Rose Creek Watershed Opportunities Assessment
HYDROLOGIC MODIFICATIONS
TECHNICAL MEMORANDUM

Prepared For:
San Diego Earthworks

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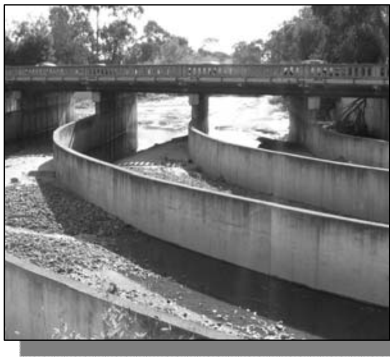
Date:
April 27, 2005



1 Introduction and Overview

A hydrologic modification is the alteration of the natural circulation or distribution of water by the placement of structures or other activities (USEPA, 1992). Hydrologic modifications are typically human modifications to the surface water hydrology (e.g. dams, stream channelization, culverts, roads, roofs, and urban development storm drains) and are typically categorized into three categories: dams; channelization and channel modifications; and streambank and shoreline erosion. These modifications can adversely impact the hydrology and quality of surface waters and aquatic and riparian habitats in a variety of ways.

Understanding the current extents of hydrologic modifications and related issues within the Rose Creek Watershed (RCW), as well as their root causes is a critical step along the path to restoration and enhancement of the watershed's riparian and aquatic resources. This technical memorandum explores the relationship of land development and changed hydrologic conditions to visible channel down-cutting and stream bank erosion. This relationship is explored by assessing aerial photographs of different time periods to identify visible changes in the stream channels, such as re-alignment or bank erosion. To understand how these visible changes related to land development a series of time periods were reviewed to allow the changes to be tracked over time and compared to the extents and timing of land development within the upstream portions of the watershed. Aerial photographs from 1928, 1945, 1953, 1966, 1977, 1989, 2000, and 2004 were utilized in this assessment. The scope of the assessment was limited to the land area effectively west of Marine Corps Air Station (MCAS) Miramar as consistent coverage of the MCAS Miramar area does not exist within several of the older sets of aerial photography. The use of this focus area is also supported by the fact the overwhelming majority of hydrologic modifications and land development has occurred within this footprint and much of MCAS Miramar is maintained in relatively natural conditions.

The extent of land development and visible physical disturbance has been reviewed in more detail within two key historic time frames. The first relates to understanding the extent of land development and hydrologic modifications during the development of the Federal Emergency Management Agency (FEMA) floodplain mapping based on hydrologic and hydraulic modeling completed in 1970 and 1978. The maps, often referred to as Flood Insurance Rate Maps (FIRM) are currently used by insurance providers to determine whether a property is required to maintain flood insurance, which is dependant on whether or not the property is within the 100-year floodplain. The second relates to understanding the extents of land development and hydrologic modifications during the development of the 1986 Watershed Erosion / Sedimentation Study –

Rose and San Clemente Canyons conducted by Woodward-Clyde for the City of San Diego that identified and described a series of problematic erosion areas and potential treatments to correct the problems. Within both of these assessments the primary goal of this analysis is to determine the degree to which today's land development and hydrologic condition differ from when the studies were completed. This understanding is important in ascertaining the relevance and accuracy of the information and recommendations contained within these important documents, as well as the recommendations that the final Assessment may make.

With an informed understanding of historic hydrologic modifications and their relationship to current conditions, the focus shifts to the identification and discussion of erosion and sedimentation issues in existence today. The focus of this discussion is on the identification of the root causes of these chronic problems and what some programmatic long-term solutions might be. More immediate solutions are also looked at where the existing issues appear to be acute and posing direct risks to high investment infrastructure or important watershed resources.

1.1 Relationship between Hydrology and Land Development

When assessing hydrologic modifications and related issues of erosion and sedimentation at a watershed-scale you need to begin by understand the degree to which the natural hydrology has been modified by land development and channel or floodplain modification projects.

As the lands within a watershed are converted from native vegetation communities to various types of developed land uses (e.g. transportation networks, commercial areas, and residential developments) the ability of the land surface to absorb rainfall is modified causing higher rates of runoff to occur. These increases in storm water runoff, which includes dissolved and suspended pollutant loads, are often focused into street gutters, roadside ditches, and storm drainpipes to be conveyed and discharged into a canyon, tributary drainage, or main channel and thereby modifying the runoff volume and velocity typically experienced under natural conditions.

Figure 1: Eroding streambank and bed in Lakehurst channel

The natural environment is forced to respond to these new forces in an effort to reach an adjusted state of dynamic equilibrium. Adjustments often appear as the formation of stream channels in canyon bottoms that did not previously have them or the enlargement of an existing stream's cross-sectional area via streambed down-cutting or stream bank erosion. As more natural land area is converted to developed land uses the volume and rate of runoff typically continues to increase, which in turn causes the natural drainage system to continue to adjust. The drainage network will continue to try and adjust to a new equilibrium by incising channels deeper or widening them until the sediment transport capacity of the 2-year bank full event reaches a point of dynamic equilibrium, which is when the sediment input to the system approximately equals the sediment being transported through the system. Figure 1 depicts the stream channel within Lakehurst Canyon that is still trying to reach a new point of dynamic equilibrium by eroding its banks.

An additional effect often associated with the increases in runoff is more frequent downstream flooding. This effect results because the volume of runoff that used to be generated by a large storm event may be being generated by a much smaller storm event due to the amount of developed land occurring within a watershed. If public infrastructure, private development, or other valuable resources are being damaged by these floods, then a typical response is to design and implement a flood control project that often includes channel 'improvements' to increase to the volume of water that can be conveyed through a channel system during a given period of time. These improvements have often included the removal of natural vegetation, the addition of rock revetment to prevent stream bank erosion, or the introduction of concrete lining on the streambeds and banks. These channel improvements may reduce the flood risk within a particular area, but may also cause additional erosion/sedimentation or flooding issues downstream as more water is flowing faster than before the improvement were implemented.

1.2 Timeline of Land Development

Based on the interrelationships between land development and hydrologic modifications to erosion, sedimentation and flooding a timeline of land development within the Rose Creek Watershed was researched through aerial photograph interpretation and GIS comparisons.

1.2.1Status of Land Development in 1928

The aerial photography from 1928 is the first comprehensive documentation of land development within the RCW (Figure 2). As can be seen within the imagery land development was predominantly limited to initial homesteading of Pacific Beach to the north of Mission Bay, a few pockets of development along within the lower canyon, and the Elvira train station just to the south of Gilman Drive.

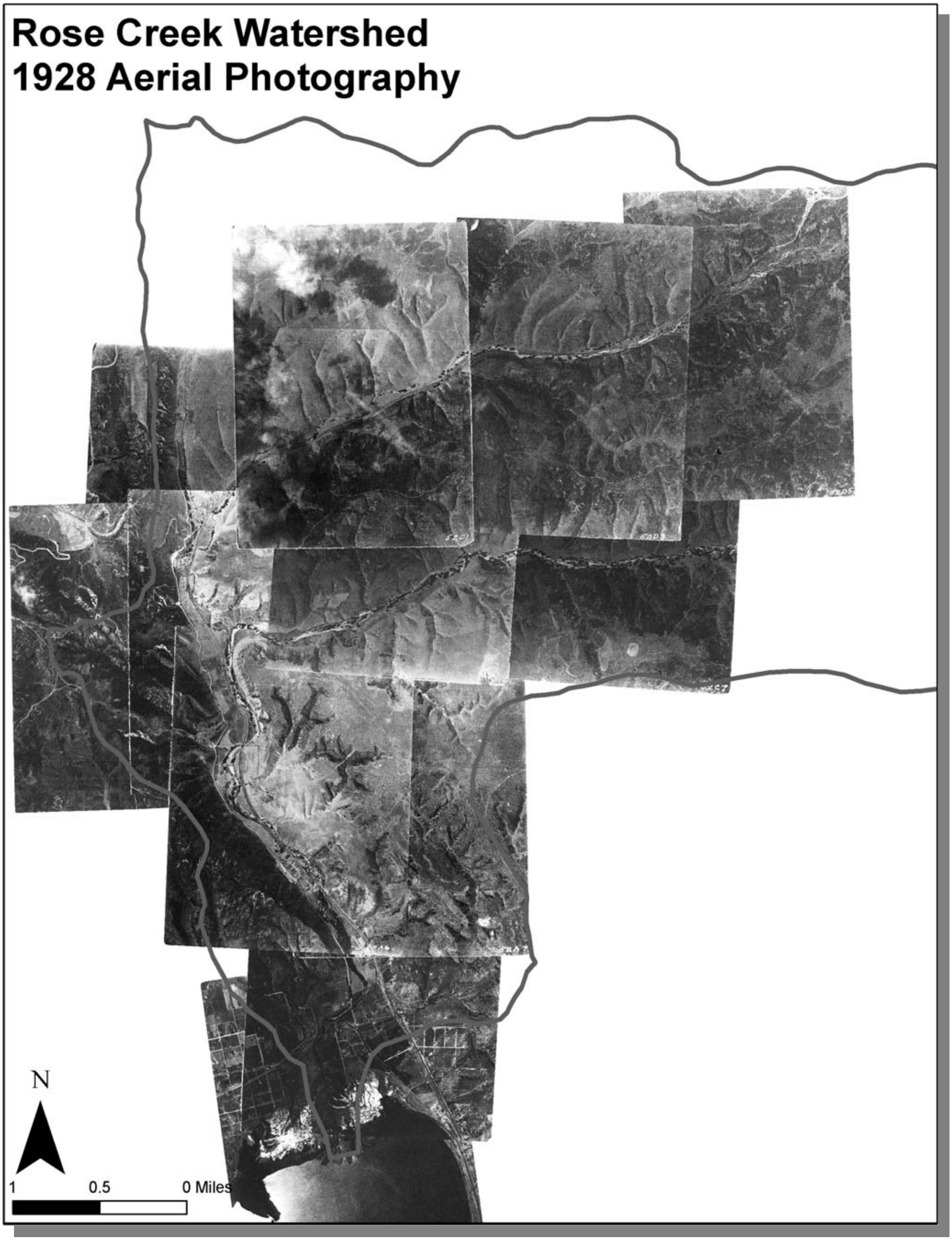


Figure 2: 1928 Aerial photography of the Rose Creek Watershed

The most notable form of development present in 1928 is the rail line, which runs essentially in its current alignment from the bottom of the watershed through lower Rose Canyon until it turns east into upper Rose Canyon where it departs from today's alignment along the northern edge of the canyon to run along the southern edge of the canyon where the multi-purpose trail/maintenance road exists today. Beyond the rail line, a few other roads are identifiable in the mid-section of the watershed: Torrey Pines Road, La Jolla Scenic Drive, historic Ardath Road, El Camino Real, which became Gilman Drive and Interstate 5, and Soledad Road near the peak of Mount Soledad. Additionally, the original discharge point and stream alignment of Stevenson Canyon can be seen entering Mission Bay in the northeast corner.

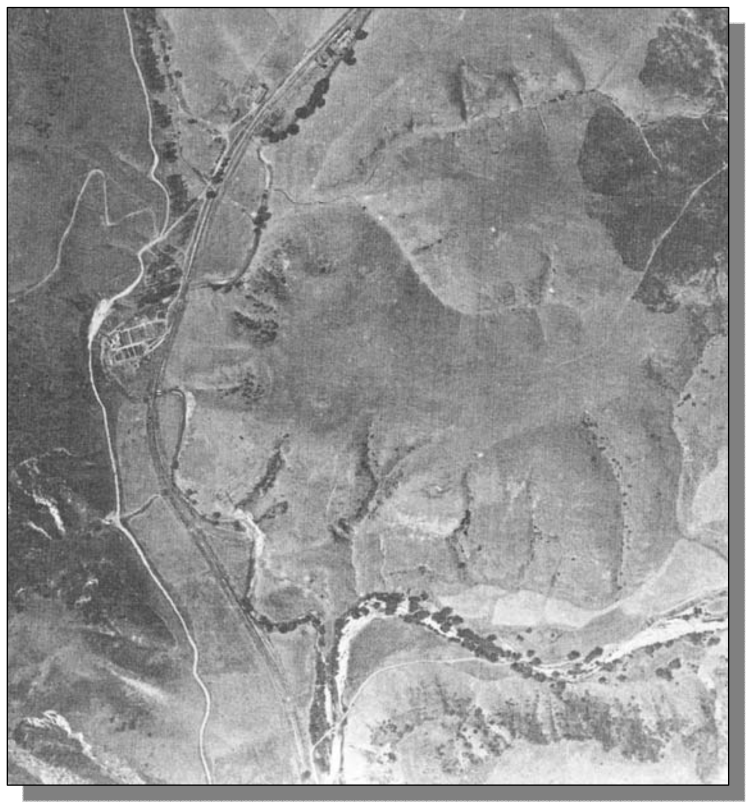


Figure 3: 1928 Aerial photography- detail of confluence region with original channel alignments

Four key hydrologic characteristics are evident from the aerial photographs. First, the pre-development landscape character of the watershed is discernable (Figure 3): pre-dominantly sparse scrub and grasslands on the mesa tops, denser scrub and pockets of oaks on the canyon slopes, and sparse riparian woodland and scrub along the primary drainages. Second, the original stream network was very dense with tributary streams branching off from the main drainages every quarter mile or so (Figure 3). Many of these tributaries were small non-branching drainages with catchment areas of 250 to 500 acres. Some of the larger tributaries developed more dendritic stream patterns as the catchment area increased above 500 acres. These larger tributaries also depict a significantly higher degree of sinuosity than the smaller tributaries (Figure 3). Third, the original channel alignments of the main creeks are evident providing the ability to assess the hydraulic and geomorphic characteristics of the system prior to major modifications being introduced (Figure 3). Lastly, the original dynamic nature of the estuary at the mouth of Rose Creek is discernable by the broad fluvial plain whose pattern indicate that storm flows could migrate the main channel over 60 degrees from east to west depending on how accumulated sediments from smaller storm events influence flow direction and velocity (Figure 4).

Figure 4: 1928 Aerial photography- detail of the mouth of Rose Creek showing historic flood delta

Figure 5: 1945 Aerial photography of the Rose Creek Watershed

1.2.2 Status of Land Development in 1945

The 1945 aerial photography depict a substantially different land development and hydrologic alteration perspective (Figure 5). The residential development within Pacific Beach has expanded significantly during the intervening 17 years and the initial development of the University area has begun in the northwest portion of the watershed. The remainder of the watershed is still essentially undeveloped. Land disturbance to develop pastures for grazing is also visible within some of the floodplain areas.

Two major transportation system improvements are the other most noticeable changes. Significant road improvements have been made within the El Camino Real / Coast Highway 101 corridor. Additionally, the rail line is in the process of relocating from the south edge of Rose Canyon to the north edge. The first major re-alignment of the Rose Creek channel is also evident (Figure 6), apparently as part of the Coast Highway 101 improvement project. A portion of the 250 foot long curved concrete stream bank designed to re-direct Rose Creek to the south is still in place today. The other significant hydrologic alteration is the apparent confinement of Rose Creek to a single channel alignment as it enters Mission Bay as evidenced by the extension of the sediment delta due south. The channelization of this lower reach also allowed the 'reclamation' of land for development in the western portion of the historic flood delta (Figure 7).

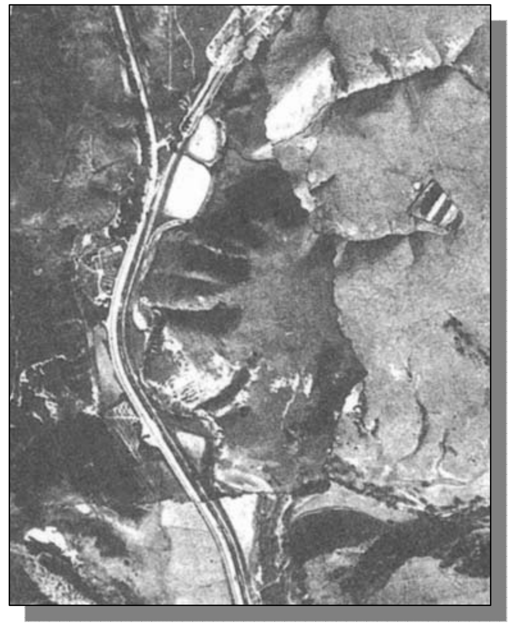


Figure 6: Rose Creek channel re-alignment along Coast Highway 101 and Railroad tracks

Figure 7: Lower Rose Creek is channelized to Mission Bay and land reclamation for development has begun

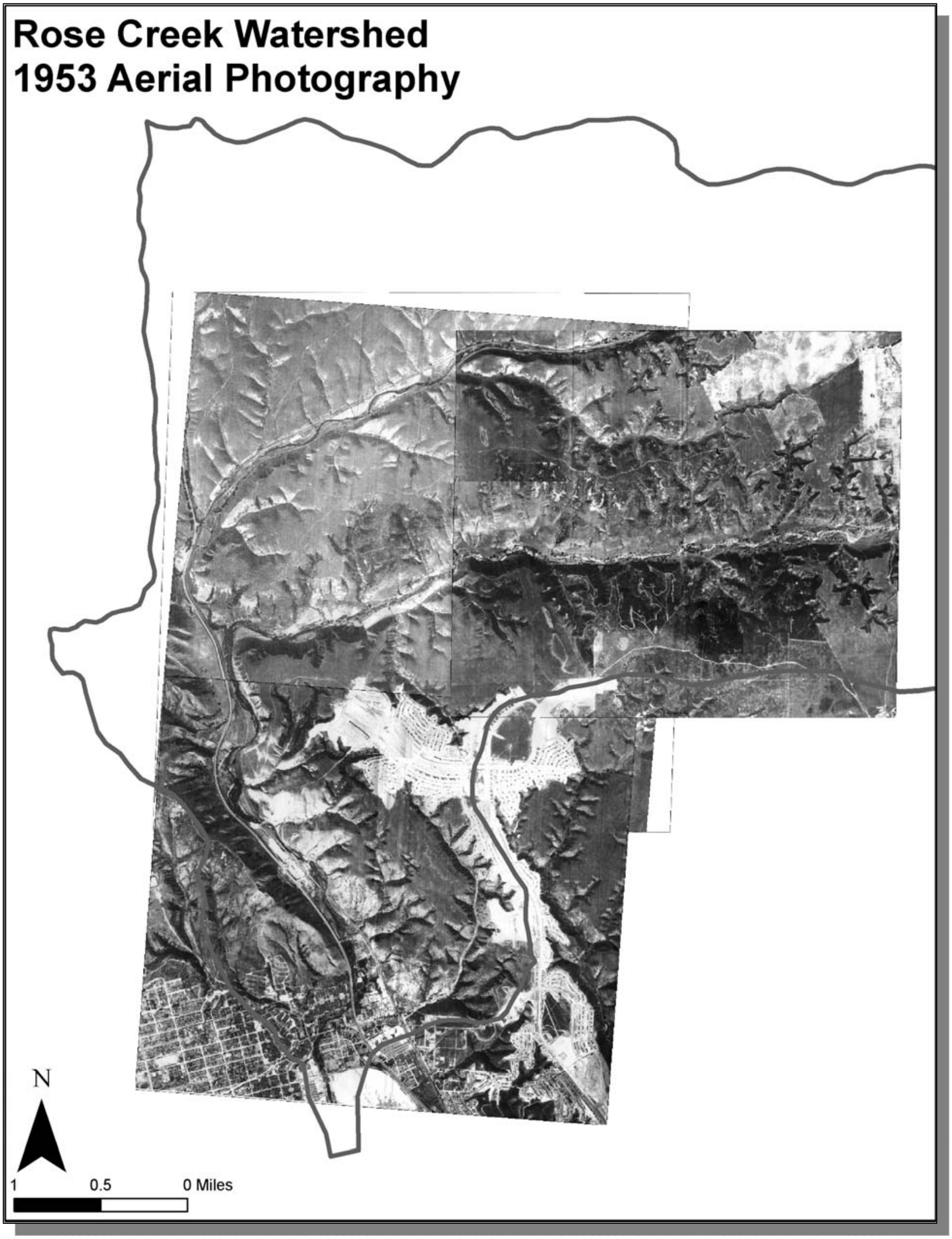


Figure 8: 1953 Aerial photography of the Rose Creek Watershed

1.2.3Status of Land Development in 1953

The 1953 aerial photography clearly depicts the initial development efforts along Clairemont Drive and Clairemont Mesa Blvd, including the Clairemont Square area (Figure 8). Residential and commercial development continues to intensify within the Pacific Beach community. This development includes additional encroachment along the creek corridor between Coast Highway 101 and Grand Avenue, as well as additional marshland reclamation for the development of what today is Mission Bay High School and the formation of De Anza point and cove.

Figure 9: Sewer main being constructed in Stevenson Canyon

The construction of the sewer main through Stevenson canyon (Figure 9) is also visible, as is the apparent disconnection of the drainage from Stevenson canyon to Mission Bay, presumably re-directing it through underground pipes to Rose Creek near Garnet Avenue and Mission Bay Drive. The railroad's re-alignment to the northern edge of Rose canyon also appears to be complete. The vast majority of land draining to upper Rose and San Clemente canyons appears to still be relatively undisturbed by human developments.

1.2.4Status of Land Development in 1966

By 1966, aerial photography no longer depict a relatively pristine watershed, but instead one that has undergone substantial land development and associated hydrologic alterations (Figure 10). By this point in time the community of Pacific Beach has expanded to occupy much of its present day developed area, including the southern slopes of Mount Soledad. The community of Clairemont has been substantially developed on the mesa tops to the south of San Clemente Canyon and along both sides of Stevenson Canyon. A substantial portion of the residential development with the community of University City along Governor Drive between present day Interstate 805 and Interstate 5 has also been developed. The expansion of development within these areas essentially established by 1966 the hydrologic and land development conditions present today within the San Clemente Canyon area.

Figure 10: 1966 Aerial photography of the Rose creek Watershed

Some additional infill development has continued to occur, but more than 80 percent appears to be in place. Additional development in the La Jolla Colony area is also evident along the western edge of the watershed. These developments have filled many tributary canyons to construct roads or residences and have turned the natural drainage network into an interconnected system of surface gutters, brow ditches, and underground storm drain pipes that are designed to efficiently collect and move runoff off of the developed areas and into the natural creek system for conveyance to Mission Bay and the Pacific Ocean.

The conversion of the Coast Highway 101 into Interstate 5 and its re-alignment through the University Towne Centre area is apparent as are the construction of the interchange with State Route 52 and the re-alignment of Ardath Road to its current configuration (Figure 10). Additionally, both Regents Road and Genesee Avenue have been constructed across San Clemente Creek creating constriction points for storm flows and disrupting the floodplain. The expansion of Interstate 5, construction of the State Route 52 interchange, and development along Morena Blvd have required significant re-alignment of the confluence of the two creeks and the lower reaches of the creek, as well as the construction of the concrete trapezoidal channel between Santa Fe Ave and Morena Blvd (Figure 11).

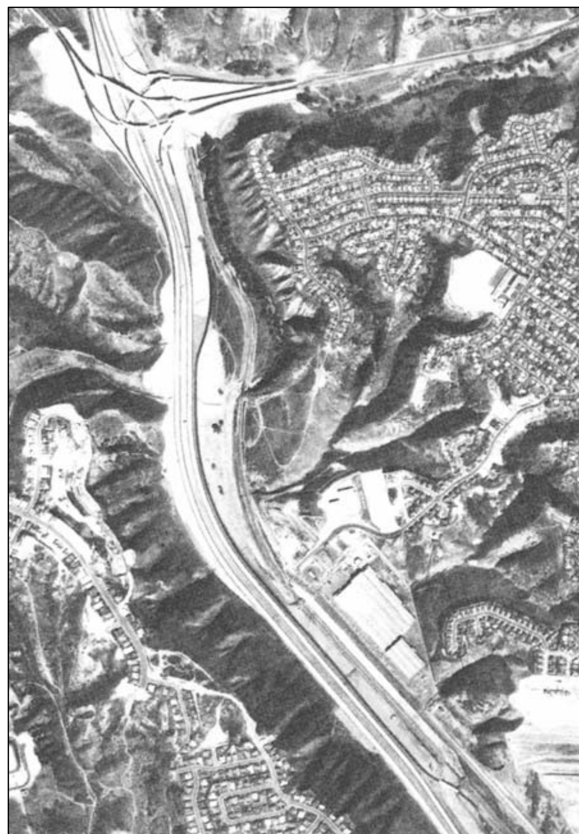


Figure 11: Re-alignment of confluence of Rose and San Clemente Creeks and construction of concrete trapezoidal channel

In addition to this completely concrete channel, significant lengths of revetment (large rock) have been installed along the re-aligned portions of Rose Creek through the lower canyon and from Interstate 5 to Mission Bay. The historic flood delta at the mouth of Rose Creek has been almost completely developed and the creek channel re-configured to its present day form. Improvements within Mission Bay, such as the construction of Fiesta Island and the mobile home park development on De Anza point have also occurred.

Figure 12: 1977 Aerial photography of the Rose Creek Watershed

1.2.5Status of Land Development in 1977

The 1977 aerial photography shows continued expansion of land development on the slopes of Mount Soledad, as well as essentially build-out conditions for the community of Clairemont to the south of San Clemente Canyon and the portion of the community of University City between Rose and San Clemente canyons. Initial development of the north slopes of Rose Canyon is underway, as is the construction of University Towne Centre shopping mall. The construction of Campland by the Bay at Mission Bay can also be identified (Figure 12).

Figure 13: Genesee Ave crosses Rose Creek

State Route 52 is complete between Interstate 5 and the newly constructed Interstate 805. The construction of Interstate 805 create two additional stretches of improved channel comprised of riprap stream banks to effectively confine flows to narrow channels under the road system effectively disrupting the floodplain and creating additional constriction points for storm flows. Genesee Ave has also been extended across Rose Canyon creating another point of constriction and floodplain disruption (Figure 13). The Genesee Ave crossing was also the first to utilize culverts to pass stream flows through the constructed embankment created to support the road, instead of constructing a bridge structure with armored channels. Also visible within the photography is the constructed alignment of the two Rose Canyon sewer mains that run parallel to each through the canyon from Interstate 5 to Genesee Ave and then split, with one heading northward into the new development within the University Towne Centre area and the other continuing along the creek toward MCAS Miramar. These sewer mains were constructed to the north of the old railroad alignment and cross under Rose Creek in several locations. The newly constructed United State Army Corps of Engineers (USACE) concrete box channel between Interstate 5 and Mission Bay Drive is also visible, as are the additional stream bank improvement (riprap) from Mission Bay Drive to below Grand Ave (Figure 14).

Figure 14: Recently constructed USACE concrete box channel

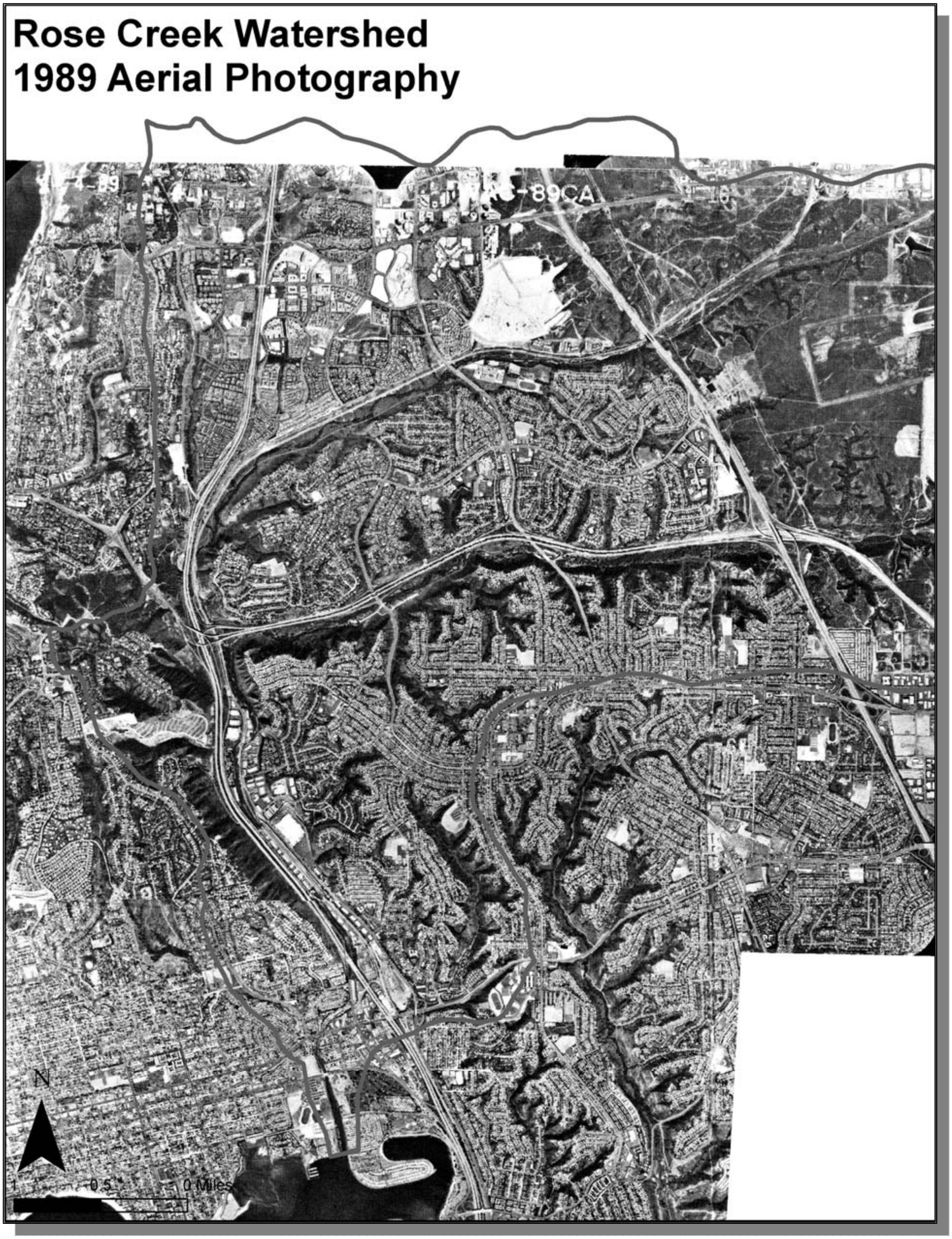


Figure 15: 1989 Aerial photography of the Rose Creek Watershed

1.2.6 Status of Land Development in 1989

The 1989 aerial photography depicts a near build-out condition with only a few relatively small areas of undeveloped mesa top lands remaining. Most of the new development has occurred within the areas of: University Town Center, La Jolla Colony, University City, and along the eastern slopes of Mount Soledad (Figure 15). These developments have continued to fill many tributary canyons for roads and residences and re-design the natural drainage network into an interconnected storm drain system to efficiently collect and move runoff off of the developed areas and into the natural creek system for conveyance to Mission Bay and the Pacific Ocean. State Route 52 has been extended east of Interstate 805 through San Clemente Canyon with additional interchange improvement being constructed at Interstate 805 that further confined San Clemente Creek within an additional length of improved channel.

1.2.7 Current Conditions

Today the RCW is nearing a built out condition from a land conversion and development perspective (Figure 16). This should shift the emphasis of new development to redevelopment and infill. It also means that essentially the vast majority of the land development related hydrologic modifications west of Interstate 805 have already occurred within the watershed, so that as we improve our understanding of how the watershed currently functions from the perspectives of hydrology, hydraulics, sediment transport, and geomorphology, we are not just developing an understanding of how it is functioning in 2005, but also how it is likely to continue to function into the future without intervention. This places the RCW in a somewhat unique situation, in that many watersheds in coastal southern California are still experiencing significant land development and will likely do so for some time into the future, making watershed planning and restoration more difficult due to constantly changing conditions.

To help assess the hydrologic condition of the RCW, without the development of various modeling tools, researchers have found that the degree of imperviousness within a watershed can be used to assess the condition and health of the aquatic resources, which are often used as a metric for determining the amount of stress a watershed is facing. Impervious surfaces (asphalt, concrete, and to some degree grass) increase surface water runoff during rainfall events, as well as during dry weather. Increased surface water runoff can result in increased flooding, pollution, and erosion. One of the primary acknowledgements that is recurrent in many water quality related plans and programs is that past construction techniques and development patterns have created large expanses of impervious surfaces that are directly linked to current hydrologic modifications and water quality problems.

Figure 16: 2000 Aerial photography of the Rose Creek Watershed

Imperviousness has been identified as a primary indicator to measure the impacts of land development within a watershed, and is defined as areas that are not "green." Impervious surfaces include transportation categories such as roads, freeways and parking lots, buildings, rooftops, sidewalks, and any development that interrupts the transport of water into the soil. At higher levels of urbanization (imperviousness), base flow is diminished, stormwater flows are larger and more frequent, sediment transport potential increases and the stability of the watershed stream channels degrade. Pollutant loads are also increased in areas of high urbanization as runoff picks up and suspends pollutants that have been deposited on the impervious surfaces as it flows over them. Infiltration is greatly reduced due to decreases in pervious areas, which can result in reductions in groundwater recharge.

Imperviousness is also one of the few variables that can be explicitly quantified, managed, and controlled at each stage of land development. It can also be assessed and managed at various scales including, watershed-wide, hydrologic basin, sub-basin, all the way down to the catchment. Researchers have identified three categories relating to the percent of impervious cover:

- 1 to 10 percent impervious surface is a sensitive watershed
- 11 to 25 percent is an impacted watershed
- More than 25 percent is a non-supporting watershed

A sensitive watershed should be the most protected category with zoning, site impervious restrictions, stream buffers, and stormwater practices applied to maintain predevelopment stream quality. An impacted watershed can expect to see more degradation after development with less stable channels and some loss of biodiversity. Non-supporting watersheds should recognize that predevelopment channel stability and biodiversity cannot be fully maintained, even when stormwater practices and zoning restrictions are fully applied. The objective then becomes to protect the downstream water quality by removing pollutants and to restore biodiversity in degraded streams as much as possible.

To initiate discussions among the stakeholders within the RCW about the relationship of impervious surfaces, land use planning, and watershed health, a visual assessment of impervious cover was completed for each of the 90 land use categories (Table 1) using the SANDAG 2000 Color Infrared Aerial Imagery and extrapolated across the entire watershed (Figure 17). Based on this analysis, imperviousness varies throughout the sub-basins within the RCW and averages about 38 percent for the entire RCW, placing it well into the non-supporting watershed category. In addition to this watershed-wide information, it is also important to understand the types and distribution of impervious surfaces to select appropriate management practices to eliminate, reduce, and minimize the negative effects caused by stormwater runoff from these surfaces.

Table 1: Impervious Percentage by Land Use Category within the RCW

LU	Description	Imp_%	LU	Description	Imp_%
1000	Spaced Rural Residential	5%	6101	Cemetery	50%
1100	Single Family Residential	varies	6102	Churches	85%
	< 1/8ac	90%	6103	Libraries	85%
	1/8 - 1/4ac	80%	6104	Post Offices	95%
	1/4 - 1/2ac	75%	6105	Fire/Police	95%
	1/2 - 3/4ac	70%	6109	Other Public Services	85%
	>3/4ac	30%	6501	UCSD Hospital	
1200	Multi-Family Residential	85%	6502	Hospitals	75%
1300	Mobile Home Park	65%	6509	Other Health Care	85%
1401	Jails/Prisons	85%	6701	Military Use	40%
1402	Dormitories		6702	Military Training	60%
1403	Military Barracks	75%	6703	Military Weapons	20%
1409	Other Quarters	70%	6801	UCSD	
1501	Low-Rise Hotel	95%	6802	Other Universities/Colleges	
1502	High-Rise Hotel		6804	Senior High Schools	
1503	Resort		6805	Junior High and Middle Schools	
2101	Industrial Park		6806	Elementary Schools	50%
2103	Light Industry	90%	6807	School District Offices	80%
2104	Warehousing/Public Storage	95%	6809	Other Schools	80%
2201	Extractive Industry	20%	7204	Golf Courses	
2301	Junkyard/Dump/Landfill		7205	Golf Course Clubhouses	
4102	Military Airports	85%	7207	Marina	95%
4104	Airstrips	20%	7210	Recreation	40%
4112	Freeway	65%	7601	Parks-Active	25%
4113	Communications And Utilities	65%	7603	Open Space Reserves, Preserves	2%
4114	Center City Parking	95%	7606	Landscape Open Space	
4116	Park and Ride Lots		7607	Residential Recreation	
4117	Railroad Right-Of-Ways	50%	8001	Orchards And Vineyards	10%
4118	Surface Street Right-Of-Ways	75%	8002	Intensive Agriculture	20%
4119	Other Transportation		8003	Extensive Agriculture	2%
5002	Regional Shopping Center		9101	Vacant, Not Graded	2%
5003	Community Shopping Center		9200	Water	
5004	Neighborhood Shopping Centers	95%	9201	Bays-Lagoons	
5005	Specialty Commercial		9202	Inland Water	100%
5006	Automotive Dealership		9300	Indian Reservations	2%
5007	Store-Front Commercial	95%	9501	Residential Under Construction	
5009	Other Retail	90%	9502	Commercial Under Construction	
6001	Office - High-Rise		9503	Industrial Under Construction	
6002	Office - Low Rise	85%	9504	Office Under Construction	
6003	Government/Civic Centers	90%	9505	School Under Construction	

Figure 17: Impervious Surfaces within the Rose Creek Watershed, 2000

Figure 18: Percent Impervious by Sub-Basin

To determine what effect, if any, the scale of the assessment might have on the results, seven sub-basins (Figure 18) were delineated and evaluated: Upper San Clemente; Marian Bear; Upper Rose; Rose Canyon; Gilman; Lower Rose; and Stevenson. Within these sub-basins, imperviousness ranges from a low of 23 percent in Upper San Clemente to a high of 78 percent within Gilman as shown in Table 2.

Table 2: Percent Impervious by Sub-basin and Basin, 2000

Sub-Basin	Total Acres	Impervious Acres	% Impervious
Upper San Clemente	9,275.1	2,089.2	23%
Marian Bear	2,408.8	1,076.4	45%
Upper Rose	5,114.8	1,679.5	33%
Rose Canyon	2,677.1	1,434.1	54%
Gilman	1,388.5	1,079.8	78%
Stevenson	384.9	178.4	46%
Lower Rose	2,178.3	1,370.7	63%
Total	23,427.6	8,908.2	38%

Basin	Total Acres	Impervious Acres	% Impervious
San Clemente Creek	11,683.9	3,165.6	27%
Rose Creek	9,180.4	4,193.5	46%
Below Confluence	2,563.3	1,549.1	60%
Total	23,427.6	8,908.2	38%

Based on this information, all of the sub-basins are at least in the impacted category, with the majority falling well within the non-supporting category. This information would appear to suggest that conditions within the watershed are highly stressed and that most of the sensitive aquatic resources have likely been lost and are not restorable. However, this perspective is not fully supported by some of the more sensitive biological resources known to still exist within the watershed. The existence of these resources would suggest there is still hope to improve and stabilize the physical conditions within the watershed and at least partially restore these resources to a more healthy and stabilized condition.

1.2.8Conditions during 1970’s FEMA Study

To try and gain a better understanding of the current hydrologic and hydraulic conditions in the RCW it was necessary to assess how conditions have changed since the USACE conducted their studies in the 1970’s, which resulted in the mapping of the 100-year floodplain. The consultant team has only been able to locate and review one of two USACE studies that were conducted in the 1970’s and provide the technical analysis utilized by the 1997 Flood Insurance Study currently used by the City of San Diego. The study reviewed was published in 1970 and covered the main stems of Rose and San Clemente creeks above the confluence. The other study was published in 1978 and presumably covers the area of Rose creek below the confluence. Based on its published date the 1970 study is likely based on base map information and field data collected within the previous year or two, which indicates that the conditions of the watershed in 1966 likely represent the conditions present within the watershed fairy accurately. The flow volumes and rates generated for the Standard Project Flood and the Intermediate Regional Flood are shown in Table 3.

Table 3: Flow volumes and rates for Rose and San Clemente creeks above the confluence

Stream and Location	Mile above mouth	Drainage area (sqmi)	Intermediate Regional Flood			Standard Project Flood		
			Discharge (cfs)	Channel (fps)	Overbank (fps)	Discharge (cfs)	Channel (fps)	Overbank (fps)
Rose Creek								
Upstream of confluence	3.4	13.7	6,200			8,900		
Near downstream study limit	3.6			5	1		6	2
Proposed Regents Crossing	5.4			5	3		8	2
Upstream of Genesee Crossing	6.9			8	5		9	6
Interstate 805	7.4	9.7	5,000			7,200		
Near upstream study limit	8.4			5	1		5	2
2400 ft east of Fish Pond	9.2	6	4,100			6,000		
San Clemente Creek								
Upstream of confluence	0	18.4	6,900			9,500		
Near downstrem study limit	0.2			13	5		13	6
Near Genesee Crossing	1.6			11	2		12	3
Interstate 805 Crossing	3.4			7	1		8	2
Above Interstate 805	4.2	12.5	4,900			7,000		
Near upstream study limit	6			9	1		10	1
Below landfill road crossing	6.6	6.9	3,400			4,900		
Lower Rose Creek								
Downstream of confluence		32.1	11,000			26,500		
Mouth of Rose Creek		37	12,000			28,000		

As mentioned previously, by 1966 land development had expanded significantly within the lower portion of the watershed. To quantify the extent of development at that time and compare it with current conditions the parcel-based impervious surface GIS layer was overlain on the 1966 aerial photography and those parcels that were either developed or under construction were flagged within the database. Once all of the parcels with some degree of imperviousness were flagged, the acreage of impervious surfaces were calculated and then compared with the total acres within each of the assessed sub-basins to determine their percent impervious value (Table 4). Based on this assessment, only the Rose Canyon sub-basin has not been significantly impacted by impervious surfaces by this date, and all the other assessed sub-basins have already crossed the threshold (25 percent) into the non-supporting category.

Additionally, when the percent difference between the amount of impervious surfaces in 1966 and current conditions is assessed it becomes apparent that none of the sub-basins were fully developed in 1966. In fact most of them have had at least an additional 15 percent of their land area converted to impervious surfaces, with Stevenson being the lowest at 7 percent and Gilman being the highest at 60 percent. This comparison is significant when assessing the current accuracy of hydrology and hydraulic modeling results that were completed during this time frame. With the Marian Bear sub-basin showing an additional 17 percent of its land areas being converted to impervious surfaces and Rose Canyon and Gilman sub-basin showing 42 and 60 percent respectively, it seems that the logical conclusion would be that the 1970 flow volumes and rates are under-representative of the current flow volume and rates under similar storm event condition (Standard Project and Intermediate Regional Flood). As such, updated hydrology and hydraulics data will be essential in determining what flow volumes and rates are like under current conditions prior to undertaking significant restoration projects to help ensure the projects are feasible, appropriately designed, and their potential downstream effects understood.

Table 4: Comparison of Percent Impervious by Sub-basin, 1966

Sub-Basin	Total Acres	1966 Impervious Acres	1966 % Impervious	2000 % Impervious	% Difference
Upper San Clemente	Not Included	Unknown	Unknown	Not Included	NA
Marian Bear	2,408.8	660.2	27%	45%	17%
Upper Rose	Not Included	Unknown	Unknown	Not Included	NA
Rose Canyon	2,677.1	311.4	12%	54%	42%
Gilman	1,388.5	252.2	18%	78%	60%
Stevenson	384.9	150.8	39%	46%	7%
Lower Rose	2,178.3	1,001.0	46%	63%	17%
Total	9,037.7	2,375.6	26%	57%	31%

1.2.9 Conditions during 1986 WCC Erosion Study

In addition to the flow volumes and rates, it was also determined to be important to try and gain a better understanding of the current erosion and sedimentation conditions in the RCW. To accomplish this the 1986 Woodward-Clyde Watershed Erosion / Sedimentation Study - Rose and San Clemente Canyons was reviewed and a few of the 52 sites identified then as experiencing significant erosions were chosen and compared in the field with current conditions. The 1986 study identified, *"Three types of rainfall erosion are occurring in the Rose and San Clemente Canyon watersheds: streambank erosion, gullying, and overland sheet and rill erosion. A certain amount of erosions, particularly sheet and rill erosion occurs naturally in the watershed. Accelerated erosion is also occurring due to man-induced changes to the watershed. These man-induced changes include the creation of impervious areas through urbanization; the concentration of flow through culverts and storm drains; the addition of water through irrigation and other urban/suburban activities; the alteration of natural flow patterns through grading and other structural encroachments; and alterations to the infiltration and soil erosion characteristics through the removal of natural vegetation."* Based on the field observations conducted as part of this project the types and sources of erosion within the watershed appear to remain as they were in 1986.

Additionally, the status of land development and impervious surfaces in 1989 were used to assess the amount of change the watershed has continued to experience since the report was published to determine if the additional land development that has occurred could be contributing to further degradation of the stream channels and banks.

Based on our previous assessment of the extents of land development within 1989, we were able to quantify the extent of development at that time and compare it with current conditions. To accomplish this, the parcel-based impervious surface GIS layer was overlain on the 1989 aerial photography and those parcels that were either developed or under construction were flagged within the database. Once all of the parcels with some degree of imperviousness were flagged, the acreage of impervious surfaces were calculated and then compared with the total acres within each of the assessed sub-basins to determine their percent impervious value (Table 5). Based on this assessment, all of the assessed sub-basins have nearly reached their current level of development and have already crossed the threshold (25 percent) into the non-supporting category. Since all of the assessed sub-basins were nearly developed to current levels in 1989, it would seem unlikely that the limited additional developed that has occurred in the intervening years have exacerbated the conditions that led to the erosion and sedimentation conditions documented in the 1986 study.

Table 5: Comparison of Percent Impervious by Sub-basin, 1989

Sub-Basin	Total Acres	1989 Impervious Acres	1989 % Impervious	2000 % Impervious	% Difference
Upper San Clemente	Not Included	Unknown	Unknown	Not Included	NA
Marian Bear	2,408.8	1,056.6	44%	45%	1%
Upper Rose	Not Included	Unknown	Unknown	Not Included	NA
Rose Canyon	2,677.1	1,409.3	53%	54%	1%
Gilman	1,388.5	1,029.8	74%	78%	4%
Stevenson	384.9	176.7	46%	46%	0%
Lower Rose	2,178.3	1,339.7	62%	63%	1%
Total	9,037.7	5,012.1	55%	57%	2%

With the degree of imperviousness (number of acres) in 1989 determined to be substantially the same as in 2000, our focus shifted to comparing the current conditions of several sites identified in the 1986 study as experiencing severe erosion. Six sites were chosen for comparison: RC-07, RC-10, RC-11, RC-24, SC-16, and SC-28. The 1986 field photographs are presented next to the 2005 field photographs below in Figures 19 - X.

Figure 19: Comparison of 1986 and 2005 field photography of site RC-07

Figure 20: Comparison of 1986 and 2005 field photography of site RC-10

Figure 21: Comparison of 1986 and 2005 field photography of site RC-11

Figure 22: Comparison of 1986 and 2005 field photography of site RC-24

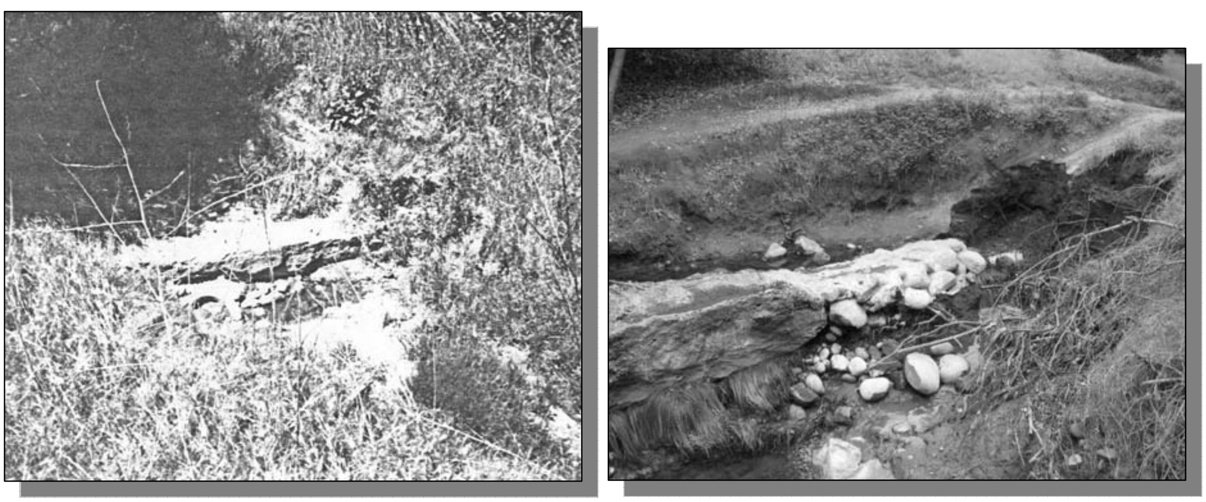


Figure 23: Comparison of 1986 and 2005 field photography at site SC-16

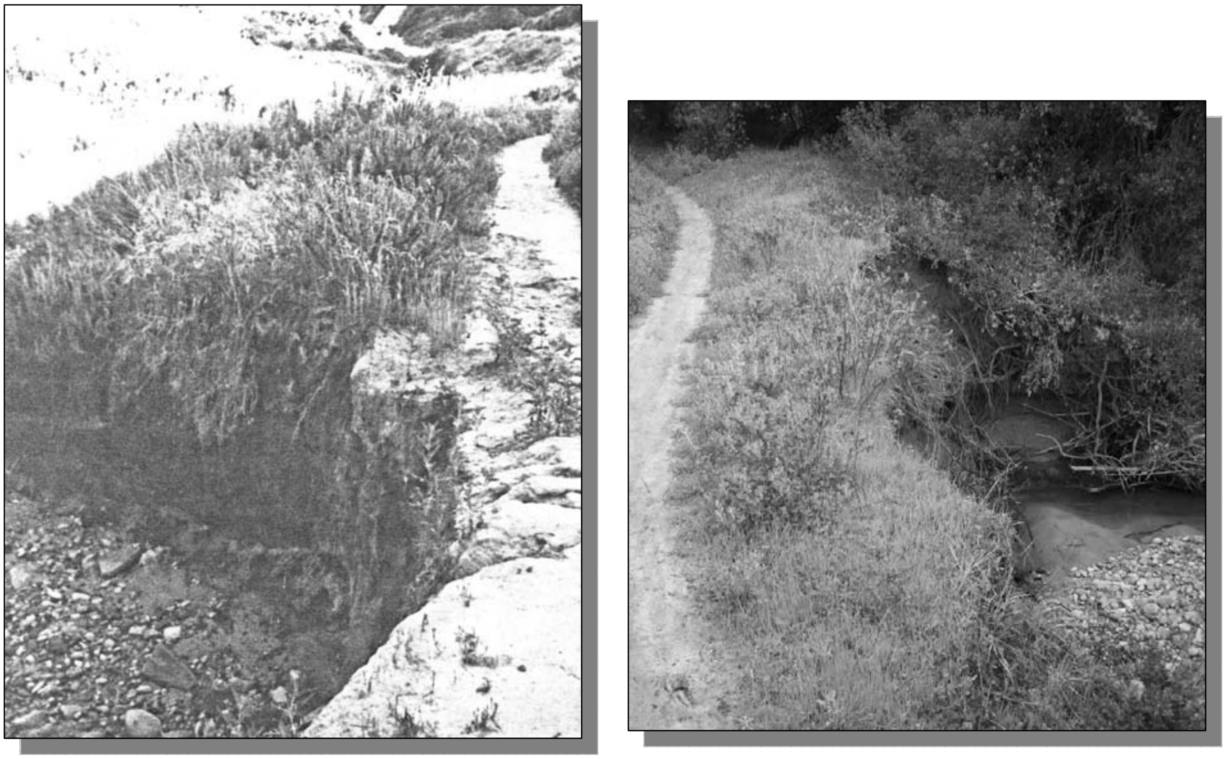


Figure 24: Comparison of 1986 and 2005 field photography at site SC-28

As can be seen from the photographic comparisons, the RC-07 site remains eroded, but appears to have had some remediation work done on it as the scour hole below the outfall pipes does not appear to be as deep as it was in 1986. The RC-10 site remains deeply incised and shows signs of continued erosion through bank undercutting and bed erosion. The RC-11 site has had some rock revetment placed, side gullys filled, and native vegetation planted on the previously disturbed areas. No signs of new erosion are apparent. The RC-24 site was actually a series of sites along a tributary canyon. The two photographs are not of the same exact site within the canyon. The 2005 photograph does illustrate that active stream bank erosion is still occurring within this tributary. The SC-16 site was also a series of sites within Biltmore canyon. The photographs depict how the stream has eroded around the historic, as well as more recent, concrete and rock protection that was placed over a sewer main that crosses the stream channel. Since the crossing acts as a small dam the forces exerted on the streambank during storm events is causing continued erosion. The SC-28 site photograph depicts one of a series of problematic areas within the tributary canyon that the SDG&E easement runs through west of Interstate 805 and south of San Clemente creek. The two photographs are believed to be taken of the same location, but from different vantage points. The 2005 photographs shows signs of active streambank erosion that threatens to destroy the current access path.

1.3 Current Issues

Based on information contained within past studies, analysis of historic aerial photography, and field reconnaissance a variety of issue areas have been identified within the RCW that will either require human intervention and management to improve and or remedy, or need to be further evaluated to determine their relationship to, and potential impact on, future restoration activities. These issues have been mapped within the GIS database and are presented in Figure 25 and discussed individually in the following sections.

Figure 25: Hydrologic Modifications and related issues within the Rose Creek Watershed

1.3.1Tributary Erosion / Storm Drains

As land development has occurred within the RCW over the past century a couple of common construction practices have altered the natural hydrology and hydraulics within the vast majority of tributary canyons. First, many of the tributary canyons were re-contoured for the purposes of constructing roads, sidewalks, residences, and businesses as part of the development process. Storm water runoff from these developed areas are typically collected within road gutter systems and conveyed to storm drain inlets and underground pipes. These pipes often consolidate the runoff from several blocks of development prior to discharging the flows into undeveloped tributaries, natural slopes, or one of the main creek channels. These unnatural flows have created severe erosion within these tributaries as their stream channels enlarge to accommodate the higher flow volumes and rates by both widening and deepening. Figures 26 – 31 depict the current conditions found within several of the tributaries in both Rose and San Clemente Canyons.

Figure 26: Eroded culvert in Rose Canyon

Figure 27: Eroded outfall in tributary canyon below elementary school

Figure 28: Erosion downstream of storm drain outfall in tributary to Rose Canyon

Figure 29: Storm drain related gully erosion along Interstate 5

Figure 30: Concrete V-ditch draining condominium complex

Figure 31: Sewer access road erosion and corrective best management practices below storm drain outfall

1.3.2Streambank Erosion

Increased storm runoff resulting from the urbanization of the watershed has resulted in larger volumes of water being delivered to the stream channels during smaller storm events. In addition, storm runoff within urbanized watersheds is usually flowing at faster rates than it did under natural conditions. The combination of these two characteristics significantly increases the erosive force applied to the stream banks along the main channels and often result in significant streambank erosion and undercutting. Sections along the main channels of both Rose and San Clemente Creek show signs of ongoing bank erosion as shown in Figures 32 – 37.

Figure 32: Active bank erosion upstream of Interstate 805 in Rose Canyon

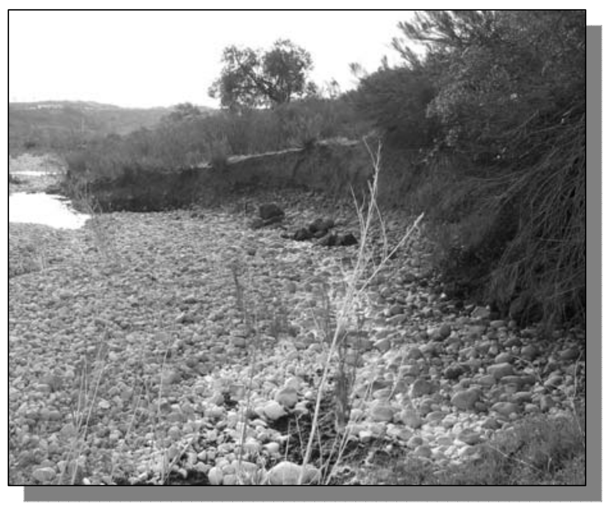


Figure 33: Active bank erosion on outer bend upstream of Interstate 805 in Rose Canyon

Figure 34: Active bank erosion in Stevenson Canyon

Figure 35: Active bank erosion in Gilman Canyon

Figure 36: Streambank undercutting and exposing Oak tree roots in Rose Canyon

Figure 37: Active bank erosion during storm flows below confluence

1.3.3 Streambed Erosion

In addition to the streambank erosion resulting from increased storm runoff caused by urbanization, streambed erosion (or incision) is also a problem within the RCW. As the streambeds incise they become disconnected from their historic floodplains, which in turn increases the flow volume and rate contained within the stream channel causing additional stress on the streambank and bed resulting in additional erosion. This cycle will continue until the stream channel finds a new dynamic equilibrium where the stream slope and channel size (width and depth) generates flow rates that transport the same amount of sediment delivered from upstream sources to downstream receptor sites. Figures 38 – 43 show sites within Rose and San Clemente Creeks that have or are experiencing streambed incision.

Figure 38: Streambed erosion undercutting concrete bank protection along railroad tracks in Rose Canyon

Figure 39: Streambed scour hole along tributary drainage that double as access road in Rose Canyon

Figure 40: Tributary drainage along Rose Canyon that has experienced significant down-cutting (10-15ft) over the past 40 years

Figure 41: Tributary drainage along San Clemente Canyon that has down-cut 4-6ft over the past 40 years

Figure 42: Streambed erosion threatened sewer manhole that is now protected with riprap in Rose Canyon

Figure 43: Concrete protect sewer main crossing Rose Creek below confluence being exposed by streambed erosion

1.3.4Depositional Areas

Based on the increased storm flows and rates being experienced throughout the RCW, very few areas of deposition or sedimentation currently exist. Depositional areas typically occur where stream gradients lessen and flow rates slow allowing suspended sediments to drop out of suspension and deposit within the streambed. Small depositional areas are frequently seen within stream channel as point bars that form downstream of some obstruction to flow that creates an eddy of lower velocity, which is where the deposition of sediments occur. This type of deposition is found within the upper portions of Rose and San Clemente creeks where stream channels are still fairly broad and shallow with braided flow paths that split and reconnect around vegetated bars. A second type of depositional area is found within the lower reaches of Rose Creek below the concrete trapezoidal channel between Morena Blvd and Santa Fe Rd and below the concrete box channel between Interstate 5 and Mission Bay Dr. Within both of these areas, the reaches just downstream of these concrete channels showed signs of sediment deposition after the storms in the first quarter of 2005. The final type of deposition found throughout the RCW is associated with changes in stream gradient within the tributary canyons and below storm drain outfalls. All of these depositional areas are represented within Figures 44 – 49.

Figure 44: Sediment flowing onto Rose Canyon trail/access road from eroding storm drain channel

Figure 45: Sediment deposition on upstream side of culvert in Rose Canyon just north of State Route 52

Figure 46: Depositional area in main channel of Rose Creek on inside of channel meander

Figure 47: Depositional area downstream of old railroad bridge crossing in Rose Canyon

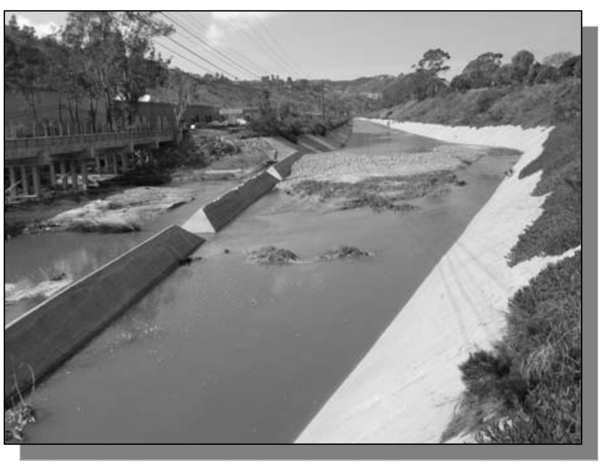


Figure 48: Depositional bar formed on inside of channel bend behind concrete flow diverter in lower Rose Creek

Figure 49: Depositional area below Mission Bay Drive

1.3.5Streambank Protection Projects

As public infrastructure has been constructed throughout the RCW, it has often been installed parallel to existing stream channels or has needed to cross them. In both situations it has been normal for project designers to determine a need for streambank protection to be installed to protect the installed infrastructure from impacts associated with erosion and undercutting. Streambank protection projects within the RCW appear in three forms. The first is concrete lining, which is located along the railroad alignment in three locations. The second and most common is loose rock revetment typically installed to protect the toe (bottom) of a streambank to prevent undercutting. These have typically been installed where the slope if eroded could damage some form of public infrastructure. The third is gabion baskets, which have been used in a couple of locations to protect a streambank from further erosion. Figures 50 – 55 show samples of each of these.

Figure 50: Streambank armoring with concrete along railroad tracks in Rose Canyon

Figure 51: Streambank armoring with riprap upstream of old railroad bridge in Rose Canyon

Figure 52: Gabion streambank protection in San Clemente Canyon near Genesee on-ramp

Figure 53: Gabion streambank protection to protect sewer main in San Clemente Canyon

Figure 54: Riprap streambank protection along lower Rose Creek

Figure 55: Concrete streambank protection and riprap streambed at Grand Ave crossing

1.3.6Concrete Channelization Projects

Four concrete channelization projects exist within the RCW. The first is a 1,500-foot long concrete trapezoidal channel located about ¼ mile above the State Route 52 / Interstate 5 interchange along the railroad tracks. The second is a 700-foot long concrete trapezoidal channel occurring underneath the State Route 52 / Interstate 5 interchange along the railroad tracks. The third is a 3,000-foot long concrete trapezoidal that occurs between Morena Blvd and Santa Fe St and is terminated at either end by railroad bridges. The forth is a 800-foot long concrete box channel with flow direction fins that occurs between Interstate 5 and Mission Bay Dr. All four of these projects are shown in Figures 56 – 60.

Figure 56: Upstream most concrete trapezoidal channel along railroad tracks north of State Route 52

Figure 57: Concrete V-ditch channel in Lakehurst Canyon

Figure 58: Concrete trapezoidal channel running underneath interchange between Interstate 5 and State Route 52

Figure 59: Concrete box channel between Interstate 5 and Mission Bay Drive during a storm event

Figure 60: Concrete trapezoidal channel above Santa Fe Street crossing looking upstream

1.3.7 Slope Failures

Slope failures have occurred throughout the RCW as a result of the rainfall received from December 2004 through March 2005. Some of these slope failures have occurred in natural areas and are the result of natural erosion processes. However, the vast majority of the slope failures appear to be related to modifications to storm runoff and the use of iceplant as am erosion control and fire protection measure within many residential areas. Residential developments that occur along the canyon rims have modified the amount of rainfall that can be absorbed by the ground and the rate at which runoff flows off the ground surface. These modifications have occurred through the construction of homes, patios, and other hardscape areas, as well as through landscape irrigation practices that maintain higher the natural moisture content in the soils. Each of these has resulted in increases in the volume and rate at which rainfall is turned into runoff and flows onto the adjacent canyon slopes.

Additionally, the use of iceplant for erosion control and fire protection has created extensive areas of steeply sloped land covered with shallow rooted iceplant. Iceplant also gets extremely heavy as it absorbs moisture and can overload the slopes bearing capacity and cause a localized landslide that can continue to the base of the slope. Examples of these slope failures are shown in Figures 61 – 66.

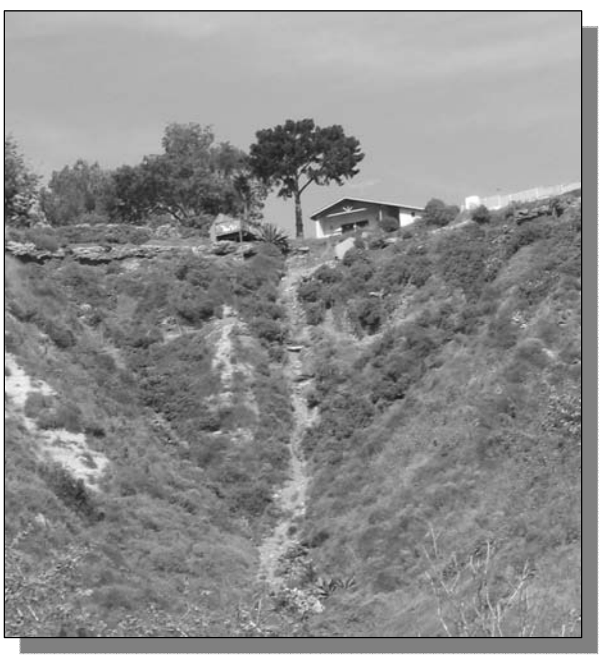


Figure 61: Slope failure along canyon rim, likely caused by storm runoff from adjacent residence

Figure 62: Slope failure related to iceplant along railroad access road in Rose Canyon

Figure 63: Slope failure related to iceplant and storm runoff below residential development

Figure 64: Slope failures related to iceplant and storm runoff from residences in Gilman Canyon

Figure 65: Slope failures related to iceplant and storm runoff from residences in Rose Canyon

Figure 66: Slope failure related to iceplant and storm runoff from residence in Gilman Canyon

References

Brooks, Kenneth N; Peter Ffolliott; Hans Gregerson; John Thames. Hydrology and the Management of Watersheds. 1991.

Engineering Research and Development Center – Environmental Laboratory, Waterways Experiment Station, Vicksburg, MS – Cold Regions Research and Engineering Laboratory, Hanover, NH. Planning Level Delineation of Aquatic Resources, Floodplain Mapping, and Functional Assessment of Riparian Ecosystems at Marine Corps Air Station, Miramar. Report to MCAS Miramar. July 2001

Hector, Susan M. 2004. Cultural Resources Overview of Rose Canyon and San Clemente Canyon, City of San Diego, California – Draft. Report to San Diego Earthworks. August 2004.

KTU+A (Kawasaki, Theilacker, Ueno and Associates). 2000. Rose Creek Canyon Enhancement Plan. Report to The Nature School. June 2000.

Lyon, John G. GIS for Water Resources and Watershed Management. 2003.

Riley, Ann L. Restoring Streams in Cities: A Guide for Planners, Policymakers, and Citizens. March 1998.

Schueler, Thomas R., Heather K. Holland. 2000. The Practice of Watershed Protection: Article 1-The Importance of Imperviousness, The Center for Watershed Protection, Ellicott City, MD.

USACE (United State Army Corps of Engineers), Los Angeles District. 1970. Flood Hazard Information – Rose Canyon and San Clemente Canyon. Report to the County of San Diego. 1970

USGS (United States Geological Survey). 2004. National Landslides Hazards Program. http://landslides.usgs.gov/html_files/landslides/program.html. Accessed December 20, 2004.

Woodward-Clyde Consultants. 1986. Watershed Erosion / Sedimentation Study – Rose and San Clemente Canyons. Volume I and II. Report to the City of San Diego. October 1986