. A pH reading of 5.00 was measured at experiment conclusion. Consequently, mortality was attributed to low pH (Figure 4; Nautilus Environmental 2019). No mortality of fathead minnows was observed in the water sample from the reference site during the 96-hour test period.

Bioassessment

Zone 2 had less than half the taxonomic diversity of the reference site and was determined to be impaired (Sibbald 2019).

Aquatic macrophyte cover, primarily aquatic mosses, was present at the reference site, comprising 23.2% of the available aquatic cover. In contrast, no aquatic macrophyte cover was observed at Zone 2 despite both sites possessing similar habitat to that found at the reference site (Sibbald 2019).

Injury and Recovery

Prior to illegal landfill releases, Zone 2 was considered to have 90% of the resource services of an unimpaired stream (pers. comm. with White and Allen, 2019.) Using ArcGIS software, Zone 2 was measured as 1,243 feet in length. Based upon the bioassay results and observed biological communities on-site, changes in water and sediment resulted in a nearly complete loss of the baseline services (Alpha 2019, Nautilus Environmental, 2019, Sibbald 2019). This was quantified as a 90% initial injury. Recovery of Zone 2 is estimated to start in March of 2021 and recovery is expected to take 3 years (pers. comm. with White and Allen, 2019).

ZONE 3 (LEACHATE POND AND STREAM 1)

Water Chemistry

Measurements of pH in Zone 3 (Stream 1) ranged from 6.90 to 7.66. Because the pH measurement of 6.9 was located downstream of the pH reading of 7.66, a strong alkaline source is thought to exist between the two sampling points (Sibbald 2019). A slightly higher pH of 7.87 was measured at the reference site (Sibbald 2019).

Orange coloration was also observed on sediment and rocks in Zone 3 (Sibbald 2019). However, no orange coloration was observed at the reference site in Figure 5 (Sibbald 2019).

Zone 3 Leachate Pond adjacent to Stream 1

Analysis of the water from the leachate collection pond (which is adjacent to Stream 1) created by landfill operators alongside Stream 1 in Zone 3, found detectable levels of arsenic, barium, and zinc (Nautilus Environmental 2019). The zinc level was elevated, but comparison to USEPA water quality criteria could not be properly performed due to a lack of hardness data for the sample. No arsenic, barium, or zinc were detected at the reference site (Alpha 2019). However, ammonia was detected in Zone 3 at 11 mg/L (Alpha 2019). This ammonia concentration exceeded chronic toxicity levels of 1.9 mg/L (USEPA 2013). No ammonia was detected in water samples from the reference site (Alpha 2019).

Toxicity Bioassay

Zone 3 Leachate Pond adjacent to Stream 1

Survival of 97.5% was observed in fathead minnow toxicity bioassay when using samples from Zone 3 (Nautilus Environmental 2019). No mortality of fathead minnows was observed in the water sample from the reference site during the 96-hour test period.

Bioassessment

Based on the organisms present at bioassessment sites in Zone 3 (Stream 1) these locations were determined to be impaired (Sibbald 2019).

Aquatic macrophyte cover, primarily aquatic mosses, was present at the reference site, comprising 23.2% of the available aquatic cover. In contrast, no aquatic macrophyte cover was observed at Zone 3 despite sites possessing similar habitat to that found at the reference site (Sibbald 2019).

Embeddedness

Rocks and cobble, which encompasses many in-stream areas of Zone 3, were covered or surrounded by sediment (i.e. embeddedness). Additionally, embeddedness was higher in Zone 3 than the reference site (Sibbald 2019).

Sediment

CDFW staff also documented impacts to biological resources caused by excessive amounts of fine sediment extending approximately one mile downstream (including Zone 3). According to

CDFW staff, the alterations appear to be the result of waste spoils from landfill earthwork deposited down a steep hillside and into a flowing stream channel.

Injury and Recovery

Prior to illegal landfill releases, Zone 3 was considered to have 90% of the resource services of an unimpaired stream (pers. comm. with White and Allen, 2019). Using ArcGIS software, Zone 2 was measured as 3,343 feet in length. Based upon observed biological communities on-site changes in water and sediment resulted in a loss of the baseline services (Alpha 2019, Nautilus Environmental, 2019, Sibbald 2019). Initial injury was quantified as 25%. Recovery of Zone 2 is estimated to start in March of 2020 and recovery is expected to take two years (pers. comm. with White and Allen, 2019).

ZONE 4 (STREAM 1)

Water Chemistry

No pH measurements were performed on samples from Zone 4.

Analysis of the water sample for Zone 4 (Figure 3) showed that the zinc level was elevated, but comparison to USEPA water quality criteria could not be properly performed due to a lack of hardness data for the sample. No Zinc was detected at the reference site. Low levels of ammonia (Alpha 2019) were also detected but these concentrations did not exceed Water Quality Criteria for ammonia set by USEPA in 2013. No ammonia was detected at the reference site (Alpha 2019).

Toxicity Bioassay

Due to the smaller water volume present from Zone 4, no toxicity bioassay was performed using this water.

Bioassessment

Biological Community Assessment

No biological community assessments were performed in Zone 4 because this zone had an inadequate amount of water flowing in the stream during the sampling period (Sibbald 2019).

Sediment

CDFW staff also documented impacts to biological resources caused by excessive amounts of fine sediment extending approximately 1-mile downstream (Zone 4). According to CDFW staff the alterations appear to be the result of waste spoils from landfill earthwork deposited down a steep hillside and into a flowing stream channel

Injury and Recovery

Prior to illegal landfill releases, Zone 4 was considered to have 50% of the resource services (See Appendix B) of an unimpaired stream (pers. comm. with White and Allen, 2019). Using ArcGIS software, Zone 2 was measured as 3,198 feet in length. Initial injury was quantified as 20% based on excessive amounts of fine sediments in the water. Recovery of Zone 4 is estimated to start in March of 2020 and recovery is expected to take 3 years (pers. comm. with White and Allen, 2019).

RESTORATION PROJECTS

Types of Injury and Restoration

There is injury to two different types of resources: in-stream habitat and oak woodland habitat. Therefore, damages are quantified using two different types of restoration projects: in-stream projects and oak woodland projects. To estimate the cost of a compensatory restoration through each type of project, the costs of comparable projects in the region are presented. Each of these comparable projects has been funded and is currently in progress. The costs associated with both in-stream riparian and oak woodland riparian restoration projects are included in the *Calculation of Damages* section of this report.

IN-STREAM RIPARIAN RESTORATION PROJECTS

Annual maintenance and monitoring for each project listed below will include replanting any areas with poor plant survival rates, maintaining irrigation systems, managing invasive plants, managing downed trees, conducting annual photo monitoring, submitting a summary of the project in an annual report. Project monitoring and annual maintenance for five years following implementation will be conducted.

2018 Tulocay Creek Bank Stabilization

This project involved the biotechnical stabilization of 200 linear feet of severely eroded stream bank along Tulocay Creek in Napa County. There was no excavation except for the keyway transitions at the edges of the project footprint. The objective was to rebuild the streambank out to the original design slope. The approach included interlocked root wads and toe logs, ½ ton rock placed below the ordinary high-water mark (OHWM), soil-choked ¼ ton rock/soil lifts with dense willow pole layering above OHWM, and two to three layers of coir logs staked with willow poles. The transition from the treated slope to the native grade was hydroseeded with native grasses and covered with coconut coir erosion control fabric.

2019 Napa Creek Bank Stabilization

The project involved biotechnical stabilization of 90 linear feet of severely eroded stream bank along Napa Creek. The area had been planted with willows, but high flows scoured the bank behind the plantings and eroded them away. Immediately upstream are a series of toe logs with willow plantings. The site is on the outside bend of a natural curve in the stream. The objective was to rebuild the streambank out to the original design slope. The approach included ¼ ton rock placed below a single vegetated soil lift above the rock layer, and willow brush mattress covered in coconut fabric transitioning up to the undisturbed slope. The transition from the treated slope to the native grade was also seeded with native grasses and the whole site was irrigated with overhead microsprinklers.

2018 York Creek Bank Stabilization

The project includes using bioengineering to reinforce an approximately 130 linear-foot section of actively eroding streambank. The new streambank will be restored to its original (pre-erosion) location and reinforced with rock boulders that will be keyed in at the toe and vegetated soil wrapped lifts constructed at a 2:1 slope up to new top of bank. In addition, the project will remove approximately 50 cubic yards of in-stream gravel from a gravel bar in the center of the channel to discourage flows from deflecting into the protected streambank. Lastly, the project will remove two in-stream willow trees and use them as streambank protection by embedding them into the toe of the bank at both the upstream and downstream ends of the project site and will require removing approximately 20 linear feet (approximately 200 square feet) of Himalayan blackberry (*Rubus armeniacus*) from the channel. Revegetation includes baltic rush (*Juncas Balticus*), snowberry (*Sumphoricarpos albus*), Pigeon Point coyote brush (*Baccharis Pilularis)*, clustered field sedge (*Carex Praegracilis*), winter currant LN *(Ribes Sanguineum)*, California meadow sedge (*Carex pansa*), toyon *(Heteromeles arbutdia*), arroyo willow (*Salix lasiolepis*), one California bay laurel (*Umbellularia californica*) and one Oregon ash (*Fraxinus latifolia*).

RIPARIAN WOODLAND RESTORATION PROJECTS

Each project listed includes mobilization, demobilization, invasive vegetation management, and three years of maintenance and reporting.

Napa River Restoration Oakville to Oak Knoll, Group A, Sites Revegetation Project

The project involves planting 4.1 acres in a riparian corridor. Oakville to Oak Knoll Group A sites were planted and irrigation installed in late spring 2017. Once the plants and irrigation were installed, the first year of plant establishment and maintenance began. Coast live oak (*Quercus agrifolia*) was the dominant species planted however other species were also planted. These species included: valley oak (*Quercus lobate*), Fremont cottonwood (*Populus fremontii*), arroyo willow (*Salix lasiolepis*), big leaf maple *(Acer macrophyllum),* California buckeye *(Aesculus californica),* Oregon ash *(Fraxinus latifolia),* California black walnut (*Juglans californica*), red willow (*Salix laevigata*), bay laurel (*Laurus nobilis*), white alder (*Alnus rhombifolia*), and yellow willow (*Salix lasiolepis*). Staff will conduct annual surveys at all planted restoration sites in Group A to determine percent survivorship, cover, and qualitative health of installed and naturally recruited vegetation.

Oakville to Oak Knoll Revegetation Project, Group B, PW 19-21

The project involves planting 7.6 acres in a riparian corridor. Oakville to Oak Knoll Group B sites were planted and irrigation was installed. Once the plants and irrigation were installed, the first year of plant establishment and maintenance began. Coast live oak (Quercus agrifolia) was the second most dominant species planted. Other species included, valley oak (*Quercus lobate),* Fremont cottonwood (*Populus fremontii*), big leaf maple (*Acer macrophyllum*), California buckeye *(Aesculus californica),* Oregon ash *(Fraxinus latifolia),* white alder *(Alnus rhombifolia),* and red willow *(Salix laevigata).* Staff conducted annual surveys at all planted restoration sites in Group B to determine percent survivorship, cover, and qualitative health of installed and naturally recruited vegetation.

Oakville to Oak Knoll Revegetation Project, Group C, PW 18-05

This project involves planting 14.4 acres in a riparian corridor. Once the plants and irrigation are installed, the first year of plant establishment and maintenance will begin. Coast live oak (*Quercus agrifolia*) and other species were planted. These species included: valley oak (*Quercus lobate),* Fremont cottonwood (*Populus fremontii*), California buckeye *(Aesculus californica),* big leaf maple *(Acer macrophyllum),* Oregon ash *(*Fraxinus latifolia*),* California black walnut *(Juglans californica),* bay laurel *(*Laurus nobilis*),* and white alder *(Alnus rhombifolia).* Staff will conduct annual surveys at all planted restoration sites in Group C to determine percent survivorship, cover, and qualitative health of installed and naturally recruited vegetation.

RESTORATION COST TABLE

In-Stream Restoration Projects

Project Name	Linear Feet	Project Cost	Cost Per Mile
2019 Tulocay Creek Bank Stabilization	200	$238,188	$6,288,163
2019 Napa Creek Stabilization	90	$70,500	$4,136,000
York Creek Bank Stabilization	130	$150,020	$6,093,120
Average Cost of Projects / Linear Mile			**$5,505,761**

Riparian Oak Woodland Planting Restoration Projects

Project Name	Acres	Project Cost	Cost Per Acre
Napa River Restoration Oakville to Oak Knoll, Group A, Sites Revegetation Project	4.1	$445,460	$108,649
OVOK Revegetation Project, Group B, PW 19-21	7.6	$588,711	$77,462
OVOK Group C Revegetation Project, PW 18-05	14.4	$1,244,361	$86,414
Average Cost of Projects/ Acre			**$90,842**

CALCULATION OF DAMAGES

The costs for in-stream riparian and oak woodland riparian restoration projects are below.

Estimates of recovery in this NRDA are based on landfill engineering projections that were provided for the NRDA. Ongoing landfill catchment activities may not be 100% effective, resulting in future impacts. Predictions of stream recovery are based on good faith that the best management practices will be implemented and effective. If engineering projections are not achieved, then subsequent modifications to the NRDA may be required to account for uncompensated injuries.

Compensatory damages are calculated using the cost of compensatory restoration projects that benefits the same types of habitat. In this case, we consider riparian stream restoration projects as compensation. The goal is to compensate for the interim lost ecological services between the time of the incident and full recovery.

The standard approach to determining the size of a compensatory restoration project in NRDA is Resource Equivalency Analysis (REA). This method considers the spatial size, degree, and duration of the injury and compares it to the ecological benefits expected from a restoration project. The aim is to estimate the size of a compensatory restoration project that would provide benefits equal in value to the losses caused by the incident. Once the appropriate restoration project size is calculated, the cost of the compensatory project is the estimate of compensatory damages. This methodology is explained in Appendix A and the results are detailed in Appendix B. In this case, the total cost of conducting two compensatory restoration projects (riparian oak woodland and in-stream) is the basis of compensatory damages.

The public should be compensated for the injuries to 1.57 acres of riparian oak woodland habitat and 1.61 miles (8,503.44 feet) of in-stream habitat. Based upon an equivalency analysis that applies the facts and circumstances described above, the public can be compensated for the identified injuries on the CFL site by the implementation of a riparian woodland restoration project that is 1.86 acres and by the implementation of an in-stream riparian restoration project that is 0.131 mile (691 feet; see Appendix B). Based on restoration costs of $90,842 per acre for riparian woodland restoration and costs of $5,505,761 per stream mile for in-stream restoration in Napa County (see table above), the public is owed $890,220. This amount assumes there will be adequate remediation of the impacted area and no further injuries. If there is a heavy rain year, or if best management practices are not maintained, protections of the stream could be compromised delaying recovery and increasing injury to the stream.

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APPENDICES

APPENDIX A: RESOURCE EQUIVALENCY ANALYSIS

Background

There are two basic approaches to measuring the compensation for natural resources injuries. One is to focus on the demand side, the "consumer valuation approach"; the other is to focus on the supply side, the "replacement cost" approach. In the former, we seek to measure the monetary value that the public puts on the natural resources (i.e., how much the public demands the services of natural resources); in the latter, we seek to measure how much it costs to replace the natural resource services that the public loses as a result of the injury (i.e., how much it costs to supply natural resource services). See the Glossary for complete definitions of some of the terms used here.

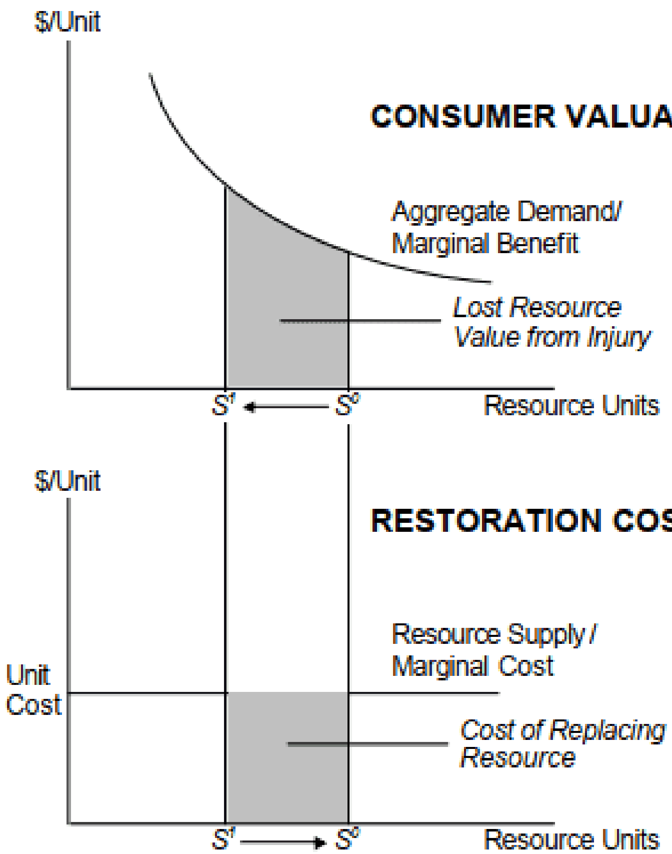

FIGURE 1: Consumer Valuation versus Replacement Cost Approaches for Natural Resource Damage Calculation.

Figure 1 illustrates the difference between these two approaches. In both graphs, the supply of natural resources shifts from S^0 to S^1 as a result of an incident (e.g., oil spill, sediment discharge into a stream, illegal removal of vegetation). The shaded area in the top graph illustrates the dollar value of the resource loss as measured by the monetary payment that would make the public indifferent to the incident. For example, if each individual in a 30 million person society would need a $.05 payment (on average) to make them indifferent to the resource loss, the shaded area in the top graph would equal $1.5 million. Because the difficulty in observing market prices that reveal the level of cash payment that would compensate individuals for resource losses, the quantitative characteristics of the demand curve(s), and consequently the size of the shaded area in the upper graph, are difficult to measure. Contingent Valuation (CV) and other types of analyses are designed to estimate this dollar value. These methodologies typically involve large surveys and can be costly.

The lower graph illustrates a replacement cost approach. Beyond noting that the injured resource has value, the actual extent to which the public values it is not directly considered. Instead, the determination of adequate compensation depends on the level of natural resource provision (versus monetary payments) that compensates society for what it has lost as a result of the incident. The cost of providing this compensation becomes the estimate of damages. Resource Equivalency Analysis (REA) is the primary methodology for conducting this type of measurement in natural resource damage assessment. It is depicted by a resource supply shift in the lower graph from S^1 back to S^0. The shaded area is the total monetary cost of funding the supply shift. For example, if 2 acres of wetland enhancement are estimated to compensate for an incident that temporarily reduced the service value of 1 acre of wetland habitat, the cost of performing 2 acres of wetland enhancement becomes the estimate of damages.

It is clear from Figure 1 that the public's valuation of the resource (the shaded area in the top graph) is not necessarily equal to the total replacement cost (the shaded area in the bottom graph). This is especially true when unique resources or rare species are involved, as the slope of the aggregate demand curve (top figure) may be much steeper due to resource scarcity. This would result in a much larger monetary payment being necessary to compensate the public. In such a case, the replacement cost approach of REA may result in damages far less than the losses as valued by the public. However, because it is easier and less costly to measure the total replacement cost than the total public value, REA has an advantage over other methods, especially for small to medium-sized incidents with minimal impact on rare species.

Resource Equivalency Analysis

In this assessment, REA has been used to determining compensatory damages. This method is relatively inexpensive and relies primarily on biological information collected in the course of determining natural resource injuries caused by the spill. It is consistent with approaches recommended in the language of the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) and the Oil Pollution Act of 1990 (OPA).

REA involves determining the amount of "natural resource services" that the affected resources would have provided had it not been injured, and it equates the quantity of lost services with those created by proposed compensatory restoration projects that would provide similar services. The unit of measure may be acre-years, stream feet-years, or some other metric. The size of the restoration project is scaled to the injury first; the cost of restoration is then calculated after the scaling has been done. The cost of restoring a comparable amount of resources to those lost or injured is the basis for the compensatory damages. In this sense, REA calculates the *replacement cost* of the lost years of natural resource services.

Future years are discounted at 3% per year, consistent with National Oceanic and Atmospheric Administration recommendations for natural resource damage assessments. Discounting of future years is done based on the assumption that present services are more valuable than future services. When it comes to natural resources, the question of whether or not society should value the present more than future is a philosophical question (e.g., one can recall the "greenhouse effect" and the question of how much expense we should incur today to preserve the future). However, the question of how much society actually discounts the value of future natural resources is an empirical one. The 3% figure is currently the standard accepted discount rate for natural resource damage assessments.

REA involves three steps: 1) the debit calculation, 2) the credit calculation, 3) the computation of the costs of restoration. These calculations may be done in a variety of ways, but the most common are to estimate the injury and the restoration benefits in terms of area years of habitat or animal years.

Habitat Example

For example, suppose a 10-acre area is degraded due to an oil spill such that it supplies only 30% of its previous habitat services during the year following the incident. In the second year after the incident, the habitat begins to recover, supplying 90% of its baseline services. By the third year it is fully recovered. In this case, the lost acre years of habitat services would be 70% x 10 acres x 1 year + 10% x 10 acres x 1 year = 8 acre years of habitat services. Figure 2 illustrates this example by showing the recovery path of the habitat over time.

As stated above, future years are discounted at a 3% rate, thus the injuries in the second year count a little less. Incorporating this, 7.97 acre years of habitat services were lost. This difference appears minimal here, but becomes significant (due to compounding) if injuries persist many years into the future.

The credit calculation focuses on the gain in habitat services that result from a restoration project. Creating acre years of habitat services is a function of both area and time. Hypothetically, compensation could involve taking 7.97 acres of land with no habitat value (e.g., a parking lot) and turning it into productive habitat for 1 year. Alternatively, we could achieve compensation by creating 1 acre for 7.97 years. In reality, most restoration projects involve taking previously degraded habitat (at another nearby location) and restoring it over a number of years, and maintaining it into the future.

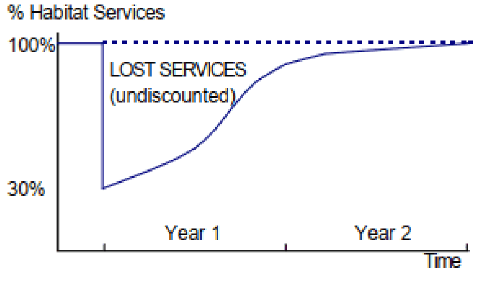

FIGURE 2: Biological Injury and Recovery

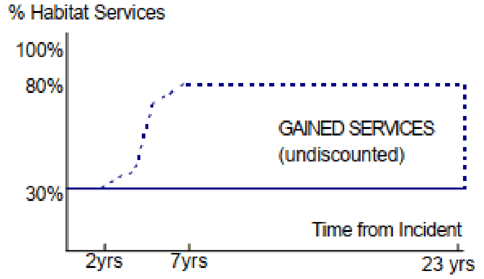

FIGURE 3: Restoration Trajectory/Credit

Suppose the restoration project improves the quality of a nearby degraded area, so that, if it previously provided only 30% of potential services, it would provide 80% of potential habitat services after restoration. Also suppose the project begins two years after the incident and it takes an additional 5 years for the 80% level to be achieved. Figure 3 provides an illustration of this restoration trajectory. In our hypothetical example, the project is expected to have a lifespan of 20 years. Note that, with future years discounted, the 20th year of the project (22-23 years after the incident) counts little; years after that are effectively completely discounted due to uncertainty regarding the future.

Mathematically, we seek to restore an area that will provide 7.97 acre years of services over the discounted 20- year phased-in life span of the restoration project. In this example, that would be an area of about 1.3 acres. That is to say, restoration of 1.3 acres for 20 years would compensate the public for the 7.96 lost acre years of habitat services due to the spill. Visually, the area identified in Figure 3 (multiplied by the affected acres and calculated to measure the present discounted value) should equal the area identified in Figure 4 (again, multiplied by the acres targeted for restoration and calculated to measure the present discounted value, thus discounting future years).

The percentage of habitat services lost (or gained, in the case of the restoration project) may be measured in a variety of ways. For our hypothetical oil spill case, three examples might include (1) the use of a habitat-wide evaluation index, (2) the use of one or more surrogate species, or (3) the use of an estimate based on the degree of oiling. Care must be taken when using a surrogate species to represent the entire affected habitat. Ideally, this surrogate is the population of one or more species that is immobile (that is, the animals do not move easily in and out of the affected area) and that has significant forward and/or backward ecological links to other species in the affected ecosystem. For example, the population of red crossbills, a bird that feeds primarily on pine cone seeds and migrates erratically from year to year, would be a poor surrogate for measuring injuries to a streambed. The aquatic macroinvertebrate community within the stream, however, provides an ideal surrogate, as they play a key role in the streambed food chain. Likewise, on the restoration side, care must taken when the project targets one or a few species rather than the entire habitat. Ideally, a project that seeks to restore the population of a key indicator species will also benefit the entire habitat and, thus, other species as well. Indeed, such projects typically focus directly on habitat improvements. However, it is important to verify that such a species-centered project is indeed benefiting the entire habitat.

Animal Example

When the injury is primarily to individual animals rather than a complete habitat, the REA may focus on lost animal- years. For example, suppose an oil spill causes negligible injury to a body of water, but results in the death of 100 ducks. Using information about the life history of the ducks (e.g., annual survival rate, average life expectancy, average fledging rate, etc.), we can estimate the "lost duck years" due to the spill. On the credit side, we can examine restoration projects designed to create duck nesting habitat and scale the size of the project such that it creates as many duck years as were lost in the incident.

Restoration Costs = Natural Resource Damages

Once the proposed restoration projects are scaled such that they will provide services equal to those lost due to the incident, the cost of the projects can be calculated. Note that this is the first time dollar figures enter the REA process. Until now, all the calculations of the "equivalency" have been in terms of years of resource services. The cost of the restoration projects is the compensatory damage of the incident.

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For another explanation of the REA methodology (in its more specific form for habitats), see "Habitat Equivalency Analysis: An Overview", prepared by NOAA. Copies of this document are available at http://www.darp.noaa.gov/library/pdf/heaoverv.pdf.

GLOSSARY

Aggregate demand

the demand of all consumers combined; e.g., if there are 20,000 people in a town and each person demands two pieces of bread each day, the aggregate demand is 40,000 pieces of bread per day.

Baseline

the conditions of the natural resources and services that would have existed had the incident not occurred.

Compensatory restoration

a restoration project which seeks to compensate the public for temporal or permanent injuries to natural resources; e.g., if a marsh is injured by an oil spill and recovers slowly over ten years, a compensatory project (which may be off-site) seeks to compensate the public for the ten years of diminished natural resources.

Discount rate

the rate at which the future is discounted, i.e., the rate at which the future does not count as much as the present; e.g., a dollar a year from now is worth less than a dollar today; if the bank offers a 3% rate, whereby $1.00 becomes $1.03 in one year, the future was discounted at 3%.

Injury

an observable or measurable adverse change in a natural resource or impairment of a natural resource service. Injury may occur directly or Indirectly to a natural resource and/or service.

Primary restoration

a restoration project which seeks to help an injured area recover more quickly from an injury; e.g., if a marsh is injured by an oil spill and would recover slowly over ten years if left alone, a primary restoration project might seek to speed the recovery time of the marsh and achieve full recovery after five years.

Recovery

means the return of injured natural resources and services to baseline.

Replacement cost

the cost of replacing that which was lost; e.g., if fifty acre-years of habitat services were lost due to an oil spill, the cost of creating fifty acre- years of similar habitat services would be the replacement cost.

Appendix B

Table 1. Resource Equivalency Analysis Details.

Calculation of Injuries (Debit Calculation)				
	Zone 1	**Zone 2**	**Zone 3**	**Zone 4**
Area Injured	1.57	**0.2354**	**0.6331**	**0.742**
Unit:	acres	stream-miles	stream-miles	stream-miles
Year	**Zone 1**	**Zone 2**	**Zone 3**	**Zone 4**
1	90%	90%	25%	20%
2	90%	90%	13%	15%
3	84%	50%	6%	8%
4	81%	25%	0%	3%
5	78%	12%		0%
6	75%	0%		
7	72%			
8	69%			
9	66%			
10	63%			
11	60%			
12	57%			
13	54%			
14	51%			
15	48%			
16	45%			
17	42%			
18	39%			
19	36%			
20	33%			
21	30%			
22	27%			
23	24%			
24	21%			
25	18%			
26	15%			
27	12%			
28	9%			
29	6%			
30	3%			
31	0			

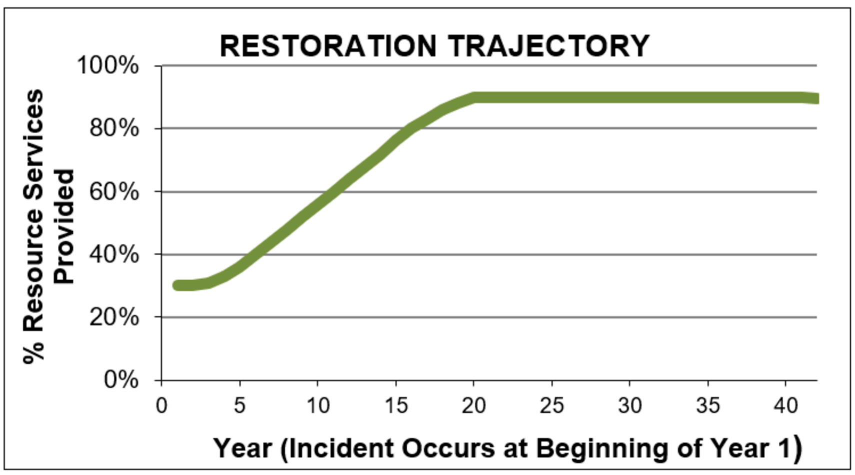
Table 2. Resource Equivalency Analysis Details.

	Zone 1	Zone 2	Zone 3	Zone 4
Total Lost-Acre Years	16.88			
Lost-Stream Mile-Years		0.607	0.274	0.332
Total Lost Stream Mile-Years		1.213		

Table 3. Lost Acre-Years and Lost Stream Mile Years (In-Stream)

IN-STREAM CREDIT CALCULATION (projected restoration benefits). Restoration actions are expected to provide an absolute net increase of 60% in ecological services (from 30% of potential to 90%) and are expected to take 40 years. The table below illustrates the gain in resource services over time.

Year	Resource Service Gains	Gained Stream Miles-Years (Discounted)
1	0%	0
2	0%	0
3	1%	0.009426
4	3%	0.027454
5	6%	0.053309
6	10%	0.086261
7	14%	0.117248
8	18%	0.146356
9	22%	0.17367
10	26%	0.199268
11	30%	0.223228
12	34%	0.245623
13	38%	0.266524
14	42%	0.286
15	46%	0.304114
16	50%	0.320931
17	53%	0.330278
18	56%	0.338809
19	58%	0.340689
20	60%	0.342172
21	60%	0.332205
22	60%	0.32253
23	60%	0.313136
24	60%	0.304015
25	60%	0.29516
26	60%	0.286563
27	60%	0.278217
28	60%	0.270113
29	60%	0.262246
30	60%	0.254608
31	60%	0.247192
32	60%	0.239992
33	60%	0.233002
34	60%	0.226216
35	60%	0.219627
36	60%	0.21323
37	60%	0.207019
38	60%	0.20099
39	60%	0.195136
40	60%	0.189452
41	60%	0.183934
42	60%	0.178577
	Total	9.265



This project provides 9.265 stream mile-years of resource services per stream mile of restoration.

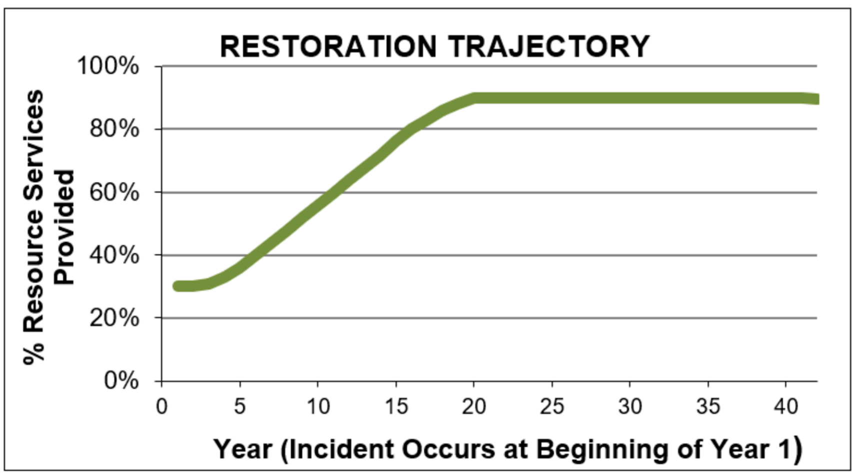
The injury resulted in 1.213 lost stream mile-years of habitat services. The public would thus be compensated with a restoration project that is 1.213 /9.265 = **0.131 stream miles** long.

Table 4. Lost Acre-Years and Lost Stream Mile Years (Riparian Woodland)

RIPARIAN WOODLAND CREDIT CALCULATION (projected restoration benefits)
Restoration actions are expected to provide an absolute net increase of 60% in ecological services (from 30% of potential to 90%) and are expected to take 40 years. The table below illustrates the gain in resource services over time.

Year	Gained Acre-Years (Discounted)	Gained Acre-Years (Discounted)
1	0%	0
2	0%	0
3	0%	0
4	6%	0.0549085
5	9%	0.0799638
6	12%	0.1035130
7	15%	0.1256226
8	18%	0.1463564
9	21%	0.1657759
10	24%	0.1839400
11	27%	0.2009053
12	30%	0.2167263
13	33%	0.2314553
14	36%	0.2451424
15	39%	0.2578359
16	42%	0.2695820
17	45%	0.2804251
18	48%	0.2904078
19	51%	0.2995712
20	54%	0.3079544
21	57%	0.3155951

Year	Resource Service Gains	Gained Stream Miles-Years (Discounted)
22	60%	0.322529
23	60%	0.313135
24	60%	0.304015
25	60%	0.295160
26	60%	0.286563
27	60%	0.278216
28	60%	0.270113
29	60%	0.262246
30	60%	0.254607
31	60%	0.247192
32	60%	0.239992
33	60%	0.233002
34	60%	0.226215
35	60%	0.219626
36	60%	0.213230
37	60%	0.207019
38	60%	0.200989
39	60%	0.195135
40	60%	0.189452
41	60%	0.183934
42	60%	0.178576
43	60%	0.17338
	Total	9.070



This project provides 9.070 acre-years of resource services per stream mile of restoration.

The injury resulted in 16.884 lost acre-years of habitat services. The public would thus be compensated with a restoration project that is 16.884 / 9.070 = **1.861 acres.**

. Appendix C: Photographs

Figure 1. Photo 575 - pipeline from the landfill into the creek, looking east. (See San Francisco Bay Regional Water Quality Control Board, SFBRWQCB NOV Report, dated March 29, 2019).

Figure 2. Photo 589 - black, oily-looking material flowing toward the creek, looking northeast. (See San Francisco Bay Regional Water Quality Control Board, SFBRWQCB NOV Report, dated March 29, 2019).

Figure 3. Representative views of Stream 2 (April 2, 2019), downstream of the leachate entering the stream (Allen 2019).

Figure 4. Looking upslope toward active landfill (not in view). Black plastic storm drain pipe on right originating from landfill travels down slope into Stream 1 (March 28, 2019) (Allen 2019).

Figure 5. Side-cast rock, boulder, and mineral earth waste spoils deposited into Stream 1 corridor where riparian canopy previously existed (Allen 2019).