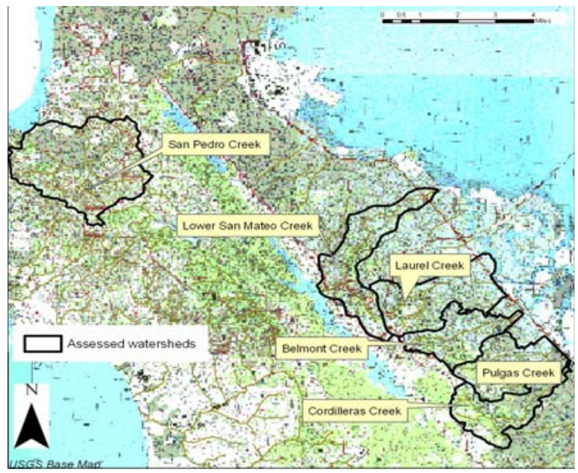
# Unified Stream Assessment in Six Watersheds in San Mateo County, California




SAN MATEO COUNTYWIDE
Water Pollution Prevention Program
Clean Water. Healthy Community.

*A Program of the City/County Association of Governments*

## August 2007

*This Page Intentionally Left Blank*

# Unified Stream Assessment in Six Watersheds in San Mateo County, California

**Prepared for the**
**San Mateo Countywide Water Pollution Prevention Program**

**by**

**EOA, Inc.**
**1410 Jackson St.**
**Oakland, CA 94612**

**August 2007**

***This Page Intentionally Left Blank***

**Summary**

During fall 2006, the San Mateo Countywide Water Pollution Prevention Program (the Program) performed creek walks in six watersheds in San Mateo County: the Cordilleras, Pulgas, Belmont, Laurel, San Mateo (below the dam), and San Pedro Creek watersheds. The primary objective was to characterize physical features of creek channels and their riparian corridors as part of the Program's screening-level water quality monitoring activities. Potential uses for these creek walk data include helping with the interpretation of existing monitoring data (e.g., benthic macroinvertebrate bioassessment data), informing the design of future monitoring programs in the study watersheds, and assisting with the selection and targeting of activities aimed at improving creek health and water quality condition.

The creek walks were conducted using the Unified Stream Assessment (USA) protocol developed by the Center for Watershed Protection. This protocol gathers data through visual observations to rapidly provide a general understanding of creek condition and existing impacts to the creek channel and riparian corridor. Each study creek was delineated into reaches. Each reach represented a relatively uniform set of conditions within the creek corridor. Factors that contributed to delineating a reach included land use in the immediate vicinity, elevation, creek order, access, and total length. Reaches were typically less than one mile long, began and ended at major creek crossings or grade changes, and reflected the general condition of the area adjacent to the creek. Tributaries were generally considered separate reaches. Creek sections were not assessed if that section was determined to be inaccessible (e.g., due to culverts or dense vegetation) or had little apparent urban influence.

A single overall reach assessment was conducted for each reach. The reach level assessment qualitatively evaluated the average characteristics of base flow, dominant substrate, water clarity, biota, shading, and active channel dynamics. This was followed by a ranking of overall instream habitat and floodplain condition. Eight subcategories (instream habitat, vegetative protection, bank erosion, floodplain connection, buffer width, floodplain vegetation, floodplain habitat, and floodplain encroachment) were each categorized as poor, marginal, suboptimal, or optimal on a 20 point scale. The subcategory scores were summed for a maximum possible reach score of 160.

Overall creek condition and resultant total reach assessment scores generally increased in the upstream direction as the study watersheds typically became less urbanized, imperviousness decreased, and impacts to riparian corridors declined. The scores were largely driven by improved instream habitat and better floodplain connection in upper parts of the study watersheds. In the lower to mid reaches, scores were in the poor to marginal range. In more upstream reaches, scores tended to increase into the sub-optimal range, with a few reaches scoring in the optimal range. In each watershed surveyed, instream habitat sub-total scores were higher than the buffer and floodplain condition sub-total scores for most of the reaches. This is likely a reflection of the degree of riparian encroachment in the urban/suburban landscape.

The USA protocol was also used to assess eight creek impacts during this study: erosion, channel modification, outfalls, creek crossings, trash/debris, recreation sites, utilities and miscellaneous features. Whereas the reach level assessment evaluated average habitat conditions for an entire reach, the impact assessments collected information at individual sites along the creek corridor.

Bank scour and failure were the most frequently observed forms of erosion. There were no particular trends within watersheds with respect to erosion. The percent of a study reach eroded generally ranged from 5% to 40%, and many of the reaches had relatively low erosion rates. However, many reaches were largely hardened and did not have large amounts of natural bank potentially subject to erosion. Creek-side landowners often attempted to control erosion and stabilize creek banks by hardening the portion of the bank adjacent to their property. In the study watersheds, such channel modification was mostly in the form of bank revetments. Overall rates of channel modification ranged from 22% to 64% and generally took the form of bank revetments. Failing bank revetments were commonly observed and channel incision frequently undercut bank revetments. These bank hardening structures reflected the efforts of individual property owners to control the impact of the creek on their property only. Such structures neglect the overall geomorphic equilibrium of the channel and may cause upstream and downstream impacts (e.g., further erosion). The reach assessment scores helped capture these interactive processes.

Outfalls observed during the USA included municipal storm drains and piping originating from private properties. Water diversion piping was also documented. The assessments were carried out during the dry season and few dry weather flows were observed. For those outfalls with discharge, few had discoloration, odor, or other indications of illicit discharge. The most important impact associated with outfall pipes was erosion, either in the form of head cuts perpendicular to the creek or erosion immediately downstream from the outfall.

The most common type of creek crossing observed during the assessments was public roadways. Most of the creek crossings observed did not appear to be potential barriers to fish migration. Hardened bottoms, which can help prevent creek bed erosion from migrating upstream, was a common feature of creek crossings.

Trash was deposited in the study creeks through several possible means including illegal dumping, littering, wind borne transport and accumulation from upstream sources. Littering and illegal dumping were particularly problematic in areas adjacent to commercial land uses (e.g., shopping centers) or high density housing such as apartment complexes.

Recreation sites were regularly observed in the study watersheds. Most of the sites consisted of rope swings over the creek, with a small path leading to the creek from a private property. The assessed creeks provided limited opportunity for swimming because they were small, had low summer flows and few natural pools.

While utilities were regularly observed in the creek corridors, they were generally in good condition and appeared to have minimal impacts on the creek. Some utilities crossed the channel close to the creek surface. In high flows, these structures (typically pipes) might trap debris. In some cases, previously buried utilities were uncovered by erosion within the channel. These observations were more of an additional indicator of other creek processes such as erosion than an indication of a problem caused by the utility.

As a follow-up to this study, it is recommended that the Program explore developing a program similar to the Urban Creeks Council's Stream Management Program for Landowners (SMPL). This program is funded by the Contra Costa Clean Water Program and provides free advice about creek care to Contra Costa County property owners. Services include free site visits and consultations on creek restoration techniques and associated permitting, including addressing issues such as bank failure, erosion, and flooding. The data from this study could assist San Mateo County property owners to target and optimize creek management and restoration efforts initiated through this type of stream management program. In addition, the limited resources available for creek restoration activities could be leveraged by encouraging property owners to coordinate and collaborate with local watershed-based organizations (e.g., community groups such as the San Pedro Creek Watershed Coalition, Friends of Pulgas Creek and Friends of Cordilleras Creek).

***This Page Intentionally Left Blank***

## Table of Contents


Glossary ........ 1

1.0 INTRODUCTION ........ 1

2.0 STUDY AREA ........ 2

2.1 Cordilleras Creek Watershed ........ 3

2.2 Pulgas Creek Watershed ........ 4

2.3 Belmont Creek Watershed ........ 4

2.4 Laurel Creek Watershed ........ 5

2.5 Lower San Mateo Creek Watershed ........ 5

2.6 San Pedro Creek Watershed ........ 5

3.0 METHODS ........ 7

4.0 RESULTS ........ 9

4.1 Cordilleras Creek Watershed ........ 9
4.1.1 Reach Delineation ........ 9
4.1.2 Impact Assessment ........ 11
4.1.3 Reach Assessment ........ 14

4.2 Pulgas Creek Watershed ........ 15
4.2.1 Reach Delineation ........ 15
4.2.2 Impact Assessment ........ 18
4.2.3 Reach Assessment ........ 21

4.3 Belmont Creek Watershed ........ 22
4.3.1 Reach Delineation ........ 22
4.3.2 Impact Assessment ........ 22
4.3.3 Reach Assessment ........ 26

4.4 Laurel Creek Watershed ........ 28
4.4.1 Reach Delineation ........ 28
4.4.2 Impact Assessment ........ 30
4.4.3 Reach Assessment ........ 32

4.5 Lower San Mateo Creek Watershed ........ 34
4.5.1 Reach Delineation ........ 34
4.5.2 Impact Assessment ........ 34
4.5.3 Reach Assessment ........ 39

4.6 San Pedro Creek Watershed ........ 41
4.6.1 Reach Delineation ........ 41
4.6.2 Impact Assessment ........ 41
4.6.3 Reach Assessment ........ 46

5.0 DISCUSSION ........ 49

6.0 RECOMMENDATIONS ........ 52

7.0 REFERENCES ........ 53

## Figures

Figure 1. Six study watersheds in San Mateo County. ..... 2
Figure 2. Reaches assessed in the Cordilleras Creek watershed. ..... 10
Figure 3. An example of bank failure in the Cordilleras Creek watershed. ..... 11
Figure 4. Impact assessments in the Cordilleras Creek watershed. ..... 13
Figure 5. Reach assessment scores in the Cordilleras Creek watershed. ..... 16
Figure 6. Reaches assessed in the Pulgas Creek watershed. ..... 17
Figure 7. Impact assessments in the Pulgas Creek watershed. ..... 19
Figure 8. Reach assessment scores in the Pulgas Creek watershed. ..... 22
Figure 9. Reaches assessed in the Belmont Creek watershed. ..... 23
Figure 10. Impact assessments in the Belmont Creek watershed. ..... 24
Figure 11. Reach assessment scores in the Belmont Creek watershed. ..... 27
Figure 12. Reaches assessed in the Laurel Creek watershed. ..... 29
Figure 13. Impact assessments in the Laurel Creek watershed. ..... 31
Figure 14. Reach assessment scores in the Laurel Creek watershed. ..... 33
Figure 15. Reaches assessed in the lower San Mateo Creek watershed. ..... 36
Figure 16. Impact assessments in the lower San Mateo Creek watershed. ..... 37
Figure 17. An example of bank failure in the lower San Mateo Creek watershed. ..... 39
Figure 18. Reach assessment scores in the lower San Mateo Creek watershed. ..... 41
Figure 19. Reaches assessed in the San Pedro Creek watershed. ..... 42
Figure 20. Impact assessments in the San Pedro Creek watershed. ..... 44
Figure 21. Reach assessment scores in the San Pedro Creek watershed. ..... 48
Figure 22. Erosion caused or exacerbated by the presence of an outfall. ..... 50

## Tables

Table 1. General characteristics of the study watersheds. ..... 3
Table 2. USA assessment components. ..... 8
Table 3. Reaches delineated in the Cordilleras Creek watershed. ..... 9
Table 4. Impact assessment summary - Cordilleras Creek watershed. ..... 12
Table 5. Reach assessment scores in the Cordilleras Creek watershed. ..... 15
Table 6. Reaches delineated in the Pulgas Creek watershed. ..... 16
Table 7. Impact assessment summary - Pulgas Creek watershed. ..... 20
Table 8. Reach assessment scores in the Pulgas Creek watershed. ..... 21
Table 9. Reaches delineated in the Belmont Creek watershed. ..... 25
Table 10. Impact assessment summary - Belmont Creek watershed. ..... 26
Table 11. Reach assessment scores in the Belmont Creek watershed. ..... 27
Table 12. Reaches delineated in the Laurel Creek watershed. ..... 28
Table 13. Impact assessment summary - Laurel Creek watershed. ..... 32
Table 14. Reach assessment scores in the Laurel Creek watershed. ..... 33
Table 15. Reaches delineated in the lower San Mateo Creek watershed. ..... 35
Table 16. Impact assessment summary - lower San Mateo Creek watershed. ..... 38
Table 17. Reach assessment scores in the lower San Mateo Creek watershed. ..... 40
Table 18. Reaches delineated in the San Pedro Creek watershed. ..... 43
Table 19. Impact assessment summary - San Pedro Creek watershed. ..... 45
Table 20. Reach assessment scores in the San Pedro Creek watershed. ..... 46

## Glossary

Aggradation – The raising of a creek-channel bed due to the deposition of excess sediment load that was eroded and transported from the upstream watershed or channel. Occurs when the creek does not have sufficient flow velocities or slope to transport the sediment load entering the creek system.

Anadromous fish - Migratory species that are born in freshwater, live mostly in estuaries and ocean water, and return to freshwater to spawn.

Bank - The sloping ground that borders a creek and confines the water in the natural channel when the water level, or flow, is normal.

Bank Failure - The collapse or slippage of a large mass of bank material (often from the top of bank to the toe) into a creek.

Bankfull - the discharge at which channel maintenance is the most effective, that is, the discharge at which moving sediment, forming or removing bars, forming or changing bends and meanders, and generally doing work results in the average morphologic characteristics of channels.

Bank toe - The break in slope at the foot of a creek bank where the bank meets the bed.

Base flow - The sustained low flow of a creek, usually groundwater inflow to the creek channel.

Scour - Erosion by flowing water and sediment on a creek channel; results in removal of mud, silt, and sand on the outside curve of a creek bank and/or the bed material of a creek channel.

Bed - The bottom of a creek channel.

Channelization - The straightening and deepening of a creek channel to permit the water to move faster or to drain a wet area for uses such as farming.

Degraded - Condition of the quality of water that has been made unfit for some specified purpose.

Discharge - The volume of fluid passing a point per unit of time (e.g., cubic feet per second, million gallons per day, gallons per minute).

Diversion - A turning aside or alteration of the natural course of a flow of water, normally considered physically to leave the natural channel.

Ecosystem - A community of organisms considered together with the nonliving factors of its environment.

Ephemeral creek - A creek or part of a creek that flows only in direct response to precipitation; it receives little or no water from springs, melting snow, or other such sources; its channel is at all times above the water table.

Erosion - The process whereby materials are loosened, dissolved, or worn away and simultaneously moved from one place to another.

Flood plain - A strip of relatively flat land bordering a creek channel that is inundated at times of high water.

Fluvial - Pertaining to a river, stream or creek.

Fluvial deposit - A sedimentary deposit consisting of material transported by suspension or laid down by a river or creek.

Geomorphology - The science that treats the general configuration of the Earth's surface; the description of landforms.

Grade control structure - A weir, dam, sill, drop structure, artificially hardened bottom or any other structure(s) used to control erosion in a creek channel with a steep grade or where the slope has been destabilized.

Habitat - The part of the physical environment in which a plant or animal lives.

Headwaters - The source and upper part of a creek.

Head cut - A break in slope at the top of a gully or section of gully that forms a 'waterfall', which in turn causes the underlying soil to erode and the gully to expand uphill.

Hydrology - The science that deals with water as it occurs in the atmosphere, on the surface of the ground, and underground.

Impervious - Incapable of being penetrated by water.

Incised Channel - A creek that has degraded and cut its bed into the valley bottom. Indicates accelerated and often destructive erosion.

Load - Material that is moved or carried by creeks, reported as weight of material transported during a specified time period (e.g., kg per year).

Pool - A small part of a creek reach with little velocity, commonly with water deeper than surrounding areas.

Reach - A continuous part of a creek between two specified points.

Regulation (of a creek) - Artificial manipulation of the flow of a creek.

Riffle - A shallow part of the creek where water flows swiftly over completely or partially submerged obstructions to produce surface agitation.

Riparian - Pertaining to or situated on the bank of a natural body of flowing water, especially a creek.

Runoff - Rainfall that is not absorbed into the ground.

Sediment - Particles suspended or settled in water that were derived from geological or biological materials. Transported by creek flow or other natural process.

Siltation - The deposition or accumulation of silt (or small-grained material) in a body of water.

Stream order - A ranking of the relative sizes of streams within a watershed based on the nature of their tributaries. The smallest unbranched tributary is called first order, the stream receiving the first order tributary is called second order, and so on.

Stream flow - The discharge of water in a natural channel.

Substrate - The surface beneath a wetland, lake, or creek in which organisms grow or to which organisms are attached.

Top of Bank - The break in slope between the bank and the surrounding terrain.

Tributary - A river or creek flowing into a larger river, creek or lake.

Watershed (of a creek) - An area of land that drains into a creek.

***This Page Intentionally Left Blank***

# UNIFIED STREAM ASSESSMENT
# IN SIX WATERSHEDS IN
# SAN MATEO COUNTY, CALIFORNIA

## 1.0 INTRODUCTION

The San Mateo Countywide Water Pollution Prevention Program (Program) conducts Watershed Assessment and Monitoring (WAM) component activities in compliance with its municipal stormwater NPDES permit. A current emphasis is collecting screening-level biological, physical and chemical water quality data from creeks in representative urban watersheds in San Mateo County. These creeks are typically receiving waters for urban runoff discharges from municipal storm drain systems. The Program collects environmental indicator data (e.g., via creek walks, bioassessment and water column toxicity testing) to help evaluate current creek health and water quality conditions. These data help establish a baseline for future evaluations of long-term trends and thereby inform the Program's efforts to improve the effectiveness of its Best Management Practices (BMPs) to prevent or reduce stormwater runoff impacts.

During fall 2006, the Program performed creek walks in six watersheds in San Mateo County. This report documents the methods and results. The creek walks were conducted using the Unified Stream Assessment (USA) protocol. This protocol uses visual observations to provide an overall picture of the condition and features of the creek channel and riparian corridor. Overall reach condition (e.g., bank stability, instream and riparian habitat, floodplain connectivity) is qualitatively assessed. In addition, individual impacts such as creek crossings, utilities, outfalls, areas with erosion, channel modifications and trash are documented.

The USA characterization is one facet of the Program's screening-level water quality monitoring activities.[1] Potential uses for the creek walk data include helping with the interpretation of existing monitoring data (e.g., benthic macroinvertebrate bioassessment data), informing the design of future monitoring programs in the study watersheds, and assisting with the selection and targeting of activities aimed at improving creek health and water quality condition.

[1] It is anticipated that the regional NPDES municipal stormwater permit under development for Phase I stormwater programs in the Bay Area (referred to as the Municipal Regional Permit or MRP) will require such creek walk characterizations.

## 2.0 STUDY AREA

The study area was comprised of the following six San Mateo County watersheds (Figure 1):

- Cordilleras Creek Watershed
- Pulgas Creek Watershed
- Belmont Creek Watershed
- Laurel Creek Watershed
- San Mateo Creek Watershed (below Crystal Springs Reservoir Dam)
- San Pedro Creek Watershed

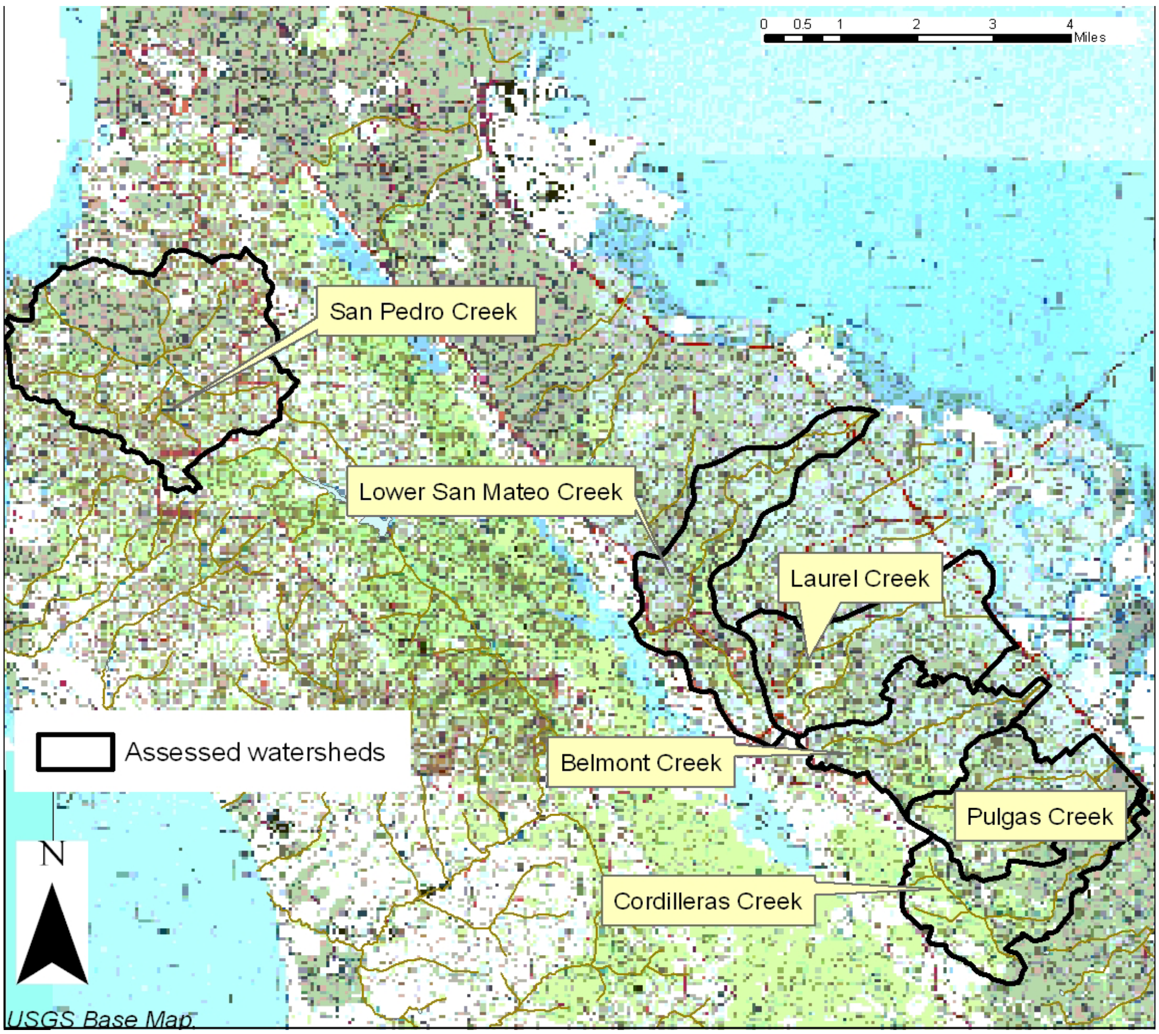



**Figure 1. Six study watersheds in San Mateo County.**

Five of the study watersheds drain into San Francisco Bay, while one (San Pedro Creek) drains into the Pacific Ocean. The areas of the study watersheds range from three to eight square miles (Table 1). The bayside watersheds are highly urbanized, with estimated imperviousness ranging from 35 – 54%. The San Pedro Creek watershed is also urbanized but to a lesser extent, with 15% imperviousness. The percent of channel modified (estimated using different methods in STOPPP 2002) in each watershed increases with increased imperviousness, with the exception of Laurel Creek. Belmont Creek and Pulgas Creek have the highest levels of modified channels (STOPPP 2002). Typically, less urbanized portions of the study watersheds with unmodified channels are located in the upper watershed where parks or protected open spaces are frequently located. Two of the watersheds, the San Pedro Creek and San Mateo Creek watersheds, currently support Steelhead/Rainbow Trout (*Oncorhyncus mykiss*) populations (Leidy, Becker, and Harvey 2005a). San Mateo Creek also historically supported a Coho salmon (*Oncorhyncus kisutch*) population (Leidy, Becker Harvey 2005b).

**Table 1. General characteristics of the study watersheds (STOPPP 2002).**

| Watershed | Area (square miles) | Estimated Imperviousness (%) | Estimated Modified Channel (%) |
|---|---|---|---|
| Cordilleras | 3.3 | 35 | 40 |
| Pulgas | 3.5 | 54 | 90 |
| Belmont | 3.0 | 42 | 74 |
| Laurel | 4.6 | 53 | 35 |
| Lower San Mateo | 4.5 | 38 | 49 |
| San Pedro | 8.0 | 15 | 36 |

## 2.1 Cordilleras Creek Watershed

The Cordilleras Creek watershed drains about 3.3 square miles. Jurisdictions within the watershed are unincorporated San Mateo County, the City of Redwood and the Town of San Carlos (the lower reaches of this creek define the boundary between Redwood City and San Carlos). The creek originates in the Pulgas Ridge Open Space district and discharges into Smith and/or Steinberger Sloughs, depending on tidal and creek flow conditions (SMCWPPP 2007a). These tidewater sloughs are tributary to San Francisco Bay.

Land use patterns in the watershed are typical for the bayside of San Mateo County. The upper watershed is relatively undeveloped and includes the Pulgas Ridge Open Space district and Edgewood County Park. The middle portion of the watershed has primarily residential land uses. A small portion of the watershed that is in the vicinity of El Camino Real and near the bottom of the watershed contains primarily commercial and industrial land uses.

SMCWPPP (2007a) documents screening-level monitoring that was performed by the Program in this watershed, including macroinvertebrate bioassessment and water column sampling and analysis.

### 2.2 Pulgas Creek Watershed

The Pulgas Creek watershed drains about 3.5 square miles. Jurisdictions include the City of San Carlos, part of the City of Belmont, and unincorporated San Mateo County. Pulgas Creek has two forks that originate east of the open space preserve near Highway 280 and flow through downtown San Carlos.

A large portion of the Pulgas Creek channel is modified (Table 1). In the lower watershed, the two forks of the creek are culverted under Arroyo Avenue near Walnut Street, where the culverts join together and continue below El Camino Real and then the Southern Pacific Railroad embankment, and then enter a channel east of Old County Road. The creek is channelized east of Old County Road, passes through a culvert under Highway 101, and is lined with levees east of Highway 101 to protect adjacent areas (primarily the San Carlos Airport) from tidal flooding (FIA 1977, cited in PWA 2000). The creek flows into Smith Slough (a tributary to San Francisco Bay) near the Bair Island National Wildlife Refuge.

### 2.3 Belmont Creek Watershed

The Belmont Creek watershed drains about 3.0 square miles and the City of Belmont is the predominant jurisdiction. Small portions of the watershed also fall within unincorporated San Mateo County and the Town of San Carlos. The creek originates along the east facing slope of Pulgas Ridge. The upper 1.0 mile of Belmont Creek is largely unmodified, with the exception of an earthen dam that was built in the 1800s to create Water Dog Lake. The creek then flows for about 0.5 mile through an underground culvert to a point just east of Alameda de las Pulgas. Below the culvert the creek flows about one mile through an open modified channel down to another culverted section west of El Camino Real. Downstream of this culvert the creek enters a channelized earthen channel and then discharges into Steinberger Slough, which is tributary to San Francisco Bay (STOPPP 2002).

Land use patterns in the watershed are typical for the bayside of San Mateo County. The upper watershed area is predominately a city park managed as an open space preserve, with some residential and commercial land uses along the ridge tops. The middle portion of the watershed is a combination of residential and commercial land uses. The lower portion of the creek upstream of El Camino Real flows through park and public institutional land use. A small portion of the creek downstream of El Camino Real flows through industrial land uses (STOPPP 2002).

### 2.4 Laurel Creek Watershed

The Laurel Creek watershed drains approximately 4.6 miles and includes parts of the City of Belmont, City of San Mateo, and portions of unincorporated San Mateo County. The headwaters of the creek originate in the vicinity of Laurelwood Park and Sugarloaf Hill near Highway 92. East Laurel Creek is the largest tributary to the main stem with the confluence near Laurelwood Drive and Fernwood Street. An earthen dam with separate culverts for the main stem and East Laurel Creek was constructed near the confluence. Downstream of the confluence, the creek flows eastward through residential neighborhoods and commercial districts. Between Edison Street and El Camino Real, the creek is channelized and lined with concrete. Downstream of El Camino Real, the creek is culverted for a section and then flows into another section of concrete channel. The channel then reverts to earthen banks as it flows toward Highway 101 and to its outlet into Seal Slough, which is tributary to the Bay (STOPPP 2002).

### 2.5 Lower San Mateo Creek Watershed

The lower portion of the San Mateo Creek watershed (below the Crystal Springs reservoir dam) drains about 4.5 square miles and includes parts of unincorporated San Mateo County, the City of San Mateo and the Town of Hillsborough. The creek headwaters originate near Sweeney Ridge in the Santa Cruz Mountains. The watershed above the dam is undeveloped and drains into Crystal Springs reservoir. Below the dam, the watershed is mostly urbanized, with the densest urbanization east of El Camino Real, where the creek enters a 2,000-foot culvert. The creek flows into San Francisco Bay at Ryder Park, just south of Coyote Point. SFRWQCB (2002) includes further information about the geologic and geomorphic setting, biota, climate, land uses and water quality issues in this watershed.

SMCWPPP (2007b) documents screening-level monitoring that was performed by the Program in this watershed, including macroinvertebrate bioassessment and water column sampling and analysis.

### 2.6 San Pedro Creek Watershed

San Pedro Creek's main stem is perennial and flows westward to the Pacific Ocean through the City of Pacifica. The creek drains roughly eight square miles of the western side of Montara Mountain and has five major tributaries, all of which contain perennial flows fed by springs. The North, Middle and South Forks extend into the upper reaches of the watershed. The North Fork headwaters are comprised of several steep first order creeks that drain into an extensive network of underground culverts flowing through an urbanized valley. The Middle and South Fork tributaries also drain steep hillsides into a low gradient creek flowing through the upper end of San Pedro Valley. The North Fork and combined Middle/South Fork drainages are roughly equal in size, about 2.4 square miles each. There are two smaller tributaries in the watershed, Sanchez Creek and an unnamed tributary flowing through Shamrock Ranch, which drain into the lower reaches of the main stem (SMCWPPP 2005). The main stem of San Pedro Creek flows for about 2.5 miles through a broad valley floor, which is mostly developed to the banks of the creek. About one-fifth of the total watershed area is urbanized with the remainder comprised mainly of open space and recreational uses (STOPPP 2002).

## 3.0 METHODS

Instream habitat and riparian corridor conditions were evaluated during the fall of 2006 (before the winter rainy season) using the Unified Stream Assessment (USA) protocol. This creek walk protocol was developed and extensively tested by the Center for Watershed Protection (CWP 2005). The USA has previously been used to evaluate watershed conditions in several San Francisco Bay Area creeks, including Calabazas and Saratoga creeks in Santa Clara County and Martin Canyon and Ward Creeks in Alameda County.

The USA uses a continuous walk of the creek corridor to rapidly evaluate and systematically identify conditions, problems and restoration opportunities within the urban creek corridor. The focus of the method is to collect basic information on key aspects of creek ecosystem function. The USA protocol includes delineating the creek corridor into survey reaches. Each reach represents a relatively uniform set of conditions within the creek corridor. Factors that contribute to delineating a reach include land use in the immediate vicinity, elevation, creek order, access, and total length. In this study reaches were typically less than one mile long, began and ended at major creek crossings or grade changes, and reflected the general condition of the area adjacent to the creek.[2] Tributaries were generally treated as separate reaches. Creek sections were not assessed if that section was determined to be inaccessible (due to factors such as culverts or vegetation) or had little apparent urban influence.

The USA consisted of eight impact assessments and a single overall reach assessment (Table 2). Impact assessments collect information at individual sites in the corridor, while the reach level assessment evaluates average habitat conditions for the entire reach. One reach level assessment is completed for each reach. The reach level assessment form contains a series of categories to qualitatively evaluate the average characteristics of the base flow, dominant substrate, water clarity, biota, shading, and active channel dynamics. This is followed by a ranking of the overall instream habitat and floodplain condition. Eight subcategories (instream habitat, vegetative protection, bank erosion, floodplain connection, buffer width, floodplain vegetation, floodplain habitat, and floodplain encroachment) are each categorized as poor, marginal, suboptimal, or optimal on a 20 point scale. The subcategory scores are summed for a maximum possible reach score of 160. The Appendix contains copies of the field forms used in the USA.

Trash and debris is one of the eight impacts assessed by the USA protocol. As a follow-up to this study, an additional protocol, the Urban Rapid Trash Assessment (URTA), was used to further characterize trash at selected locations in the study watersheds with relatively high amounts of trash (SMCWPPP 2007b).

For the purposes of this study a few adjustments were made to the standard USA protocol. The original USA protocol includes an impact assessment for impacted buffer

[2] If in a given stretch of stream corridor, the land use immediately surrounding the creek changed from, for example, high density residential to protected forested open space, a new reach would be delineated.

zones. Given the high degree of urbanization in San Mateo County, it was deemed that this assessment would contribute little additional useful information; it was therefore omitted from the assessment. Another change was the use of a hip chain, in addition to a Global Positioning System (GPS) unit, to identify the location of impacts in the creek corridor.[3] The hip chain had two benefits: 1) when the GPS unit failed to receive satellite information, location information could still be collected, and 2) it allowed for the collection of data at a finer spatial resolution. Finally, a new impact assessment category was added to the protocol to evaluate the use of creeks for recreation.

**Table 2. USA assessment components.**

| Assessment Form | Features Assessed | Information Collected (In Addition to GPS and Photographs) |
|---|---|---|
| Outfalls | All discharge pipes or channels and water diversion pipes. | Basic type (private, municipal storm drain[4]), source, and condition. If flowing, characteristics of discharge (e.g., flow rate, discoloration, or odor) are recorded. The presence of diversion pipes and whether they are pumping water is also noted. |
| Bank Erosion | Bank scour, bank and slope failure, head cuts, incision, and widening. | Location, threat to property and basic bank measurements. |
| Utilities | Leaking or exposed utilities causing water quality, habitat, or channel stability problems. | Type, condition, location, and discharge characteristics associated with leaks, if present. |
| Channel Modification | Channelized, concrete or reinforced sections of creek. | Type of modification, length of creek impacted, condition of the modification. |
| Recreation[5] | Areas where there is evidence of people using the creek for recreation | Evidence of access, evidence of recreational activity (e.g., rope swings over the creek). |
| Creek Crossings | All man-made or natural structures that cross the creek, such as roads, railroads, or dams. | Type of crossing and characteristics (e.g., hardened bottom, height, width), dimensions, relevant information if suspected fish barrier (i.e., 6-inch water drop, or less than ½-inch water depth during normal flow). |
| Trash and Debris | Areas with relatively high amounts of trash and debris. | Mobility, dispersal, amount and type of trash. |
| Miscellaneous | High quality areas or unusual features impacting the creek corridor that do not fit easily within other categories. | |
| Reach Level Assessment | Average characteristics for each reach. Tracks locations of impacts. | Average conditions of water, flow, riparian vegetation, and dominant sediment type. Also includes a ranking of the instream habitat conditions and floodplain habitat conditions for the reach. |

Adapted from CWP (2005).

[3]The hip chain was used to measure the distance walked upstream from the start of a reach to an observed impact.
[4]Municipal storm drains were generally assumed to be any pipe with a diameter greater than six inches, except for pipes that obviously originated from a private property.
[5]The original USA methodology did not include this impact. This study added recreation sites to the protocol to document potential recreational beneficial uses of the creek.

## 4.0 RESULTS

The following sections summarize the results of the assessments. Database and Geographic Information System (GIS) electronic files containing complete study datasets are available upon request.

### 4.1 Cordilleras Creek Watershed

#### 4.1.1 Reach Delineation

Cordilleras Creek was delineated into seven reaches (Table 3). Reaches C1 – C6 are located on the main stem of the creek, while C7 is a small tributary that meets the main stem just downstream of Stagecoach Road (Figure 2). Reaches C1 – C3 flow through high density residential areas. Reaches C4 – C7 are located in low to moderate density residential areas.

**Table 3. Reaches delineated in the Cordilleras Creek watershed.**

| Reach | Geographic Extent | Length (ft) | Reach Description |
|---|---|---|---|
| C1 | Industrial Blvd to Stafford Bridge | 1,940 | Channelized, incised; bank hardening; high levels of encroachment. Dry above outfall. |
| C2 | Stafford Bridge to Stanford Lane Bridge | 1,675 | Bank hardening, steep banks, dry creek bed. |
| C3 | Stanford Bridge to Alameda de las Pulgas | 4,045 | Banks are mostly hardened; incision throughout; erosion on right bank in upper section. |
| C4 | Alameda de las Pulgas to Edgewood | 2,935 | Hardened banks; eroded banks threatening property; less incised than C3, more floodplain, bedrocks and large boulders in channel |
| C5 | Edgewood Drive to Cordilleras Road/Edgewood | 5,315 | Lower part of reach: more flood prone areas, bank slopes moderate, grade control structures present (e.g., dams); upper part: erosion high, especially along roads, more incision. Bedrock exposed. Modification high on right bank. |
| C6 | Cordilleras Rd to confluence with unnamed tributary at Edgewood Park | 1,800 | Bank hardening, particularly on right bank, channel modifications, dams and grade control, erosion. |
| C7 | Edgewood Park to confluence | 1,815 | Bank hardening, urban encroachment, some erosion threatening property. |

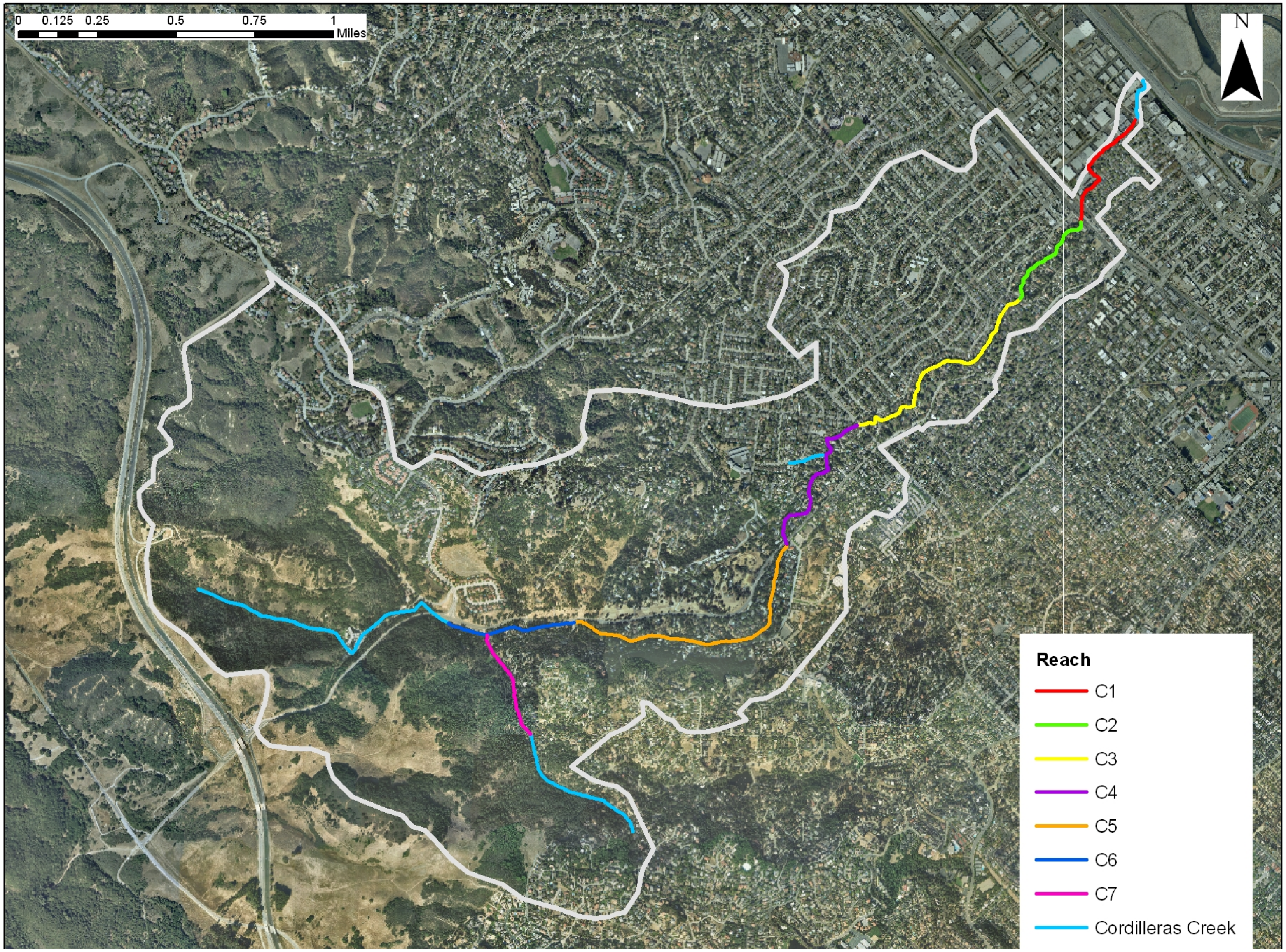



**Figure 2. Reaches assessed in the Cordilleras Creek watershed.**
Base image: San Mateo County Department of Public Works.

4.1.2 Impact Assessment

All of the channel modifications observed consisted of bank hardening. Forty-six percent of the total assessed length was modified. There were extensive individual sections of channel modification in reaches C1, C4, and C6 (800, 500, and 635 feet, respectively). In C1, this modification consisted of a channelized, hardened left bank that ran the length of an industrial area. In C4, the modification consisted of bank hardening with a series of grade control structures / concrete weirs. Below each structure was a plunge pool with considerable sediment deposition. Five small grade control structures were observed in reach C5. These were generally weirs about 1 – 3 feet high and were typically part of a bank hardening structure. These weirs are potential barriers to fish migration. The mid to upper portions of the Cordilleras Creek watershed had more channel modifications than most of the other study watersheds.

Twelve road crossings were observed in the Cordilleras Creek watershed (Table 4). In the lower reaches (C1 and C2), the crossings generally did not have hardened bottoms (for one crossing in C2 it was not possible to see the bottom of the crossing culvert and thus it is not known whether it is hardened). The other crossings all had hard bottoms. In reach C3, the crossing had a short drop (~6 inches), which would likely not impede the passage of large fish, but could potentially block small fish. In C4, one of the creek crossings might act as a partial blockage to fish movement during low flows because of very low flow within the crossing culvert. In reach C6, three creek crossings had drops of 3 – 4 feet that could block fish migration upstream.

Erosion was mainly manifested as bank failure (Figure 3) (twenty incidences); a minority of the observed cases was bank scour (Figure 4). Reaches C5 and C7 had the highest erosion rates (Table 4). Aggrading sediments were observed in reaches C1, C2 and C6, with evidence of fine sediment and gravel accumulating mid-channel.

**Figure 3. An example of bank failure in the Cordilleras Creek watershed.**
Note the associated outfalls, which do not appear to be municipal storm drains but instead appear to originate from private properties adjacent to the creek. In the foreground is a rope swing used for recreation.

**Table 4. Impact assessment summary - Cordilleras Creek watershed.**

| | C1 | C2 | C3 | C4 | C5 | C6 | C7 |
|---|---|---|---|---|---|---|---|
| **Total Length of Reach (ft)** | 1,940 | 1,675 | 4,045 | 2,935 | 5,315 | 1,800 | 1,815 |
| **Channel Modification** | | | | | | | |
| Total Length of Channel Modification (ft) | 900 | 955 | 2,505 | 1,390 | 1,050 | 1,225 | 743 |
| Percent of Reach Modified | 46 | 57 | 62 | 47 | 20 | 68 | 41 |
| **Creek Crossing** | | | | | | | |
| Number | 2 | 3 | 1 | 2 | 4 | 10 | 0 |
| Type | road | road (2); other (1) | road | road | road | road (1), footbridge (9) | |
| Hardened Bottom | no | no (2); unknown (1) | yes | yes | yes (3), no (1) | yes (3) | |
| **Erosion** | | | | | | | |
| Total Length Eroded (ft) | 415 | 175 | 1,180 | 455 | 2,126 | 130 | 355 |
| Percent Eroded | 21 | 10 | 29 | 16 | 40 | 7 | 50 |
| **Outfalls** | | | | | | | |
| Total Number of Outfalls | 13 | 6 | 20 | 32 | 29 | 11 | 8 |
| Diversion pipe | 2 | | | 2 | 5 | 1 | 1 |
| Private outfall | 7 | 3 | 18 | 21 | 13 | 6 | 6 |
| Storm drain | 4 | 3 | 2 | 9 | 11 | 4 | 1 |
| **Recreations Sites** | | | | | | | |
| Total Number of Sites | | | | 2 | 2 | | |
| Access (Public, Private) | | | | private | private | | |
| Swimming Potential (High, Medium, Low) | | | | low | low | | |
| **Trash** | | | | | | | |
| Total Number of Trash Sites | 2* | 1* | | | 1 | | |
| Trash Source (Litter: L; Illegal Dumping: ID; Accumulation: TA) | TA, L | L, ID | | | ID | | |
| **Utilities** | | | | | | | |
| Total Number of Utilities | | | 1 | 1 | 9 | 3 | 3 |

*One site in C1 and one site in C2 were evaluated using the URTA protocol (SMCWPPP 2007b).

One hundred and nineteen outfalls were documented during the assessment (Figure 4, Table 4). Slightly more than 60% of these were private outfalls. The middle reaches had the highest number of observed outfalls, likely corresponding to the highest housing density. Most of these outfalls had no dry weather flow (83%). However, two storm drains had substantial flow at the time of the assessment. C1 had one storm drain with a substantial flow. Upstream of this outfall the creek was dry. All of the flow in the downstream section of the reach apparently originated from this outfall.

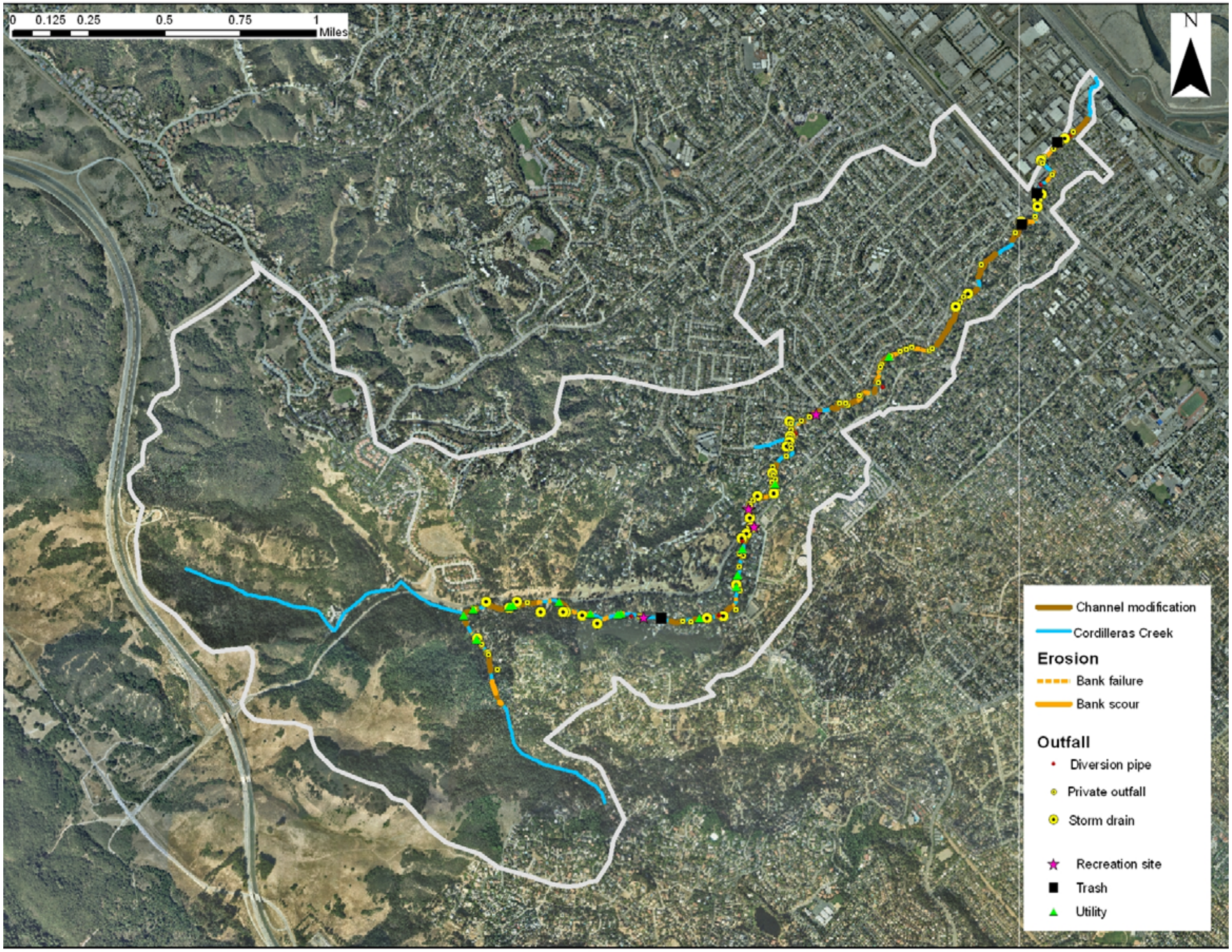



**Figure 4. Impact assessments in the Cordilleras Creek watershed.**
Base image: San Mateo County Department of Public Works.

The creek bed remained dry until the middle of reach C3. The second outfall with substantial flow was a unique situation (in reach C6) in which a 12-inch outfall pipe was modified to produce a constant flow. This outfall is located immediately upstream of a diversion pipe that was pumping water out of the creek at the time of the assessment. It appeared that the diversion pipe was used to carry water from the creek to the outfall to create a miniature waterfall. While moderate to trickle flows were observed elsewhere in the creek, the flows had no other signs of illicit discharge associated with them (no odors, colors, or evidence of oils or unusual vegetative growth). Some corrosion was observed in an outfall in reach C4.

Four recreation sites were observed in Cordilleras Creek. Surrounding land use was private property for all of these sites and all had rope swings over or near the creek (see Figure 3 for an example). Water levels were very low at all of the sites (less than 10 inches).

Four trash sites were observed in three reaches (Table 4). In C1, a small amount of trash was present that consisted of small and/or floatable items such as plastics, food waste, and balls. Items were accumulating around a log that had fallen into the channel. In reach C2, litter appeared to be carried into the creek from an adjacent commercial area on the left bank. Litter consisted of food and cigarette waste, newspaper, plastics, and some small electronic equipment. Litter predominantly originated from the left bank. In addition, in reach C5, a large amount of organic waste (grape skins) had been dumped on the right bank of the creek. Presumably, a local resident produces wine and disposed of the used grape skins in the creek.

Seventeen utilities were observed, most of which were pipes that crossed the channel above the creek (generally one to 15 feet above the creek). One SFPUC utility crossed the creek in reach C7. All but one of the utility pipes were in good condition (one pipe in reach C3 was rusted). None of the utilities was contributing to channel instability.

Rat traps were consistently observed throughout the watershed. The traps were tubes containing poison anchored to the creek bank. The labeling indicated that the traps contained the rodenticide Diphacinone.

### 4.1.3 Reach Assessment

Gravel was the dominant sediment observed in five of the seven assessed reaches. Sand (reaches C1 and C4) and cobble (reaches C4 and C6) were also dominant in the channel. In reach C6, bedrock was exposed in much of the channel.

Bank failure and channelization were commonly observed active channel dynamics in the Cordilleras Creek watershed. Channel widening, sediment deposition, and aggradation were also common. Bed scour and down cutting were also observed in reach C7.

In the lower to mid parts of the creek (reaches C1 – C3), instream and floodplain condition scores were generally in the 'poor' and 'marginal' range (Table 5). Reach condition scores increased in the upper watershed reaches (reaches C4 – C7) and were generally higher than those for the buffer/floodplain. Channelization and bank hardening in the lower reaches has decreased the diversity and stability of instream habitat and reduced the creek's connection to its floodplain. Residential and commercial encroachment in the floodplain of the lower reaches had greatly reduced the buffer zone and decreased the diversity of floodplain habitat (Table 5).

**Table 5. Reach assessment scores in the Cordilleras Creek watershed.**

| | C1 | C2 | C3 | C4 | C5 | C6 | C7 |
|---|---|---|---|---|---|---|---|
| **Overall Reach Condition** | | | | | | | |
| Instream Habitat | 7 | 8 | 8 | 10 | 15 | 15 | 15 |
| Vegetative Protection: Left Bank | 3 | 4 | 2 | 5 | 8 | 9 | 9 |
| Vegetative Protection: Right Bank | 4 | 5 | 3 | 5 | 6 | 8 | 9 |
| Bank Erosion: Left Bank | 6 | 6 | 5 | 5 | 6 | 8 | 8 |
| Bank Erosion: Right Bank | 5 | 7 | 3 | 3 | 3 | 7 | 7 |
| Floodplain Connection | 10 | 8 | 4 | 12 | 15 | 12 | 15 |
| ***Subtotal*** | ***35*** | ***38*** | ***25*** | ***40*** | ***53*** | ***59*** | ***63*** |
| **Overall Buffer and Floodplain Condition** | | | | | | | |
| Vegetated Buffer Width: Left Bank | 2 | 2 | 1 | 3 | 6 | 8 | 6 |
| Vegetated Buffer Width: Right Bank | 4 | 3 | 1 | 4 | 4 | 6 | 4 |
| Floodplain Vegetation | 5 | 6 | 4 | 11 | 14 | 14 | 14 |
| Floodplain Habitat | 5 | 6 | 4 | 11 | 13 | 12 | 12 |
| Floodplain Encroachment | 5 | 5 | 2 | 9 | 14 | 13 | 8 |
| ***Subtotal*** | ***21*** | ***22*** | ***12*** | ***38*** | ***51*** | ***53*** | ***44*** |
| ***Total*** | ***56*** | ***60*** | ***37*** | ***78*** | ***104*** | ***112*** | ***107*** |

Residential and commercial development around the lower reaches has reduced the buffer zone. Moving upstream, floodplain encroachment decreased, which contributed to an increase in the buffer width and floodplain habitat diversity. Bank slopes were more moderate, particularly in reaches C5 and C6. Scores decreased in C7 due to residential encroachment in the floodplain, particularly on the right bank. In general, total reach assessment scores increased in the upstream direction (Figure 5).

## 4.2 Pulgas Creek Watershed

### 4.2.1 Reach Delineation

Pulgas Creek is made up of two branches that join in a culvert at Highway 82. These two branches were each delineated into three reaches (Table 6). For the purpose of this assessment, reaches P1, P2, and P3 are referred to as the south branch and reaches P4, P5, and P6 are referred to as the north branch (Figure 6).

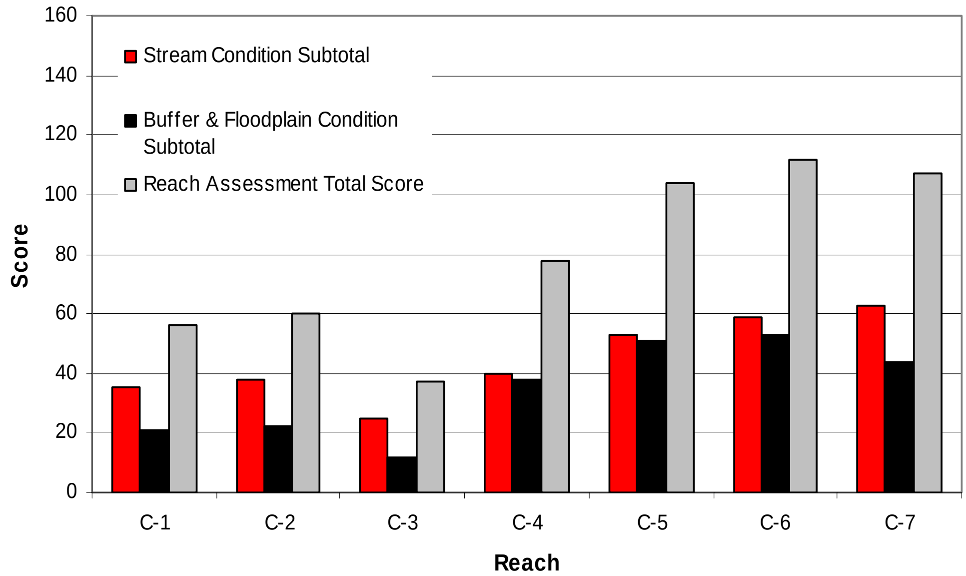



**Figure 5. Reach assessment scores in the Cordilleras Creek watershed.**

**Table 6. Reaches delineated in the Pulgas Creek watershed.**

| Reach | Geographic Extent | Length (ft) | Notes |
|---|---|---|---|
| P1 | Elm St to Cordilleras Rd | 2,491 | Bank hardening extensive. Creek channel narrow and incised. Very little water in creek. |
| P2 | Cordilleras Rd to Alameda de las Pulgas | 2,145* | Bank hardening extensive. Creek channel narrow and incised. |
| P3 | Alameda de las Pulgas to Graceland and Valmar | 1,082 | Moderately more floodplain area, banks hardened and steep. |
| P4 | Elm St to Cedar St | 1,225 | Channel modifications still extensive, some small floodplain areas, channel widens. |
| P5 | Cedar St to Alameda de las Pulgas | 3,684 | Bank hardening, small floodplain benches throughout reach, bedrock exposed in sections, grade control structures, incision present throughout reach. |
| P6 | Alameda de las Pulgas to Manor St | 2,351* | Bank hardening and grade control structures throughout reach, small floodplain benches present. Incision throughout and deep (~18 feet) at upstream end. |

*Reach lengths estimated using GIS.

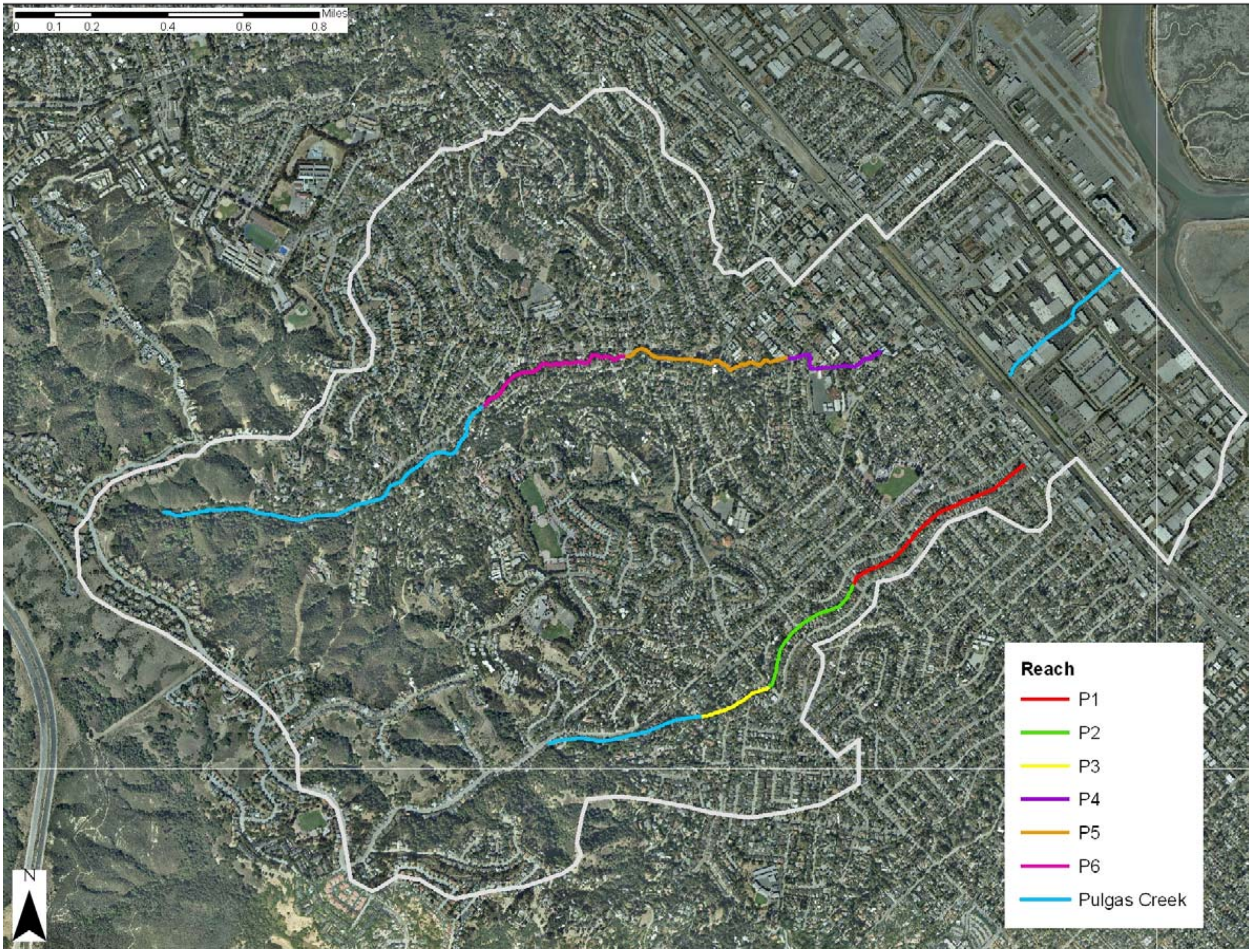



**Figure 6. Reaches assessed in the Pulgas Creek watershed.**
Base image: San Mateo County Department of Public Works**.**

4.2.2 Impact Assessment

Pulgas Creek was highly modified (Figure 7), with a total of 8,301 feet of modified channel, equaling ~64% of the total length assessed. Reaches P1 and P6 had the highest proportion of channel modification with 87% and 82% modified, respectively (Table 7). All of the channel modifications took the form of bank hardening. Concrete, sackcrete, gunnite, and stone were among the materials commonly used to harden banks sides.

All of the creek crossings documented during the assessment were road crossings (two private roads and ten public streets) (Table 7). Five of these had hardened bottoms and thus were acting as grade controls in the creek corridor. The creek crossings in P4 appeared to be potential partial barriers to fish migration due to the shallow flow within the culvert.

Erosion rates were low in this watershed's reaches (Table 7). The highest erosion rate was 9% (reach P4). Most of the erosion consisted of bank scour. Seven instances of bank failure and one case of slope failure were observed. While erosion was not as extensive as in the other study watersheds, the channel was typically deeply incised with steep banks (90˚ bank angles).

A total of 73 outfalls were observed in Pulgas Creek, 77% of which were associated with private properties (Table 7). Only seven outfalls had flow (moderate or trickle) and all but one of the outfalls with flow was a storm drain. There were no unusual odors or discharges associated with the flows. Also, three of the seven flows were observed just after intermittent rain and therefore were not dry weather flows.

Three recreation sites were observed along the creek (Table 7). It appeared that all three sites are accessed from residential private properties. All three sites had rope swings over the creek and one site also had a small fort and trampoline. Swimming potential at the time of the assessment was low as the maximum water depth was 4 – 8 inches.

Three trash sites were documented in the watershed (Table 7). Land use surrounding these sites was generally residential. Types of trash observed included plastic bags, Styrofoam, and beverage containers.

Eight utilities were observed in the watershed (Table 7). Most of these were water or electrical utilities that crossed the channel 2 – 5 feet above the creek and none was observed to be contributing to bank instability.

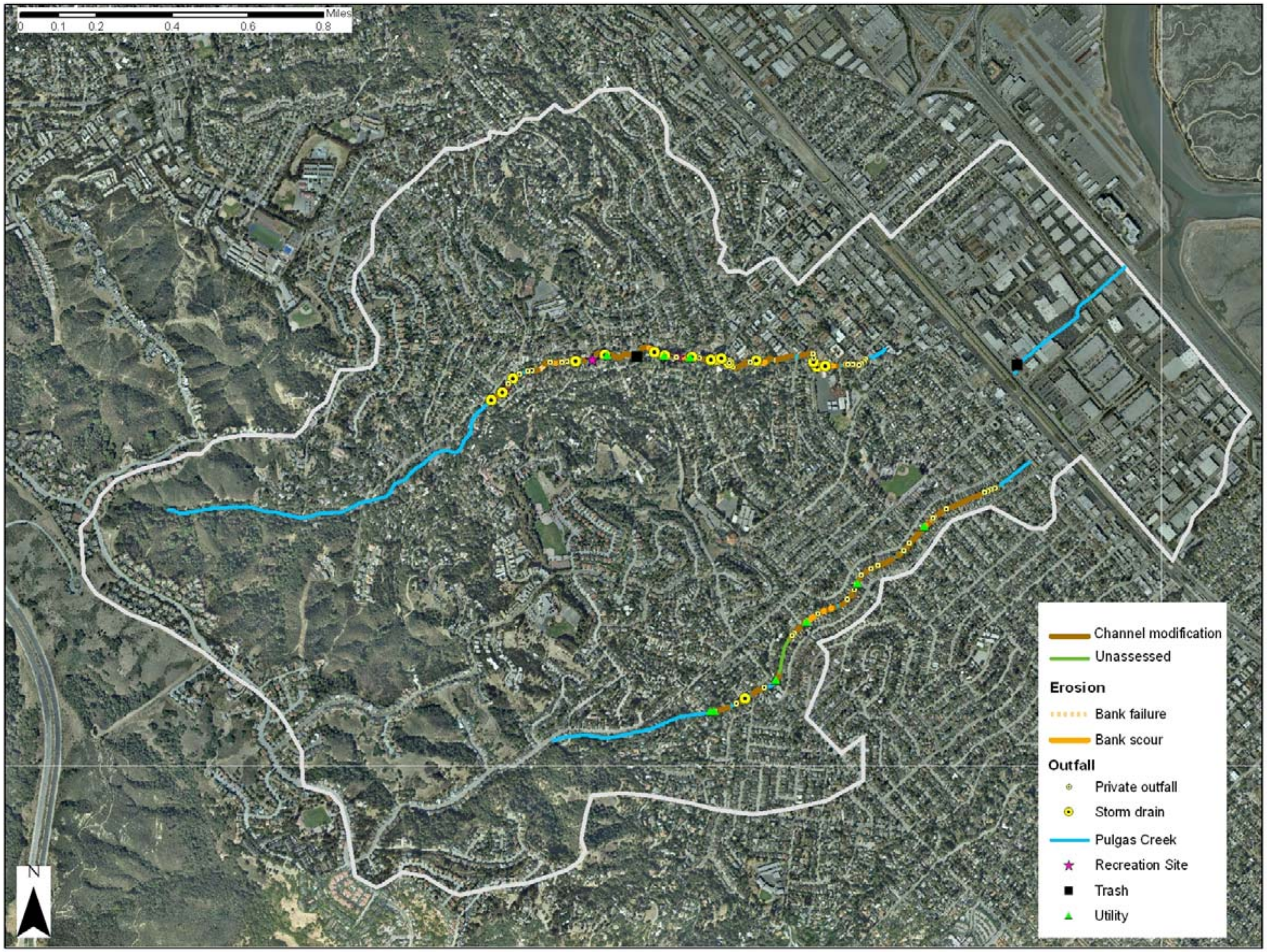



**Figure 7. Impact assessments in the Pulgas Creek watershed.**
Base image: San Mateo County Department of Public Works.

**Table 7. Impact assessment summary - Pulgas Creek watershed.**

| | P1 | P2 | P3 | P4 | P5 | P6 |
|---|---|---|---|---|---|---|
| **Total Length of Reach (ft)** | 2,491 | 2,145* | 1,082 | 1,225 | 3,684 | 2,351* |
| **Channel Modification** | | | | | | |
| Total Length of Channel Modification | 2,179 | 1,259 | 425 | 797 | 1,725 | 1,917 |
| Percent of Reach | 87 | 59 | 39 | 65 | 47 | 82 |
| **Creek Crossing** | | | | | | |
| Number | 2 | 2 | 4 | 2 | 2 | |
| Type | road | road | road | road | road | |
| Hardened Bottom | no | yes, unknown | no, unknown | yes | yes | |
| **Erosion** | | | | | | |
| Total Length of Reach Eroded | 130 | 124 | 0 | 108 | 246 | 15 |
| Percent of Reach Eroded | 5 | 6 | 0 | 9 | 7 | 1 |
| **Outfalls** | | | | | | |
| Total Number of Outfalls | 15 | 6 | 5 | 15 | 17 | 15 |
| Diversion Pipe | | | | | | |
| Private Outfall | 15 | 6 | 4 | 12 | 9 | 10 |
| Storm Drain | | | 1 | 3 | 8 | 5 |
| **Recreation Sites** | | | | | | |
| Total Number of Sites | | | | | 1 | 2 |
| Access (Public, Private) | | | | | private | private |
| Swimming Potential (High, Medium, Low) | | | | | low | low |
| **Trash** | | | | | | |
| Total Number of Trash Sites | 1** | 1** | | | | 1 |
| Trash Source (Litter: L; Illegal Dumping: ID; Accumulation: TA) | TA | TA | | | | L, TA |
| **Utilities** | | | | | | |
| Total Number | 1 | 3 | 1 | | 2 | 1 |

*Reach lengths estimated using GIS.
**Evaluated using the URTA protocol (SMCWPPP 2007b).

### 4.2.3 Reach Assessment

In most of the reaches of the Pulgas Creek watershed, gravel was observed to be the dominant substrate. However, finer particles, like silt/clay and sand, were also noted to be prevalent, particularly in the south branch of Pulgas Creek. Cobble dominated the upper reaches of the north branch. The south branch has a bypass culvert that diverts flow out of the channel, which might contribute to the accumulation of fine sediments in these reaches.

Bank scour was a commonly observed active channel dynamic. Channelization and sediment deposition were also noted in the south branch. In the north branch, bank failure was also documented as a common active channel dynamic.

Instream habitat was observed to be unstable or lacking, and substrate that is favorable for aquatic organisms was not common. In addition, floodplain encroachment was high and the floodplain habitat tended to lack complexity. In the north branch, the instream habitat was somewhat improved. There was more stable instream habitat observed and slightly better vegetative protection on the banks. As a result, scores for creek condition were higher (34 – 47) than those in the south branch (26 – 37) (Table 8, Figure 8). However, the condition of the buffer and floodplain remained similar to those in the south branch, with scores in the poor and marginal range (Figure 8). High levels of encroachment, an obvious lack of diverse floodplain habitat, and a narrow buffer width, were all observed in these reaches.

**Table 8. Reach assessment scores in the Pulgas Creek watershed.**

| **Survey Reach:** | **P1** | **P2** | **P3** | **P4** | **P5** | **P6** |
|---|---|---|---|---|---|---|
| **Overall Creek Condition** | | | | | | |
| Instream Habitat | 3 | 5 | 4 | 8 | 10 | 10 |
| Vegetative Protection: Left Bank | 1 | 1 | 2 | 3 | 6 | 3 |
| Vegetative Protection: Right Bank | 1 | 2 | 3 | 3 | 6 | 3 |
| Bank Erosion: Left Bank | 8 | 5 | 8 | 7 | 7 | 7 |
| Bank Erosion: Right Bank | 8 | 6 | 8 | 6 | 7 | 7 |
| Floodplain Connection | 5 | 8 | 12 | 7 | 11 | 8 |
| ***Subtotal*** | ***26*** | ***27*** | ***37*** | ***34*** | ***47*** | ***38*** |
| **Overall Buffer and Floodplain Condition** | | | | | | |
| Vegetated Buffer Width: Left Bank | 0 | 1 | 3 | 3 | 4 | 4 |
| Vegetated Buffer Width: Right Bank | 0 | 2 | 3 | 3 | 4 | 4 |
| Floodplain Vegetation | 1 | 2 | 5 | 5 | 8 | 8 |
| Floodplain Habitat | 1 | 2 | 5 | 5 | 10 | 7 |
| Floodplain Encroachment | 0 | 5 | 8 | 4 | 10 | 4 |
| ***Subtotal*** | ***2*** | ***12*** | ***24*** | ***20*** | ***36*** | ***27*** |
| ***Total*** | ***28*** | ***39*** | ***61*** | ***54*** | ***83*** | ***65*** |

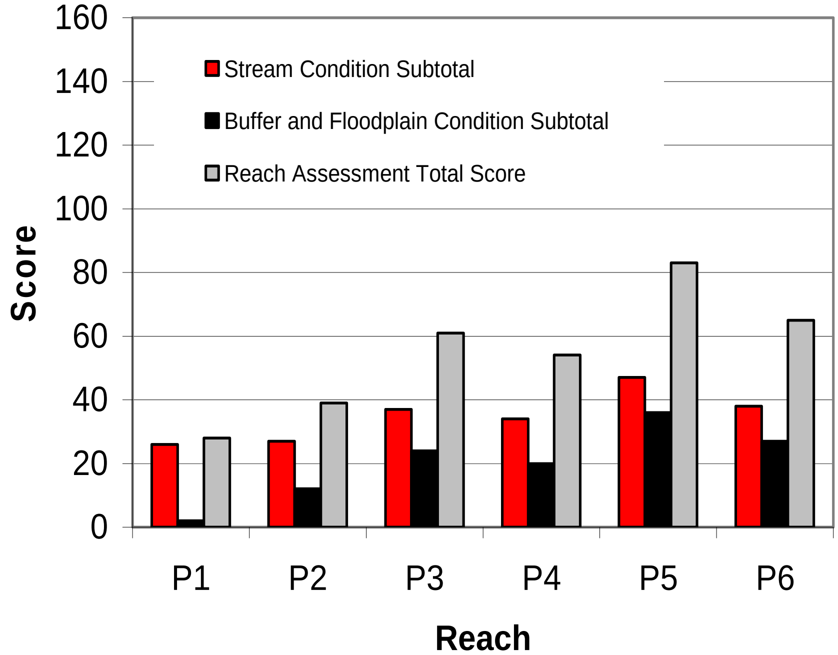



**Figure 8. Reach assessment scores in the Pulgas Creek watershed.**

### 4.3 Belmont Creek Watershed

4.3.1 Reach Delineation

Belmont Creek was delineated into three relatively long reaches and a shorter tributary reach that joins the mainstem upstream of Maywood Street (Table 9 and Figure 9). Reaches B1 and B2 flow through mixed residential land uses with a park area at the downstream end of B1. B3 is a channelized tributary that emerges from a culvert and flows past a commercial area. B4 flows from an impoundment called Water Dog Lake.

4.3.2 Impact Assessment

Approximately 50% of Belmont Creek has undergone some form of channel modification (Figure 10). The most downstream reaches (B1 and B2) had the highest proportion of their channels modified. The proportion of channel modification decreased in the upstream direction. Most of the modifications included bank hardening, although ~800 feet of B1 and ~3,400 feet of B2 were culverted.

The majority of creek crossings in Belmont Creek were road crossings (Table 10). Each road crossings had a hard bottom and therefore acts as a grade control within the creek channel. At the upstream end of the creek, there was one large earthen dam at the outflow of Water Dog Lake. Two of the road crossings documented in Belmont Creek (in reaches B1 and B2) could potentially act as a migration barrier to some fish species.

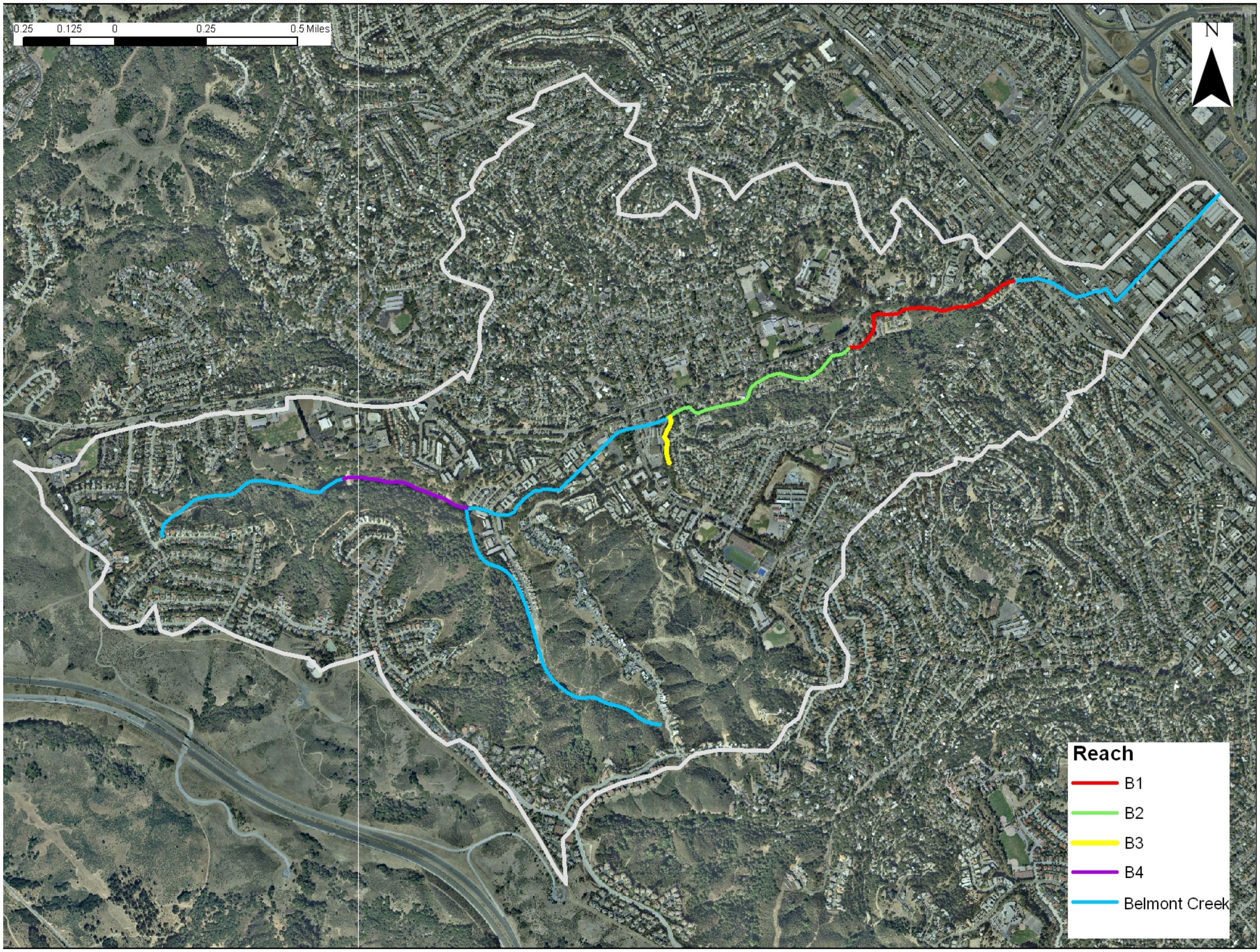



**Figure 9. Reaches assessed in the Belmont Creek watershed.**
Base images: San Mateo County Public Works.

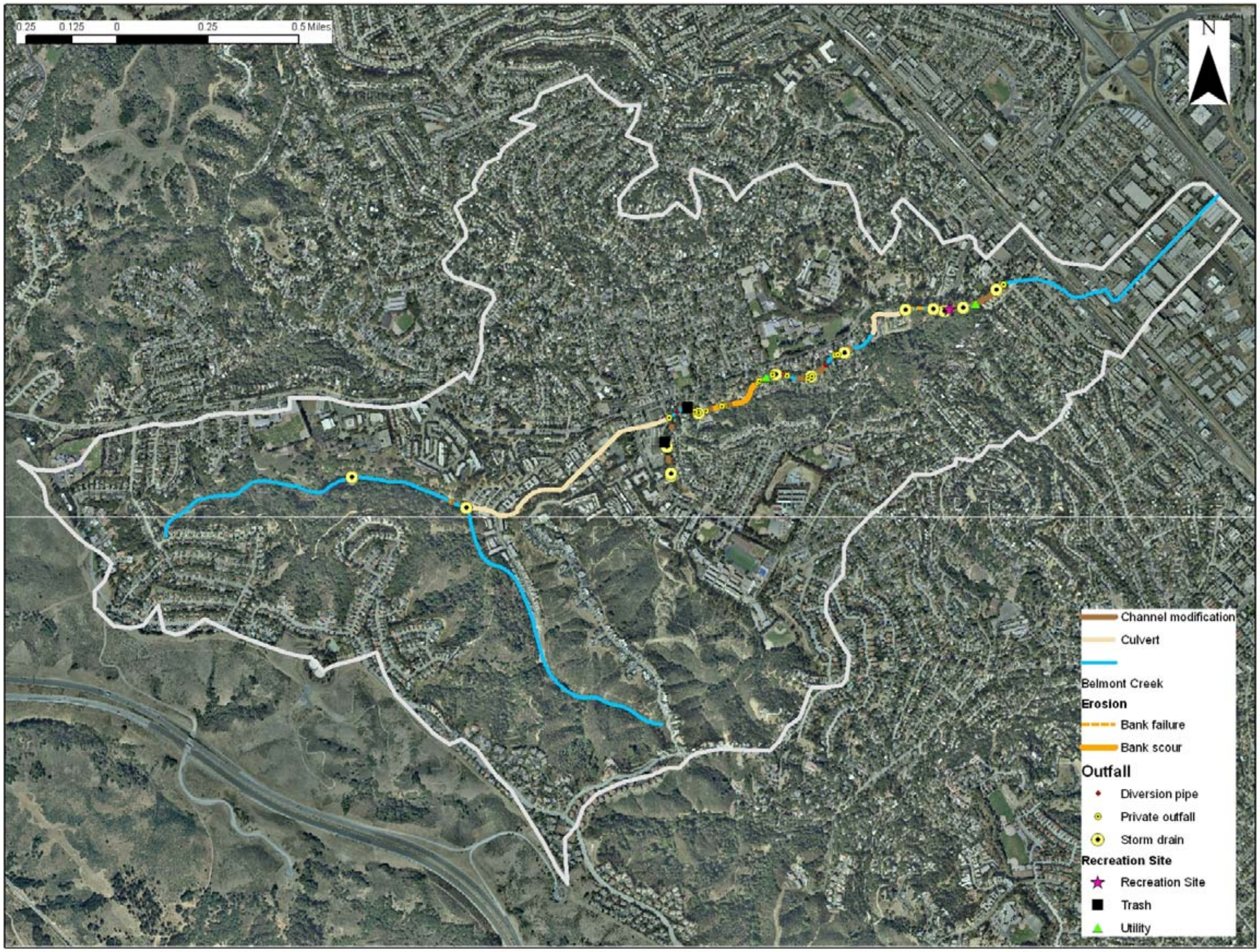



**Figure 10. Impact assessments in the Belmont Creek watershed.**
Base image: San Mateo County Department of Public Works.

**Table 9. Reaches delineated in the Belmont Creek watershed.**

| Reach | Geographic Extent | Length (ft) | Notes |
|---|---|---|---|
| B1 | 6th St to Chula Vista | 2,881* | Bank hardening, exposed bedrock, long section culverted. Downstream end has steep, failing banks, particularly at meander bends. |
| B2 | Chula Vista Rd to Upstream of Maywood at culvert | 3,107 * | Bank hardening and bank erosion; deep channel incision. |
| B3 | Fifty feet upstream of Maywood St Bridge to culvert end at south end of shopping center | 743* | Channelized, reach lacks vegetation cover. |
| B4 | Live Oak Culvert to Water Dog Lake | 1.865* | Surrounding land use is mostly open space. Downstream is incised with active erosion. Incision present in reach. |

*Reach lengths estimated using GIS.

The urbanized reaches of the Belmont Creek watershed (reaches B1 - B3) had roughly equal erosion rates. In B4, where the majority of the surrounding land is open space, less erosion was observed. B1 and B2 each had an extensive eroded section (412 and 435 feet, respectively). Bank failure and bank scour accounted for the majority of the observed erosion.

Only one recreation site was observed in the watershed (in reach B1). Water depth at the site was ~6 inches. Thus, this site had a low potential for swimming or other water contact recreation at the time of the assessment. Paths to the creek at Twin Pines Park were noted, but no pools, containment dams, ropes, swings, benches or other indications of recreation were observed.

The majority of outfalls documented in the Belmont Creek watershed were associated with piping on private properties (Table 10). Only 34% of the outfalls appeared to be municipal storm drains. Approximately 61% of the outfalls had no discharge. Five storm drains had a moderate or trickle flow at the time of the assessment.[6] None of the observed outfalls had suspicious discharges. Two outfalls (in B1 and B3) appeared to have caused bank erosion.

Two trash sites were documented in the Belmont Creek watershed, one in reach B2 and one in B3 (Table 10). In B2, the surrounding area was residential and the observed type and location of the trash suggested that litter from the adjacent area and accumulation from upstream sources were the major sources. In B3, the surrounding land use was commercial and the type of trash suggested that the source was mostly litter from an adjacent parking lot.

[6]There had been a rain event on the previous day, so it is not clear whether the flows observed were from the rain or from other sources.

**Table 10. Impact assessment summary - Belmont Creek watershed.**

| | B1 | B2 | B3 | B4 |
|---|---|---|---|---|
| **Total Length of Reach (ft)** | 2,881 | 6,507 | 743 | 1,865 |
| **Channel Modification** | | | | |
| Length of Channel Modifications (ft) | 1,562 | 4,267 | 84 | 13 |
| Percent of Reach Modified | 54 | 65 | 11 | 1 |
| **Erosion** | | | | |
| Total Length Eroded (Ft) | 567 | 762 | 167 | 228 |
| Percent of Reach Eroded | 20 | 25 | 22 | 12 |
| **Outfall** | | | | |
| Total Number of Outfalls | 6 | 29 | 3 | 2 |
| Diversion Pipe | | 4 | | |
| Private Outfall | 1 | 21 | 2 | |
| Storm Drain | 5 | 4 | 1 | 2 |
| **Recreation Sites** | | | | |
| Total Number of Sites | 1 | | | |
| Access (Public, Private) | Public | | | |
| Swimming Potential | Low | | | |
| (High, Medium, Low) | | | | |
| **Trash** | | | | |
| Total Number of Trash Sites | | 1* | 1* | |
| Trash Source (Litter: L; Illegal Dumping: ID; Accumulation: TA) | | TA | L, ID | |
| **Creek Crossings** | | | | |
| Number | 2 | 2 | | 1 |
| Type | footbridge, road | road | | dam |
| Hardened Bottom | no, yes | yes | | yes |
| **Utilities** | | | | |
| Total Number Observed | 1 | 1 | | |

*Evaluated using the URTA protocol (SMCWPPP 2007b).

Two utility pipes were observed during the assessment (Table 10). Both pipes crossed the creek above the channel and did not appear to impact creek function.

4.3.3 Reach Assessment

Gravel was the dominant substrate in the creek channel, except in reach B4, where cobble was the dominant substrate. Channel widening, bank scour, and bank failure were the most prevalent active channel dynamics observed. Sediment deposition was noted as an active channel dynamic in only one reach (L3). Channelization was observed in B3.

In reaches B1 – B3, instream and floodplain condition scores were generally in the poor or marginal range (Figure 11). In B1, half of the reach was hardened; banks that were not hardened were eroding (Table 11). However, total reach scores were slightly higher than in B2 because the downstream end of B1 is surrounded by open space/park, which contributes to an increased buffer width and better vegetative protection. In reach B2, channel incision was observed, and erosion and bank hardening contributed to creating a deeply entrenched creek with tall banks. Floodplain conditions appeared poor. Scores improved slightly in B3, but the overall condition scores still fell in the marginal and poor range. In B4, conditions improved considerably, with scores falling in the optimal range. Land use immediately around this reach is mostly undeveloped forest, which helps maintain the floodplain habitat conditions. However, some incision was still evident and a small portion of the banks was actively eroding. Sections of this reach were entrenched, which diminished the creeks ability to access its floodplain.

**Table 11. Reach assessment scores in the Belmont Creek watershed.**

| | **B1** | **B2** | **B3** | **B4** |
|---|---|---|---|---|
| Instream Habitat | 9 | 10 | 6 | 13 |
| Vegetative Protection: Left Bank | 3 | 2 | 2 | 9 |
| Vegetative Protection: Right Bank | 3 | 3 | 3 | 9 |
| Bank Erosion: Left Bank | 5 | 2 | 6 | 3 |
| Bank Erosion: Right Bank | 5 | 2 | 6 | 3 |
| Floodplain Connection | 9 | 3 | 12 | 10 |
| ***Subtotal*** | ***34*** | ***22*** | ***35*** | ***47*** |
| Vegetated Buffer Width: Left Bank | 4 | 1 | 2 | 10 |
| Vegetated Buffer Width: Right Bank | 5 | 2 | 4 | 10 |
| Floodplain Vegetation | 5 | 4 | 6 | 20 |
| Floodplain Habitat | 6 | 5 | 7 | 20 |
| Floodplain Encroachment | 5 | 3 | 6 | 20 |
| ***Subtotal*** | ***25*** | ***15*** | ***25*** | ***80*** |
| ***Total Score*** | ***59*** | ***37*** | ***60*** | ***127*** |

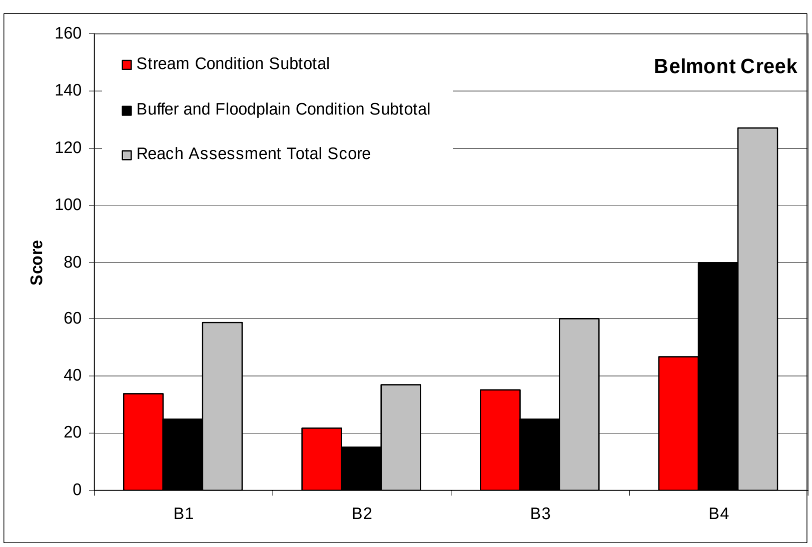



**Figure 11. Reach assessment scores in the Belmont Creek watershed.**

## 4.4 Laurel Creek Watershed

### 4.4.1 Reach Delineation

Laurel Creek was delineated into eight reaches (Table 12). Reaches L1 – L6 comprise the mainstem and L7 and L8 are designated the east fork (Figure 12). The lower reaches (L1 – L4) were highly modified, with considerable channelization and deep incision. In upper watershed reaches L5 and L6 the creek channel had a more natural shape, including some sinuosity.

**Table 12. Reaches delineated in the Laurel Creek watershed.**

| Reach | Geographic Extent | Length (ft) | Notes |
|---|---|---|---|
| L1 | El Camino Real to Edison St culvert | 970 | Channelized and concrete-lined. |
| L2 | Edison St culvert to Hacienda Rd | 1,266 | Channelized, bank hardening and incision, with steep banks. Some bedrock exposed. |
| L3 | Hacienda Rd to Alameda de las Pulgas | 1,752 | Bank hardening/channel modification and incision, but small floodplain areas with more natural sinuosity is present in reach. Small grade control structures present throughout reach. |
| L4 | Alameda de las Pulgas to confluence of main fork | 1,684 | Channel modification, erosion, and incision present but less severe than downstream. Some floodplain areas still present. |
| L5 | Fernwood Culvert to earthen dam structure | 3,000 | Creek entrenched, bank hardening and some sections of bottom hardened. Bedrock exposed in some sections. |
| L6 | Earthen dam to Shasta Rd culvert and outfall | 2,,191 | Channel less entrenched. Culvert outfall at Shasta Road had a very dense population of chironomids below the outfall indicating potential nutrient enrichment from outfall. |
| L7 | E Fork of Laurel Cr, u/s of Fernwood Br to dam Laurel Wood Open Space | 1,224 | Channel incision, bank hardening, and grade control structures present in reach. Some areas of bank failure. |
| L8 | Earthen dam to E. Laurel Cr | 2,426 | Incision present and sections of hardened bottom. Sinuosity of creek improves. |

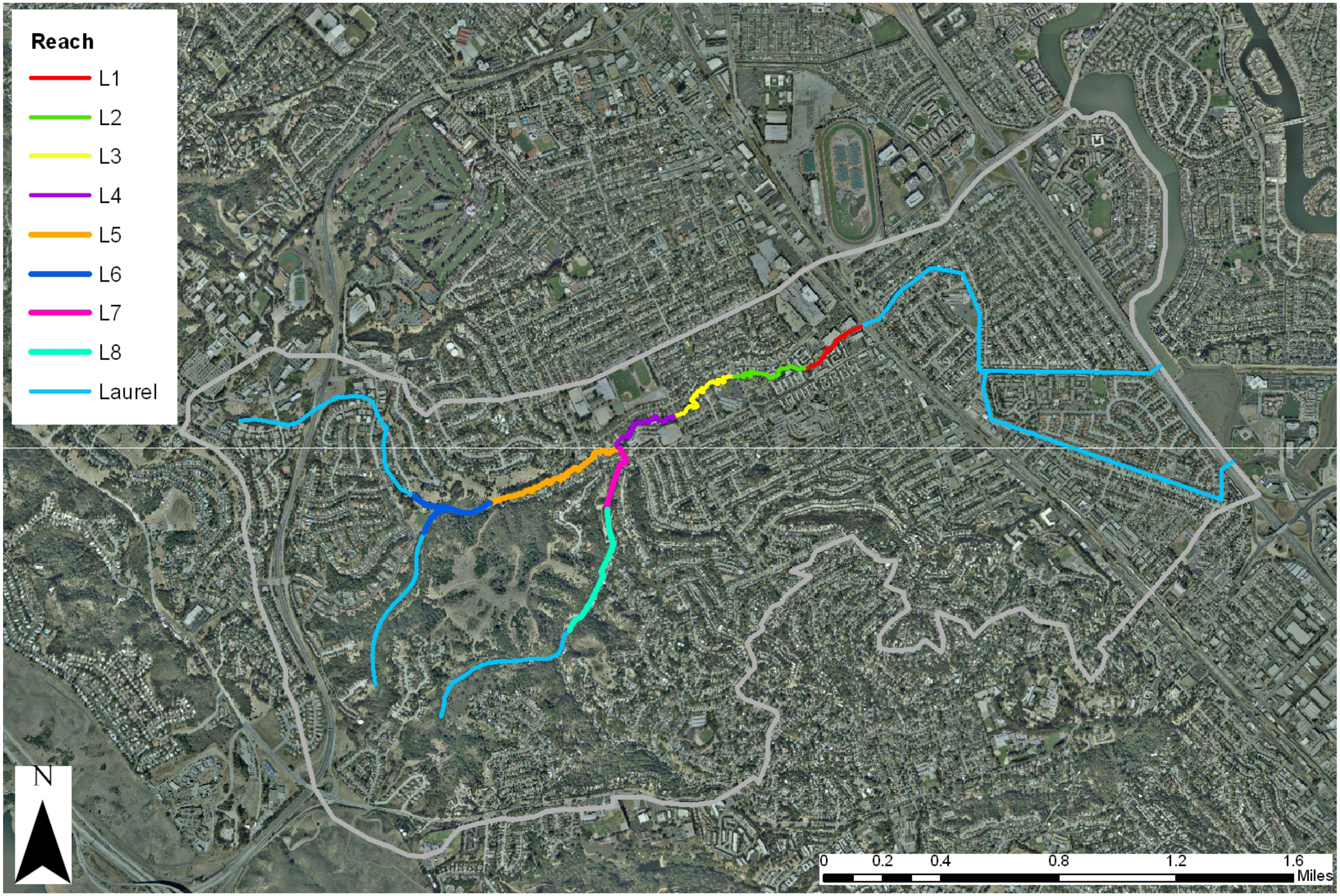



**Figure 12. Reaches assessed in the Laurel Creek watershed.**
Base image: San Mateo County Department of Public Works.

4.4.2 Impact Assessment

A total of 5,500 feet (~38%) of the creek length in the Laurel Creek watershed was modified. Approximately 90% of the modifications were in the form of bank armoring. Other modifications observed included three short culverts. Several of the bank revetments were also associated with grade control structures (i.e., small sections of hardened creek bed). For example, in L3, seven grade control structures were observed. These were generally small, notched weirs that were ~1 – 2 feet in height and associated with small sections of hardened bed, though one grade control structure was associated with a relatively long section (~100 feet) of hardened bed. Other reaches (L4, L5, L7 and L8) had similar structures, but fewer of them. Generally, percent channel modification was inversely related to elevation. Concrete and stone were among the most common materials used to harden banks in this watershed.

A total of 2,246 feet of erosion was documented. Bank scour and failure accounted for all of this erosion. Five cases of erosion appeared to potentially threaten properties located in reaches L2, L3, L4, and L5. Generally, in these cases, eroding banks were destabilizing the integrity of structures such as fences at the top of the bank. The middle reaches L2 and L3 had the highest percent erosion (Table 13).

The majority of the creek crossings were public roads, four of which functioned as grade control structures. Two were large earthen dams (~200 and ~500 feet long), located at the upstream end of L5 and L7.

There were a total of 62 outfalls observed in Laurel Creek, with approximately equal numbers of private outfalls and storm drains (Figure 13, Table 13). Reach L5 had the highest number of private outfalls, likely because that reach is located in a high density residential area. Ten outfalls (all were storm drains) had a trickle of flow, while three had moderate flow (2 storm drains, 1 private outfall). One of these outfalls was observed to contain lawn waste, likely due to a resident washing out a lawnmower.

No recreation sites were observed in Laurel Creek.

Several trash sites were observed in Laurel Creek (in reaches L1, L2 and L8).[7] In L1, trash was accumulating under a footbridge that connected an apartment complex to a shopping center. The origin of this trash appeared to be littering and illegal dumping. In L2, a range of trash, including large items like electronics, computer equipment, and other smaller items (paper, plastic, styrofoam, food related waste) were observed behind the apartment complex on Hacienda Boulevard. In L8, trash was accumulating on the right bank. At this site, there were no houses on the creek bank, the road ran parallel to the creek, and the trash observed included small bags of garbage, suggesting that the trash was dumped.

Only one utility was observed in this watershed - a 6-inch diameter metal pipe that crossed the channel about 25 feet above the creek bed in reach L3.

[7]The trash sites in L1 and L2 were further characterized with the URTA.

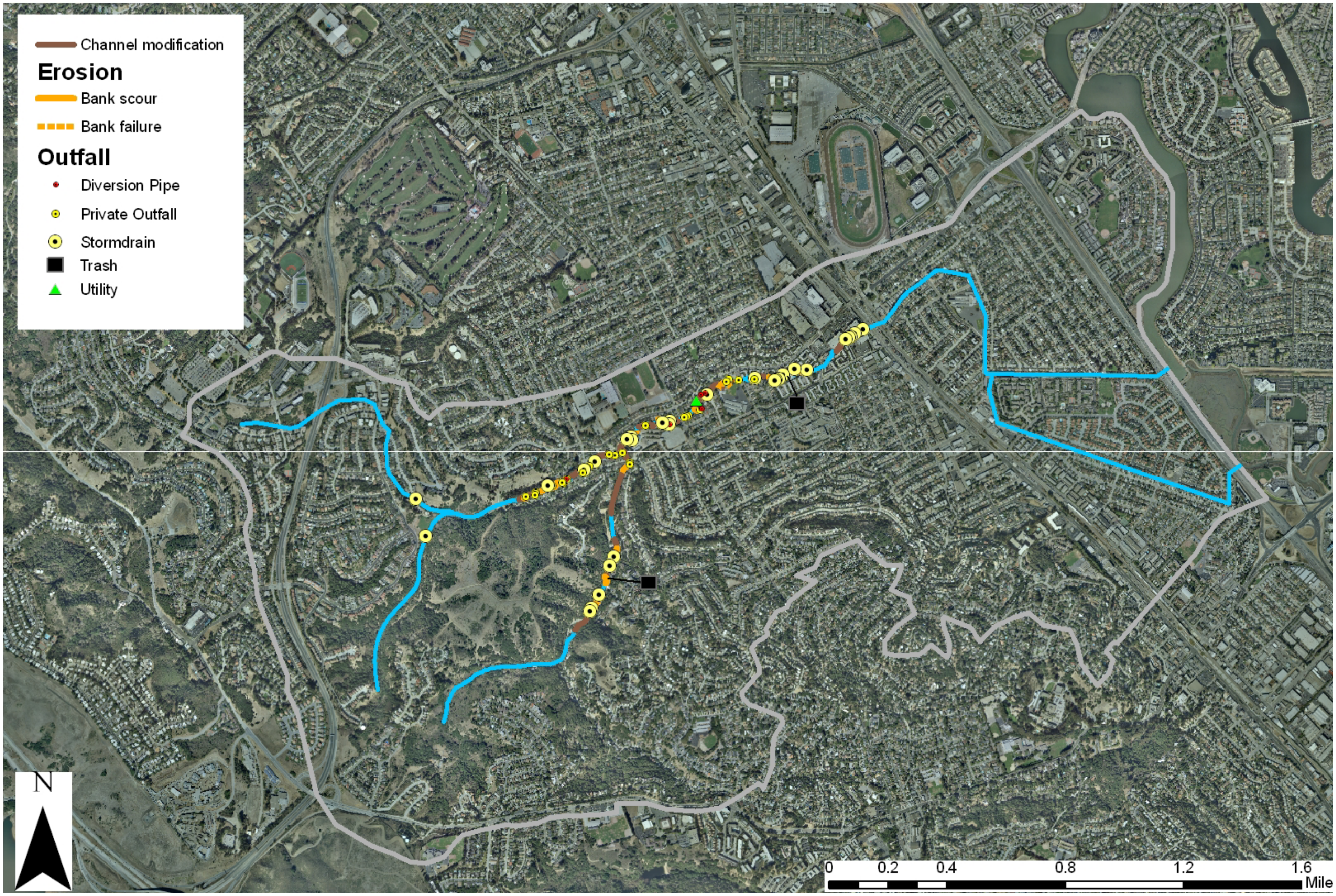



**Figure 13. Impact assessments in the Laurel Creek watershed.**
Base image: San Mateo County Department of Public Works.

**Table 13. Impact assessment summary - Laurel Creek watershed.**

| | L1 | L2 | L3 | L4 | L5 | L6 | L7 | L8 |
|---|---|---|---|---|---|---|---|---|
| **Total Length of Reach (ft)** | 970 | 1,266 | 1,752 | 1,684 | 3,000 | 2,191 | 1,224 | 2,426 |
| **Channel Modification** | | | | | | | | |
| Total Length of Channel Modifications (ft) | 674 | 810 | 1,109 | 836 | 1,385 | 0 | 414 | 260 |
| Percent of Reach Modified | 69 | 64 | 63 | 50 | 46 | 0 | 34 | 11 |
| **Creek Crossing** | | | | | | | | |
| Number | 2 | 2 | 1 | 1 | 1 | | 1 | |
| Type | footbridge, road | footbridge, road | road | road | other | | other | |
| Hardened Bottom | no, unknown | no, yes | unknown | yes | yes | | yes | |
| **Erosion** | | | | | | | | |
| Total Length Eroded (ft) | 87 | 433 | 674 | 199 | 565 | 0 | 88 | 201 |
| Percent of Reach Eroded | 9 | 34 | 38 | 12 | 19 | 0 | 7 | 8 |
| **Outfall** | | | | | | | | |
| Total Number of Outfalls | 5 | 8 | 13 | 8 | 19 | 2 | 2 | 5 |
| Diversion Pipe | | | 5 | 1 | 2 | | | |
| Private Outfall | | 1 | 7 | 1 | 14 | | 2 | |
| Storm Drain | 5 | 7 | 1 | 6 | 3 | 2 | | 5 |
| **Trash** | | | | | | | | |
| Total Number of Trash Sites | 1* | 1* | | | | 1 | | |
| Trash Source (Litter: L; Illegal Dumping: ID; Accumulation: TA) | L, ID | L, ID | | | | TA, ID | | |
| **Utilities** | | | | | | | | |
| Total Number Observed | | | 1 | | | | | |

*Evaluated using the URTA protocol (SMCWPPP 2007b).

### 4.4.3 Reach Assessment

Dominant substrates in the Laurel Creek watershed were sand and gravel in the lower reaches, transitioning to gravel and cobble in the upstream sections of the creek. Average active channel dynamics were dominated by bank failure and scour (noted in almost all of the study reaches). Other notable active channel dynamics observed included channelization, which was frequent in the lower reaches, and down cutting.

Overall condition of the mainstem (reaches L1 to L6) tended to increase in the upstream direction (Figure 14). Most of L6 is surrounded by open space and conditions in this section of the creek were generally stable. Its scores were therefore generally in the optimal range (Table 14). Tributary reach L7 had poorer conditions due to hardened banks and bed (Table 14, Figure 14). These modifications have reduced the creek's connection to its floodplain and decreased the amount of instream and riparian habitat. Creek condition improved in L8 because the channel still had some connection to its floodplain.

**Table 14. Reach assessment scores in the Laurel Creek watershed.**

| | L1 | L2 | L3 | L4 | L5 | L6 | L7 | L8 |
|---|---|---|---|---|---|---|---|---|
| **Overall Creek Condition** | | | | | | | | |
| Instream Habitat | 7 | 9 | 11 | 11 | 11 | 20 | 11 | 17 |
| Vegetative Protection: Left Bank | 1 | 4 | 4 | 6 | 7 | 10 | 1 | 9 |
| Vegetative Protection: Right Bank | 3 | 4 | 3 | 5 | 2 | 10 | 3 | 8 |
| Bank Erosion: Left Bank | 8 | 3 | 3 | 6 | 7 | 8 | 8 | 6 |
| Bank Erosion: Right Bank | 7 | 4 | 2 | 5 | 8 | 10 | 3 | 6 |
| Floodplain Connection | 9 | 10 | 10 | 13 | 10 | 20 | 8 | 15 |
| ***Subtotal*** | ***35*** | ***34*** | ***33*** | ***46*** | ***45*** | ***78*** | ***34*** | ***61*** |
| **Overall Buffer and Floodplain Condition** | | | | | | | | |
| Vegetated Buffer Width: Left Bank | 1 | 3 | 2 | 4 | 8 | 10 | 1 | 10 |
| Vegetated Buffer Width: Right Bank | 3 | 2 | 2 | 6 | 2 | 9 | 4 | 6 |
| Floodplain Vegetation | 2 | 10 | 7 | 11 | 7 | 20 | 8 | 16 |
| Floodplain Habitat | 3 | 10 | 5 | 10 | 8 | 20 | 5 | 15 |
| Floodplain Encroachment | 2 | 10 | 4 | 10 | 8 | 20 | 6 | 17 |
| ***Subtotal*** | ***11*** | ***35*** | ***20*** | ***41*** | ***33*** | ***79*** | ***24*** | ***64*** |
| ***Reach Assessment Total Score*** | ***46*** | ***69*** | ***53*** | ***87*** | ***78*** | ***157*** | ***58*** | ***125*** |

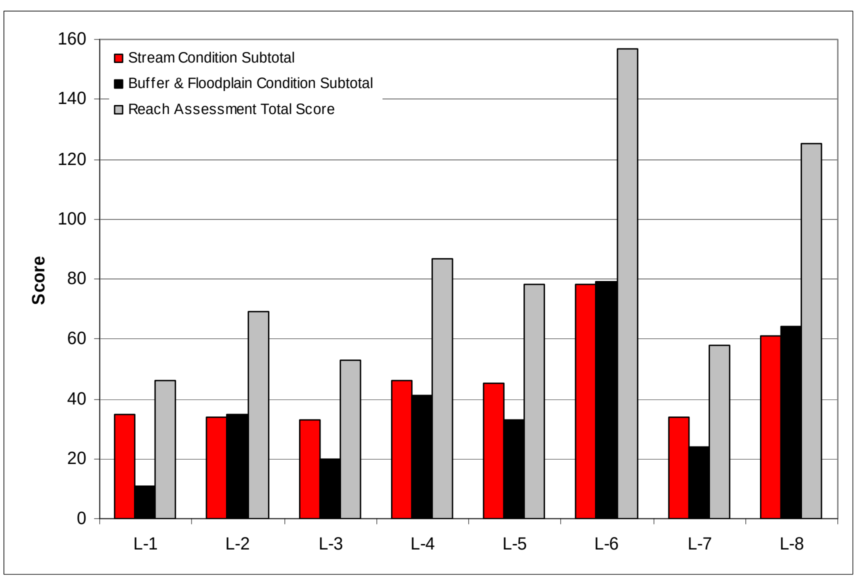



**Figure 14. Reach assessment scores in the Laurel Creek watershed.**

## 4.5 Lower San Mateo Creek Watershed

### 4.5.1 Reach Delineation

Seven reaches were delineated in the San Mateo Creek watershed (Figure 15) that range in length from about 1,400 to 7,600 feet (Table 15). Reach delineations were primarily based on major creek crossings (e.g., road crossings).

### 4.5.2 Impact Assessment

Table 16 and Figure16 summarize the results of the impact assessments. Approximately 40% (9,080 ft) of the linear creek length assessed in the San Mateo Creek watershed was modified channel. While some reaches had very little channel modification, many were extensively altered, particularly in the lower and middle reaches. For example, 92% of reach SM2 had some form of channel modification. Approximately 2,000 feet of this reach (between El Camino Real and the Caltrain station) is culverted.

Channel modifications in San Mateo Creek typically took the form of bank armoring. Banks were hardened with a range of materials including wood, concrete, riprap, and sackcrete. Hardened banks were often vertical walls ranging from about 5 to 15 feet in height. Frequently, the toe of bank revetments was undercut, indicating that the creek bed had eroded since the installation of the channel modification.

Road crossings (private and public roads) were the most common type of creek crossing observed in San Mateo Creek (Table 16). Other crossings observed included a tennis court and a public school building. Creek crossings in the San Mateo Creek watershed generally did not serve as grade control structures as the creek crossings did not have hardened bottoms. None of the creek crossings appeared to be a potential fish barrier.

The amount of erosion varied widely among the reaches in the San Mateo Creek watershed (Table 16). Reach SM5 had the highest erosion rate (31%). Most of the observed erosion was bank scour. Bank failure (Figure 17) was also observed in four reaches (SM3, 4, 5 and 6). Erosional areas were often between sections of hardened banks. Sediment aggradation was observed in reaches 1, 2, and 6. Deposition of fine sediments was observed in reaches 1 through 5, while in reaches 6 and 7 gravel was depositing and accumulating in bars.

A total of 89 outfalls were observed in this watershed. Private outfalls (<6-inch diameter) outnumbered storm drains in two reaches (SM1 and SM3). Discharge was not observed from the majority (~84%) of the outfalls. Of the pipes with discharge, most had only a moderate amount or trickle of flow. All but one of the pipes with discharge was a storm drain. No unusual discharge characteristics were observed such as odor or discoloration, but one storm drain in reach SM6 had soap suds in its discharge during a rain event. At least one storm drain in reach SM5 was observed to be contributing to bank erosion. In addition to the private outfalls and storm drains noted in the creek, three diversion pipes were also observed. None of these was pumping at the time of the assessment.

**Table 15. Reaches delineated in the lower San Mateo Creek watershed.**

| Reach | Geographic Extent | Length (ft) | General Characteristics |
|---|---|---|---|
| SM1 | 3rd St at Gateway Park and Culvert at Caltrain Station | 2,775 | Modified channel, channel hardening common, steep banks. Upstream end of reach emerges from ~2,000-ft culvert that runs under downtown commercial area. |
| SM2 | El Camino Real and Crystal Spring Rd | 1,395 | Channel hardening, sedimentation zones. Downstream end, creek channel is narrow with hardened, steep banks. Mid to upstream end, creek channel is less modified with more access to floodplain areas. |
| SM3 | Crystal Springs Rd and Stonehedge Dr. | 2,940 | Hardened banks, local erosion/ bedrock control throughout, good floodplain access. |
| SM4 | Stonehedge Dr and Sierra Dr. | 3,580 | Channel hardening common, some floodplain connection maintained despite very high walls in sections. |
| SM5 | Sierra Dr. and Crystal Springs Rd. | 2,360 | More habitat stability, improved floodplain connection, right bank has relatively large buffer width and overall good vegetation protection in the floodplain. |
| SM6 | Crystal Springs Rd. | 7,618 | Instream habitat stable and diverse, banks well protected with vegetation, erosion minor, wide buffer zone on right bank. Gravel bar formation, road encroachment in some areas. |
| SM7 | Crystal Springs Rd. and Polhemus Cr. confluence. | 1,656 | Instream habitat stable and diverse, banks well protected with vegetation, wide buffer zone. Gravel bar formation extensive, road encroachment in some areas. |

Recreation sites were observed in two of the reaches in the San Mateo Creek watershed. In reach SM2, a trail led from Arroyo Court Park to the bank of the creek where there was a rope hanging over the creek. The water depth at the time of observation was ~4 inches. In SM-3, two recreation sites were observed. The access to both of these sites was from private property and both sites had swings over the water. The maximum water depth at these sites was 36 inches and 24 inches.

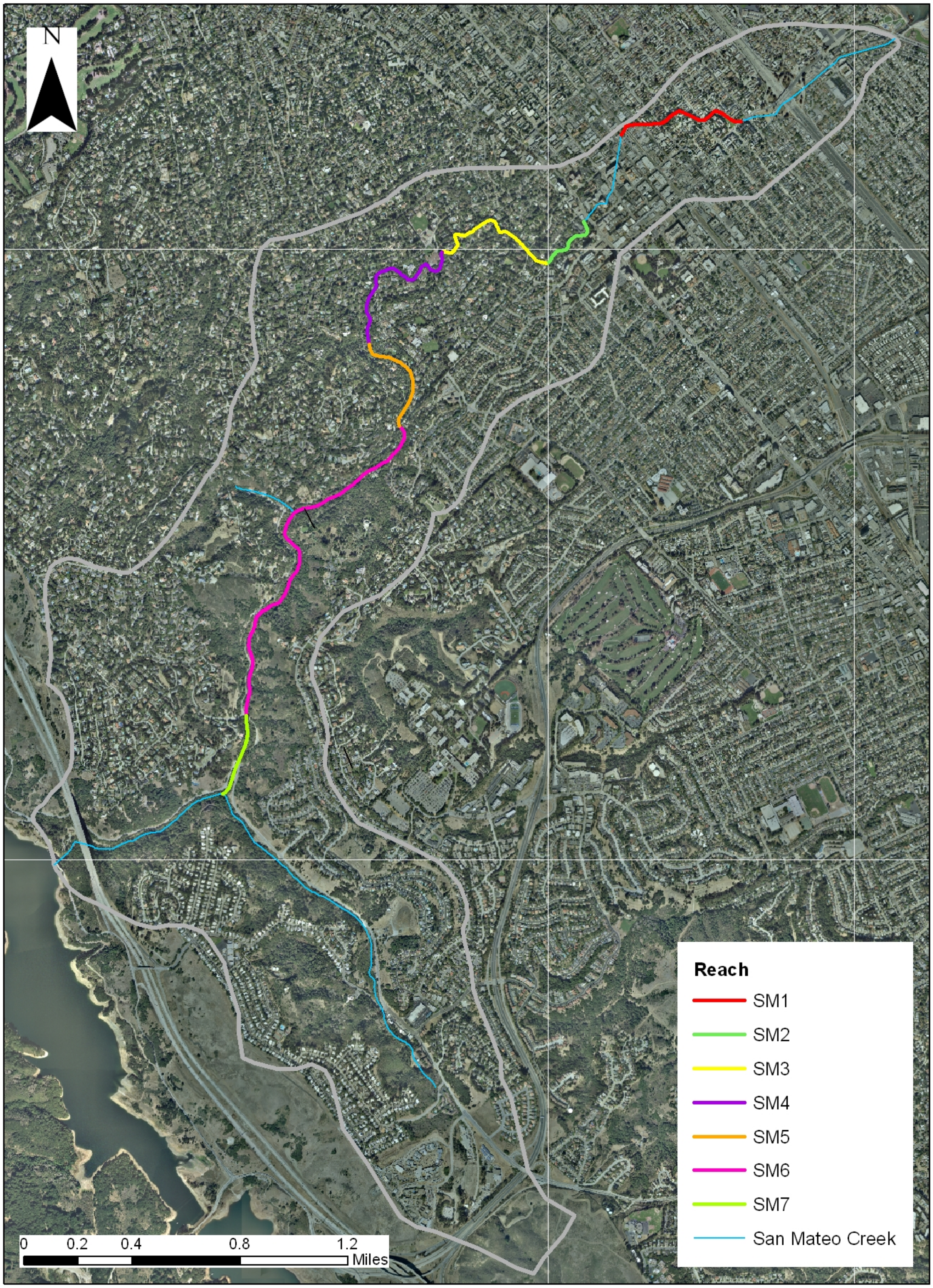



**Figure 15. Reaches assessed in the lower San Mateo Creek watershed.**
Base image: San Mateo County Department of Public Works.

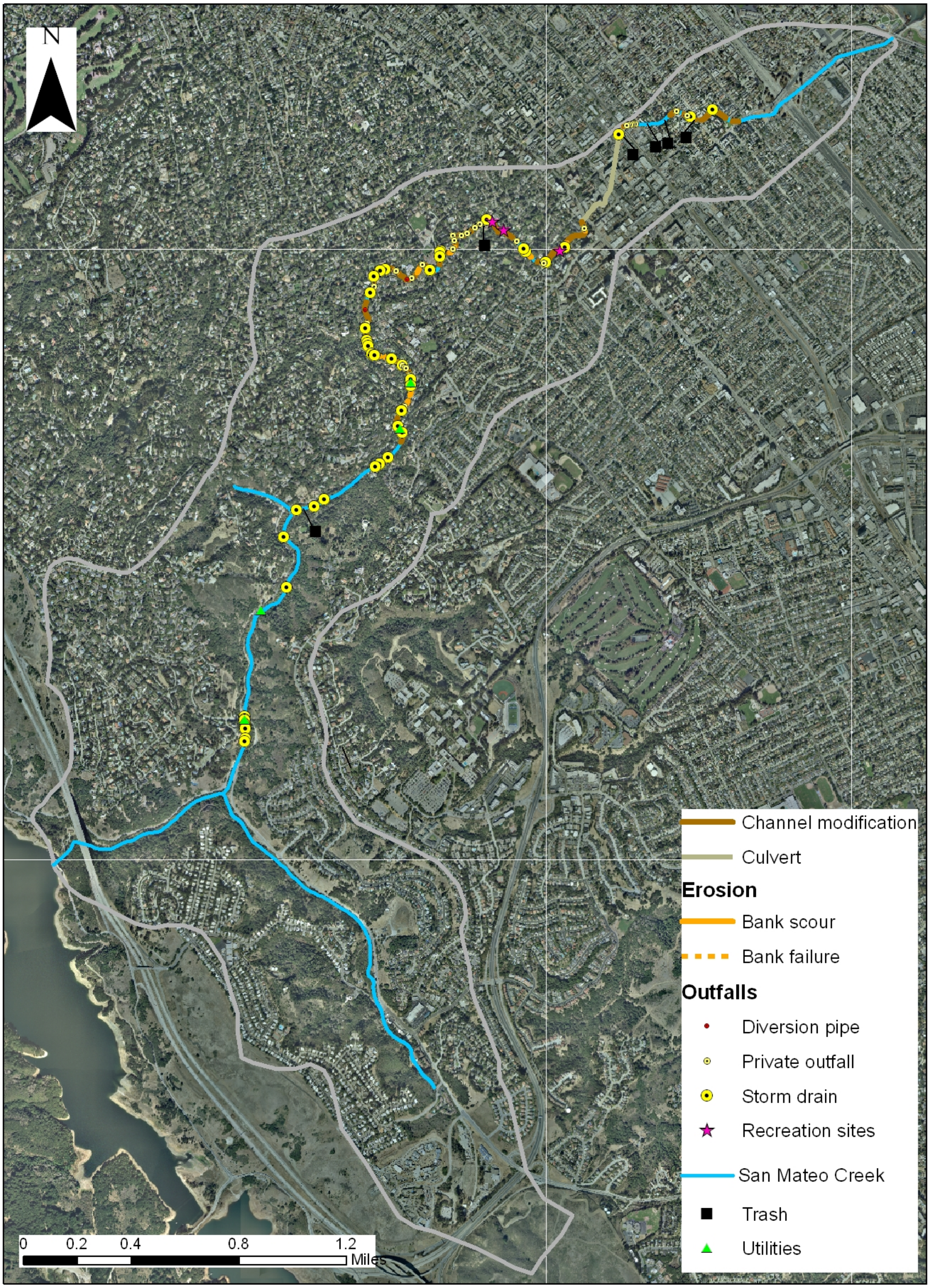



**Figure 16. Impact assessments in the lower San Mateo Creek watershed.**
Base image: San Mateo County Department of Public Works.

**Table 16. Impact assessment summary - lower San Mateo Creek watershed.**

| | SM1 | SM2 | SM3 | SM4 | SM5 | SM6 | SM7 |
|---|---|---|---|---|---|---|---|
| **Total Length of Reach (feet)** | 2,775 | 3,395[8] | 2,940 | 3,580 | 2,360 | 7,618 | 1,656 |
| **Channel Modification** | | | | | | | |
| Total Length (feet) | 1,370 | 3,135 | 1,065 | 2,215 | 665 | 550 | 78 |
| Percent of Reach Modified | 49 | 92 | 36 | 62 | 28 | 7 | 5 |
| **Erosion** | | | | | | | |
| Total Length (feet) | 125 | 135 | 680 | 270 | 725 | 75 | 0 |
| Percent of Reach Eroded | 5 | 10 | 23 | 8 | 31 | 1 | 0 |
| **Outfalls** | | | | | | | |
| Total Number of Outfalls | 11 | 4 | 20 | 19 | 14 | 11 | 10 |
| Diversion Pipes | | | 1 | 2 | | | |
| Private Outfalls | 8 | 1 | 15 | 6 | 4 | | 1 |
| Storm Drains | 3 | 3 | 4 | 11 | 10 | 11 | 9 |
| **Recreation Sites** | | | | | | | |
| Total Number of Sites | | 1 | 2 | | | | |
| Access (Public, Private) | | Public | Private | | | | |
| Swimming Potential | | Low | Medium | | | | |
| (High, Medium, Low) | | | | | | | |
| **Creek Crossing** | | | | | | | |
| Number | 4 | 1 | 4 | 2 | 4 | 2 | 3 |
| Type | road, rail | road | road, other[9] | road, other[10] | road | road | road |
| Hardened Bottom | no | no | no | no | no | no | yes (1 site) |
| **Trash** | | | | | | | |
| Number of Trash Sites | 4* | 1* | | | | 1 | |
| Trash Source (Litter: L; Illegal Dumping: ID; Accumulation: TA) | L, ID, TA. | L, ID, TA | | | | ID | |
| **Utilities** | | | | | | | |
| Total Number Observed | | 1 | | 2 | 3 | 2 | 2 |

*One of the four sites in SM1 and the site in SM2 were evaluated using the URTA protocol (SMCWPPP 2007b).

[8]Includes an approximate 2,000-foot culvert.
[9]One footbridge and one tennis court.
[10]One school building.


**Figure 17. An example of bank failure in the lower San Mateo Creek watershed.**

Accumulated trash was observed in reaches SM1 and SM6. In SM1, trash was observed at four locations. The most impacted site was between Delaware Street and Claremont Street where garbage bags and other large items (grocery carts, a lawnmower, and electronic equipment such as televisions) had been dumped on the right bank and into the creek ~100 feet downstream of Claremont Street. Much of this trash appeared to be dumped over the fence at the top of bank. Trash also appeared to be accumulating in the creek at this point from upstream sources. The accumulated trash was mostly floatable items like plastic bottles and bags. In SM6, illegal dumping was observed at the turn out of Crystal Springs Road. Trash observed included construction and automotive waste, and litter (e.g., beer cans, paper, and metal scraps).

The majority of utilities observed in the San Mateo Creek watershed were pipes that were less than 12 inches in diameter and crossed the channel above the creek. One utility was observed in the channel in reach SM7. None of the utilities observed was leaking or appeared to cause channel instability.

4.5.3 Reach Assessment

In the lower reaches of San Mateo Creek, waters were turbid, but by reach SM3 clarity was high. Trout and stickleback were noted in some of the upper reaches of the creek.

Dominant substrates increased in size in the upstream direction. Sand and gravel were the average dominant substrate in reaches SM1 and SM2. Upstream of SM2, the channel was dominated by gravel and cobble substrate.

In the lower reaches (SM1 and SM2), channelization and aggradation were common average active channel dynamics. Sediment deposition continued to be noted as an active channel dynamic throughout all of the reaches. However, in more upstream reaches like SM7, sediment deposition was often in the form of gravel bars as opposed to excessive accumulation of finer sediments. Bank failure and scour were observed to be active channel process in most of the upstream reaches (SM3 – SM7).

Creek condition, buffer and floodplain condition, and overall reach condition scores generally increased with increasing elevation (Figure 18). This pattern also held true for each of the subcomponents of creek condition (instream habitat, vegetative protection, and bank erosion) and buffer condition (vegetated buffer width, floodplain vegetation, floodplain habitat, and floodplain encroachment) (Table 17). Most of the scores for the subcomponents fell into the marginal (6 – 10) or suboptimal (11 – 15) range, except in the most upstream reaches, SM6 and SM7, which scored in the optimal range (16 -20). Total reach assessment scores ranged from 62 (SM1) to 154 (SM7). Conditions were approximately the same for the left bank and right bank (Table 17). Instream habitat condition scores were consistently slightly higher than the scores for buffer and floodplain conditions, particularly in lower reaches where creek channelization was prevalent (Figure 18).

**Table 17. Reach assessment scores in the lower San Mateo Creek watershed.**

| Reach | SM1 | SM2 | SM3 | SM4 | SM5 | SM6 | SM7 |
|---|---|---|---|---|---|---|---|
| Instream Habitat | 8 | 9 | 15 | 14 | 18 | 20 | 19 |
| Vegetative Protection: Left Bank | 3 | 3 | 5 | 5 | 8 | 9 | 10 |
| Vegetative Protection: Right Bank | 4 | 5 | 6 | 5 | 7 | 10 | 9 |
| Bank Erosion: Left Bank | 8 | 8 | 6 | 7 | 7 | 10 | 10 |
| Bank Erosion: Right Bank | 8 | 7 | 7 | 7 | 5 | 10 | 10 |
| Floodplain Connection | 8 | 14 | 16 | 14 | 14 | 18 | 20 |
| ***Subtotal Creek Condition*** | ***39*** | ***46*** | ***55*** | ***52*** | ***59*** | ***77*** | ***78*** |
| Vegetated Buffer Width: Left Bank | 3 | 4 | 4 | 5 | 3 | 7 | 10 |
| Vegetated Buffer Width: Right Bank | 4 | 6 | 6 | 5 | 8 | 10 | 7 |
| Floodplain Vegetation | 6 | 7 | 14 | 12 | 16 | 20 | 20 |
| Floodplain Habitat | 6 | 6 | 13 | 12 | 15 | 20 | 20 |
| Floodplain Encroachment | 4 | 11 | 12 | 6 | 10 | 18 | 19 |
| ***Subtotal Buffer & Floodplain Condition*** | ***23*** | ***34*** | ***49*** | ***40*** | ***52*** | ***75*** | ***76*** |
| ***Total Reach Assessment Score*** | ***62*** | ***80*** | ***104*** | ***92*** | ***111*** | ***152*** | ***154*** |

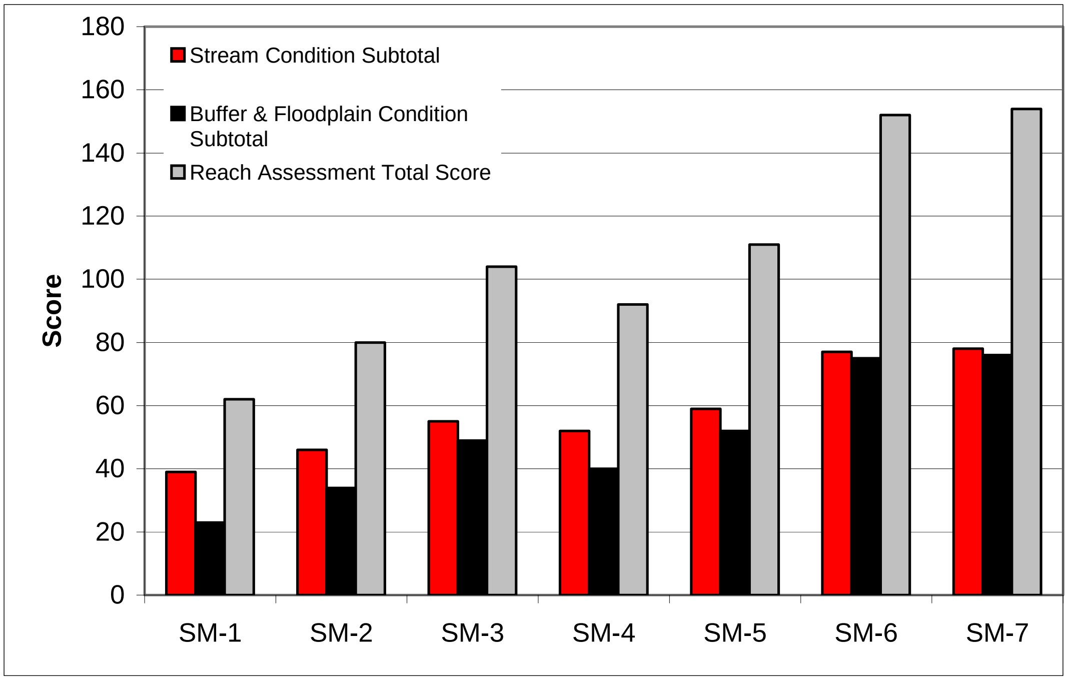



**Figure 18. Reach assessment scores in the lower San Mateo Creek watershed.**

## 4.6 San Pedro Creek Watershed

### 4.6.1 Reach Delineation

San Pedro Creek was delineated into ten reaches (Table 18, Figure 19).

### 4.6.2 Impact Assessment

Approximately 22% of the assessed length of San Pedro Creek was modified. Reach SP3 had the most channel modification (about 70%)(Table 18). Channel modifications in this watershed generally took the form of bank armoring constructed using a variety of materials. Armored bank heights ranged from 5 to ~25 feet. While most channel modifications observed were various types of bank hardening, remnant historical dam structures were also observed. In areas where old dam structures were present, the bottom of the channel was often hardened in addition to the banks. Restoration work has recently been performed in reaches SP1, SP2, and SP5 to alleviate flooding problems (SP1 and SP2) and to improve steelhead habitat (SP5), resulting in no armoring of banks in these reaches.[11] The downstream end of reach SP6 was channelized for 640 feet; both banks and the creek bottom were lined with concrete.

[11]It should be noted that as part of the restoration work, log/boulder weirs were installed to help control the grade and create stable, diverse, trout-friendly habitat. These structures were not counted as channel modifications in the USA sense.

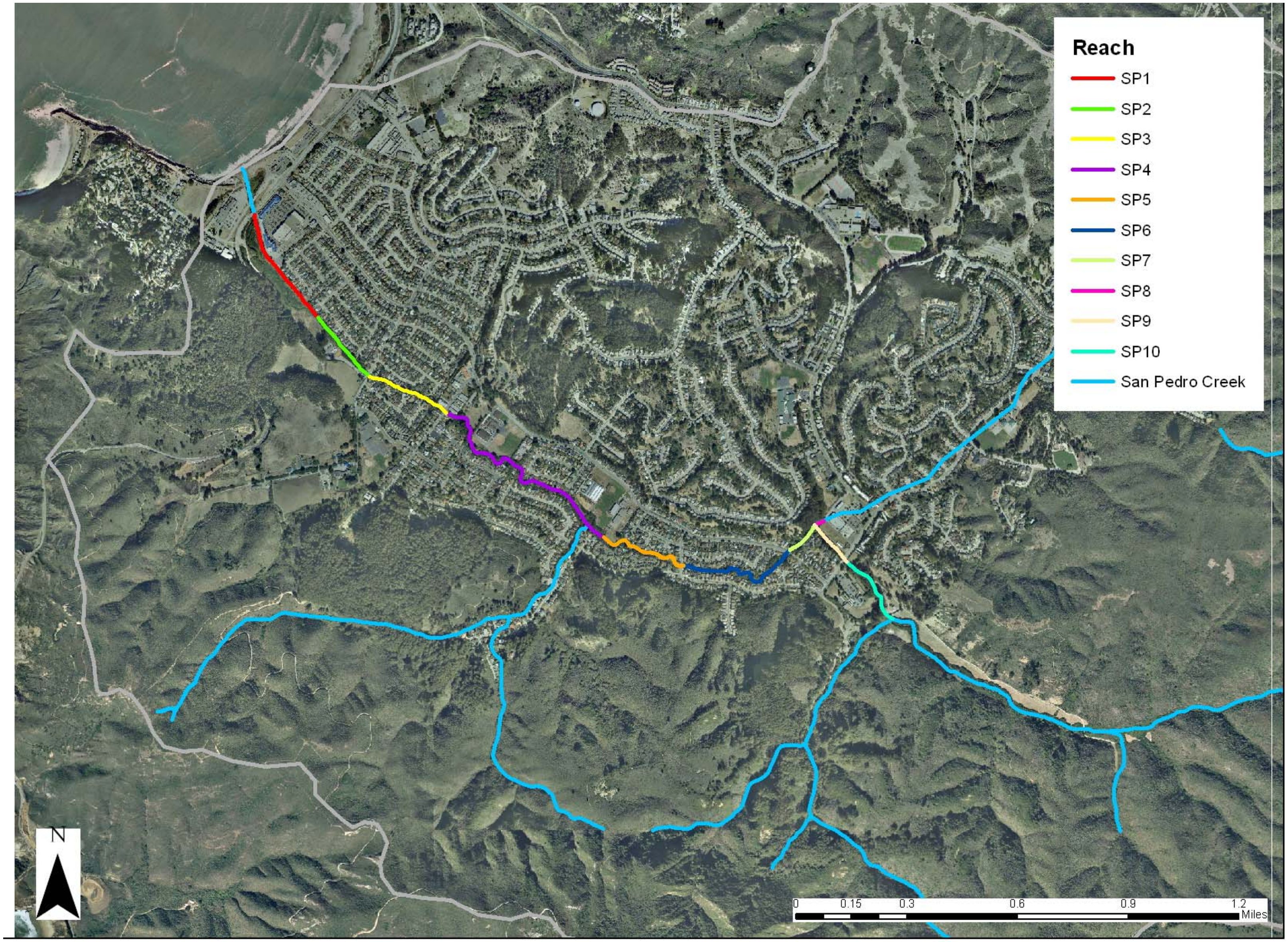



**Figure 19. Reaches assessed in the San Pedro Creek watershed.**
Base image: San Mateo County Department of Public Works.

**Table 18. Reaches delineated in the San Pedro Creek watershed.**

| Reach | Geographic Extent | Length (ft) | Notes |
|---|---|---|---|
| SP1 | Upstream end of HWY 1 to upstream end of restoration zone | 2,111* | Active restoration site (~1 yr old): channel is well vegetated with meanders; creek has large floodplain space |
| SP2 | Upstream of restoration site to Peralta St Bridge | 1,133* | LB bank hardening and historic entrenchment. |
| SP3 | Peralta Bridge to Adobe Bridge | 1,244* | Bank hardening extensive; steep walls; old dam structure. |
| SP4 | Adobe St Br to d/s end of Capistrano Fish Restoration Site | 3,565 | Bank armoring and erosion on left bank; creek incision. |
| SP5 | Downstream end of restoration site to Capistrano Bridge | 1,386* | Recently restored site; creek banks have little shading as the newly planted riparian vegetation has not yet grown in. |
| SP6 | Capistrano Bridge to Linda Mar Bridge | 1,885 | Concrete channel at downstream end; steep bank walls throughout reach; |
| SP7 | Linda Mar Bridge to North Fork Confluence | 455 | Bank erosion severe. |
| SP8 | Confluence with main stem to culvert | 136 | Flow emanates from culvert; water opaque, milky; bank erosion severe on LB. |
| SP9 | Confluence with main fork to Oddstad Bridge | 780 | Bank erosion |
| SP10 | Oddstad Bridge to confluence | 1,100 | Right bank erosion; much of reach is incised 2-3 feet; left bank is very steep. |

*Reach lengths estimated using GIS.

Six road crossings were observed (Table 19). The drop from the crossings in SP3, SP4, and SP9 to the surface of the creek was high enough to potentially block fish passage. However, barriers to fish migration are currently being addressed by the City of Pacifica and the San Pedro Creek Watershed Coalition.

Erosion was greatest in reach SP10 (Table 19, Figure 20). In SP10, one relatively long section (400’) of erosion and 2-3 feet of channel incision were observed. Bank scour and bank failure were both equally present in the creek and were often observed at creek meander bends. Slope failure was documented in SP4. Erosion threatened property infrastructure in four reaches (SP4, SP6, SP7 and SP8). In these areas, fences and decks were being undercut by the erosion and the backyards of private properties were often eroding.

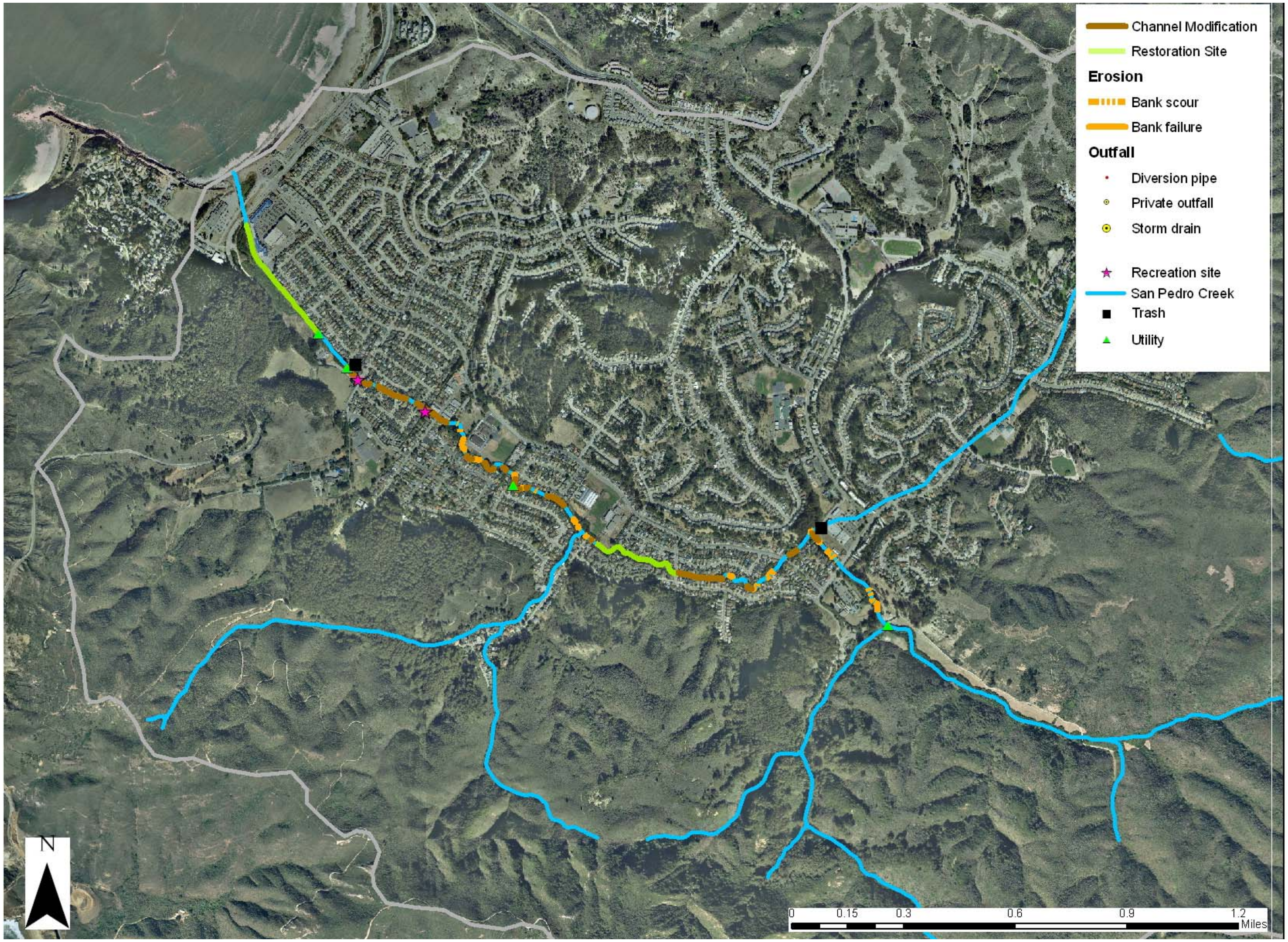



**Figure 20. Impact assessments in the San Pedro Creek watershed.**
Base image: San Mateo County Department of Public Works.

**Table 19. Impact assessment summary - San Pedro Creek watershed.**

| | SP1 | SP2 | SP3 | SP4 | SP5 | SP6 | SP7 | SP8 | SP9 | SP10 |
|---|---|---|---|---|---|---|---|---|---|---|
| **Total Reach Length (ft)** | 2,111 | 1,133 | 1,244 | 3,565 | 1,386 | 1,885 | 455 | 136 | 780 | 1,100 |
| **Channel Modification** | | | | | | | | | | |
| Total length of Channel Modification (ft) | 0 | 0 | 865 | 927 | 0 | 717 | 230 | 0 | 130 | 0 |
| Percent of Reach Modified | 0 | 0 | 70 | 26 | 0 | 38 | 51 | 0 | 17 | 0 |
| **Creek Crossings** | | | | | | | | | | |
| Number | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 0 |
| Type | | road | road | road | road | road | | | road | |
| Hardened bottom | | no | no | yes | no | yes | | | yes | |
| **Erosion** | | | | | | | | | | |
| Total length eroded (ft) | 0 | 0 | 15 | 783 | 0 | 288 | 120 | 25 | 175 | 400 |
| Percent of Reach Eroded | 0 | 0 | 1 | 22 | 0 | 15 | 26 | 18 | 22 | 36 |
| **Outfalls** | | | | | | | | | | |
| Total Number of Outfalls | | | 2 | 8 | 4 | 7 | | | 2 | |
| Diversion pipe | | | | 1 | | 2 | | | 1 | |
| Private outfall | | | | 2 | | 1 | | | 1 | |
| Storm drain | | | 2 | 5 | 4 | 4 | | | | |
| **Recreation Sites** | | | | | | | | | | |
| Total Number of Sites | | 1 | 1 | | | | | | | |
| Access (Public, Private) | | Public | Private | | | | | | | |
| Swimming Potential (High, Medium, Low) | | low | low | | | | | | | |
| **Trash** | | | | | | | | | | |
| Total Number of Trash Sites | | 1* | | | | | | 1* | | |
| Trash Source (Litter: L; Illegal Dumping: ID; Accumulation: TA) | | TA, L | | | | | | ID, TA | | |
| **Utilities** | | | | | | | | | | |
| Total Number of Utilities | | 2 | | 1 | | | | | | 1 |

*Evaluated using the URTA protocol (SMCWPPP 2007b).

Sixty-five percent of the outfalls observed were storm drains. Of the 23 outfalls documented, four had a moderate flow and two had trickle flow. Two storm drains had flow that was discolored. One of these discharges was bright orange and stained the bank below the outfall. The other had a trickle flow with a brown color. Two other storm drains had trash in the pools below the outfall.

Two recreation sites were documented in the San Pedro Creek watershed. In reach SP2, a foot trail from the Peralta Street bridge and two rope swings over the creek were observed. Litter was also observed at this site. The second recreation site was in reach SP3 and included a foot path from a private property and a rope swing over the creek. At both sites, water depth was approximately six inches.

Four utility pipes were observed in the watershed, two in reach SP2, one in reach SP4 and one in reach SP10. Three of the pipes crossed the channel above the creek while the pipe in reach SP2 crossed at the channel bottom and was contributing to a scour pool below the pipe. The utility pipe in SP10 was corroded.

4.6.3 Reach Assessment

Table 20 presents the reach assessment scores in the San Pedro Creek watershed. Sand and gravel were the most common dominant substrate observed. However, silt was documented as dominant in the most downstream reach (SP1) and in reach SP8. SP8 is a small tributary that flows out of a culvert and it is therefore not surprising that normal sediment transport is disrupted in this reach.

Active channel dynamics were dominated by bank scour and failure, but widening and sediment deposition were also commonly documented. In SP10, active channel dynamics also included down cutting and bed scour.

**Table 20. Reach assessment scores in the San Pedro Creek watershed.**

| **Survey Reach ID:** | **SP1** | **SP2** | **SP3** | **SP4** | **SP5** | **SP6** | **SP7** | **SP8** | **SP9** | **SP10** |
|---|---|---|---|---|---|---|---|---|---|---|
| **Overall Creek Condition** | | | | | | | | | | |
| Instream Habitat | 20 | 15 | 10 | 13 | 15 | 8 | 10 | 10 | 13 | 16 |
| Vegetative Protection: Left Bank | 10 | 5 | 4 | 3 | 8 | 6 | 6 | 5 | 5 | 6 |
| Vegetative Protection: Right Bank | 10 | 6 | 4 | 5 | 8 | 6 | 7 | 6 | 6 | 6 |
| Bank Erosion: Left Bank | 10 | 10 | 6 | 2 | 10 | 5 | 4 | 3 | 5 | 4 |
| Bank Erosion: Right Bank | 10 | 10 | 6 | 4 | 10 | 5 | 5 | 7 | 6 | 5 |
| Floodplain Connection | 20 | 13 | 8 | 8 | 20 | 13 | 13 | 12 | 13 | 13 |
| **Subtotal** | **80** | **59** | **38** | **35** | **71** | **43** | **45** | **43** | **48** | **50** |
| **Overall Buffer and Floodplain Condition** | | | | | | | | | | |
| Vegetated Buffer Width: Left Bank | 10 | 6 | 4 | 3 | 8 | 7 | 6 | 7 | 6 | 7 |
| Vegetated Buffer Width: Right Bank | 9 | 5 | 2 | 6 | 8 | 7 | 8 | 9 | 6 | 8 |
| Floodplain Vegetation | 18 | 12 | 7 | 9 | 15 | 11 | 12 | 11 | 12 | 15 |
| Floodplain Habitat | 20 | 10 | 7 | 8 | 15 | 11 | 10 | 8 | 11 | 13 |
| Floodplain Encroachment | 19 | 12 | 4 | 6 | 15 | 10 | 14 | 18 | 12 | 13 |
| **Subtotal** | **76** | **45** | **24** | **32** | **61** | **46** | **50** | **53** | **47** | **56** |
| ***Total*** | ***156*** | ***104*** | ***62*** | ***67*** | ***132*** | ***89*** | ***95*** | ***96*** | ***95*** | ***106*** |

Unlike the other study watersheds, reach scores did not increase in the upstream direction in the San Pedro Creek watershed (Figure 21). This is mostly due to creek restoration work that has been performed in this watershed. In the restored reaches (primarily SP1 and SP5), reach scores were relatively high (Table 20). SP1, which was restored approximately two years ago, now has a naturally meandering channel, dense riparian vegetation, and a large diverse floodplain that is well connected to the creek channel. Instream habitat is stable and diverse, with large woody debris snags. These factors help optimize habitat for aquatic organisms. The lower part of SP2 was also at the beginning stages of a restoration project: riparian vegetation (willow spikes) had recently been planted, and soil on the left bank was secured with straw. The left bank in this section had a large floodplain that was connected to the creek. Further upstream conditions in SP2 worsened somewhat with a long stretch of the reach hardened with sackcrete. In reaches SP3 and SP4, scores reflect an increase in bank hardening, erosion, and floodplain encroachment. The channel in these reaches was entrenched and tall banks were common. Failing or undercut bank revetments were also common in these reaches.

SP5 was restored in the fall of 2005 to improve creek and riparian habitat, primarily to improve conditions for steelhead trout. A fish migration barrier at the Capistrano Drive bridge had been removed and the creek bed had been raised. In addition, instream habitat had been improved by installation of a series of rock/log weirs to create a riffle/pool and step-pool series that gradually rises in elevation. Non-native plants were removed and banks were replanted with native plant species. The creek banks were re-graded and covered with erosion control materials. All these factors contribute to the high reach scores in SP5. Given how recently the restoration work was done, riparian vegetation had not fully grown in and the habitat instream was not yet fully stable. Thus, some reach scores were sub-optimal rather than optimal. It appears likely, however, that this reach will score in the optimal range at some point in the future.

Upstream of SP5, reach scores generally fell in the marginal to sub-optimal range (Table 20). Although buffer width increased somewhat in these reaches, the channels were still entrenched and the creek banks were tall and actively eroding. At the downstream end of reach SP6 a stretch of the creek was channelized and hardened with concrete on the banks and bottom. SP7 and SP8[12] were both relatively short reaches that were characterized by steep, eroding banks (particularly the left bank). In reaches SP9 and SP10, bank hardening was mostly absent, but erosion was still common. Reach SP10 was characterized by 2-3 feet of channel incision, a very steep left bank, and sections with slope failure.

[12]SP8 is a tributary to the main stem that is culverted for the majority of its length. A small section of this tributary that is not culverted was assessed.

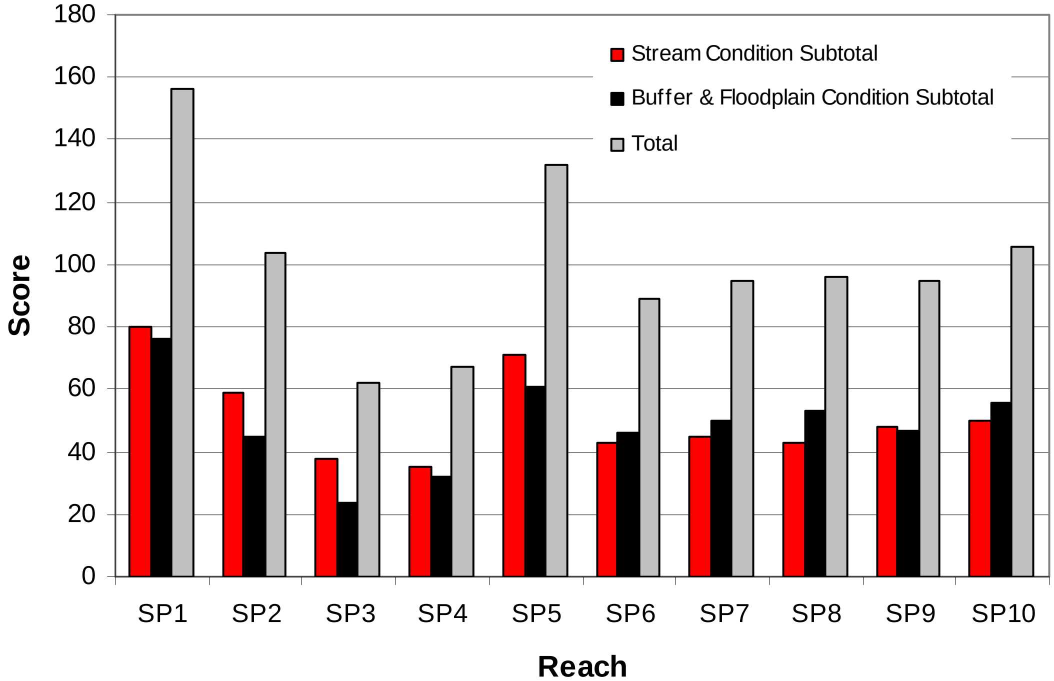



**Figure 21. Reach assessment scores in the San Pedro Creek watershed.**

## 5.0 DISCUSSION

Natural creek corridors are dynamic ecosystems. Over time, equilibrium is reached among slope, channel dimensions, discharge, and sediment load (Riley 1998). The creek channel evolves to balance the energy from the flow of water and the need to transport sediment. Under equilibrium conditions, creek banks and channel morphology are relatively stable. This equilibrium is disturbed as urbanization changes the land cover and other surface characteristics of the watershed. Urbanization increases imperviousness and diverts much of the surface drainage into storm drain systems. This results in changes in the volume and timing of water delivered to creeks, and the amount and type of material conveyed to creeks (Walsh et al. 2005). Additionally, urbanization typically reduces the width of the riparian corridor, which reduces the space in which the creek can migrate laterally.

In response to urbanization, creek channels adjust their widths, depths, gradients and meanders (Riley 1998). Typically, this will result in accelerated bank erosion, widening, and deeper channels. As channels continue to deepen, they can become entrenched and disconnected from their floodplains. As a result, the energy of the water flow concentrates within the channel, as it cannot dissipate on the floodplain. Bed erosion can destabilize creek banks by oversteepening the slope and undermining the bank toe. The combination of increased energy within the channel and reduced bank stability often leads to rapid bank erosion (Riley 1998).

The bayside study watersheds have land use patterns that are typical of urbanized watersheds in the Bay Area. In general, the upper parts of the watersheds flow through land managed as park or protected open space. As the creeks flow through the alluvial plain, the surrounding land use is primarily moderate to dense residential. Closer to the Bay, the surrounding land use is residential, light industrial, commercial and mixed.

Creek-side landowners often try to control erosion and stabilize creek banks by hardening the portion of the bank adjacent to their property. In the study creeks, such channel modification was mostly in the form of bank revetments. Often, the bank revetments were vertical walls ranging in height from about 2 to >10 feet. These bank hardening structures reflect the efforts of individual property owners to control the impact of the creek on their property only. They were not designed to maximize the overall geomorphic equilibrium of the channel and may cause upstream and downstream impacts (e.g., further erosion). While many of these channel modifications were in good condition, many were not, and failing bank revetments were commonly observed in the study watersheds. Channel incision was frequently observed to be undercutting bank revetments.

The majority of erosion observed was in the form of bank erosion and bank failure. Unlike channel modifications, there were no particular trends within watersheds with respect to erosion. Many of the creeks had relatively low proportions of their reaches exhibiting current erosion. However, many of these reaches were largely hardened and no longer subject to erosion.

The assessments were carried out during the dry season and few dry weather flows were observed. For those outfalls with discharge, few had discoloration, odor, or other indications of illicit discharge. The most important impact associated with outfall pipes was erosion (Figure 22), either immediately downstream from the outfall or head cuts perpendicular to the creek.

**Figure 22. Erosion caused or exacerbated by the presence of an outfall.**
This outfall did not appear to be a municipal storm drain but instead apparently originated from a private property.

Utilities in the study watersheds did not appear to be particularly problematic. Some utilities crossed the channel close to the creek surface. In high flows, these structures (typically pipes) could potentially trap debris. In some cases, previously buried utilities were uncovered by erosion within the channel. These observations were more of an additional indicator of other creek processes than an indication of a problem caused by the utility.

The most common type of creek crossing observed was road crossings. One of the most important impacts associated with road crossings is their potential to act as barrier to fish migration. This issue is being addressed in the San Pedro Creek watershed. In

San Mateo Creek, where there is a known population of trout (Leidy, Becker, and Harvey 2005a), there were few crossings that could act as a barrier to fish migration. Conversely, creek crossings can be beneficial by serving as grade controls. When the bottoms of creek crossings are hardened, creek bed erosion may be prevented from migrating upstream.

Most of the observed recreation sites consisted of rope swings over the creek, typically with a small path leading to the creek from a private residence. The assessed creeks provided limited opportunity for swimming because they are small, have low summer flows and few natural pools. Four recreation sites were observed in Cordilleras Creek.

Trash is deposited in creeks through several possible means including illegal dumping, littering, windborne transport and waterborne transport from upstream sources. Littering and illegal dumping were particularly problematic in areas adjacent to commercial land uses (e.g., shopping centers) or high density housing such as apartment complexes. SMCWPPP (2007b) discusses application of an additional protocol (the URTA) to further characterize selected locations in the study watersheds with relatively high levels of trash.

The impact assessments made during the USA are documented as individual problems. They may however act as interacting processes. For example, when one landowner hardens the creek bank along his/her property, the unreleased creek energy will be released at the first opportunity, causing or exacerbating downstream erosion. This domino-like effect can in turn worsen channel incision to the point that floodplains are disconnected from the creek. This affects the establishment and survival of riparian vegetation and decreases the overall integrity of the creek ecosystem. The reach assessment scores in this study capture these related interactions.

Total reach assessment scores tended to increase in the upstream direction where the watersheds were typically less urbanized, had lower percent imperviousness, and riparian corridors were less impacted. In the lower to mid reaches, scores were in the poor to marginal range. In more upstream reaches, scores tended to increase into the sub-optimal range, with a few reaches scoring in the optimal range. In each watershed surveyed, instream habitat sub-total scores were higher than the buffer and floodplain condition sub-total scores for most of the reaches. This is likely a reflection of the degree of riparian encroachment of the urban/suburban landscape.

## 6.0 RECOMMENDATIONS

Many of the creek impacts observed resulted from individual private property owners attempting to control bank instability on their properties. Education and outreach could help landowners understand the impacts of such actions on creeks and potentially lead to the use of better practices in the future. As a follow-up to this study, it is recommended that the Program explore developing a program similar to the Urban Creeks Council's (www.urbancreeks.org) Stream Management Program for Landowners (SMPL). This program is funded by the Contra Costa Clean Water Program and provides free advice about creek care to Contra Costa County property owners. Services include free site visits and consultations on creek restoration techniques and associated permitting, including addressing issues such as bank failure, erosion, and flooding. The data from this study could assist San Mateo County property owners to target and optimize creek management and restoration efforts initiated through this type of stream management program. In addition, the limited resources available for creek restoration activities could be leveraged by encouraging property owners to coordinate and collaborate with local watershed-based organizations (e.g., community groups such as the San Pedro Creek Watershed Coalition, Friends of Pulgas Creek and Friends of Cordilleras Creek).

In addition, the Program should use the creek walk data to assist with the interpretation of existing monitoring data (e.g., benthic macroinvertebrate bioassessment data) and to inform the design of future monitoring programs in the study watersheds.

## 7.0 REFERENCES

Center for Watershed Protection (CWP) 2005. *Unified Stream Assessment: A User's Manual.* Manual 10, Version 2.0, February 2005.

Federal Insurance Administration (FIA) 1977. *U.S. Department of Housing and Urban Development, Flood Insurance Study, City of San Carlos, San Mateo County, California.* September. Cited in: PWA 2000. *Bair Island Restoration and Management Plan: Existing Hydrologic Conditions Assessment.* Prepared by Philip Williams & Associates, Ltd. for H.T. Harvey & Associates. Revised June 30, 2000.

Leidy, R.A., G.S. Becker, and B.N. Harvey. 2005a. *Historical distribution and current status of steelhead/rainbow trout (Oncorhynchus mykiss) in streams of the San Francisco Estuary, California*. Center for Ecosystem Management and Restoration, Oakland, CA.

Leidy, R.A., G.S. Becker, and B.N. Harvey. 2005b. *Historical status of Coho salmon in streams of the urbanized San Francisco Estuary, California.* California Fish and Game 91(4): 219 – 254.

Riley, A. 1998. *Restoring Streams in Cities. A Guide for Planners, Policymakers, and Citizens.* Island Press, Washington D.C.

SMCWPPP 2007a. *Water Quality Screening in the Cordilleras Creek Watershed in San Mateo County, California.* Prepared by EOA, Inc. for the San Mateo Countywide Water Pollution Prevention Program. May 2007.

SMCWPPP 2007b. *Trash Assessments in Six Watersheds in San Mateo County, California.* Prepared by EOA, Inc. for the San Mateo Countywide Water Pollution Prevention Program. August 2007.

STOPPP 2002. *Characterization of Imperviousness and Creek Channel Modifications for Seventeen Watersheds in San Mateo County*. Prepared by EOA, Inc. for the San Mateo Countywide Stormwater Pollution Prevention Program. January 1, 2002.

STOPPP 2005. *Bioassessment and Water Quality Monitoring in the San Pedro Creek Watershed, San Mateo County, California.* Prepared by EOA, Inc. for the San Mateo Countywide Stormwater Pollution Prevention Program. March 2005.

Walsh, C.J., A.H. Roy, J.W. Feminella, P.D. Cottingham, P. M. Groffman, and R.P. Morgan II. 2005. *The urban stream syndrome: current knowledge and the search for a cure.* Journal of North American Benthological Society 24(3): 706-723.

*This Page Intentionally Left Blank*

# APPENDIX

| | | |
|---|---|---|
| **WATERSHED/SUBSHED:** | **DATE:** ___/_____/___ | **ASSESSED BY:** |
| **SURVEY REACH ID:** / **TIME:**___:____AM/PM | **PHOTO ID:** (*Camera-Pic #*) /# | |
| **SITE ID** (*Condition-#*): **OT-**_____ / **LAT** ___°_____'_____" **LONG** ___°_____'_____" **LMK**_____ | | **GPS:** (*Unit ID*) |

**BANK:** ☐LT ☐RT ☐ Head

**FLOW:** ☐ None ☐ Trickle ☐ Moderate ☐ Substantial ☐ Other:

| **TYPE:** | **MATERIAL:** | **SHAPE:** ☐ Single | **DIMENSIONS:** | **SUBMERGED:** |
|---|---|---|---|---|
| ☐ Closed pipe | ☐ Concrete ☐Metal ☐ PVC/Plastic ☐Brick ☐ Other: | ☐ Circular ☐ Double ☐ Elliptical ☐ Triple ☐ Other: | Diameter:_____(in) | ☐ No ☐ Partially ☐ Fully |
| ☐ Open channel | ☐ Concrete ☐ Earthen ☐ Other: | ☐ Trapezoid ☐ Parabolic ☐ Other: | Depth: _____(in) Width (Top):_____(in) " (Bottom):_____(in) | *NOT APPLICABLE* |

| **CONDITION:** | **ODOR:** ☐ NO | **DEPOSITS/STAINS:** | **VEGGIE DENSITY:** | **PIPE BENTHIC GROWTH:** ☐ None |
|---|---|---|---|---|
| ☐ None ☐ Chip/Cracked ☐ Peeling Paint ☐ Corrosion ☐ Other: | ☐Gas ☐ Sewage ☐Rancid/Sour ☐ Sulfide ☐ Other: | ☐ None ☐Oily ☐ Flow Line ☐ Paint ☐Other: | ☐ None ☐ Normal ☐ Inhibited ☐ Excessive ☐ Other: | ☐ Brown ☐ Orange ☐ Green ☐ Other: **POOL QUALITY:** ☐ No pool ☐ Good ☐Odors ☐Colors ☐Oils ☐ Suds ☐ Algae ☐ Floatables ☐ Other: |

| | | |
|---|---|---|
| ***FOR FLOWING ONLY*** | **COLOR:** | ☐ Clear ☐ Brown ☐ Grey ☐ Yellow ☐ Green ☐ Orange ☐ Red ☐ Other: |
| | **TURBIDITY:** | ☐ None ☐ Slight Cloudiness ☐ Cloudy ☐ Opaque |
| | **FLOATABLES:** | ☐ None ☐ Sewage (toilet paper, etc.) ☐ Petroleum (oil sheen) ☐ Other: |
| **OTHER CONCERNS:** | ☐ Excess Trash (paper/plastic bags) ☐ Dumping (bulk) ☐ Excessive Sedimentation ☐ Needs Regular Maintenance ☐ Bank Erosion ☐ Other: | |

**POTENTIAL RESTORATION CANDIDATE** ☐ Discharge investigation ☐ Stream daylighting ☐ Local stream repair/outfall stabilization ☐ no ☐ Storm water retrofit ☐ Other:

*If yes for daylighting:*
Length of vegetative cover from outfall: ___________ft Type of existing vegetation:_____________________ Slope: ___________°

*If yes for stormwater:*
Is stormwater currently controlled? Land Use description:________________________________
☐ Yes ☐ No ☐ Not investigated Area available:

| **OUTFALL SEVERITY:** (*circle #*) | Heavy discharge with a distinct color and/or a strong smell. The amount of discharge is significant compared to the amount of normal flow in receiving stream; discharge appears to be having a significant impact downstream. | Small discharge; flow mostly clear and odorless. If the discharge has a color and/or odor, the amount of discharge is very small compared to the stream's base flow and any impact appears to be minor / localized. | Outfall does not have dry weather discharge; staining; or appearance of causing any erosion problems. |
|---|---|---|---|
| | 5 4 | 3 2 | 1 |

**SKETCH/NOTES:**

**REPORTED TO AUTHORITIES:** ☐ YES ☐ NO

Severe Bank Erosion

# ER

| | | |
|---|---|---|
| **WATERSHED/SUBSHED:** | **DATE:** ___/_____/___ | **ASSESSED BY:** |
| **SURVEY REACH:** **TIME:**___:____AM/PM | **PHOTO ID** (CAMERA-PIC #): /# | |
| **SITE ID:** (*Condition-#*) **ER-**_____ | *START* **LAT** ____°____'____" **LONG** ____°____'____" **LMK** _____ <br> *END* **LAT** ____°____'____" **LONG** ____°____'____" **LMK** _____ | **GPS:** (*Unit ID*) |

**PROCESS:** ☐ Currently unknown

| | |
|---|---|
| ☐ Downcutting | ☐ Bed scour |
| ☐ Widening | ☐ Bank failure |
| ☐ Headcutting | ☐ Bank scour |
| ☐ Aggrading | ☐ Slope failure |
| ☐ Sed. deposition | ☐ Channelized |

**BANK OF CONCERN:** ☐ LT ☐ RT ☐ Both (*looking downstream)*

**LOCATION:** ☐ Meander bend ☐ Straight section ☐ Steep slope/valley wall ☐ Other:

**DIMENSIONS:**

| | | | | |
|---|---|---|---|---|
| Length *(if no GPS)* | LT_______ft | and/or RT_________ft | Bottom width | _______ft |
| Bank Ht | LT_______ft | and/or RT__________ft | Top width | __________ft |
| Bank Angle | LT________° | and/or RT________° | Wetted Width | _______ft |

**LAND OWNERSHIP:** ☐ Private ☐ Public ☐ Unknown

**LAND COVER:** ☐ Forest ☐ Field/Ag ☐ Developed:

**POTENTIAL RESTORATION CANDIDATE:** ☐ Grade control ☐ Bank stabilization
☐ No ☐ Other:

**THREAT TO PROPERTY/INFRASTRUCTURE:** ☐ No ☐ Yes (Describe):

**EXISTING RIPARIAN WIDTH:** ☐ ≤25 ft ☐ 25 - 50 ft ☐ 50-75ft ☐ 75-100ft ☐ >100ft

| | | | |
|---|---|---|---|
| **EROSION SEVERITY**(*circle#*) <br> Channelized= ☐ 1 | Active downcutting; tall banks on both sides of the stream eroding at a fast rate; erosion contributing significant amount of sediment to stream; obvious threat to property or infrastructure. | Pat downcutting evident, active stream widening, banks actively eroding at a moderate rate; no threat to property or infrastructure | Grade and width stable; isolated areas of bank failure/erosion; likely caused by a pipe outfall, local scour, impaired riparian vegetation or adjacent use. |
| | 5 4 | 3 2 | 1 |
| **ACCESS:** | **Good access:** Open area in public ownership, sufficient room to stockpile materials, easy stream channel access for heavy equipment using existing roads or trails. | **Fair access**: Forested or developed area adjacent to stream. Access requires tree removal or impact to landscaped areas. Stockpile areas small or distant from stream. | **Difficult access.** Must cross wetland, steep slope or other sensitive areas to access stream. Minimal stockpile areas available and/or located a great distance from stream section. Specialized heavy equipment required. |
| | 5 4 | 3 2 | 1 |

**NOTES/CROSS SECTION SKETCH:**

**REPORTED TO AUTHORITIES** ☐ YES ☐ NO

Stream Crossing

# SC

| WATERSHED/SUBSHED: | | DATE: ___/_____/___ | ASSESSED BY: |
|---|---|---|---|
| SURVEY REACH ID: | TIME:___:____AM/PM | PHOTO ID: (*Camera-Pic #*) /# | |
| SITE ID: (*Condition-#*) SC-_____ | LAT ___°_____'_____" LONG ___°_____'_____" LMK_____ | | GPS (*Unit ID*) |

**TYPE:** ☐ Road Crossing ☐ Railroad Crossing ☐ Manmade Dam ☐ Beaver Dam ☐ Geological Formation ☐ Other:

***FOR ROAD/ RAILROAD CROSSINGS ONLY***

**SHAPE:**
☐ Arch ☐ Bottomless
☐ Box ☐ Elliptical
☐ Circular
☐ Other:

**# BARRELS:**
☐ Single
☐ Double
☐ Triple
☐ Other:

**MATERIAL:**
☐ Concrete
☐ Metal
☐ Other:

**ALIGNMENT:**
☐ Flow-aligned
☐ Not flow-aligned
☐ Do not know

**DIMENSIONS:** (*if variable, sketch*)
Barrel diameter: _________(ft)
Height: _________(ft)
Culvert length: _________(ft)
Width: _________(ft)
Roadway elevation:__________(ft)

**CONDITION:** (*Evidence of…*)
☐ Cracking/chipping/corrosion ☐ Downstream scour hole
☐ Sediment deposition ☐ Failing embankment
☐ Other (*describe*):

**CULVERT SLOPE:**
☐ Flat
☐ Slight ($2^o – 5^0$)
☐ Obvious (>$5^o$)

**POTENTIAL RESTORATION CANDIDATE** ☐ Fish barrier removal ☐ Culvert repair/replacement ☐ Upstream storage retrofit
☐ no ☐ Local stream repair ☐ Other:

**IS SC ACTING AS GRADE CONTROL** ☐ No ☐ Yes ☐ Unknown

*If yes for fish barrier*

**EXTENT OF PHYSICAL BLOCKAGE:**
☐ Total ☐ Partial
☐ Temporary ☐ Unknown

**CAUSE:**
☐ Drop too high Water Drop: ______ (in)
☐ Flow too shallow Water Depth:______ (in)
☐ Other:

**BLOCKAGE SEVERITY:** (*circle #*)

| | | |
|---|---|---|
| A structure such as a dam or road culvert on a 3rd order or greater stream blocking the upstream movement of anadromous fish; no fish passage device present. | A total fish blockage on a tributary that would isolate a significant reach of stream, or partial blockage that may interfere with the migration of anadromous fish. | A temporary barrier such as a beaver dam or a blockage at the very head of a stream with very little viable fish habitat above it; natural barriers such as waterfalls. |

5 4 3 2 1

**NOTES/SKETCH:**

**REPORTED TO AUTHORITIES** ☐ YES ☐ NO

Channel Modification **CM**

| | | |
|---|---|---|
| **WATERSHED/SUBSHED:** | **DATE:** ___/_____/___ | **ASSESSED BY:** |
| **SURVEY REACH ID:** | **TIME:**___:____AM/PM | **PHOTO ID:** (*Camera-Pic #*) /# |
| **SITE ID:** (*Condition-#*) **CM-**_____ | *START* **LAT** ____°____'____" **LONG** ____°____'___" **LMK** _____<br>*END* **LAT** ____°____'____" **LONG** ____°____'___" **LMK** _____ | **GPS:** (*Unit ID*) |

**TYPE:** ☐ Channelization ☐ Bank armoring ☐ concrete channel ☐ Floodplain encroachment ☐ Other:

| **MATERIAL:** | | **DIMENSIONS:** |
|---|---|---|
| ☐ Concrete ☐ Gabion | Does channel have perennial flow? ☐ Yes ☐ No | Height ________________(ft) |
| ☐ Rip Rap ☐ Earthen | Is there evidence of sediment deposition? ☐ Yes ☐ No | Bottom Width ________________(ft) |
| ☐ Metal | Is vegetation growing in channel? ☐ Yes ☐ No | Top Width: ________________(ft) |
| ☐ Other: | Is channel connected to floodplain? ☐ Yes ☐ No | Length: ________________(ft) |

| **BASE FLOW CHANNEL** | **ADJACENT STREAM CORRIDOR** |
|---|---|
| Depth of flow _____________(in) | Available width LT_________(ft) RT________(ft) |
| Defined low flow channel? ☐ Yes ☐ No | Utilities Present? ☐ Yes ☐ No |
| % of channel bottom __________% | Fill in floodplain? ☐Yes ☐ No |

**POTENTIAL RESTORATION CANDIDATE** ☐ Structural repair ☐ Base flow channel creation ☐ Natural channel design ☐ Can't tell
☐ no ☐ De-channelization ☐ Fish barrier removal ☐ Bioengineering

| **CHANNEL-IZATION SEVERITY:** (*Circle #*) | A long section of concrete stream (>500') channel where water is very shallow (<1" deep) with no natural sediments present in the channel. | A moderate length ( > 200') ,but channel stabilized and beginning to function as a natural stream channel. Vegetated bars may have formed in channel. | An earthen channel less than 100 ft with good water depth, a natural sediment bottom, and size and shape similar to the unchannelized stream reaches above and below impacted area. |
|---|---|---|---|
| | 5 4 | 3 | 2 1 |

**NOTES:**

Trash and Debris **TR**

| | | | |
|---|---|---|---|
| **WATERSHED/SUBSHED:** | | **DATE:** ___/_____/___ | **ASSESSED BY:** |
| **SURVEY REACH ID:** | **TIME:**___:____AM/PM | **PHOTO ID:** (*Camera-Pic #*) /# | |
| **SITE ID:** (*Condition-#*) **TR-**_____ | **LAT** ___°_____'_____" **LONG** ___°_____'_____" **LMK** _____ | | **GPS:** (*Unit ID*) |

| **TYPE:** | **MATERIAL:** | **SOURCE:** | **LOCATION:** | **LAND OWNERSHIP:** |
|---|---|---|---|---|
| ☐ Industrial<br>☐ Commercial<br>☐ Residential | ☐ Plastic ☐ Paper ☐ Metal<br>☐ Tires ☐ Construction ☐ Medical<br>☐ Appliances ☐ Yard Waste<br>☐ Automotive ☐ Other: | ☐ Unknown<br>☐ Flooding<br>☐ Illegal dump<br>☐ Local outfall | ☐ Stream<br>☐ Riparian Area<br>☐ Lt bank<br>☐ Rt bank | ☐ Public ☐ Unknown<br>☐ Private<br>**AMOUNT** (*# Pickup truck loads*): |

**POTENTIAL RESTORATION CANDIDATE** ☐ Stream cleanup ☐ Stream adoption segment ☐ Removal/prevention of dumping
☐ no ☐ Other:

| | | |
|---|---|---|
| *If yes for trash or debris removal* | **EQUIPMENT NEEDED :** ☐ Heavy equipment ☐ Trash bags ☐ Unknown | **DUMPSTER WITHIN 100 FT:**<br>☐ Yes ☐ No ☐ Unknown |
| | **WHO CAN DO IT:** ☐ Volunteers ☐ Local Gov ☐ Hazmat Team ☐ Other | |

| **CLEAN-UP POTENTIAL:** (*Circle #*) | A small amount of trash (i.e., less than two pickup truck loads) located inside a park with easy access | A large amount of trash, or bulk items, in a small area with easy access. Trash may have been dumped over a long period of time but it could be cleaned up in a few days, possibly with a small backhoe. | A large amount of trash or debris scattered over a large area, where access is very difficult. Or presence of drums or indications of hazardous materials |
|---|---|---|---|
| | 5 | 4 3 | 2 1 |

**NOTES:**

**REPORTED TO AUTHORITIES** ☐ YES ☐ NO

Utility Impacts **UT**

| | | |
|---|---|---|
| **WATERSHED/SUBSHED:** | **DATE:** ___/_____/___ | **ASSESSED BY:** |
| **SURVEY REACH ID:** | **TIME:**___:____AM/PM | **PHOTO ID:** (*Camera-Pic #*) /# |
| **SITE ID:** (*Condition-#*) **UT-**_____ | **LAT**___°_____'_____" **LONG** ___°_____'_____" **LMK:** _____ | **GPS:** (*Unit ID*) |

| **TYPE:** | **MATERIAL:** | **LOCATION:** | **POTENTIAL FISH BARRIER:** | **PIPE DIMENSIONS:** |
|---|---|---|---|---|
| ☐ Leaking sewer<br>☐ Exposed pipe<br>☐ Exposed manhole<br>☐ Other: | ☐ Concrete<br>☐ Corrugated metal<br>☐ Smooth metal<br>☐ PVC<br>☐ Other: | ☐ Floodplain<br>☐ Stream bank<br>☐ Above stream<br>☐ Stream bottom<br>☐ Other: | ☐ Yes ☐ No<br><br>**CONDITION:** ☐ Joint failure ☐ Pipe corrosion/cracking<br>☐ Protective covering broken ☐ Manhole cover absent<br>☐ Other: | Diameter: _____in<br>Length exposed: _____ft |

| **EVIDENCE OF DISCHARGE:** | | |
|---|---|---|
| | **COLOR** | ☐ None ☐ Clear ☐ Dark Brown ☐ Lt Brown ☐ Yellowish ☐ Greenish ☐ Other: |
| | **ODOR** | ☐ None ☐ Sewage ☐ Oily ☐ Sulfide ☐ Chlorine ☐ Other: |
| | **DEPOSITS** | ☐ None ☐ Tampons/Toilet Paper ☐ Lime ☐ Surface oils ☐ Stains ☐ Other: |

**POTENTIAL RESTORATION CANDIDATE** ☐ Structural repairs ☐ Pipe testing ☐ Citizen hotlines ☐ Dry weather sampling
☐ no ☐ Fish barrier removal ☐ Other:

*If yes to fish barrier,* Water Drop: ________ (in)

| **UTILITY IMPACT SEVERITY:** (*Circle #*) | | | |
|---|---|---|---|
| | Section of pipe undermined by erosion and could collapse in the near future; a pipe running across the bed or suspended above the stream; a long section along the edge of the stream where nearly the entire side of the pipe is exposed; or a manhole stack that is located in the center of the stream channel and there is evidence of stack failure. | A moderately long section of pipe is partially exposed but there is no immediate threat that the pipe will be undermined and break in the immediate future. The primary concern is that the pipe may be punctured by large debris during a large storm event. | Small section of exposed pipe, stream bank near the pipe is stable; the pipe is across the bottom of the stream but only a small portion of the top of the pipe exposed; the pipe is exposed but is reinforced with concrete and it is not causing a blockage to upstream fish movement; a manhole stack that is at the edge of the stream and does not extend very far out into the active stream channel. |
| Leaking= ☐ 5 | 5 | 4 3 | 2 1 |

**NOTES:**

**REPORTED TO LOCAL AUTHORITIES** ☐ Yes ☐ No

Miscellaneous **MI**

| | | |
|---|---|---|
| **WATERSHED/SUBSHED:** | **DATE:** ___/_____/___ | **ASSESSED BY:** |
| **SURVEY REACH ID:** | **TIME:**___:____AM/PM | **PHOTO ID:** (*Camera-Pic #*) /# |
| **SITE ID:** (*Condition-#*) **MI-**_____ | **LAT**___°_____'_____" **LONG** ___°_____'_____" **LMK:** _____ | **GPS:** (*Unit ID*) |

**POTENTIAL RESTORATION CANDIDATE** ☐ Storm water retrofit ☐ Stream restoration ☐ Riparian Management
☐ no ☐ Discharge Prevention ☐ Other:

**DESCRIBE:**

**REPORTED TO LOCAL AUTHORITIES** ☐ Yes ☐ No

| | | |
|---|---|---|
| **WATERSHED/SUBSHED:** | **DATE:** ___/_____/___ | **ASSESSED BY:** |
| **SURVEY REACH ID:** | **TIME:**___:____AM/PM | **PHOTO ID:** (*Camera-Pic #*) /# |
| **SITE ID:** (*Condition-#*) **MI-**_____ | **LAT**___°_____'_____" **LONG** ___°_____'_____" **LMK:** _____ | **GPS:** (*Unit ID*) |

**POTENTIAL RESTORATION CANDIDATE** ☐ Storm water retrofit ☐ Stream restoration ☐ Riparian Management
☐ no ☐ Discharge Prevention ☐ Other:

**DESCRIBE:**

**REPORTED TO LOCAL AUTHORITIES** ☐ Yes ☐ No

| | | |
|---|---|---|
| **WATERSHED/SUBSHED:** | **DATE:** ___/_____/___ | **ASSESSED BY:** |
| **SURVEY REACH ID:** | **TIME:**___:____AM/PM | **PHOTO ID:** (*Camera-Pic #*) /# |
| **SITE ID:** (*Condition-#*) **MI-**_____ | **LAT**___°_____'_____" **LONG** ___°_____'_____" **LMK:** _____ | **GPS:** (*Unit ID*) |

**POTENTIAL RESTORATION CANDIDATE** ☐ Storm water retrofit ☐ Stream restoration ☐ Riparian Management
☐ no ☐ Discharge Prevention ☐ Other:

**DESCRIBE:**

**REPORTED TO LOCAL AUTHORITIES** ☐ Yes ☐ No

Reach Level Assessment

# RCH

| **SURVEY REACH ID:** ______ | **WTRSHD/SUBSHD:** | **DATE:** ___/_____/___ | **ASSESSED BY:** |
|---|---|---|---|

| | | |
|---|---|---|
| *START* **TIME:**____:____AM/PM **LMK:** ______<br>**LAT**____°______'______" **LONG** ____°______'______"<br>**DESCRIPTION:** | *END* **TIME:**____:____AM/PM **LMK:** ______<br>**LAT**____°______'______" **LONG** ____°______'______"<br>**DESCRIPTION:** | **GPS ID:** |

**RAIN IN LAST 24 HOURS** ☐ Heavy rain ☐ Steady rain ☐ None ☐ Intermittent ☐ Trace

**PRESENT CONDITIONS** ☐ Heavy rain ☐ Steady rain ☐ Intermittent ☐ Clear ☐ Trace ☐ Overcast ☐ Partly cloudy

**SURROUNDING LAND USE:** ☐ Industrial ☐ Commercial ☐ Urban/Residential ☐ Suburban/Res ☐ Forested ☐ Institutional ☐ Golf course ☐ Park ☐ Crop ☐ Pasture ☐ Other:

## AVERAGE CONDITIONS *(check applicable)*

**BASE FLOW AS % CHANNEL WIDTH** ☐ 0-25% ☐ 50%-75% ☐25-50 % ☐ 75-100%

**DOMINANT SUBSTRATE**
☐ Silt/clay (fine or slick) ☐ Cobble (2.5 –10")
☐ Sand (gritty) ☐ Boulder (>10")
☐ Gravel (0.1-2.5") ☐ Bed rock

**WATER CLARITY** ☐ Clear ☐Turbid *(suspended matter)*
☐ Stained *(clear, naturally colored)* ☐ Opaque *(milky)*
☐ Other *(chemicals, dyes)*

**AQUATIC PLANTS IN STREAM** Attached: ☐ none ☐ some ☐ lots
Floating: ☐ none ☐ some ☐ lots

**WILDLIFE IN OR AROUND STREAM** (Evidence of)
☐ Fish ☐ Beaver ☐ Deer
☐ Snails ☐ Other:

**STREAM SHADING** (water surface)
☐ Mostly shaded (≥75% coverage)
☐ Halfway (≥50%)
☐ Partially shaded (≥25% )
☐ Unshaded (< 25%)

**CHANNEL DYNAMICS**
☐ Downcutting ☐ Bed scour
☐ Widening ☐ Bank failure
☐ Headcutting ☐ Bank scour
☐ Aggrading ☐ Slope failure
☐ Sed. deposition ☐ Channelized
☐ Unknown

**CHANNEL DIMENSIONS** *(FACING DOWNSTREAM)*
Height: LT bank ____________(ft)
RT bank ____________(ft)
Width: Bottom ____________(ft)
Top ____________(ft)

### REACH ACCESSIBILITY

| **Good:** Open area in public ownership, sufficient room to stockpile materials, easy stream channel access for heavy equipment using existing roads or trails. | **Fair**: Forested or developed area adjacent to stream. Access requires tree removal or impact to landscaped areas. Stockpile areas small or distant from stream. | **Difficult.** Must cross wetland, steep slope, or sensitive areas to get to stream. Few areas to stockpile available and/or located a great distance from stream. Specialized heavy equipment required. |
|---|---|---|

5 4 3 2 1

## REACH SKETCH AND SITE IMPACT TRACKING

*Simple planar sketch of survey reach. Track locations and IDs for all site impacts within the survey reach (OT, ER, IB,SC, UT, TR, MI) as well as any additional features deemed appropriate. Indicate direction of flow*

**NOTES:** *(biggest problem you see in survey reach)*

**REPORTED TO AUTHORITIES** ☐ YES ☐ NO

| | | | | |
|---|---|---|---|---|
| **OVERALL STREAM CONDITION** | | | | |
| | **Optimal** | **Suboptimal** | **Marginal** | **Poor** |
| **IN-STREAM HABITAT**<br>*(May modify criteria based on appropriate habitat regime)* | Greater than 70% of substrate favorable for epifaunal colonization and fish cover; mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are not new fall and not transient). | 40-70% mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of newfall, but not yet prepared for colonization (may rate at high end of scale). | 20-40% mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed. | Less than 20% stable habitat; lack of habitat is obvious; substrate unstable or lacking. |
| | 20 19 18 17 16 | 15 14 13 12 11 | 10 9 8 7 6 | 5 4 3 2 1 0 |
| **VEGETATIVE PROTECTION**<br>*(score each bank, determine sides by facing downstream)* | More than 90% of the streambank surfaces and immediate riparian zone covered by native vegetation, including trees, understory shrubs, or nonwoody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally. | 70-90% of the streambank surfaces covered by native vegetation, but one class of plants is not well-represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining. | 50-70% of the streambank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining. | Less than 50% of the streambank surfaces covered by vegetation; disruption of streambank vegetation is very high; vegetation has been removed to 5 centimeters or less in average stubble height. |
| | Left Bank 10 9 | 8 7 6 | 5 4 3 | 2 1 0 |
| | Right Bank 10 9 | 8 7 6 | 5 4 3 | 2 1 0 |
| **BANK EROSION**<br>**(**facing downstream) | Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. <5% of bank affected. | Grade and width stable; isolated areas of bank failure/erosion; likely caused by a pipe outfall, local scour, impaired riparian vegetation or adjacent use. | Past downcutting evident, active stream widening, banks actively eroding at a moderate rate; no threat to property or infrastructure | Active downcutting; tall banks on both sides of the stream eroding at a fast rate; erosion contributing significant amount of sediment to stream; obvious threat to property or infrastructure. |
| | Left Bank 10 9 | 8 7 6 | 5 4 3 | 2 1 0 |
| | Right Bank 10 9 | 8 7 6 | 5 4 3 | 2 1 0 |
| **FLOODPLAIN CONNECTION** | High flows (greater than bankfull) able to enter floodplain. Stream not deeply entrenched. | High flows (greater than bankfull) able to enter floodplain. Stream not deeply entrenched. | High flows (greater than bankfull) **not** able to enter floodplain. Stream deeply entrenched. | High flows (greater than bankfull) **not** able to enter floodplain. Stream deeply entrenched. |
| | 20 19 18 17 16 | 15 14 13 12 11 | 10 9 8 7 6 | 5 4 3 2 1 0 |
| **OVERALL BUFFER AND FLOODPLAIN CONDITION** | | | | |
| | **Optimal** | **Suboptimal** | **Marginal** | **Poor** |
| **VEGETATED BUFFER WIDTH** | Width of buffer zone >50 feet; human activities (i.e., parking lots, roadbeds, clear-cuts, lawns, crops) have not impacted zone. | Width of buffer zone 25-50 feet; human activities have impacted zone only minimally. | Width of buffer zone 10-25 feet; human activities have impacted zone a great deal. | Width of buffer zone <10 feet: little or no riparian vegetation due to human activities. |
| | Left Bank 10 9 | 8 7 6 | 5 4 3 | 2 1 0 |
| | Right Bank 10 9 | 8 7 6 | 5 4 3 | 2 1 0 |
| **FLOODPLAIN VEGETATION** | Predominant floodplain vegetation type is mature forest | Predominant floodplain vegetation type is young forest | Predominant floodplain vegetation type is shrub or old field | Predominant floodplain vegetation type is turf or crop land |
| | 20 19 18 17 16 | 15 14 13 12 11 | 10 9 8 7 6 | 5 4 3 2 1 0 |
| **FLOODPLAIN HABITAT** | Even mix of wetland and non-wetland habitats, evidence of standing/ponded water | Even mix of wetland and non-wetland habitats, no evidence of standing/ponded water | Either all wetland or all non-wetland habitat, evidence of standing/ponded water | Either all wetland or all non-wetland habitat, no evidence of standing/ponded water |
| | 20 19 18 17 16 | 15 14 13 12 11 | 10 9 8 7 6 | 5 4 3 2 1 0 |
| **FLOODPLAIN ENCROACH-MENT** | No evidence of floodplain encroachment in the form of fill material, land development, or manmade structures | Minor floodplain encroachment in the form of fill material, land development, or manmade structures, but not effecting floodplain function | Moderate floodplain encroachment in the form of filling, land development, or manmade structures, some effect on floodplain function | Significant floodplain encroachment (i.e. fill material, land development, or man-made structures). Significant effect on floodplain function |
| | 20 19 18 17 16 | 15 14 13 12 11 | 10 9 8 7 6 | 5 4 3 2 1 0 |

**Sub Total** In-stream: _____ **/80** + Buffer/Floodplain: _____ **/80** = **Total** Survey Reach _____ **/160**

***This Page Intentionally Left Blank***