Habitat Restoration Opportunities for the Lower Ventura River

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Protecting and restoring the Santa Barbara Channel and its watersheds through science-based advocacy, education, field work, and enforcement.

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Ben Pitterle

December 2010

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Last but not least, Channelkeeper is eternally grateful to the hundreds of Ventura Stream Team volunteers who have contributed countless hours of community service towards monitoring water quality throughout the Ventura River watershed. Our most dedicated and devoted volunteers from 2007 through 2010 are listed below:

Ian Achimore ♦ Sara Benjamin ♦ Joseph Burgess ♦ Andre Casanave ♦ Cynthia Hartley ♦ Paul Jenkin
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Executive Summary

Santa Barbara Channelkeeper conducted water quality monitoring activities, field surveys, stakeholder interviews, literature reviews, and Geographic Information System (GIS) analysis from 2007 to 2010 to identify riparian habitat impairments and restoration opportunities in the lower Ventura River watershed. Water quality monitoring activities included continuation of the Ventura River Stream Team citizen monitoring project, periodic "full-suite" analysis of water quality and sediment samples for parameters such as pesticides, heavy metals, and organic compounds, and coordination of volunteers to conduct pre-dawn monitoring in order to assess the impacts of algal growth on water quality throughout the watershed. Field surveys of the lower watershed were conducted by vehicle and by foot to identify where landscape alterations and other activities affect river water quality and habitat. Many governmental and non-governmental stakeholders were consulted throughout the course of this project for additional input.

Several factors were found to be contributing to habitat degradation in the lower watershed including significant historic physical modifications to river and stream channels due to floodplain development and flood control measures, non-point pollution sources, dams, invasive species, and human habitation of the river bottom. Large-scale, overarching watershed issues threatening riparian habitat were also identified such as increasing water supply demands and floodplain development.

Opportunities for habitat restoration were identified that include traditional forms of stream bank and riparian restoration as well as opportunities to address sources of water quality impairment and other activities degrading habitat. Agricultural, industrial, and urban land uses contributing to water quality impairment were highlighted. A list of projects and recommendations were developed to provide conceptual starting points to facilitate further assessment and implementation.

Introduction

The Ventura River and its tributaries provide many critical ecosystem services. The river, floodplain, and riparian zones provide habitat for a diverse array of plant and animal species, including many rare, threatened, or endangered species. These areas serve as important migration corridors for aquatic and terrestrial wildlife. Riparian vegetation improves water quality by filtering nutrients, sediment, and other pollutants and by providing canopy shade to regulate stream temperature. Root systems of riparian vegetation help anchor the soil and prevent erosion. The Ventura River floodplain and wetlands detain stormwater and reduce flooding. The river is a primary source of water for municipal, agricultural, and residential uses. The Ventura River and its ecosystems also provide abundant recreational and educational opportunities for the surrounding community.

Despite its recognized value, the Ventura River watershed has been degraded by human activities. Urban, agricultural, and industrial development throughout the watershed has impacted water quality. Much of this development has occurred within the floodplain, directly replacing riparian and wetland habitat and resulting in additional habitat loss through subsequent alterations of river and stream corridors for flood control purposes. These alterations include extensive channelization, stream bank armoring, and the construction of multiple levees. The construction of dams within the watershed has severely reduced available habitat for migratory species such as southern steelhead trout and has disrupted natural sediment transport processes. Water diversions and pumping have altered the natural flow regime of the river and its tributaries. Exotic invasive species have become established throughout the watershed, competing with native wildlife, reducing available native habitat, and reducing the biodiversity of both plants and animals in the region. Certain human activities within the floodplain such as poaching, littering, and transient habitation also degrade the ecosystem.

Despite these impairments, the Ventura River watershed still supports valuable ecosystem functions and is a central and critically important feature of western Ventura County. As awareness and concern regarding the river and its important functions grows throughout the community, so too has interest in restoring degraded ecosystem features and services. Many opportunities for restoration of the Ventura River ecosystem exist and may be realized through investment in this critical resource.

Project Purpose and Approach

Santa Barbara Channelkeeper's mission is to protect and restore the Santa Barbara Channel and its watersheds through science based advocacy, education, field work, and enforcement. In 2007, Channelkeeper accepted a grant from the California State Coastal Conservancy to expand upon existing water quality monitoring efforts by identifying and summarizing impairments to wetland, riparian and aquatic habitat throughout the lower Ventura River watershed, examining many of the overarching land-use and resource management issues causing these impairments, and by providing specific recommendations for habitat restoration projects along with additional recommended actions to protect and restore habitat in the watershed.

Many habitat impairments such as invasive exotic species, stream bank alterations, and severe erosion are prevalent throughout the watershed. Opportunities for physical habitat restoration, however, are constrained by multiple factors, including limited funding, existing private and public infrastructure, private property interests, flood control concerns, and dynamic and extreme hydrogeologic processes that govern surface flow and sediment transport in the floodplain. For this reason, this report does not focus on inventorying every individual occurrence of habitat impairment, but rather provides a menu of specific key restoration project opportunities as examples that could be applied elsewhere throughout the watershed, identifies critical regions and issues in need of further assessment and attention, and lays out recommendations to address significant sources of impairment such as non-point source pollution.

This report identifies many broad, overarching issues that are impairing habitat impairment throughout the Ventura River

watershed. It was beyond the scope of this project to thoroughly evaluate all of these issues, such as preservation of adequate in-stream flows and floodplain management. These issues are included in the discussion, however, to both provide context for our restoration recommendations as well as to flag them for future examination through the development of a comprehensive watershed plan.

The projects and recommendations provided in this report are conceptual and are meant to serve as examples and starting points to facilitate further assessment and implementation.

Figure 1: The Ventura River watershed and project study area.

Geographic Scope

Much of the attention to habitat restoration in the Ventura River watershed to date has focused in its upper reaches, largely in relation to efforts to remove the Matilija Dam. The Ojai Valley Land Conservancy has also developed and begun implementing a plan to restore and preserve its Ventura River Preserve located just north of Highway 150. In 2005, a City of Ojai Urban Watershed Assessment and Restoration Plan (DMEC, 2005) was prepared for the San Antonio Creek watershed. This project focuses on the "lower" watershed, with an emphasis on the mainstem river downstream of Highway 150 as well as along San Antonio Creek downstream of the City of Ojai boundary.

Methods

Stream Team Water Quality Monitoring

This study relied in part on findings and observations collected through the implementation of Santa Barbara Channelkeeper's Ventura River Stream Team water quality monitoring program. The Stream Team program is a volunteer-based program initiated in 2001 as a partnership between Santa Barbara Channelkeeper and the Ventura Chapter of the Surfrider Foundation. The goals of the Ventura Stream Team program are to collect baseline data on the health of the watershed, to educate and train a force of volunteer watershed stewards, and to identify sources of pollution in the watershed.

From 2001 through 2010, Ventura Stream Team conducted monthly on-site testing at designated locations throughout the watershed. Teams of volunteers measured physical and chemical parameters in the field using portable hand-held

instruments. Data collected included on-site measurements of dissolved oxygen, turbidity, conductivity, pH, temperature, and flow. Water samples were collected at each site and processed in Channelkeeper's laboratory for three Public Health bacterial indicators using approved standard methodology (Colilert-18 and Enteroloert-24, manufactured by Idexx Laboratories; US EPA, 2003). Additional samples were analyzed for nutrients (ammonium, nitrite plus nitrate, orthophosphate, total dissolved nitrogen and particulate carbon, nitrogen and phosphorus) through cooperation with the Santa Barbara Channel – Long Term Ecological Research Project (SBC-LTER) at the University of California, Santa Barbara (UCSB). All Stream Team data is made publicly available by Santa Barbara Channelkeeper and is regularly submitted to the State Water Resources Control Board.

Additional Water Quality Monitoring

Throughout the course of this project (2007 – 2010), Channelkeeper also performed additional water quality monitoring activities that aided in the formulation of this report. These activities included periodic "full-suite" analysis of water quality and sediment samples for parameters such as pesticides, heavy metals, and organic compounds. Channelkeeper also coordinated volunteers to conduct pre-dawn monitoring in order to assess the impacts of algal growth on water quality throughout the watershed.

River and Watershed Surveys

Channelkeeper conducted numerous field surveys throughout the Ventura River watershed to gather information for this study. Surveys were conducted by vehicle and by foot, primarily via public right of ways and in public lands along river and stream corridors. Many upland watershed regions were also surveyed, including the Ventura Avenue corridor, where alterations to the landscape and activities affect river water quality.

Interviews and Literature Review

This study relied heavily on interviews conducted with community members living and working in the Ventura River watershed. Individuals interviewed included landowners, local non-governmental organization representatives, public agency officials, cultural leaders, and individuals with historical experience in the watershed. A literature review was also conducted to provide historic context and to aid in the development of restoration recommendations.

Geographic Information Systems (GIS)

Aerial imagery and spatial information layers that included hydrologic and land-use data were analyzed and utilized to aid in development of restoration recommendations for this study.

Lower Ventura River Watershed Restoration Recommendations

The following projects and recommendations were developed to address habitat impairments throughout the lower Ventura River watershed. Some of the recommendations described in this document address specific locations within the watershed. Some recommendations address broader regions in the lower watershed where similar types of impairment are known to occur. Issues outside the scope of this project, but necessary to note for context and thoroughness are described in the Additional Watershed Issues section of this report.

The Lower Ventura River and Estuary

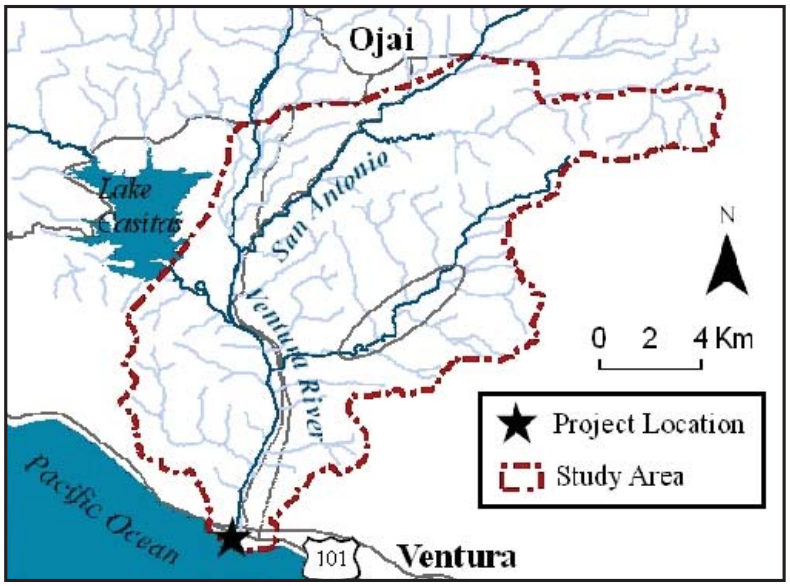

Figure 2: The Ventura River Estuary and project study area.

The Ventura River Estuary is located at the southern terminus of the Ventura River where it meets the Pacific Ocean. A levee has been constructed to form the eastern border of the estuary. The Ventura Beach RV Camp and Emma Wood Group Camp site form the western border, although both of these sites are known to be located within the path of the river's high flow distributary channels. The estuary's salt water influence extends north approximately to the Highway 101 bridge. A brackish lagoon is contained seasonally by a sand berm that forms at the river mouth during drier months. Although the berm is known to persist for extended periods of time throughout the summer, Stream Team water quality data indicates that conductivity in the lagoon fluctuates continually throughout the year, presumably due to tidal influences. Stream Team volunteers have also observed incidences of lagoon breaching during summer months caused both by tampering by members of the public and by the build-up of pressures caused by ponding of river flows.

The Ventura River Estuary and surrounding land is owned by a variety of private and public entities. The City of Ventura owns most of the lagoon south of the railroad tracks. The State of California owns the property immediately to the east of the eastern levee where the Ventura Fairgrounds is located. The California State Department of Parks and Recreation owns the land to the west of the main lagoon where the Emma Wood Group Camp Site is located as well as the main river stem upstream of the lagoon between the railroad tracks and Highway 101. The land between Highway 101 and Main Street is divided into two privately owned parcels, the western most of which is utilized by the Ventura Beach RV Park. The river channel and floodplain north of Main Street is owned by Ventura County to the east and a private property owner to the west.

Habitat types in and around the Ventura River Estuary include fresh and salt water marshes, riparian, coastal dune and dune scrub. A 1990 study (Ferren et al., 1990) compiled an inventory of botanical resources in the Ventura River Estuary. The estuary provides important potential aquatic habitat for over-summering and acclimation of steelhead trout (Stoecker, 2007) as well as seasonal habitat for tidewater goby (Wetlands Research Associates, 1994). Other fish species that have been observed in the estuary include killifish, stickleback, sculpin, striped mullet, top smelt, and carp (Allen, 2008). According to the Ventura Audubon Society, numerous bird species inhabit the Ventura River Estuary including a variety of whimbrels, tattlers, shorebirds, ducks, shearwaters, great egrets, brown pelicans, and migratory birds. Special status bird species that use the estuary include the California least tern and western snowy plover (Wetlands Research Associates 1994).

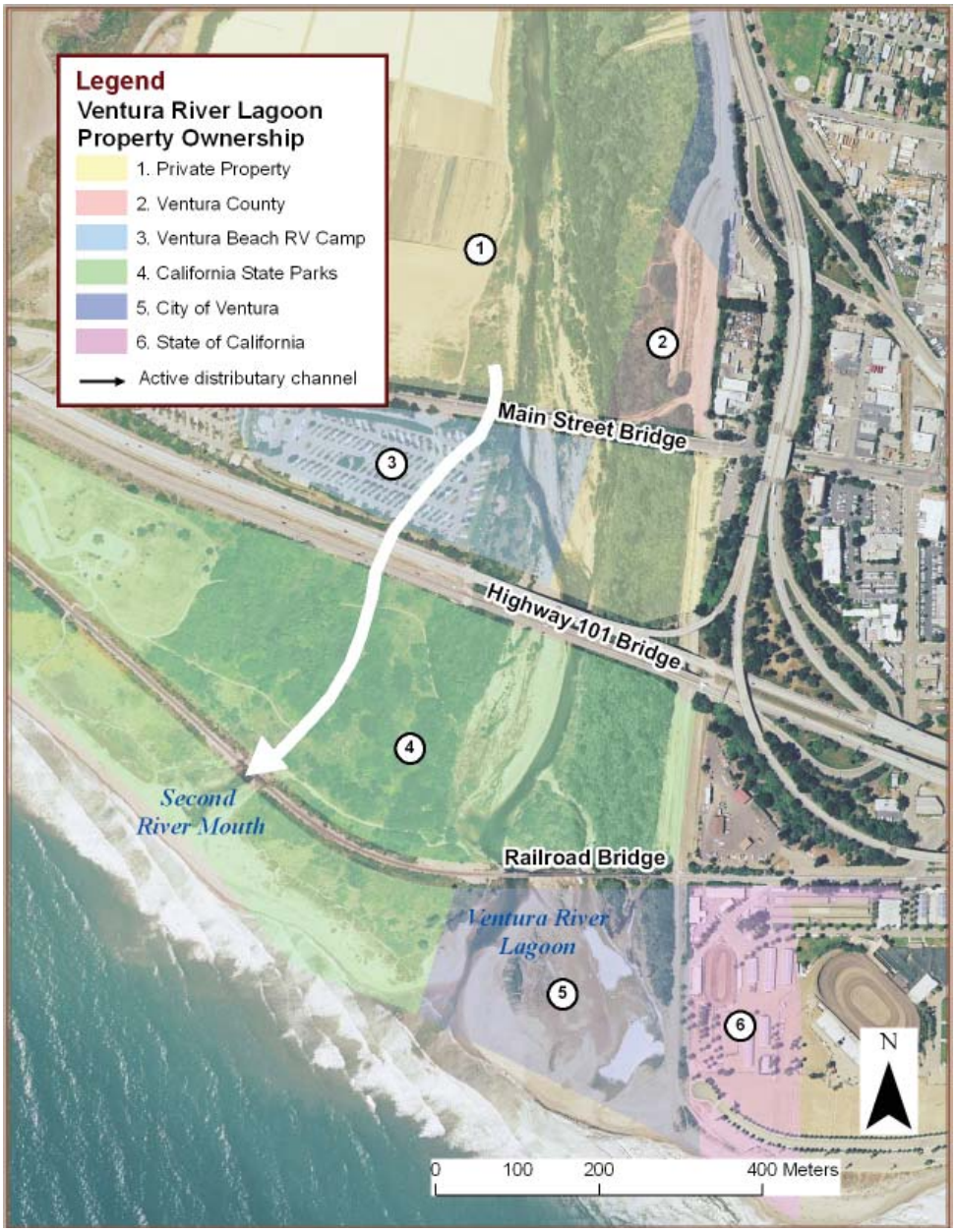

Figure 3: Property ownership of the Ventura River Estuary and surrounding area.

Impairments

The following issues are resulting in habitat impairment at this location:

Loss of historic wetlands

Historic construction activities, beginning with construction of the railroad in the late 1800s, have resulted in significant loss of wetland habitat in the Ventura River Estuary (Wetlands Research Associates, 1994). Subsequent construction of Main Street in 1932, Highway 101 in 1964, the Ventura Beach RV Camp in 1987, Emma Wood Group Camp, and the installation of oil pipelines and adjacent agricultural development have further encroached into the estuary and surrounding floodplain. This encroachment has resulted in a significant loss of wetland habitat in the estuary.

Disruption of flood plain processes

In the late 1800s, the Southern Pacific Transportation Corporation recognized that a 'second' river mouth sustained by an active western distributary channel was located to the west of the existing river mouth (Keller and Capelli, 1992). This second river mouth sustains seasonal fresh/brackish wetland habitat and is itself sustained by seasonal flood flows. The railroad company constructed a two-span bridge over the Ventura River in 1914. The western span of this bridge was constructed over the second river mouth out of recognition that the western distributary channel could wash out the railroad tracks during floods. In 1970, the western span was removed and replaced with fill material. This deposit of fill material dramatically interferes with the natural high-flow scour and depositional processes which sustain the second river mouth, resulting in significant degradation of wetland habitat at this location.

Flooding and property damage

Severe flooding has repeatedly caused property damage in and around the Ventura River Estuary. Records of severe flooding in the area date back over 100 years. On Christmas day of 1867, local newspapers reported three feet of water on Main Street due to flooding of the Ventura River. In January 1911, the Southern Pacific Railroad bridge spanning the estuary and Ventura River washed out. In 1914, the Main Street bridge was destroyed by flood waters. The Ventura Free Press reported on February 27, 1914, "Certainly the Old Ventura River went crazy. It swelled up and writhed about like

a monster constrictor, cutting new channels and filling old ones, carrying away fields and building new ones down the line."

Despite these historic records, continued development within the alluvial river delta overtime has resulted in significant flood damages in recent years. In 1992, a flood with a calculated recurrence interval of 22 years (Keller and Cappeli, 1992) caused over $1 million in damages to the Ventura Beach RV Park as well as extensive damage to Emma Wood State Beach. The 1992 flood threatened the safety of visitors staying at the RV Park when river flows increased from gauged measurements of 100 cubic feet per second to 46,700 cfs in less than three hours (Keller and Cappeli, 1992). Despite these issues, the City of Ventura voted to allow the RV Camp to rebuild and remain at its location with no changes to its permit following the 1992 flood. As a result, the RV Park sustained additional damage in 1993 and again in February 1998 when the Southern Pacific Railroad bridge was also damaged (Capelli, pers. comm.). Until these facilities within the floodplain are either modified to accommodate greater flood flows or are removed from the floodplain entirely, future damages to property and infrastructure will inevitably occur.

Figure 4: Ventura River flood at Main Street in 1914 Photo Credit: Ventura County Museum of History & Art.

Figure 5: Foster Park bridge washed out by flooding in 1914. Photo Credit: Ventura County Museum of History & Art.

Figure 6: In 1993 the Southern Pacific Railroad bridge was severely damaged by flood waters. Photo credit: Mark Capelli.

Figure 7: Evacuations at the Ventura Beach RV Camp in 1993.

Agriculture

The acreage to the northwest of the Ventura River Estuary (north of Main Street) has been developed as agricultural land for decades. Based on analysis of historical photographs, portions of agricultural development have encroached onto the floodplain, where infilling has also apparently occurred. Flooding of this area during major storms, along with stormwater runoff transports nutrients and other pollutants bound in agricultural sediments into the lower river and estuary. Additional impacts to wildlife, riparian habitat and water quality are also likely to exist due to the immediate proximity of row crops to the river and riparian corridor. Throughout most of the area, the only buffer between row crops and the riparian zone is a compacted dirt access road. This facility is off-limits to the public and provides no recreational value to the surrounding community.

Figure 8: Flooding of agricultural lands adjacent to the Ventura River Estuary is known to occur. Photo credit: Mark Capelli.

Homeless encampments and trash

Humans have regularly inhabited the Ventura River Estuary and other areas of the lower Ventura River since at least the 1940s. Currently, hundreds of transient individuals set up camp in the river bottom (Brown, pers. comm.), and these encampments

have significant impacts on the ecology of the estuary.

Enormous amounts of garbage are generated by the expansive network of homeless encampments that persists in the river bottom. Local agencies, volunteers, and community groups have worked for decades to periodically sweep portions of the river bottom of garbage. A 1995 Los Angeles Times article (Wilson, 1995) describes a massive volunteer cleanup event that occurred consisting of 150 individuals who attempted to remove the remnants of about 40 encampments from the lower Ventura River after being damaged by floods and abandoned. The article describes volunteers being, "startled to learn that people were actually living down in the river brush, and angered at the amount of debris they uncovered."

Figure 9: A camp site in the Ventura River Estuary surrounded by garbage.

Figure 10: In 2010 alone, over 16 tons of garbage were removed from the Ventura River Estuary.

Sadly, this problem has persisted. In recent years, numerous volunteer cleanup efforts hosted by the City of Ventura and community groups have continued to target the estuary. In 2010 alone, nearly 16 tons of garbage were collected from the lower river and estuary by volunteers during two massive cleanup events (Brown, pers. Comm.). These events targeted only a small portion of homeless encampments in the area. The garbage produced by homeless encampments is harmful to wildlife, hazardous to the public, a nuisance, and source of pollution to the river, estuary, and ocean.

Homeless encampments cause many other impacts as well. Over a period of decades, individuals have created an extensive network of walking paths and camping areas, trampling vegetation and damaging native habitat. Homeless individuals are known to bring pets down the river, and it is likely that over time this has resulted in the release and propagation of feral animals that now live in the estuary and impact wildlife (Hunt, 1994). Illegal fishing or poaching by transient residents in the estuary and lower river is also known to occur. The homeless encampments pose a significant threat to water quality during storms due to the lack of sanitary facilities in the river bottom. Illegal activity is also known to occur in the transient encampments, causing community members to avoid the area, which limits public appreciation of this significant environmental and recreational resource.

Figure 11: A community member removes hundreds of paint containers from the estuary during a volunteer cleanup event.

Graffiti pollution

Graffiti artists are another significant source of pollution in the Ventura River Estuary. After using the walls and support beams of the Main Street and Highway 101 bridges as canvasses for their artwork, graffiti artists leave behind paint cans and spray paint bottles. Over time, large quantities of spent or unused containers of paint are discarded in the river bottom. Many of these containers are not completely empty and are left open leaking paint into the environment. Volunteers regularly remove hundreds of paint containers from the area, but abandoned containers often end up in the river and lagoon nonetheless.

Invasive vegetation

Several species of invasive vegetation, including giant reed (Arundo donax) have overtaken much of the estuary area as well as the surrounding riparian corridor and coastal dune habitat.

Water quality

The Ventura River Estuary is listed on the State's "303(d)" List of Water Quality Limited Segments for multiple impairments including algae, eutrophic conditions, total coliforms, and trash. The presence of algae and eutrophic conditions within the estuary is the result of complex bio-chemical processes. These processes are driven in part by inputs of biostimulatory substances into the river, which are transported to the lagoon and result in algae blooms, plant growth, and the eventual decomposition of organic matter. The river also serves as an additional source of organic material as dead algae and plants are washed into the lagoon. Eutrophic conditions are most likely to occur when the sand berm closes off the lagoon from the ocean, which eliminates tidal flushing and allows for the accumulation and eventual decomposition of organic material.

Restoration Recommendations

Restoration of the Ventura River Estuary is considered a priority action for Steelhead recovery by National Marine Fisheries Service. At least two prior reports have focused on restoration opportunities within the Ventura River Estuary, including the Ventura River Estuary Enhancement and Management Plan (Wetlands Research Associates, 1994) and the Vision Plan for a Lower Ventura River Parkway (Escario et al., 2008) developed for the Trust for Public Land. Although these reports differ somewhat in their approaches, they generally share the same common goals of enhancing wetland ecological resources and recreational opportunities for the public.

Collaborative partnerships should be formed between the California State Parks, the City of Ventura, and a non-profit land conservancy such as the Ventura Hillsides Conservancy to implement restoration recommendations that have been outlined in prior reports. Restoration strategies outlined in prior reports include:

Re-construct a double span railroad bridge to restore flood flows to the second river mouth

According to the 1994 Estuary Enhancement and Management Plan, enhancement of the second river mouth requires restoration of the self-maintaining system of floodplain processes that were interrupted by construction of the railroad. In order to restore flood plain processes, the railroad bridge should be reconstructed to provide, as once existed, a western span to allow floodwaters to flow into the second river mouth. Restoring this connectivity would allow for subsequent habitat restoration at the second river mouth. Conceptual plans for such restoration activities are included in the Estuary Enhancement and Management Plan.

Restore the Ventura Beach RV Camp

The City of Ventura should prohibit reconstruction of the RV Camp within the floodplain the next time it is damaged. This could be done through amendments to local floodplain or zoning ordinances. A local land conservancy could then negotiate with the property owner to acquire the land for restoration purposes. The Trust for Public Land (TPL) Ventura River Parkway Vision Plan outlines restoration concepts for the RV Camp property, including restoration of the eastern portion of the parcel into wetland habitat and the development of an interpretive center on the western portion.

Remove invasive plants

The 1994 Estuary Enhancement and Management Plan describes a strategy for removal of invasive vegetation and restoration of native plants around the lagoon at the Emma Wood Group Camp, at the adjacent Seaside Wilderness Park, and along the shoreline coastal dunes. Since it was written, some of the recommendations for restoration of the Group Camp have been implemented by the State Park. Additional restoration recommendations for the surrounding areas have yet to be implemented. The Plan recommends that over-arching hydrologic issues, such as restoration of floodplain processes at the second river mouth be dealt with before significant vegetative restoration work is conducted. The 1994 Plan also recommends using low-impact mechanical removal methods wherever possible to minimize ecosystem impacts from chemical applications and heavy equipment. Removal of invasive giant reed in the estuary area should be incorporated into a broader program to eradicate the plant throughout the entire watershed, beginning first with the upper watershed and moving downstream.

Enhance public access

Public access should be enhanced through trail construction and maintenance, installation of viewing stations, and the development of an interpretive center. Informal trails created by transient inhabitants should be removed and restored. Enhanced access corridors should connect various areas of interest including the Ventura Bike Path, Emma Wood Group Camp, a second river mouth viewing station, and the Ventura Wilderness Trail. Safe pedestrian crossing over the estuary should also be considered to prevent individuals from utilizing the railroad bridge for this purpose. These concepts are outlined in both the Parkway Plan and Estuary Enhancement and Management Plan.

Expande the eastern border of wetlands

The TPL Ventura River Parkway Vision Plan also calls for expansion and enhancement of the estuary on its eastern border through the removal of the eastern levee, restoration of historic wetland currently occupied by the Ventura Fairgrounds, and construction of pedestrian pathways. While removal of the Fairgrounds or a portion of the Fairgrounds may face significant political obstacles, there is a scientific basis that may support the eventual abandonment or relocation of the facility for the purpose of wetland restoration. Sea level rise is an issue that community planners are now being forced to address. In May 2010, the City of Ventura approved $1.6 million in funding for a managed shoreline retreat project at Surfer's Point in front of the Fairgrounds to restore beach area and mitigate erosion problems. The project has been designed to accommodate 1.5 feet of sea level rise (Jenkin, Pers. Comm.). According to the California State Coastal Conservancy, by 2100 sea levels could be expected to rise by 5.5 inches. While the upper IPCC estimate already exceeds the 1.5 foot rise accommodated by the Surfer's Point project, many scientists predict that more abrupt changes in sea level associated with increased melting of the polar ice caps could reach levels of as much as 23 feet (NRC, 2002). In either case, it is likely that local officials will have to address long-term sea level rise issues at the Fairgrounds. Relocation of the Fairgrounds to a more suitable location and restoration of historic wetlands could be considered a prudent and proactive approach to this coastal management issue.

The Estuary Enhancement and Management Plan offers an alternative solution to mitigate impacts of the Fairgrounds on the estuary. It recommends installation of a strip of native vegetation between the eastern levee and the Fairgrounds to serve as a visual and auditory barrier to reduce impacts to sensitive species.

Additional Recommendations

Acquire and restoration of adjacent agricultural development

The TPL Ventura River Parkway Vision Plan (Parkway Plan) identifies the agricultural land on the western bank of the river upstream of the estuary as the potential southern entry point for a Ventura Wilderness Trail that would provide the surrounding community with public access along the western bank of the Ventura River from Main Street to Foster Park. The Parkway Plan identifies the existing hard-packed dirt access road currently used for agricultural purposes as a conduit for public access along the western river corridor. The Parkway Plan provides a conceptual design for a project that provides public access while preserving agricultural activities that currently exist on-site within the floodplain. The provision of public access and enhancement of recreational opportunities on the land as part of a Ventura River Parkway project would provide significant benefits to the surrounding community.

It is recognized, however, that the existing agricultural development poses potential impacts to water quality and habitat due to its presence within the floodplain and immediate proximity to the river. A preferable approach that prioritizes habitat restoration could instead be to pursue the conversion of agricultural operations within the active flood plain to restored riparian habitat. A local land conservancy organization could pursue conservation easements or acquisition of a portion or all of the property through negotiations with the landowner. The area could still serve as a southern entry point for the Ventura River Parkway utilizing features developed in the Parkway Plan. Such a project might not necessarily preclude compatible agricultural activities from still occurring on the property.

Address pollution and impacts associated with homeless encampments

The presence of homeless individuals in the Ventura River Estuary and the question of how to deal with the impacts they cause is extremely complex and requires consideration of a number of difficult issues including social services, poverty, mental illness, and substance abuse. While these issues are well beyond the scope of this report, the fact remains that human habitation within the estuary causes major environmental impacts.

Ultimately, to achieve pollution targets established in the Los Angeles Regional Water Quality Control Board's (LARWQCB) existing Total Maximum Daily Load (TMDL) for trash in the Ventura River as well as to ameliorate additional impacts to habitat and wildlife, local agencies and property owners within the floodplain need to work together with law enforcement officials to restrict access and prevent the establishment of encampments. Doing so will produce substantial consequences for the surrounding community and resources as displaced individuals seek out alternative accommodations. It is likely that many displaced individuals will simply move further up into the watershed or into another watershed where the presence of law enforcement is less intensive. While it is beyond the scope of this report to develop alternative housing recommendations or solutions to Ventura County's homeless issues, suffice it to say that humane housing alternatives will need to be developed by local agencies to prevent transferring the environmental impacts from the Ventura River Estuary to another area. Because of the multi-jurisdictional nature of the Ventura River Estuary and surrounding watershed, it is imperative that local agencies and landowners work in a coordinated fashion to resolve this issue.

Address graffiti associated pollution

Similar to the issue of homeless encampments, pollution associated with graffiti activities in the Ventura River Estuary is complicated by a broad array of social issues that are beyond the scope of this report to address. However, the most obvious mehod of reducing pollution associated with these activities is to more effectively enforce local ordinances that prohibit graffiti and dumping. This would likely require increasing the presence of law enforcement during both daylight and nighttime hours when illegal activities could be expected to occur. Over time, an increased law enforcement presence should help deter individuals from entering the area for such purposes. In the meantime, local agencies and community groups should continue to support and host clean-ups targeting the bridges to remove paint containers before they are washed into the river and estuary.

Alternative prevention strategies may also be available. The City of Ventura recently revamped its graffiti prevention program by installing cameras in some areas and utilizing the internet to document and monitor graffiti activity throughout the city. The City should consider installing surveillance systems in the Ventura River Estuary. A variety of additional anti-graffiti enforcement measures have been implemented by regional municipalities with varying degrees of success. The most effective of these programs generally incorporate some form of community-based graffiti removal and neighborhood beautification efforts. Many cities have also promoted "free-graffiti" areas as a way to provide alternative, legal locations for graffiti art. The Venice Beach Art Walls project, for example, requires artists to submit pencil sketches for approval and then allows the legal use of walls in a designated area. The City could choose to construct 'art walls' somewhere along the bike path corridor to provide a legal alternative for artwork, while simultaneously increasing law enforcement presence in the area. Regardless of what method the City chooses to pursue, there is no question that the graffiti pollution problem is significant in the Ventura River, and to effectively meet local TMDL targets, additional attention and effort needs to be expended to address the issue.

Control non-point source pollution sources

During drier years, when sand berms that frequently block the lagoon mouth are most likely to persist, relatively high concentrations of nutrients and warm temperatures can contribute to periodic algal blooms and eutrophic conditions. Although under these conditions most of the nitrate entering the Ventura River is assimilated by algae and aquatic plants before reaching the estuary, concentrations of phosphorus and organic nitrogen typically remain excessive (Leydecker, 2010). The decay of accumulated organically enriched sediment washed down from above, especially in semi-isolated sections of the lagoon, adds to the problem. To improve water quality in the lagoon, nutrient inputs to the Ventura River need to be reduced. To do so, various non-point sources of nutrients will need to be addressed.

Currently, the Los Angeles Regional Water Quality Control Board is developing a Total Maximum Daily Load (TMDL) program for the algae impairment on the Ventura River. The program will set numeric limits on nutrient inputs from multiple sources to reduce concentrations in the river that are arguably linked with algae growth and eutrophic conditions in the estuary. While limits will likely be imposed for effluent from the upstream Ojai Valley Sanitary District wastewater treatment plant, the improvement of water quality in the lagoon will also depend on the region's ability to target and address non-point nutrient sources including faulty or leaking septic tanks, improperly sited leach fields, equestrian activities, ranching, irrigated agriculture, groundwater pollution and urban runoff.

Watershed Urbanization along Lower Ventura Avenue

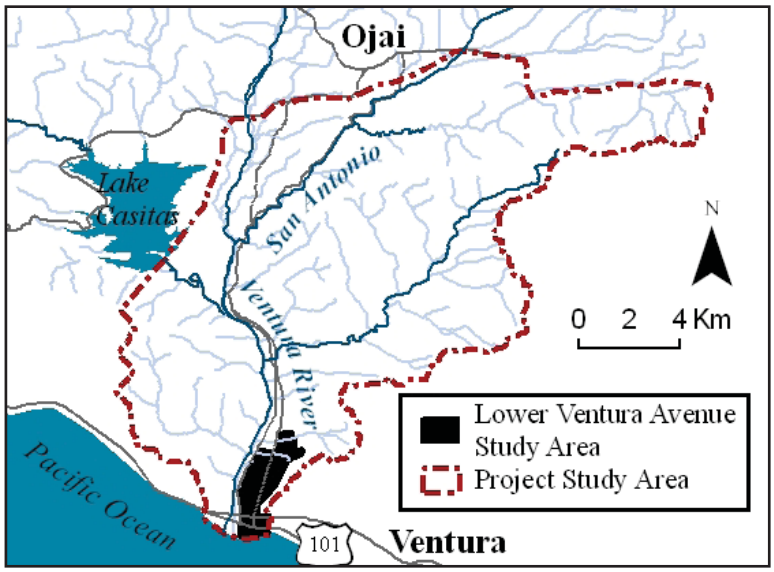

Figure 12: Lower Ventura Avenue Study Area

The lower (southern) end of Ventura Avenue on the eastern side of the Ventura River is one of the most highly urbanized areas in the Watershed. For the purposes of this project, Channelkeeper delineated the lower Ventura Avenue study area (Figure 12) to examine how urbanization has impaired the watershed and to identify potential opportunities for urban watershed restoration.

Intensive commercial, residential, and industrial development has occurred along Ventura Avenue, beginning at the Ventura Fairgrounds near downtown Ventura and extending upstream (north) all the way to the Cañada de San Joaquin Creek. Beyond Cañada de San Joaquin Creek, land use is dominated by industrial oil and natural gas development activities. These activities are addressed elsewhere in this report, but some oil and natural gas production does occur within the lower Ventura Avenue study area as well. Our study area is entirely encompassed by the City of Ventura.

Impairments

The following issues are resulting in habitat impairment at this location:

Watershed Urbanization

The vast majority of the Ventura River watershed remains undeveloped. In fact, urban development accounts for only 6.7% of the entire watershed (VCWPD, 2009). However, portions of the watershed have been severely degraded as a result of urbanization. Nowhere is this more apparent within our project area than along the Ventura Avenue corridor.

The lower Ventura Avenue study area suffers from impacts that are characteristic of intensive urbanization. Numerous studies have demonstrated that urbanization of watersheds has resulted in significant impacts to freshwater and saltwater wetlands (Wright et al, 2006). National wetland tracking studies conducted by the United States Fish and Wildlife Service show that urban and rural development accounts for greater than 60% of freshwater wetland loss, and most losses are the result of incremental development on parcels of less than five acres (Dahl, 2000; Dahl, 2006). Construction activities associated with urban development such as draining, dredging, and filling result in habitat loss. Wetland hydrology can also be significantly affected by removal of vegetation, an increase in impervious surfaces, installation of storm drainage systems, and construction of roads and bridges (Schueler, 1987). These alterations increase peak flows during storms, decrease groundwater recharge (Schueler, 2001), and often result in flow constrictions (Gailbrath et al., 2005) that may result in flooding and or stream bank erosion problems. Urbanization can also lead to degradation of

water quality as pollutants are washed from homes, streets, and businesses to wetlands during storms or dry weather nuisance flows (Brabec et al., 2002; Beach, 2002).

Stream Alterations

In the past, watershed management throughout the lower Ventura Avenue study area focused primarily on flood control. The small ephemeral tributaries that existed in the area were nearly all converted into city storm drains to convey runoff from storms to the Ventura River as quickly as possible. As a result, an extensive network of concrete drains and tunnels now spans this sub-watershed, and pollutants move freely to the Ventura River and the beach during storms.

Figure 13: Canada de San Juaquin Creek as it heads underground at Ventura Avenue

Very little riparian habitat remains in the lower Ventura Avenue study area due to historic stream alterations. What little riparian habitat remains is primarily located within Cañada de San Joaquin Creek. Cañada de San Joaquin (CSJ Creek) is a small ephemeral creek located at the northern end of the lower Ventura Avenue area. This creek has been significantly impacted by adjacent residential, agricultural, and industrial land uses. Lower CSJ Creek has been converted into an underground concrete box culvert that begins at its intersection with Ventura Avenue and extends underground through industrial land-uses to the Ventura River a half-kilometer downstream. Above Ventura Avenue, CSJ Creek is severely encroached upon by adjacent land uses. The southern side of the creek is bordered by agriculture and oil development. The northern side is bordered by residential development. The upper watershed of CSJ Creek is heavily utilized for oil development.

The impacts of adjacent land uses can be visually observed in CSJ Creek. Numerous pipelines located in the creek channel extend the length of the creek (Figure 13). Severe stream bank erosion is threatening adjacent homes along Dakota Drive. Based on stream bank conditions, the dominant presence of fine particles in stream bed substrate, and adjacent agricultural and oil development, it is likely that CSJ Creek is a significant source of sediment to the Ventura River during storms. A bank stabilization project for CSJ Creek is slated for implementation in the VCWPD Integrated Watershed Protection Plan.

Due to the severity of historic channel alterations throughout this area, the potential for in-stream habitat restoration is nearly non-existent. Drainages throughout the area lack a regular supply of surface water. Most of the water that is available is urban runoff nuisance flows of poor and insufficient quality to support aquatic life. Efforts to 'daylight' or restore underground drainages to provide in-stream habitat would be enormously expensive and complicated.

Impervious surfaces

Many studies have demonstrated a positive correlation between the degree of effective impervious cover throughout a watershed and water quality degradation in adjacent surface waters. Effective impervious cover is a term used to define impervious surfaces that drain to the storm drain system rather than to a pervious area such as a lawn or garden. Impacts to streams from increased impervious surfaces in a watershed include increased frequency of flooding and peak flow volumes, increased sediment loadings, loss of aquatic/riparian habitat, changes to physical stream characteristics (channel width and depth), decreased base flow, and increased stream temperature (Horner et. al., 1994). Literature also suggests that impervious cover as low as 8% – 12% of watershed area may result in negative impacts to biotic communities (Brabec et al., 2002; Beach, 2002). The lower Ventura Avenue study area is well over this impervious cover threshold, so water quality impacts are occurring and of concern.

Without accurate urbanized sub-watershed boundaries, it is difficult to determine the percentage of impervious cover in a meaningful way, and more thorough watershed modeling needs to occur to enable estimates of specific pollutant loads from this urbanized area. However, based on Ventura County Assessor data and our own calculations, we were

able to estimate impervious acreage throughout the area categorized by land-use.

Table 1 displays impervious acreage by land use type in the lower Ventura Avenue study area. Streets and highways account for the largest proportion of impervious surface in the study area. Despite having a much lower percent imperviousness, residential lots account for the next largest portion of impervious surface coverage due to the large amount of existing residential development. Industrial parcels rank third, with "services" (mainly comprised of schools) a close fourth.

Table 1. Lower Ventura Avenue study area estimated impervious cover by land-use

Land-use	Acres	% Imperviousness	Impervious Acreage
Industrial	227	76% (a)	173
Residential	371	51% (b)	189
Resource Production	60	4% (b)	2.4
Services	276	50% (c)	138
Streets and Highways	223	96% (b)	214
Trade	43	86% (d)	37
Transportation/Commercial/Utility	116	96% (e)	111
Ventura Fairgrounds	62	50% (f)	31
Total	**1,378**	**65%**	**895**

a) Approximated from aerial photographs based on average percent imperviousness of 10 randomly selected parcels. S.Dev = 27%
b) California EPA. July, 2008
c) Primarily schools. Percent cover extrapolated from 'public/quasi public' category in California EPA. July, 2008
d) Approximated from aerial photographs based on average percent imperviousness of 10 randomly selected parcels. S.Dev = 17%
e) Primarily parking lots. Percent cover extrapolated from 'urban roads' category in California EPA. July, 2008
f) Approximated from aerial photographs

Stormwater Management

Due to the high degree of development in the study area and the relative proximity to the Ventura River Estuary and Surfer's Point, the primary concern for this area is the potentially significant contribution to water quality degradation during storm events and from dry weather nuisance flows. Currently, the nearest County stormwater mass emissions monitoring site is located upstream near the Ojai Valley Sanitary District, so stormwater quality from the lower Ventura Avenue study area remains uncharacterized. The Ventura Countywide Stormwater Quality Urban Impact Mitigation Plan includes a list of existing pollutants of concern for the region including total and fecal coliform, mercury, PAHs, DDT and byproducts, diazinon, sediment/TSS, chlorpyrifos, copper, lead, thallium, bis(2-ethylexyl)phthalate, and phosphorus.

In the winter of 2007, Channelkeeper conducted a full-suite monitoring event at the Ventura River Estuary. A sediment sample was collected at a location in the estuary directly downstream of an urban storm drain outfall. The sample was sent to certified analytical laboratories for chemical analyses for metals, chlorinated pesticides, organo-phosphorus pesticides, pyrethroid pesticides, and aquatic toxicity. Toxicity effects were not observed in the sample, but multiple chemical contaminants were identified. Both selenium and zinc were detected in concentrations well above screening levels used by NOAA to evaluate potential contaminant sources to aquatic habitats of concern (Bachman, 1999). Additionally, very small concentrations of pyrethroid pesticides were also detected in the sediment sample, indicating that a potential pollutant pathway is present.

Since 2000, the County and City of Ventura have managed stormwater through the Ventura Countywide Stormwater Quality Management Program (VCSQMP) to address urban stormwater pollution. As required by California's General Permit for Stormwater Discharges From Municipal Separate Storm Sewer Systems, the VCSQMP outlines a variety of Best Management Practices (BMPs) that are implemented to reduce stormwater pollution to the maximum extent practicable. Many of these BMPs apply to the lower Ventura Avenue study area. They include education and outreach programs for businesses and residents, business inspections, land development guidelines, construction site management guidelines, illicit discharge controls, and good housekeeping practices for public facilities and activities.

The City has undertaken additional measures in recent years to address stormwater quality. For example, two dry weather diversion stations have been installed to divert dry weather runoff to the City's wastewater treatment plant. One of these stations is located on Figueroa Street, near Surfer's Point. Additionally, the City has recently approved a policy to incorporate "Green Street" elements into repaving projects on a citywide basis. This policy is described in greater detail below in the "Street Retrofit Opportunities" section in Appendix A of this report. Despite these measures, however, stormwater pollution is still a significant problem throughout the region.

Restoration Recommendations

The following recommendations should be considered by local watershed managers in an effort to promote the restoration of the lower Ventura River watershed.

Implement Low Impact Development techniques as an alternative approach to stormwater management

Low Impact Development (LID) is a term used to describe approaches to stormwater management that aim at managing stormwater runoff close to the source using the natural environment. According to the EPA, "LID employs principles such as preserving and recreating natural landscape features, minimizing effective imperviousness to create functional and appealing site drainage that treat stormwater as a resource rather than a waste product. There are many practices that have been used to adhere to these principles such as bioretention facilities, rain gardens, vegetated rooftops, rain barrels, and permeable pavements" (USEPA, 2009). LID techniques are generally designed to infiltrate, evapotranspirate, and reuse runoff. Through these processes, numerous benefits to water quality, flood control, wetland habitat, and urban aesthetics can be achieved. Studies indicate that significant cost savings can be achieved by utilizing LID techniques versus traditional stormwater practices (USEPA, 2007).

According to United States Natural Resource Conservation Service maps, nearly the entire Ventura Avenue study area is classified in the Hydrologic Soils Group B. Group B soils typically exhibit an infiltration capacity of 0.5 – 1.0 inches per hour (VCSQMP, 2001). Generally, Group B soils are considered good candidates for LID projects that rely on stormwater infiltration.

Local agencies are already beginning to incorporate LID concepts into local ordinances and planning efforts. The VCSQMP has published a Technical Guidance Manual for Stormwater Quality Control Measures that includes several LID concepts. Many improvements to existing stormwater infrastructure will be eventually be phased in through new requirements on redevelopment projects. However, improvements to stormwater quality through redevelopment in the lower Ventura Avenue study area will take a very long time and by themselves will likely not be adequate to achieve the community's water quality improvement goals.

Channelkeeper developed a list of potential urban watershed retrofit projects for the Ventura Avenue area. These projects are outlined in Appendix A of this report.

Conduct a sub-watershed hydrological assessment

A sub-watershed assessment should be conducted before any rigorous stormwater management retrofit program is undertaken. Such an assessment needs to identify accurate sub-watershed boundaries using updated storm drain information, and it needs to include hydrologic modeling to identify volumetric treatment targets that would be required

to achieve various goals such as protection of water quality, groundwater recharge, flood protection, and stream bank protection.

Determine treatment capacity of available stormwater management projects

Further investigations need to be conducted to identify additional stormwater retrofit opportunities not listed in this document. Additional assessment will be required to determine the treatment capacity of each available project.

Bundle and prioritize projects to achieve watershed goals

Once the volumetric treatment targets and capacities have been calculated, watershed managers will need to examine the feasibility of individual projects. In addition to cost, individual project constraints will also need to be identified such as low soil permeability, topography, adjacent structures or utilities, maintenance requirements, and property ownership constraints. Conducting this assessment will allow managers to then bundle and prioritize individual projects to achieve various treatment targets in the most efficient manner.

Develop a tiered watershed improvement plan

To successfully implement projects, local agencies will need to take advantage of multiple implementation strategies. By creatively combining retrofit projects with financing, education, subsidies, permit coordination and stormwater regulations, the amount of watershed acreage covered can be maximized (Schueler et al., 2007). An effective, long-term program will need to utilize multiple LID techniques and will need to bundle improvement projects with new City projects, redevelopment plans for the Ventura Avenue area, and ongoing City maintenance. By combining projects with educational, recreational, and environmental improvements, an effective watershed improvement program will provide multiple benefits that will attract State and Federal grant funding to aid with initial construction and design costs.

Utilize existing community groups to promote a residential retrofit and education program

The City should work with existing community and environmental groups to educate and encourage residents to implement simple on-site residential retrofits such as the installation of rain gardens, rainwater storage tanks, infiltration devices such as French drains, and conservation landscape measures. Such efforts would provide valuable water quality and water conservation benefits while also helping the City achieve its municipal stormwater permit education and outreach requirements. Early participating residences can serve as demonstration projects to help educate other community members.

Intensify efforts to minimize the amount of trash entering the municipal storm sewer

Project surveyors identified significant amounts of trash in the municipal storm sewer throughout the lower Ventura Avenue Study Area. Santa Barbara Channelkeeper's Stream Team monitors have identified local storm drains as a significant source of trash to the Ventura River. The City should intensify efforts to implement standard measures designed to prevent trash from entering the storm drain. Such measures include installation of catch basin inserts, enhanced street sweeping, education and outreach, promotion of volunteer neighborhood cleanup efforts, improved trash bin and container management, enhanced anti-litter and dumping enforcement, and, where necessary, the installation of trash separator devices (Santa Clara Valley, 2004).

Enhance education, inspection, and enforcement activity for commercial and industrial businesses through implementation of the City's Stormwater Management Program.

Based on county land use data, over 300 acres within the study area is currently occupied by industrial or commercial land uses. Many of the activities associated with these land uses serve as potential hot spots for stormwater pollution. The best way to address such hot spots is through pollution prevention practices implemented through the City's Stormwater Management Program.

The Ventura Avenue Oil Field and Petrochem Plant

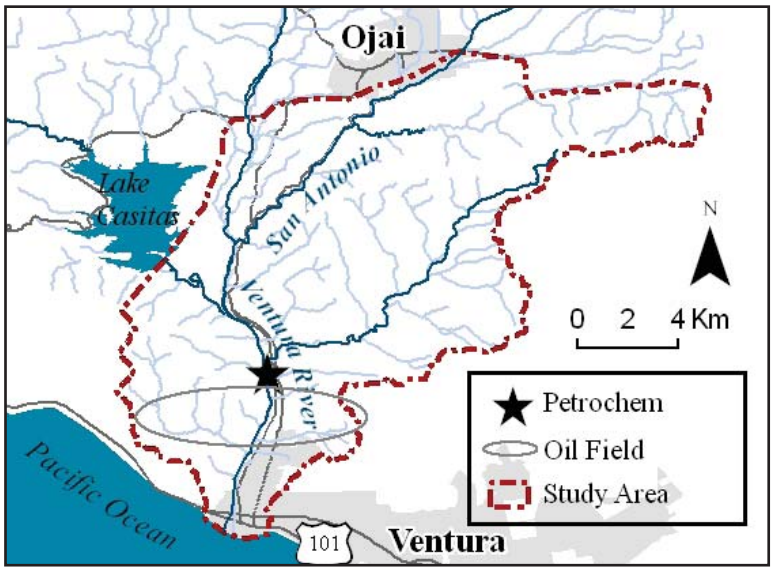

Figure 14: The Ventura Avenue Oil Field and Petrochem Plan location.

Approximately 2.5 miles upstream from the mouth of the Ventura River lies the Ventura Avenue Oil Field. The Oil Field covers roughly 3,000 acres of the Ventura River watershed. Spanning miles into the Ventura hillsides both east and west of the river, the Ventura Avenue Oil Field has been utilized for oil and natural gas production since the early 1900s. The Oil Field is clearly visible from Ventura Avenue when traveling north from the Cañada de San Joaquin drainage (near Dakota Drive) to Cañada de Las Encinas, which lies just south of Cañada Larga Road. Oil wells, drilling pads, equipment storage areas, buildings, and a vast network of pipelines are prevalent throughout the area. Though field operations are clearly visible from the Avenue, the majority of wells and facilities are actually blocked from public view due to the hillside topography.

Oil and gas operations within the Ventura Avenue Oil Field are primarily conducted by Aera Energy LLC. According to Aera, their facilities produce on average 11,500 barrels of crude oil and 7,000 mcf (one thousand cubic feet) of natural gas per day.

Impairments

The following issues are resulting in habitat impairment at this location:

Stormwater pollution

Throughout the winter of 2009-2010, Channelkeeper conducted investigations of the Ventura Avenue Oil Fields from public right-of-ways along the Ventura Avenue corridor during a number of storm events. On these occasions, a significant amount of sediment-contaminated stormwater was observed washing off the oil facility landscape into the storm drain system. Indications of chemical contamination of stormwater runoff have also been observed The expansive oil development facility along Ventura Avenue and extending into the hillsides is a significant source of stormwater pollution to the Ventura River.

Habitat destruction

Decades of intensive industrial development throughout the Ventura Avenue Oil Field has resulted in the destruction of riparian and wetland habitat. According to local residents who lived in Ventura throughout the 1930s and 1940s (J. Capitoe, E. Henke, Pers. Comm.), the most prominent fishing and swimming hole in the area, the Gosnell Hole (also

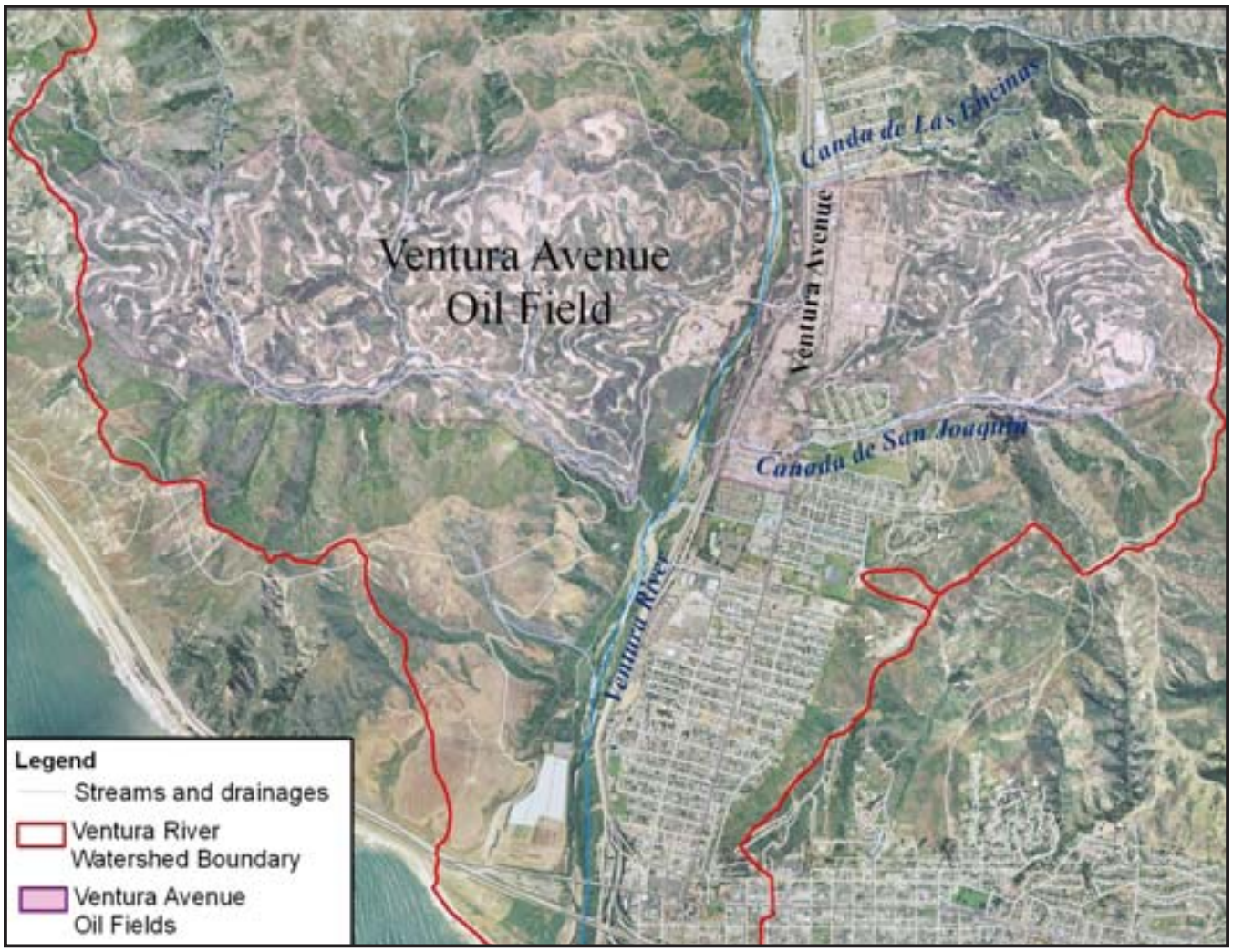

Figure 15: The Ventura Avenue Oil Field.

once known as 2-mile hole), used to be located at the oil field just west of the two-mile bend along Ventura Avenue. The Gosnell Hole, named after a physician that lived nearby, was once connected to the Ventura River and was large enough that locals occasionally launched boats there for fishing. The Gosnell Hole was a well-known location for steelhead. It is believed that hyporheic exchanges between ground and surface water kept water temperatures in the Gosnell Hole cool, creating productive steelhead habitat that was frequently used by so called "early arrival" fish that had just migrated upstream from the estuary (E. Henke, Pers. Comm.). In the late 1930s, extensive channel modification was performed along the river by the oil companies for flood control and construction purposes. By the early 1940s, the Gosnell Hole had been permanently detached from the river and severely degraded.

Figure 16: Chemical and sediment contaminated runoff from oil development facilities during a storm.

Remnants of the Gosnell Hole can still be found. A small pond remains in the area, although it is no longer connected to the Ven-

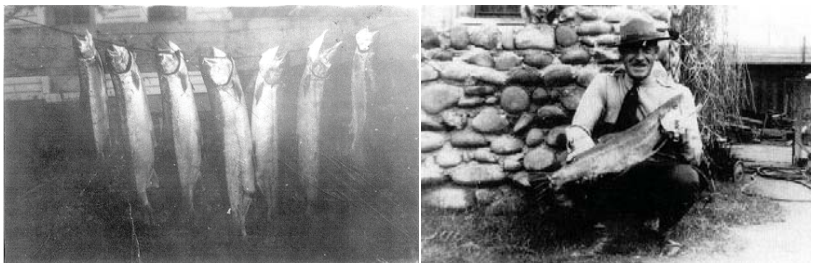

Figure 17: Left: Steelhead caugt by Jack Dent and August Hahn out of the Gosnell Bend/2-Mile Hole in February, 1924. Right: Ernie Bedwell, Ventura and Santa Barbara County California Division of Fish and Game Warden holding a 30-inch steelhead caught out of the Gosnell Bend/2-Mile Hole in the Winter of 1926. Photos provided to Ed Henke by Jack Bedwell in 1996 and Jack Dent in 1989.

Figure 18: Gosnell Hole remnant pond.

tura River by way of surface flows and is supported only by subsurface seeps. Remnants of the Hole's adjacent wetlands also still exist. Small springs supporting emergent aquatic vegetation can be observed from Ventura Avenue and the Ventura River bike path in many locations throughout the area.

The loss of the Gosnell Hole was perhaps one of the biggest impacts that the historic Ventura Avenue Oil Field development had on lower river habitat, although clearing, grading, and culverting of small riparian drainages east of the river still occurs. During a storm in March 2008, Channelkeeper witnessed a small ephemeral tributary to the Ventura River being graded and culverted to provide drainage for drilling operations. This activity resulted in a heavy flow of mud that filled in a portion of the river.

Historic groundwater contamination

Historic oil development activity in the lower Ventura River watershed has degraded groundwater resources (Mann and Stone, 1957). In the earlier years of oil development, standard practice for disposing of produced water (brines and hydrocarbons) was to release it to natural drainages, settling ponds (sumps), or ocean outfalls. It was quite common for wastewater from nearby sumps to spill directly into the Ventura River (E. Henke, Pers. Comm.), causing fish that were caught downstream to taste like oil and become inedible (Henke, 1994). Sumps also resulted in the infiltration of produced water into the shallow alluvium along the lower Ventura River, which had severe impacts to groundwater from five miles inland to the ocean (Mann and Stone, 1957)

Today, according to the Department of Conservation, produced water from the Ventura Avenue Oil Field is ultimately disposed of through re-injection into disposal wells deep below the aquifer. Re-injection activities take place under the oversight of the Department of Conservation's, Division of Oil, Gas and Geothermal Resources (DOGGR). According to DOGGR (2009), 42,900,000 barrels of water were produced from oil wells in the Ventura Avenue field in 2009 and disposed of through re-injection.

It has been suggested that groundwater quality in the lower watershed has improved over time due to continuous discharge of treated effluent into the Ventura River from the Ojai Sanitary District Wastewater Treatment Plant (J. Correa, R. Baggerly, Pers. Comms.). Ventura County maintains a groundwater quality database, and a minimal amount of historic water quality data exists from wells located south of the Ventura Avenue Oil Field. Recent well data from two shallow wells in this area (< 100 ft) shows that State Water Quality

Figure 19: Recent construction activities (left) activities have resulted in the deposit of sediment and fill in the Ventura River (right).

Objectives (WQOs) for groundwater are being met. One of these wells is located along the western bank of the Ventura River at Taylor Ranch. The other is located at the Ventura Beach RV Park. Data on file from two deeper wells also exists, which indicate that deeper groundwater does not meet State WQOs. One of these wells is located at Emma Wood State Beach. The other is located near the Ventura Avenue Oil Field east of Ventura Avenue near the Cañada de Las Encinas drainage. This well is over 400 feet deep and exceeds State WQOs for total dissolved solids, chloride, sulfate and boron based on available data.

Petrochem Plant

Perhaps the most compelling and prominent example of historic industrial activity in the Ventura Avenue Oil Field is the idle Petrochem refinery located along the banks of the Ventura River just north of the Avenue well field. The facility was originally built by Shell Oil Company in 1953 and operated as a urea fertilizer plant throughout the 1950s and 1960s. The fertilizer plant shut down shortly after losing a lawsuit in 1969 for discharging ammonia into the river, which resulted in severe mortality to downstream aquatic life (E. Henke, Pers. Comm.) Following the plant's closure, USA Petroleum took over the site and operated it as a chemical refinery from 1974 to 1984. During the years that it was operated as a refinery, the County Fire Department responded to 23 fires, spill, or accidents at the facility, and former employees and residents anecdotally documented regular chemical releases to the air, soil and water (Reed, 1992). In 1984 the Citizens to Preserve the Ojai blocked a planned expansion of the Petrochem refinery in court citing air quality concerns. Since that time, the plant has been idle.

An extensive array of abandoned metal tanks, pipelines, metal structures and concrete pads still litter the facility, which covers over 35 acres of floodplain immediately adjacent to the Ventura River. Soil and groundwater contamination beneath the facility has been identified, and limited efforts are currently underway to remediate and monitor portions of the site, although cleanup efforts have fallen behind schedule due to fiscal insolvency of the owner (D. Salter, Pers. Comm.). A full scale site assessment, however, has yet to be conducted, so the extent of contamination is currently unknown. Such an assessment will have to be completed, along with environmental and zoning clearances from local agencies before the property can be redeveloped.

The Petrochem facility is located within the floodplain and has constricted the meandering pathway of the Ventura River. It has a history of flooding during large storms, causing property damage and contamination of the river. The Petrochem facility is also considered a significant source of visual blight in the watershed by many members of the surrounding community.

Restoration Recommendations

The following recommendations should be considered by local watershed managers in an effort to promote the restoration of the lower Ventura River watershed.

Remediate and restore the Petrochem plant

The Petrochem plant has been targeted by various investors and developers as a potential Brownfield redevelopment site for many years. Although most entities who have assessed the property have aimed to redevelop the site for light industrial or commercial uses, from an environmental standpoint, the greatest improvement to the habitat value of the Ventura River would come from a coordinated effort to remediate this property and gradually incorporating it into the larger effort to develop a Ventura River Parkway.

The Trust for Public Land's (TPL) Vision for a Ventura River Parkway document outlines a blueprint for remediation of the site that focuses on demonstrative phytoremediation techniques partly as a means of generating community interest and support. While the TPL Parkway Vision allows for an open allowance for multiple types of future land use, it stresses that such land uses must be compatible with natural floodplain processes. The Parkway Vision describes the development of a "Refinery Park" that celebrates the history of oil development in the watershed while also providing amenities for cultural gatherings and community events.

With habitat restoration as a primary focus, any proposed redevelopment of the Petrochem site should incorporate reclamation of the river's active floodplain and channel. Remediation techniques employed at the site should be selected with the goal of eventual floodplain reclamation in mind. The existing channel constriction caused by construction of levee structures and infilling should be eliminated and generous buffers should separate the riparian corridor from other developed land uses. These restoration components should be required as conditions of any future redevelopment that occurs at the site.

Install Stormwater Best Management Practices

BMPs should be adopted to minimize and prevent stormwater pollution throughout the entire oil field by oil and gas developers. BMPs should be implemented around all active and idle drilling pads, storage areas, and roads. Regular inspections and compliance monitoring should be performed to ensure that such practices are being implemented effectively.

Inventory and assess historic wetlands

A study should be completed to inventory and assess the current status of the remnant wetland habitat at the Gosnell Hole. It is likely that the remnant spring-fed ponds throughout the area still provide important habitat for wetland wildlife. This study should identify measures to protect remnant habitat from future drilling operations and should explore opportunities for restoration and enhancement.

Enhance monitoring and enforcement by local agencies

Local regulatory agencies such as the Regional Water Quality Control Board, the Ventura County Environmental Health Department, and the California Department of Fish and Game should focus resources and attention on the Ventura Avenue Oil Field to ensure that water quality protection measures are implemented, non-permitted grading and infilling of wetland habitat does not occur, and cleanup requirements for contaminated areas are met.

Cañada Larga Creek

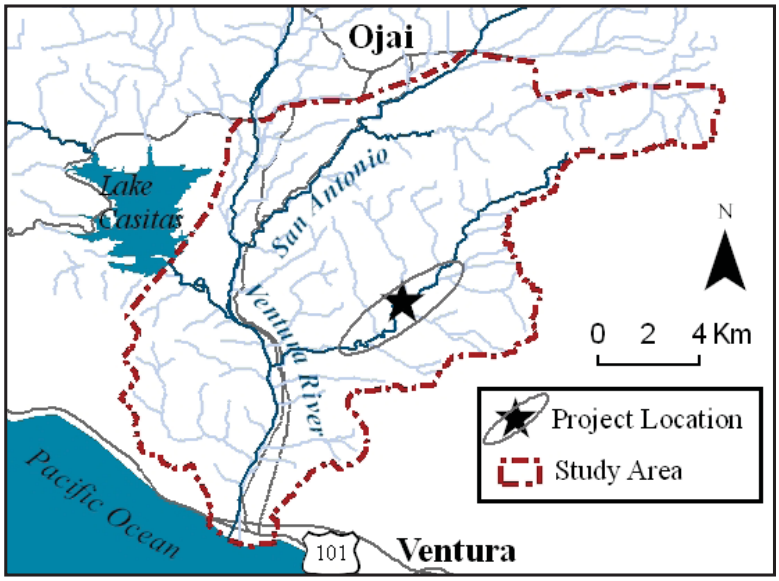

Figure 20: Location of Canada Larga Creek.

Cañada Larga Creek is an ephemeral tributary that joins the Ventura River approximately 4.5 miles upstream of the Ventura River Lagoon. The land in the Cañada Larga valley is privately owned and has been used for decades for ranching and farming. Currently, the dominant land use throughout the entire valley is pasture land for cattle grazing. A small number of ranch homes and livestock enclosure facilities have been constructed. A public road extends up the valley for approximately four miles until it becomes private. Otherwise, the valley remains mostly undeveloped, and the creek itself meanders relatively undisturbed from its headwaters in the Ventura hillsides to Highway 33. At this point, the remaining half-mile of Cañada Larga Creek, before it joins the Ventura River has been extensively modified for flood control purposes.

Two Channelkeeper Stream Team monitoring sites have historically been located along Cañada Larga Creek. Site 5 was historically located 3.5 miles up Cañada Larga Road, at a small bridge over the creek. Regular monitoring of Site 5 was discontinued in the summer of 2008 in an effort to reallocate and optimize monitoring efforts. Until the summer of 2008, Site 4 was located under the Ventura Avenue bridge, one-tenth of a mile upstream of the Ventura River confluence. In August 2008, Site 4 was permanently moved a few meters upstream of the confluence itself.

Impairments

The following issues are resulting in habitat impairment at this location:

Stream bank erosion

A choke point in has been created approximately 2.75 miles up Cañada Larga Creek by the construction of a bridge along Cañada Larga Road. Severe erosion has occurred downstream of this choke point. Widespread, year–round cattle grazing has also severely impacted stream banks and hillsides, likely exacerbating erosion problems. As a result, stream bank erosion is quite severe along Cañada Larga Creek. Along significant stretches of the creek, stream banks appear to be vertical in angle and bank collapse is causing a loss of pasture area. It is likely that significant erosion will continue to occur until a new hydrogeological equilibrium is achieved.

Figure 21: Severe erosion has affected stream banks along Canada Larga Creek.

Figure 22: The Canada Larga Creek confluence with the Ventura River. Canada Larga Creek enters from the right of each frame. These photos were taken during storms that occurred on February 7, 2009 and February 6, 2010 (left to right).

Water quality impairments

Grazing activities have impaired water quality in Cañada Larga Creek. Grazing cows deposit large quantities of manure along the hillsides of the canyon and within the floodplain of Cañada Larga Creek. Fifty-four of 85 of Channelkeeper's Stream Team E.coli samples collected from Cañada Larga Creek between January 2001 to March 2010 exceed the Los Angeles Regional Water Quality Control Board's Basin Plan water quality objective (235 MPN/100 ml). During storms, animal waste is washed off the landscape and into Cañada Larga Creek, often producing the highest bacteria levels exhibited at any Stream Team monitoring site. Cañada Larga Creek is listed on California's 303(d) List of Water Quality Limited Segments for the Los Angeles Region for fecal coliform, low dissolved oxygen, and total dissolved solids.

Turbidity is also extremely high at this location within the creek during and after storms. Widespread grazing has removed most of the vegetation that would otherwise hold soil in place during storms, exacerbating erosion and causing large volumes of sediment to enter the creek. During storms, turbidity levels are often high enough in Cañada Larga Creek that they exceed the maximum detection limits of Stream Team monitoring equipment (1,100 NTUs). The severity of the problem can often be viewed during storms at the confluence of Cañada Larga Creek and the Ventura River where, by contrast, cloudy creek water is orders of magnitude greater in turbidity than the relatively clear river water (Figure 22).

Table 2. Turbidity comparison (NTUs) at Ventura River above the Cañada Larga Confluence (Site 3.5) and at the downstream terminus of Cañada Larga Creek (Site 4)

Date	Turbidity at Site 3.5	Turbidity at Site 4
2/7/2009	8.83 NTUs	313.33 NTUs
2/6/2010	30.37 NTUs	554 NTUs

Restoration Recommendations

The following recommendations should be considered by local watershed managers in an effort to promote the restoration of the lower Ventura River watershed.

Develop a conservation and restoration plan for Cañada Larga Creek

Despite the water quality and erosion impairments created by cattle grazing, the Cañada Larga valley and creek have significant value as open space and wildlife habitat. However, due to its proximity to the City of Ventura, the land within Cañada Larga valley has significant development potential. Urban development within close proximity to the

creek could be detrimental to existing habitat value. Given the geological instability of the floodplain and flashy nature of Cañada Larga hydrology, development in the floodplain would likely face flood control and erosion issues. It is likely that these issues would be addressed and mitigated through development of 'hard' flood control projects such as bank armoring or channelization that would be incompatible with existing wildlife habitat. Local conservation groups should take advantage of any opportunity that exists prior to development to form collaborations with the property owner in the interest of preserving and enhancing habitat. Such collaborations could take the form of either acquisitions or conservation easements. These efforts should focus on the floodplain and wide buffers on either side of the creek to preserve the natural meandering processes that occur in this watershed. In the event that development within Cañada Larga Canyon precedes conservation efforts, developers should be required to incorporate conservation and restoration goals into any project that is approved. No project should be approved that results in the permanent modification of Cañada Larga Creek for flood control purposes.

Conduct stream bank restoration

Once conservation arrangements have been made, a plan for restoration of creek habitat could be developed. Significant benefits to habitat quality could be gained through strategic stream bank stabilization. These efforts should also be combined with strategies to exclude cattle from the floodplain or stream banks. Denuded stream banks should be restored with native riparian vegetation. These efforts would further enhance habitat by improving water quality. The Natural Resource Conservation Service's (NRCS) Environmental Quality Incentives Program (EQIP) provides funding and technical assistance to growers and ranchers undertaking voluntary measures to address threats to soil, water, air, and related natural resources on their land. The EQIP program could perhaps serve as a resource for restoration efforts along Cañada Larga Canyon.

Preservation of the floodplain and its buffers would have the added benefit of providing significant public recreation opportunities. Cañada Larga Creek is currently inaccessible to the public. Given its close proximity to Ventura Avenue neighborhoods and the creek's existing nexus with the Ventura River bike path, a trail or bike path extending up the canyon would significantly enhance outdoor recreation opportunities for the surrounding community.

Adopt livestock exclusion policies for surface waters and stream banks

Allowing cattle to graze in streams and along stream banks can cause significant ecological damage. The State and County should adopt strict policies that prohibit livestock from accessing these areas. Existing Federal Confined Animal Feeding Operation (CAFO) requirements do not apply to smaller livestock enclosures or to pasture lands. Other states have adopted policies to protect surface waters from these land uses. Kentucky and Wisconsin are both states that have broadened their water quality protection policies to apply to not only livestock enclosures but also to pasture lands (Dexter, 2010). In both states, livestock in pasture lands are prohibited from contacting surface waters. Erosion and water quality problems would be further improved in the Ventura River watershed by expanding exclusions to accommodate stream banks and buffer areas.

Figure 23: Livestock in Canada Larga valley.

Cañada Larga Creek Livestock Enclosure

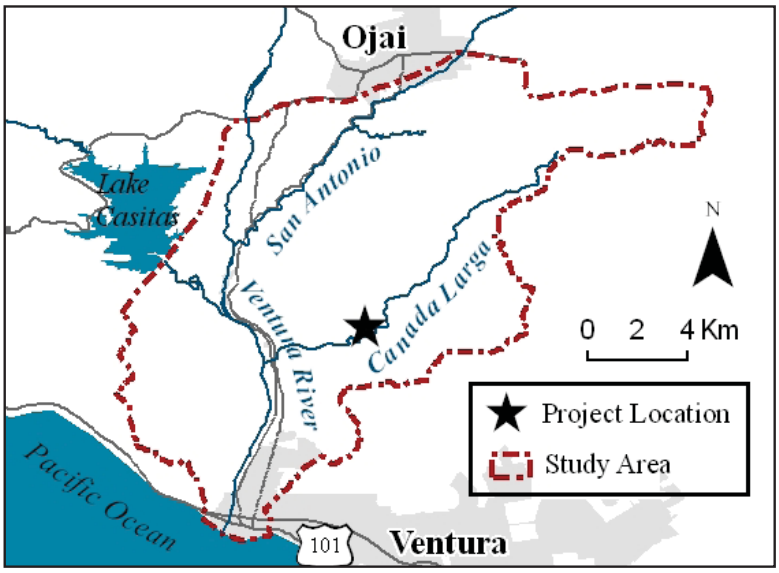

Figure 24: Location of Canada Larga Creek livestock enclosure.

A livestock enclosure is maintained on the north side of Cañada Larga Road approximately two miles from Ventura Avenue. This enclosure is constructed on top of a small, ephemeral tributary to Cañada Larga Creek named Cañada de Aliso.

Impairments

The following issues are resulting in habitat impairment at this location:

In-stream livestock enclosure

Although grazing cattle have access to Cañada Larga Creek and its tributaries throughout most of Cañada Larga Canyon, the Cañada de Aliso enclosures concentrate large numbers of animals in the immediate vicinity of the tributary. During the wet season, cattle have direct access to the tributary where animal waste is directly deposited. Runoff from storms also carries pollutants from adjacent animal containment areas into the tributary. This site is a significant source of microbial, nutrient, and sediment pollution to Cañada Larga Creek and the Ventura River.

Figure 25: Large numbers of cattle being loaded into a cattle enclosure overlying a tributary to Canada Larga Creek.

Restoration Recommendations

The following recommendations should be considered by local watershed managers in an effort to promote the restoration of the lower Ventura River watershed.

Livestock exclusion and manure management

This livestock enclosure should be modified or relocated so that animals do not have direct access to Cañada de Aliso Creek. Physical barriers should be constructed to exclude all physical contact with livestock. Manure management BMPs for proper collection, storage and disposal of animal waste should be implemented throughout the facility to prevent contamination of the creek with animal waste during storms. Treatment BMPs such as filter strips and buffer areas should also be implemented on site. Once these measures are in place, vegetative restoration using native riparian plants could restore habitat value and provide further water quality benefits to the tributary.

Live Oak Creek Livestock Enclosure

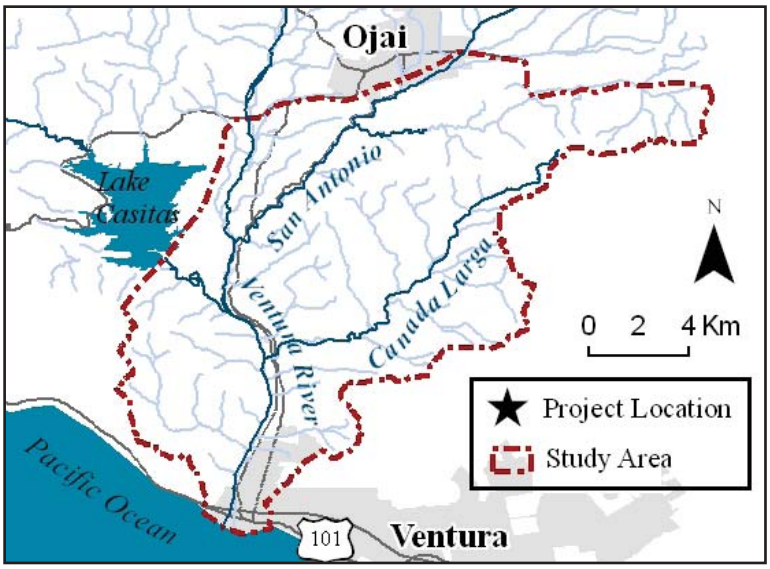

Figure 26: Location of Live Oak Creek livestock enclosure.

Live Oak Creek is an ephemeral tributary to the Ventura River that originates in the hillsides northeast of Lake Casitas. Live Oak Creek runs an extent of roughly five kilometers before joining the Ventura River, through the heart of the Live Oak community, where it has been severely degraded by encroachment and channel alterations for flood control purposes. Approximately one-half kilometer upstream of its confluence with the Ventura River, Live Oak Creek is joined by a small tributary that drains the adjacent hillside and runs through livestock and equestrian facilities near the intersection of Santa Ana Road and Santa Ana Boulevard.

Impairments

In-stream livestock enclosure

Livestock and equestrian enclosures have been constructed directly on top of the small tributary that flows for much of the year to the Ventura River. Animals such as cattle, buffalo and horses have direct access to this small drainage throughout most of the year, including during periods when the tributary is flowing. Animal waste is directly deposited into the drainage, and contaminated water from this site flows directly to the Ventura River. This site is a source of microbial, nutrient, and sediment pollution.

Figure 27: Photos taken on February 8 2010, March 24 2009 and April 7 2006 (left to right) demonstrate the presence of livestock and animal waste in a Live Oak Creek tributary.

Restoration Recommendations

The following recommendation should be considered by local watershed managers in an effort to promote the restoration of the lower Ventura River watershed.

Livestock exclusion and manure management

The livestock and equestrian facility should be modified to prevent animals from contaminating the Live Oak Creek tributary. Physical barriers should be constructed to prevent all physical contact with livestock. Manure management BMPs for proper collection, storage and disposal of animal waste should be implemented throughout the facility to prevent contamination of the creek with animal waste during storms. Treatment BMPs such as filter strips and buffer areas should also be implemented on site. Once these measures are in place, vegetative restoration using native riparian plants could restore habitat value and provide further water quality benefits to the tributary.

Stream Bank Restoration at Highway 33 and Creek Road

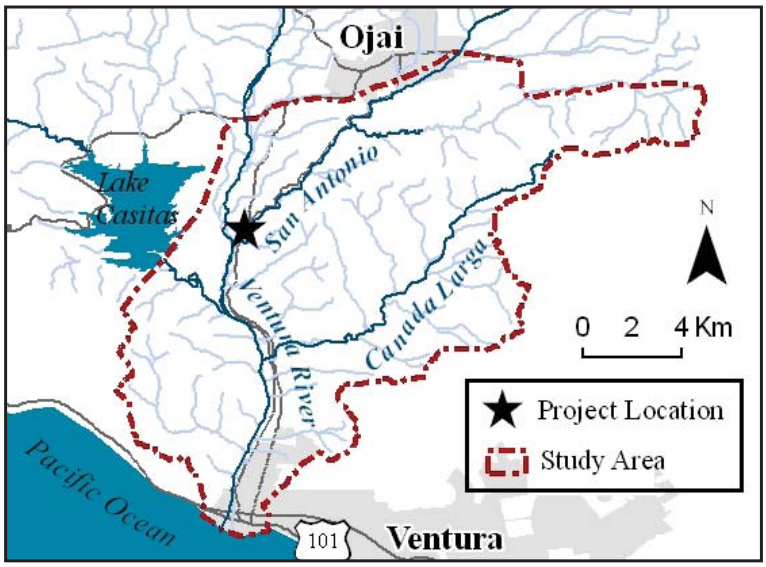

Figure 28: Location of San Antonio Creek stream bank impairment.

Highway 33 skirts the top of San Antonio Creek's stream bank just south of the community of Oak View. As San Antonio Creek flows out of the Ojai area, it makes a near 90-degree bend where it abuts Highway 33, approximately one kilometer before the creek's confluence with the Ventura River.

Impairments

The following issues are resulting in habitat impairment at this location:

Stream bank erosion

Heavy stream flows generated by winter storms in 2004 – 05 caused severe erosion along the outer stream bank of San Antonio Creek near Creek Road. The erosion destroyed riparian vegetation along the stream bank and also undermined Highway 33, prompting emergency repairs.

Emergency repairs were made to the creek bank and road including: 1) temporary diversion of the stream channel away from the toe of the slope; 2) clearing and grubbing of vegetation to allow for equipment access, staging and storing of materials; 3) recontouring of the slope; and 4) placement of ungrouted rock to stabilize the toe of slope. These repairs further denuded the stream bank of vegetation. Nearly 200 meters of stream bank were impacted by these measures.

Figure 29: Stream bank repair work and surface water diversion in 2005 (Photo credit: Paul Jenkin).

The U.S. Army Corps of Engineers issued a Regional General Permit (RGP) 63 for these emergency repairs to Highway 33. The RGP 63 required special conditions including revegetation of the stream bank with native plants and trees. In 2006, CalTrans applied hydromulch and installed a significant number of tree plantings at the project site, but they were unsuccessful in maintaining the plantings. To date, no trees have been successfully installed and maintained along the stream bank and the area is covered predominantly by exotic annual grasses and other non-native plants.

Restoration Recommendations

The following recommendations should be considered by local watershed managers in an effort to promote the restoration of the lower Ventura River watershed.

Stream bank revegetation

Although revegetation of the stream bank with riparian trees is technically a mandatory permit condition, it is important to highlight this site as an impaired area until revegetation is successfully achieved. Restoration should include the planting and maintenance of riparian trees such as cottonwoods, sycamores, and willows. The trees must be maintained until they are mature enough to survive without watering.

Figure 30: (August 2010) failure to maintain restored riparian trees.

Provide tree canopy shade

Unfortunately, revegetating the stream bank itself may not provide the benefits of shade and temperature control to San Antonio Creek. An unpaved access road was installed between the base of the stream bank and the creek when the highway was repaired, and a compacted access road prevents vegetation from growing between the creek and toe of the slope. In-stream root wad habitat features were installed in the creek when the highway repairs were completed, but these features cannot provide the full benefit they were intended to provide without adequate shade from riparian vegetation. Willow plantings and other riparian vegetation should be installed between the road and stream to provide shade and other benefits to the creek.

Residential Stream Bank Restoration along San Antonio Creek

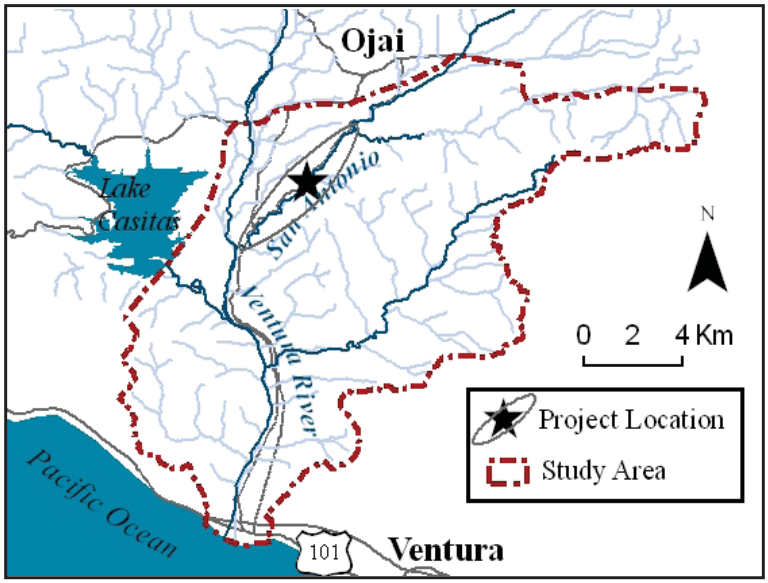

Figure 31: Project location.

Hundreds of private property parcels abut San Antonio Creek as it flows from Soule Park Golf Course to its confluence with the Ventura River. Land use of private properties along this portion of San Antonio Creek is primarily a mixture of single family residential homes and small equestrian operations. This portion of San Antonio Creek contains critical habitat for the endangered Southern California steelhead, is considered important to Ventura River steelhead production and recovery. San Antonio Creek has been identified as the second priority reach for steelhead recovery actions in the Ventura River watershed following the Matilija tributaries (ENTRIX, 2003).

Impairments

The following issues are resulting in habitat impairment at this location:

Stream bank modifications

Stream bank modifications caused by decades of residential and agricultural encroachment into the flood plain have cumulatively degraded riparian and aquatic habitat in San Antonio Creek. Historically, effective policies prohibiting development within the flood plain were not implemented. As a result, homes, other buildings, utilities and roads have all been constructed in extremely close proximity to the creek. The San Antonio Creek watershed can produce tremendous volumes of runoff during storms. Flooding in San Antonio Creek has repeatedly destroyed homes, damaged public infrastructure, and caused injury or death to local residents. Public and private bank armoring projects have frequently been employed as the primary means of minimizing flooding damages.

Figure 32: Rock rip-rap bank armoring protecting a private property along San Antonio Creek.

Numerous public bank armoring projects have been constructed along San Antonio Creek, many of which have incorporated the use of large boulder rip-rap. This material has been used along significant stretches of the creek to protect public resources such as Creek Road and utilities including the Ojai Valley Sanitary District's sewer lines. In many cases, installed boulder rip-rap has been left un-grouted. Over decades, this has allowed

Figure 33: Deposition of rocks and boulders to protect an unvegetated and severely eroding stream bank where property damage has occurred.

re-growth of riparian vegetation in the spaces between boulders to occur along protected banks, but these projects have cumulatively reduced the amount of riparian vegetation and canopy cover along the creek. These armoring projects have also altered the natural meandering in-stream hydrogeologic forces, resulting in increased stream velocities and exacerbating downstream erosion and flooding problems.

In response to ongoing flooding hazards, many private residents along San Antonio Creek have implemented their own stream bank armoring projects using a variety of methods including pouring concrete, building walls, installing rip rap, and constructing earthen levees. Many of these projects occurred historically without permitting or oversight by State and local resource management agencies. As a result, these projects have cumulatively impacted riparian habitat along San Antonio Creek.

Flooding and stream bank erosion continue to be a problem along San Antonio Creek. As recently as 2005, severe flooding caused significant stream bank erosion and property damage. Property owners will continue to look for opportunities to stabilize and armor stream banks on their property to prevent damages. Currently, regulatory agencies have minimal capacity to monitor the floodplain to identify new modifications, and it is likely that further impacts to riparian habitat will occur.

Restoration Recommendations

The following recommendations should be considered by local watershed managers in an effort to promote the restoration of the lower Ventura River watershed.

Establish a community watershed group or council

Local watershed groups can be a popular and effective means of coordinating and engaging community members to become watershed stewards. Such a group in the San Antonio Creek watershed could pursue funding opportunities, facilitate educational programs and events, and help establish bonds and partnerships among a diverse group of stakeholders. The Carpinteria Creek Watershed Coalition in Carpinteria provides a good model and resource for citizens in the San Antonio Creek watershed who may be interested in developing their own watershed group.

Develop a homeowner education and outreach program

Most of San Antonio Creek runs through private property. There will be an ongoing need for property owners to address flooding and erosion issues, so targeted homeowner education and outreach program is needed to raise awareness about habitat issues associated with stream bank modification and to provide information about alternative methods of restoring and stabilizing stream banks.

Pursue demonstration projects with willing landowners

Partnerships between restoration groups and willing landowners should be pursued to do stream bank restoration projects that improve habitat and help protect private property. Public funding is often available for this purpose and could be pursued to implement a series of stream bank stabilization demonstrations projects in the San Antonio Creek watershed.

Conduct monitoring and enforce the floodplain management ordinance and other stream bank alteration policies

Local regulatory agencies such as the Department of Fish and Game and Ventura County Planning Division have authority to conduct creek inspections. Agencies should begin conducting regular monitoring of stream bank conditions and properties along San Antonio Creek to document existing stream bank modifications and identify new un-permitted bank modifications or floodplain development projects that negatively impact riparian and aquatic habitat and take appropriate enforcement actions when necessary.

Horses and Animal Husbandry

The Ventura River watershed is home to many horses and horse-boarding facilities. No database exists to provide an accurate count of the number of horses in the watershed. A nutrient source assessment report (Larry Walker Associates, 2009) estimated that approximately 2,000 horses may reside in the watershed, but this estimate was based on the personal observations of a community member and not an actual survey data. A 'preliminary' survey of horses in the watershed conducted by Hawks & Associates in October 2009 counted 792 horses, although the actual number of horses living in the watershed is likely greater.

Few if any horses are located south of the Cañada Larga Creek confluence with the Ventura River. North of the confluence, horses and equestrian boarding facilities are spatially distributed throughout the rest of the watershed. Within the study area, the San Antonio Creek sub-watershed contains the greatest concentration of horses and equestrian boarding facilities. Multiple equestrian trails are also located within the watershed, including the Ojai Valley Trail from Foster Park to Ojai as well as trails within the Ventura River Rancho El Nido Preserve. The rural nature of the Ventura River watershed is also well-suited for additional types of small-scale animal husbandry, so many landowners raise small animals such as goats, pigs, and chickens on their residential properties.

Impairments

The following issues are resulting in habitat impairment at this location:

Water quality degradation

Equestrian facilities throughout the watershed pose a threat to water quality. Horses produce a large quantity of manure. A 1,000 pound horse produces approximately fifty pounds of manure per day, or about ten tons per year, and from six to ten gallons of urine per day (Livestock and Land Program). Based on a literature review of estimated rates of nitrogen output from horse manure, Larry Walker Associates calculated that horses in may deposit anywhere from 232,226 to 928,906 pounds of nitrogen into the Ventura River Watershed every year. Although illegal dumping of manure into waterways is a known occurrence, the vast majority of this animal waste is deposited on land where it may eventually be transported to streams.

Waste from horses and other animals may be washed into streams as a result of improper disposal of wash-water during cleaning of equestrian facilities. During storms, runoff from equestrian facilities without adequate BMPs can transport contaminants to storm drains and streams. Contaminants may also soak into the ground during storms, infiltrate into the water table and eventually reach streams and the river via sub-surface flows.

Contamination of the river, streams, and ocean from horse excrement can pose a risk to human health. Zoonotic diseases in humans due to contact with horse excrement do exist and may be present in the Ventura River watershed. Salmonellosis, Giardia,

Figure 34: A manure pile left uncovered at an equestrian boarding facility near the Ventura River during a storm in December 2010.

Figure 35: A pipe discharging contaminated storm water from an equestrian boarding facility. When analyzed, this discharge exceeded maximum detection limits for fecal indicator bacteria tests.

and Crytoporidium parvum (Marcella, 2009; Westendorf, 2009) are all organisms that may be present in horse manure and may cause illness in humans via fecal to oral transmission. Leptospirosis is a water-borne illness that can spread from exposure to horse urine (Westendorf, 2009). Disease transmission risk from horses to humans has not been well researched, though studies focused on assessing risks to hikers from exposure to manure on backcountry trails concluded that such risks are generally insignificant (Ford et al., 1997; Johnson et al., 1997). Backcountry conditions, however, are quite different than those within the Ventura River watershed where relatively large numbers of horses (up to 158 at one location according to Hawks & Associates) are kept at individual boarding facilities in close or immediate proximity to the Ventura River or its tributaries. Given the extensive recreational use that occurs both in the Ventura River itself (i.e. at the San Antonio Creek confluence) and at Surfer's Point, human health risks due to contamination of water with horse waste should be considered a realistic concern.

Restoration Recommendations

The following recommendations should be considered by local watershed managers in an effort to promote the restoration of the lower Ventura River watershed.

Develop and implement a program to provide outreach, education and technical assistance for horse owners to improve manure management.

Currently, there is no program in Ventura County that offers targeted outreach and education for horse owners about manure and equestrian facility management to protect water quality. Local agencies and organizations should develop a program to provide education and technical assistance for horse owners who want to implement BMPs on their properties.

A good example of a horse manure management and education program is the Livestock and Land Program based in Santa Cruz, CA. In 2005, Ecology Action, a Santa Cruz-based nonprofit environmental group, partnered with the Santa Cruz County Resource Conservation Districts to develop the Livestock & Land Program, a voluntary and non-regulatory program to help decrease the impacts of livestock facilities on local watersheds. The Livestock & Land Program works to implement water quality and watershed improvements by educating livestock owners on appropriate BMPs. The educational opportunities are conveyed via various forms of outreach including workshops, technical trainings and demonstration projects. Trained staff meet with interested ranch and land owners for free site visits and provide consultations to discuss runoff, erosion, and manure management issues. Participating landowners can apply for funding to help cover the costs of implementing some of the BMPs as part of the project.

To date the Livestock & Land Program has 18 demonstration sites throughout Santa Cruz, San Benito and south Santa Clara counties. Projects include installation of drainage features to prevent arena flooding, grass filter strip installation to filter sediment and nutrients from paddocks, and installation of erosion control features. Land owners participating in the demonstration projects serve as a resource for other community members.

Adopt a manure management ordinance

The City of Norco, California adopted a Manure Management and Disposal Ordinance in 2008. The Ordinance outlines BMPs and establishes regulations for the handling, temporary storage, collection and disposal of manure and requires livestock owners to participate in the City's manure collection program. Examples of regulations include requirements to remove manure from livestock-keeping areas on a weekly basis at minimum, a prohibition against the spreading of manure across keeping areas, storage and disposal specifications, and oversight of composting activities. Ventura County and the City of Ojai should consider adopting a manure management ordinance for the Ojai Valley.

Explore development of a bio-digestion facility

Hawk and Associates, a Ventura-based environmental consulting firm, is exploring the possibility of developing a bio-digestion system as a local cooperative to decrease the amount of equine waste that makes its way into surface waters. They have proposed a pilot project using new anaerobic digestion technology created at UC Davis that can handle

20 - 50 tons of waste and is capable of converting 60 to 90% of the organic solids to biogas. The biogas can then be used to produce electricity or be converted to compressed or liquid natural gas. Additional byproducts include liquid fertilizer and soil amendment byproducts, which could be sold or returned to the ranchers for their use.

Explore development of a manure composting businesses or co-ops

At least one small business currently works in the Ventura River watershed to collect manure from the area and distribute compost to local growers. Such programs could likely be expanded throughout the watershed, providing both green business opportunities as well as useful disposal methods for manure.

Streamline permitting processes for restoration projects

While a growing number of farmers and ranchers are interested in implementing small, environmentally beneficial projects on their lands, the time and complexity involved in obtaining multiple permits for each project often discourages them from moving forward (Lockhart, Pers. Comm.). According to Sustainable Conservation, an environmental group that works on streamlining permit processes for restoration projects throughout California, the permit process for landowners who want to implement restoration projects can involve up to eight government agencies, cost more than $1,000 in fees and take over a year. As part of their Partners in Restoration project, they have simplified and fast-tracked the permit process in specific regions of California for landowners who want to control soil erosion, improve water quality and enhance wildlife on their properties. Permit streamlining processes have been initiated in the Calleguas Creek watershed, but no such efforts have been implemented in the Ventura River watershed to date (Ingram, Pers. Comm.)

Fraser Street Low Flow Crossing

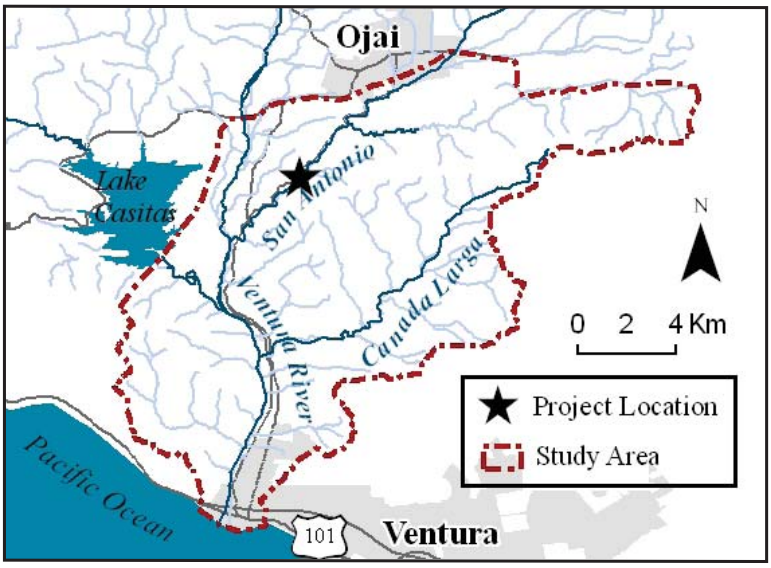

Figure 36: Project location.

Approximately 2.5 miles upstream of the confluence with the Ventura River, Fraser Street crosses San Antonio Creek. The crossing consists of a simple low-flow "Arizona crossing" that is paved with concrete.

Impairments

The following issues are resulting in habitat impairment at this location:

Steelhead migration impediment

The Fraser Street crossing is not considered a barrier to steelhead migration, however, it likely does act as an impediment and does block non-migratory movement of fish to suitable rearing habitat in low flow conditions (Entrix, 2003).

Restoration Recommendation

The following recommendation should be considered by local watershed managers in an effort to promote the restoration of the lower Ventura River watershed.

Explore potential for removal of arizona crossing

Local organizations specializing in fish barrier removal should communicate with the landowner to explore possibilities for removal or modification of the Fraser Street crossing. Landowners on the east side of the creek have extremely limited access to and from their property. Crossing San Antonio Creek during high flows may be impossible at times. A span bridge that eliminats impacts to the creek would provide ecological benefits as well as improved access to the private eastern parcels.

Figure 37: Fraser Street crossing.

San Antonio Creek Restoration at Dos Rios Ranch

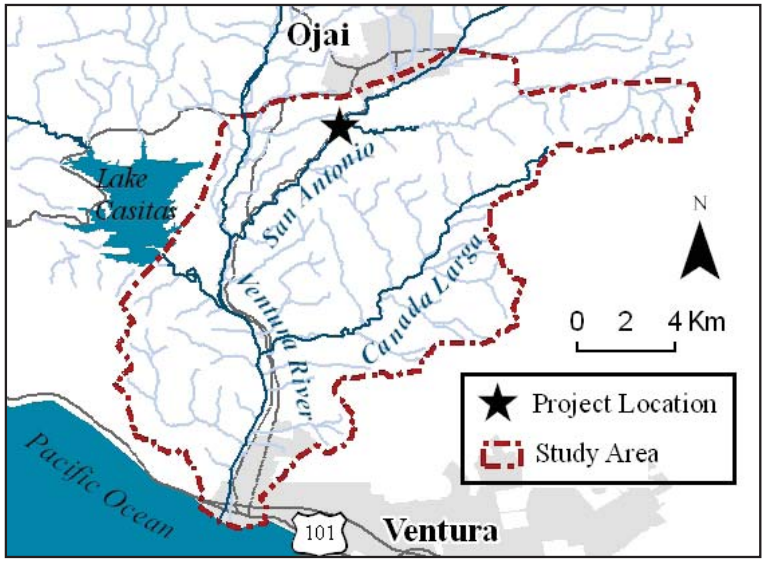

Figure 38: Project location.

Dos Rios ranch is a cattle and avocado operation located in the lower San Antonio Creek Basin, immediately downstream of Camp Comfort, approximately 4.5 kilometers upstream of San Antonio Creek's confluence with the Ventura River. San Antonio Creek runs along the ranch's western boundary for approximately 2.6 kilometers. In addition to ranching and farming activities, the ranch also historically operated equestrian boarding and riding facilities. The ranch is accessed from Creek Road via a 140-foot long bridge that spans the creek.

San Antonio Creek contains critical habitat for the endangered Southern California steelhead, is considered important to Ventura River steelhead production and recovery, and has been identified as the second priority reach for steelhead recovery actions in the Ventura River watershed following the Matilija tributaries (ENTRIX, 2003). A shallow subsurface bedrock barrier situated near Camp Comfort (Entrix, 2001d) forces groundwater to rise above the creek bed immediately upstream of Dos Rios Ranch. As a result, this stretch of San Antonio Creek experiences perennial stream flows. Multiple steelhead spawning sites have been identified in recent years along nearby stretches of San Antonio Creek (Capelli, pers. comm.).

Impairments

The following issues are resulting in habitat impairment at this location:

Stream bank erosion

In 2005, extremely high stream flows from large storms caused significant erosion to occur along the banks of San Antonio Creek at Dos Rios Ranch. Although extreme flooding events are a natural occurrence in this watershed, it is likely that upstream hydro-modification of San Antonio Creek and the upland watershed have exacerbated recent flooding problems. The 2005 floods scoured over 800 feet of stream bank and degraded the stream bed, resulting in exposure of the bridge pier footings. Although the bridge pier footings were repaired, riparian habitat along the southern stream bank remains severely impacted. Vertical banks prevent the establishment of riparian vegetation. Lateral scouring of the southern stream bank damaged a paved road. Asphalt and compacted soil from the damaged road further prevent the reestablishment of riparian vegetation.

Cattle ranching activities

Cattle that have access to portions of San Antonio Creek and Lion Creek also impact water quality and habitat by

depositing animal waste in the stream, eroding stream banks, generating fine sediments, disturbing spawning sites, and removing in-stream riparian vegetation through grazing.

Figure 39: Southern stream bank at Dos Rios Ranch.

Restoration Recommendations

The following recommendations should be considered by local watershed managers in an effort to promote the restoration of the lower Ventura River watershed.

The Dos Rios Ranch property presents multiple opportunities to restore significant habitat value to San Antonio Creek. The owner of Dos Rios Ranch is interested in habitat restoration and has experience with restoration projects on her property. Although protection of the bridge is a priority for the property owner, there is interest in the possibility of additional bank stabilization and habitat restoration to improve conditions caused by the 2005 flood.

Stream bank stabilization and restoration

In 2005, Questa Engineering Corp conducted a preliminary design for bank stabilization for Dos Rios. Design plans included components to protect the bridge from scour, provide stream bank stabilization, and improve in-stream salmonid habitat (Questa, 2005). Questa conducted hydrologic and hydraulic analyses and developed site design plans to reduce peak velocities up to a 50-year design storm.

Figure 40: Dos Rios Ranch bridge.

The proposed Questa project uses standard rock rip-rap to protect the Dos Rios Ranch bridge. An ideal alternative to the use of rock rip-rap bank armoring could be to replace or extend the bridge, but protection of the existing bridge could provide an opportunity for significant restoration along the up-stream and down-stream banks. Stream banks could be stabilized through grading and revegetation using native plants, and could include concepts outlined in the Questa design such as the installation of a series of rock groins and keyways to accumulate sediment along the toe of the slope, redirect stream flows away from the bank, and produce in-stream pool habitat. These features would significantly enhance existing riparian habitat value at Dos Rios Ranch. The Questa design also describes the placement of in-stream features such as woody debris structures to further enhance salmonid habitat.

This project would not be the first time that in-stream features were incorporated into bank stabilization efforts in the Ventura River watershed. In 2006 The City of Ventura constructed a series of cabled boulder single-wing deflectors in the Ventura River to protect the stream bank at Foster Park. Wing-deflectors are listed in the Department of Fish and Game's California Salmonid Stream Habitat Restoration Manual as a method of deflecting flow away from the bank and of creating quiet water resting areas for use by upstream migrating spawners (Flosi et al. 1998). Since their installation, the deflectors at Foster Park have produced in-stream benefits as designed (Adams, Pers. Comm.).

Cattle exclusion

The Dos Rios Ranch site could be additionally improved through the incorporation of measures to protect water quality. A wire fence and a cattle exclusion device currently prohibit cattle from entering the upstream portion of San Antonio Creek on Dos Rios Ranch. However, cattle still have access to the downstream portion of San Antonio Creek as well as portions of Lion Creek. The incorporation of additional cattle exclusion measures to keep cattle from accessing the stream would provide water quality and habitat benefits.

Restoration efforts at Dos Rios Ranch could provide a variety of benefits. A multi-beneficial project at this site would

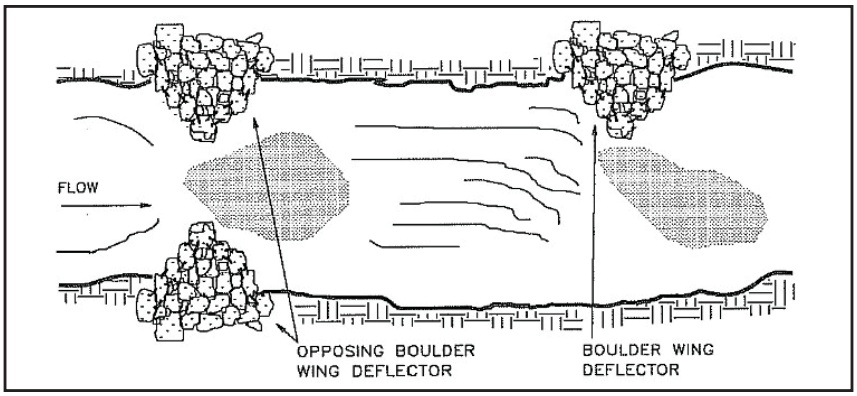

Figure 41: Diagram of boulder wing deflector design excerpted from Flosi et al. 1998

protect existing private property infrastructure, significantly enhance riparian habitat on up to 800 feet of stream bank, enhance in-stream salmonid habitat, and provide water quality benefits. This property has a willing and cooperative landowner with a history in riparian restoration. Preliminary engineering and design have already been conducted. These conditions make restoration of San Antonio Creek at Dos Rios Ranch a high priority project for consideration and implementation.

Soule Park Golf Course

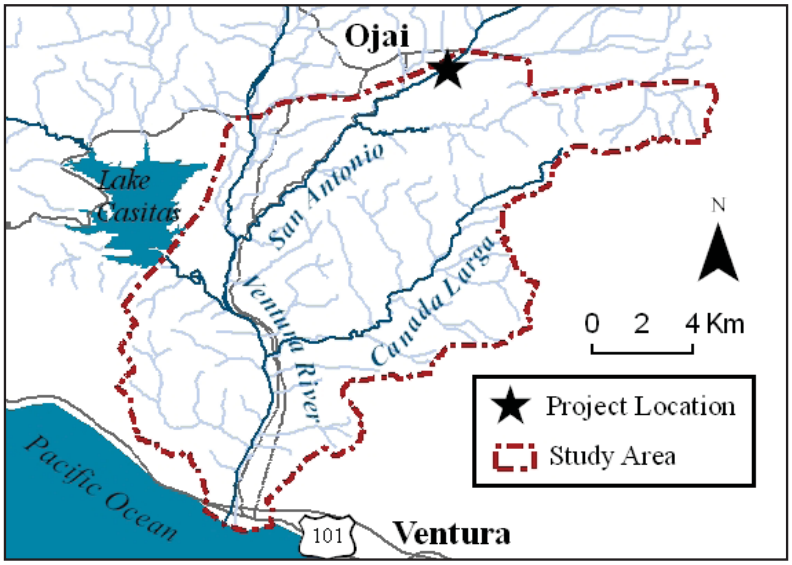

Figure 42: Project location.

Soule Park Golf Course is located southeast of the City of Ojai along San Antonio Creek, approximately six miles upstream of its confluence with the Ventura River. Soule Park is a public golf course located on land owned and maintained by the Ventura County Parks Department. The facility is currently managed by Highlands Golf, L.L.C. San Antonio Creek runs directly through Soule Park for roughly two kilometers. Approximately one-half a kilometer of Thacher Creek also runs through Soule Park where it joins San Antonio Creek near the center of the golf course. Channelkeeper's Stream Team Monitoring Site 10 is located less than one mile downstream of Soule Park along San Antonio Creek.

San Antonio Creek contains critical habitat for the endangered Southern California steelhead, is considered important to Ventura River steelhead production and recovery, and has been identified as the second priority reach for steelhead recovery actions in the Ventura River watershed following the Matilija tributaries (ENTRIX, 2003). Steelhead trout sightings have been confirmed in Soule Park by Department of Fish and Game and National Fisheries Management Service biologists (ENTRIX, 2003).

In 2005, severe stream flows washed out a nine-foot high arizona crossing and golf cart bridge along San Antonio Creek near its confluence with Thacher Creek. The Arizona crossing structure was considered the first of several critical migration barriers to steelhead trout preventing access to historic spawning habitat located along Gridley Creek. Following damages incurred to the crossing and bridge in 2005, the facilities were removed and replaced with a span bridge. Although one of the main goals of constructing the new bridge was to restore fish passage, the project did not incorporate any substantive stream bank restoration components.

Impairments

The following issues are resulting in habitat impairment at this location:

Lack of Riparian Vegetation

San Antonio and Thacher Creeks are impaired at Soule Park Golf Course by encroachment of the golf course into stream buffers and stream banks. Golf course landscaping extends in many areas to the toe of the stream bank, preventing the establishment of riparian vegetation. Concerns over maintaining golf course 'playability' present challenges when considering riparian habitat restoration efforts.

Figure 43: Lack of riparian vegetation along Thacher Creek due to encroachment of the golf course.

Water Quality Impacts

The close proximity of golf course greens to the stream increases the risk of contaminated irrigation runoff impacting water quality. The lack of shade from riparian tree canopy may also impact water quality by increasing stream temperatures.

Stream Bank Stability

According to the golf course superintendent, stream bank erosion has been a continual problem for golf course grounds managers (Specter, Pers. Comm.). The lack of riparian vegetation along stream banks likely exacerbates stream bank erosion during high flow events.

Restoration Recommendations

The following recommendations should be considered by local watershed managers in an effort to promote the restoration of the lower Ventura River watershed.

There are multiple opportunities for projects and programs that could enhance and restore habitat at Soule Park Golf Course. The County Parks Department should apply for funding to develop an environmental management plan that could include the following components:

Revegetate and stabilize stream banks and stream buffer areas along San Antonio and Thacher Creeks

The County should begin restoration efforts by working with the course's golf professional and superintendent to identify areas that are currently out-of-play. These areas should be targeted for stream bank and stream buffer restoration. Course managers should then identify areas that are in-play and attempt to develop restoration components that would enhance habitat but minimize interference with playability. Opportunities to thin buffer strips or manage vegetation height could be considered in critical areas to preserve playability.

Figure 44: Stream bank erosion at Soule Park Golf Course.

Develop and implement chemical use reduction strategies

Soule Park Golf Course currently minimizes chemical usage in an effort to manage maintenance costs, but reduction of chemical use to protect water quality should also be a focus of the facility's management practices. Reduction strategies should incorporate Integrated Pest Management practices.

Optimize of water efficiency

According to the golf course managers, Soule Park recently upgraded its irrigation system and optimizes water efficiency by

integrating on-site weather station data and calculations based on evapo-transpiration rates. Although these measures reduce over-irrigation, additional benefits may be achieved by focusing on in-play and out-of-play landscaping modifications that would reduce water demand by replacing existing vegetation that requires significant irrigation with drought tolerant species.

Watershed Scale Issues

Assessing the feasibility and benefit of any individual habitat restoration project requires consideration of several broad, over-arching issues that affect the watershed. This section outlines multiple critical issues related to habitat restoration of the Ventura River that need to be addressed on a watershed scale. The success and feasibility of habitat restoration projects within the watershed may rely heavily on how these issues are managed.

Sustainable water management for the preservation of in-stream beneficial uses

Municipal, domestic, and agricultural entities within the watershed rely on the Ventura River and its groundwater basins as their primary or sole source of water. The Ventura River is also a critically important component of the water supply budget for the broader Ventura community. As the community continues to grow, so too will the demand for water.

Many of the community's goals for river restoration, particularly those that revolve around steelhead recovery, require the maintenance and recovery of adequate baseflows. The amount of water flowing in the river can influence spawning potential during the migration season and determines the availability of rearing habitat throughout the dry season. Stream flows are also interconnected with water quality. Reduced flows can cause water temperatures to increase and exacerbate the bio-chemical impacts of stressors such as algae growth.

Although certain components of the watershed's water supply system are well studied and have incorporated management mechanisms designed to preserve watershed ecosystems, some components, such as cumulative, private domestic and agricultural groundwater demands, are less understood and controlled. Work is currently being performed to develop a clearer and more accurate water budget. As this type of information becomes available, watershed managers should develop a safe yield model that prioritizes maintenance of beneficial uses in the Ventura River watershed. Water management strategies and programs that are capable of addressing cumulative extractions should then be developed with the goal of ensuring that base flows are preserved and restored where necessary. Enhanced efficiency and conservation strategies, such as wastewater reclamation projects and greywater systems, should also be developed to help achieve this goal.

Flood plain management

Ventura County and local municipalities currently rely almost exclusively on traditional "base flood elevation" approaches to flood plain management that focus on protection of life and property from flooding as the sole or primary objective. These approaches depend heavily on mapping and modeling efforts that, in a dynamic hydrologic system such as the Ventura River watershed, may be affected by significant uncertainty and error.

Efforts to protect life and property could be improved by incorporating additional approaches that focus on the multiple benefits provided by flood plains. These benefits include protection and restoration of wildlife habitat, water quality improvements, stormwater capture and management, ground water recharge, and recreational and cultural opportunities. Development and implementation of a flood plain management approach that utilizes strategies such as land use measures, flood plain development restrictions, relocation of property, and proactive acquisition and reclamation of flood plain would improve the quality of habitat throughout the Ventura River watershed while also enhancing protection of life and property.

Restoration of Fish Passage through Matilija and Casitas Dams

Steelhead recovery has been the primary focus of much of the historic effort to evaluate and conduct restoration projects in the Ventura River watershed. Ultimately, steelhead recovery will depend upon the restoration of fish passage to historic spawning grounds above the Matilija Dam. While downstream restoration efforts should continue to be evaluated and performed in conjunction with developing efforts to remove the Matilija Dam, its removal should still be considered the number one priority for steelhead recovery. Downstream steelhead habitat enhancement projects should always be evaluated keeping over-arching Matilija Dam removal goals in mind.

Watershed managers should not overlook the ongoing impact to steelhead trout created by the presence of Casitas Dam. Before the construction of the Casitas Dam, Coyote Creek and its tributaries provided up to 33% of the historic habitat for steelhead trout (Capelli, 2009). The National Marine Fisheries Service's Draft Southern California Steelhead Recovery Plan has identified the restoration of fish passage through Casitas Dam as a critical recovery action.

Nutrient loading from non-point sources

Currently, the Los Angeles Regional Water Quality Control Board is developing a Total Maximum Daily Load (TMDL) program to address algae impairments on the Ventura River. The program will set numeric limits on nutrient inputs from multiple sources to reduce concentrations on the river that arguably are linked with algae growth and eutrophic conditions in the estuary. While limits will likely be imposed for effluent from the upstream Ojai Valley Sanitary District wastewater treatment plant, improvement of water quality throughout the watershed will also depend on the region's ability to target and address non-point nutrient sources that include faulty or leaking septic tanks, improperly sited leach fields, equestrian activities, ranching, irrigated agriculture, groundwater pollution and urban runoff.

Public access to the Ventura River

Decades ago, the Ventura River was an integral part of the daily lives of local community members. Residents of Ventura who grew up in the 1920s and '30s remember a network of trails that extended to the river from the end of every east-west street along Ventura Avenue (J. Capito, Pers. Comm.) and were utilized on a daily basis to access the river for fishing, swimming, and other recreational activities.

Today, access to the river is severely restricted, largely due to the construction of levees and, in many locations, including along most of "Ventura River Bike Path," the river itself is not even visible to the public. Heavy infiltration and use of the river bottom for camping by transient individuals further dissuades community members from utilizing the river for recreation. Unfortunately, the transient community that does regularly access the river has a history of engaging in activities that degrade ecological resources.

A plan should be developed and implemented to restore and control public access to the lower Ventura River. Some critics worry that allowing any public access to the river will result in degradation of the ecosystem. Development of a public access restoration plan, however, implemented through a project such as the Ventura River Parkway, would help ensure that human activities that do take place in the Ventura River are compatible with the ecosystem and beneficial to the community. The current approach provides no such assurances. In conjunction with development of a public access restoration plan, local agencies should re-evaluate policies and practices designed to restrict public access to the river as well as improve enforcement of existing laws designed to protect the river from harmful activities. Over the longterm, restoration of the lower Ventura River will require commitments and investments by the surrounding community. Providing beneficial public access opportunities would help to re-establish a sense of watershed stewardship that will be absolutely critical to achieving long-term habitat restoration goals.

Levee maintenance procedures

The Ventura County Watershed Protection District (WPD) operates over 3.8 kilometers of flood control levees along the Ventura River downstream of Highway 150. WPD levee maintenance prevents the establishment of vegetation and wildlife on or within 15 feet of its facilities through mechanical clearing and the use of pesticides. These maintenance practices eliminate riparian habitat, reduce beneficial shade to surface waters, and increase the likelihood that the river may be exposed to harmful chemicals. The WPD's maintenance program conforms with policies recently adopted

by the U.S. Army Corps of Engineers (USACE). These USACE policies are currently the subject of litigation by the Center for Biological Diversity over endangered species concerns. Some recent studies suggest that the establishment of some forms of vegetation on levees may actually increase levee stability. Modification of WPD levee maintenance policy to allow vegetation to grow along its levees would enhance the quality of habitat along the Ventura River.

Invasive species control

Many invasive species have become established within the Ventura River watershed. Restoration projects frequently employ removal of invasive species as a method of restoring habitat. Perhaps the most notable invasive plant species targeted for removal in the Ventura River watershed is Giant Reed (Arundo donax), which has spread from the river's headwaters in Matilija Canyon down to the Ventura River Estuary. Significant efforts are currently underway watershed, including two large-scale efforts to eradicate Arundo from Matilija Canyon and upper San Antonio Creek. These projects have utilized a combination of mechanical and chemical removal techniques.

Although removal of Giant Reed from the watershed should provide many ecological benefits, removal techniques also have the potential to cause temporary negative impacts. Invasive species removal can be expensive, and the least intensive or damaging removal techniques are not always employed due to restricted funding. Removal projects are also often funded by temporary grant funding opportunities. The long-term success of invasive species control programs depends critically on the ability of local agencies and restoration groups to conduct follow-up monitoring and removal. Local agencies and restoration groups are often restricted in the amount of follow-up monitoring and removal that they can conduct once temporary grant funding expires, resulting in the re-establishment of invasive species. This scenario produces inefficiencies and environmental impacts as removal efforts and impacts are eventually have to be repeated. Local resource managers should develop programs and funding mechanisms to provide for the least environmentally damaging, long-term management of invasive species.

Conclusion

The lower Ventura River watershed has been severely degraded throughout the last century by human activities, though it still contains important wildlife habitat and provides valuable services to the surrounding community. Many large and small-scale opportunities for restoration and habitat value enhancement exist throughout the watershed. These opportunities include traditional forms of riparian restoration such as stream bank stabilization, invasive species removal, and installation of in-stream habitat features, as well as significant opportunities to improve water quality by addressing non-point sources of pollution.

While opportunities to restore degraded habitat exist, long-term success will also depend on addressing critical stressors related to population growth in the watershed, which pose the risk of causing significant impairment in the future. Of prime concern should be the preservation and enhancement of in-stream flows in the face of increasing water supply demands. Further hydro-modification of river and stream channels resulting from continued floodplain development and consequential flood control measures must also come to an end.

Many projects targeting non-point pollution sources may be developed due to regulatory requirements to achieve water quality standards. Certain smaller-scale restoration efforts may also be implemented by existing community groups and governmental agencies over time. Widespread public support, however, will be critical if long-term and large-scale habitat restoration goals are to be successful. To this end, development of a Ventura River Parkway should be a top priority to enhance public access, generate watershed awareness and appreciation, provide educational and recreational opportunities, and preserve valuable floodplain habitat and migration corridors for wildlife.

The issues and stressors contributing to habitat impairment throughout the watershed are complex, dynamic, and interconnected. Navigation of these issues and the development of achievable solutions will require careful planning and coordination amongst a broad spectrum of watershed stakeholders and governmental agencies. The development of a comprehensive watershed plan that balances the needs of humans and those of wildlife and the environment will be an early and necessary step in outlining future actions to effectively restore the lower Ventura River watershed.

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Appendix A

Restoration Opportunities within the Lower Ventura Avenue Study Area

The Ventura Avenue study area shares a significant nexus to the Ventura River and estuary through stormwater-related impacts. Significant benefits to lower Ventura River habitat could result from an investment in stormwater management improvements throughout the study area. Channelkeeper recommends that the City and County conduct a vigorous watershed assessment to proactively identify opportunities to retrofit existing stormwater infrastructure.

The following section provides a conceptual blueprint of locations and opportunities for such watershed improvements throughout the lower Ventura Avenue study area. It should be noted that before any rigorous stormwater retrofit program is initiated, a technical sub-watershed assessment should be conducted to quantify specific water quality goals, volumetric treatment targets, treatment capacities, and project constraints including estimated costs. The following list of projects is intended to serve as a starting point to generate discussion and movement towards a sub-watershed scale approach to minimizing water quality impacts from an urbanized area. Potential opportunities are not limited to those listed below.

For practical purposes, the restoration opportunities in this report have been divided into multiple sections, including: *public retrofit opportunities; private retrofit opportunities; street retrofit opportunities; residential opportunities.*

For this assessment, Channelkeeper obtained existing watercourse GIS layers from the Ventura County Watershed Protection District. The existing watercourse layer is very limited for the lower Ventura Avenue study area, and it does not accurately identify most drainages. At the time of this study, the City of Ventura was contracting with consultants to update the City's storm sewer map. An updated storm

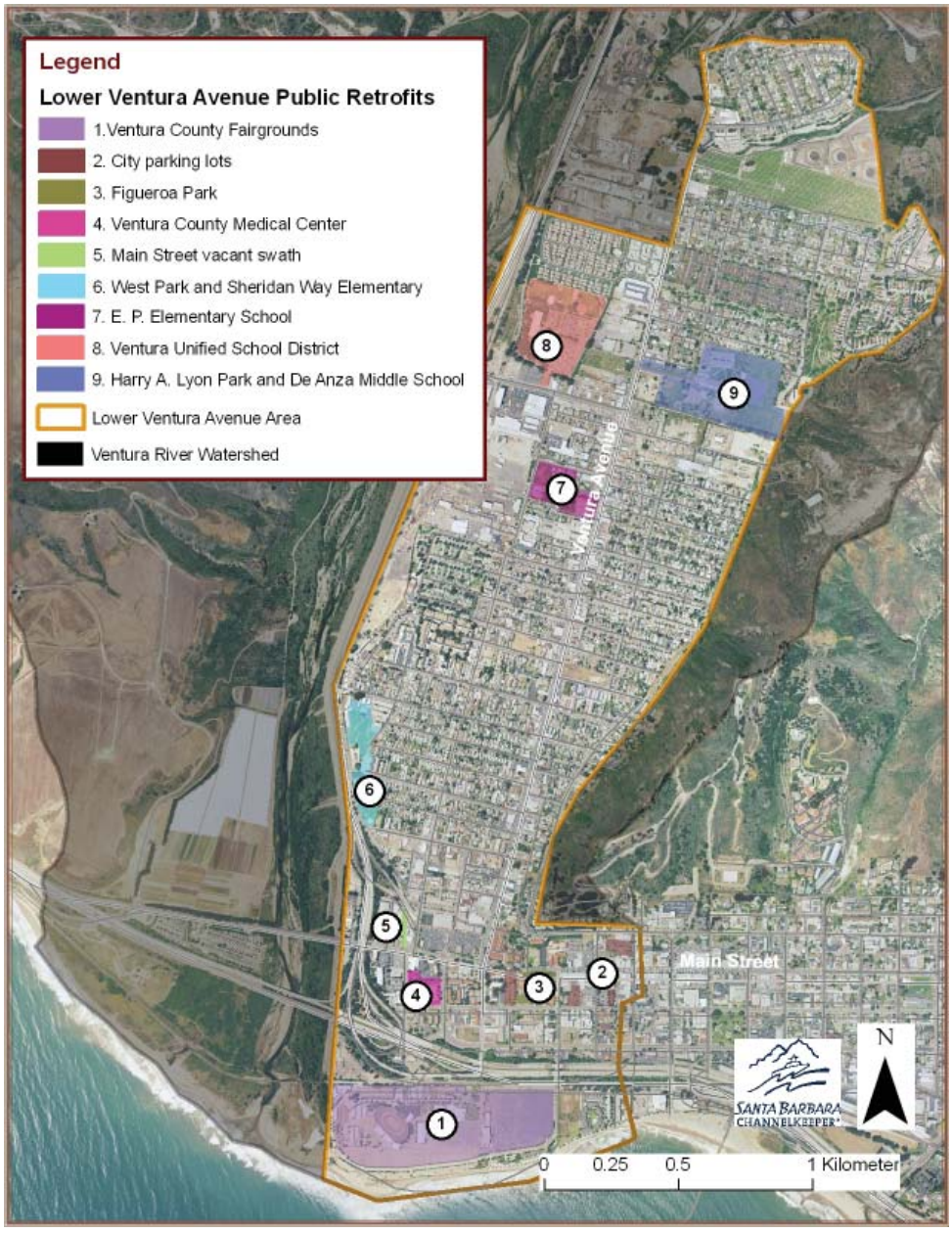

Figure 45: Opportunities for stormwater retrofits on public property within the lower Ventura Avenue study area

drain map will greatly help local agencies and stakeholders in delineating urban sub-watershed boundaries, identifying specific pollution problem areas, and identifying potential opportunities for stormwater improvement projects. However, since this information is not yet available, the following analyses and recommendations are based on known outfall locations as well as storm drain infrastructure as visible by above-ground inspections (i.e. storm drain inlets, drains, and culverts).

In addition to watercourse information, Channelkeeper obtained Ventura County Assessor data in GIS format. This information was used to identify property boundaries, ownership, and land use categories throughout the study area. Desktop inspections of the study area were conducted using a 2006 ortho-rectified aerial photo. Measurements of the square footage of various pervious and impervious features were made using aerial photographaphy with the assistance of GIS software. Multiple surveys were conducted by foot and vehicle for ground-truthing purposes and to help further identify watershed impairments and restoration opportunities.

Public Retrofit Opportunities

Public facilities such as parks, municipal parking lots, schools, and government buildings are often excellent candidates for stormwater retrofits. The benefits of targeting public facilities include political will, existing design, construction and maintenance capabilities, and the availability of State and Federal water quality grants to augment funding. Public retrofits in high traffic areas also can serve as demonstration projects that help educate local citizens and businesses about stormwater retrofits. The following is a list of locations that provide opportunities to install stormwater retrofits or watershed improvements on public land (see Figure 45).

1. Ventura County Fairgrounds

The "Managed Shoreline Retreat Project" is currently being developed to address an ongoing problem with beach erosion at Surfer's Point. The project will call for the relocation of the coastal bike path and parking lot at Surfer's Point and provides for the construction of a cobble berm to protect the shoreline. Additionally, the project includes the installation of permeable paving and other infiltration features to enhance the southern dirt parking lot at the Ventura County Fairgrounds, which consists of approximately five acres of unpaved parking area along the southern border of the property. Unfortunately, this area appears to consist primarily of tightly compacted fine soil particles and provides minimal infiltration. During large storm events, runoff collects in the southern dirt lot and is pumped directly to the beach. The addition of permeable paving and other infiltration features will greatly improve the stormwater management capacity of the Fairgrounds. However, additional stormwater management opportunities also exist at the facility.

Figure 46: Ventura County Fairgrounds stormwater retrofit opportunities

The most obvious stormwater retrofit opportunity within the Fairgrounds is to install permeable paving and bioretention features throughout the sizeable visitor parking lot (Figure 46). This parking area covers approximately 12 acres of land and is entirely covered in asphalt. Immediately adjacent to the northwest of the visitor lot is an additional 4.5 acres of pavement used for trailer parking and exhibitions. Existing greenway space throughout the facility could potentially be used to re-direct Fairgrounds rooftop runoff for infiltration or detention.

2. City of Ventura Parking Lots

Several large municipal parking lots provide stormwater management opportunities for the downtown Main Street area. Each City lot has existing planter areas and medians for landscaping purposes. Curb cuts could be placed in each planter to allow stormwater to enter these areas. The infiltration capacity of each planter or median could be improved by grading, providing soil amendments, and mulching. Parking lot planter areas with turf grass could be re-landscaped with local, drought-tolerant plants that require less water and maintenance. The installation of tree pits could also enhance bioretention. To further reduce runoff from these areas, the City should begin phasing in pervious pavement, filter strips, and infiltration trenches at strategic, down-gradient areas to prevent parking lot runoff from entering the municipal storm sewer system. Such modifications could be implemented during scheduled re-surfacing or maintenance activities.

Figure 47: Existing grass medians provide infiltration and bioretention opportunities at City parking lots

3. Figueroa Park

This large park is situated across the street from the San Buenaventura Mission. The park covers approximately 2.2 acres of land and primarily consists of heavily manicured turf grass. Along Main Street, a 0.08 acre (3,700 square foot) segment of the park has been disconnected from the rest of the park by the sidewalk. This segment currently juts out into the street parking area and is disconnected from the Main Street storm drain system by curbs. Curb cuts and improved bioretention capacity within this Main Street segment could be a relatively cheap and effective method of treating and infiltrating street runoff. This park is large enough to potentially provide additional storage and treatment options such as underground storage or stormwater detention to reduce peak flows, allowing for downstream stormwater treatment. On the southwest corner of Figueroa Park lies approximately 0.4 acres of manicured grass lawn adjacent to Santa Clara Street (Figure 48). This section of the park is disconnected from the main park area and appears to be highly underutilized by the public, and public amenities such as benches or trees to provide shade are lacking. Significant stormwater treatment improvements could be constructed in this portion of Figueroa Park without significantly impacting park visitation. In fact, well designed landscape improvements such as rain gardens could also enhance park aesthetics and reduce landscape maintenance costs.

Figure 48: The southwestern manicured lawn area of Figueroa Park is separated from the rest of the park and is very underutilized

4. Ventura County Medical Center

The Ventura County Medical Center currently provides approximately 1.3 acres of impervious parking space. Existing medians and parking lot planter areas are currently designed to keep stormwater runoff out. At a minimum, curb cuts could be inserted into these areas to enhance infiltration and bioretention. To further reduce the effective impervious area

Figure 49: The Ventura County Medical Center parking lot covers approximately 1.3 acres.

of this parking lot, infiltration trenches and underground infiltration chambers could be constructed across the down-gradient exit to Santa Clara Street. This facility also includes one acre of rooftop area that could be converted to a green rooftop.

5. West Main Street Vacant Railroad Swath

This narrow strip of property covers approximately 0.5 acres and forms a 135-meter corridor between businesses from W. Main Street to the Highway 33 on-ramp. The property used to be a right-of-way for the old Southern Pacific Railroad (Figure 50). Currently the property is owned by the City of Ventura and is vacant. Given the length of the parcel and the lack of current use, this parcel could potentially be converted into a stormwater treatment area such as a dry swale to treat highway or Ventura Avenue runoff. Runoff could be directed from these areas into the swale. A fabricated soil bed could temporarily store and filter stormwater.

Figure 50: This abandoned swath of land could be converted into a bike path and dry swale

This property also has the potential to enhance and beautify public access to the Ventura River bike trail that runs along the old railroad line. When the bike trail was initially designed, the parcel was not utilized due to concerns that it would force bikers to cross the Highway 33 on-and off-ramps. However, the trail is currently configured such that people must cross the busy Main Street/Olive Street/Ventura Avenue intersection, which is not only potentially dangerous but can also be quite confusing. Bikers must again cross Ventura Avenue to re-access the bike trail. An alternative to this design could be to use the vacant railroad swath to connect W. Main Street to the bike trail. A pedestrian foot bridge could be constructed to span the Highway 33 on and off ramps. Construction of a bike path would not necessarily preempt the construction of some sort of bioswale to treat highway or Ventura Avenue stormwater runoff. A well-designed swale could greatly improve the aesthetics of the lower Avenue study area. Thus, this property presents an opportunity for a multi-beneficial project that could thus score better on grant applications.

Figure 51: Alternative Ventura River bike trail route

6. West Park – Sheridan Way Elementary School

Combined, West Park and Sheridan Way Elementary School encompass approximately six acres of grass playground area. Existing storm drains currently convey water from the lower Avenue study area via underground tunnels that run through these properties to the Ventura River. Due to the size of this relatively undeveloped site, there could be potential to store, infiltrate, and treat adjacent storm runoff. One alternative could be to construct a large underground detention reservoir that could store stormwater runoff until it could be treated on-site and released to the Ventura River. By placing these facilities underground, much of the existing playground could be preserved. Another alternative could include the construction of swales, bioretention areas, and infiltration strips along the edges or within portions of the playground area to partially treat a portion of adjacent stormwater runoff. Sheridan Way Elementary School has relatively large pavement and rooftop areas that currently drain to municipal storm drains. This facility could redirect rooftop runoff to playground areas with enhanced infiltration capacity. Pervious paving could also be installed in strategic locations to infiltrate stormwater.

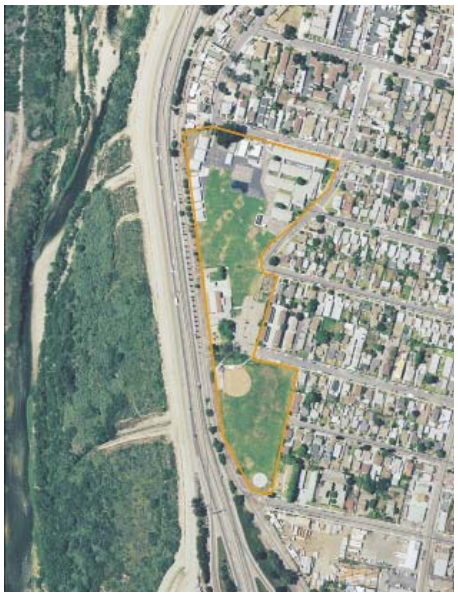

Figure 52: Sheridan Way Elementary School and West Park

7. E.P. Foster Elementary School

E. P. Foster Elementary School consists of approximately 2.5 acres of grass playground area, 0.6 acres of parking lot, one acre of impervious playground area, and 1.5 acres of rooftops. Currently, most stormwater runs directly from rooftops and impervious areas to the municipal storm drain system. Rooftop runoff to storm drains could be largely eliminated by simply installing or redirecting roof gutters to pervious areas such as existing planters, grass areas, or newly installed tree pits. Stormwater infiltration and bioretention could be greatly enhanced by strategically installing tree pits and pervious medians in the parking area. These features would have the added benefit of improving school aesthetics and providing shade.

8. Ventura Unified School District

This Ventura Unified School District campus encompasses nearly eight acres of impervious asphalt parking lot and boasts a 1.5 acre building rooftop. An additional three acres of intensively landscaped green space surrounds the District's building. Generously sized medians and greenways are currently situated downgradient of the large parking area, including one grass and tree-planted median that covers a quarter acre. This facility could be an ideal candidate to develop a large public pilot project in the Ventura Avenue area to demonstrate the effective capture, treatment, and storage of stormwater. The existing layout and design of the School District campus provides several opportunities (A – E).

Figure 53: Several large existing planter areas could provide significant infiltration and bioretention capacity.

A) **Parking lot retrofits** - Significant improvements could be achieved by modifying existing parking area medians. Stormwater could be channeled to the multiple large existing planter areas, which could be modified to provide significant infiltration and bioretention capacity. Additional planter areas could be constructed to further capture stormwater without significantly reducing parking availability. The straregic placement of strips of pervious paving would further enhance onsite infiltration capacity.

B) **Rain garden conversion** - A large manicured grass area is maintained adjacent to the southwest corner of the building. The area cur

Figure 54. Rain garden location southwest of building

rently lacks amenities for staff such as benches or tables and is likely under-utilized. Water efficiency could be greatly improved by converting this area into a rain garden with drought-resistant plants. The rain garden could be designed to be aesthetically pleasing as well as to accommodate additional use by staff as a break or lunch area.

C) **Southwest infiltration area** – A large wooded open space currently exists at the southwest corner of the facility. The open space is already slightly depressed in elevation and could provide a ponding area with significant capacity for detention and infiltration of stormwater with minor modifications. This area is the most down-gradient portion of the property. Stormwater runoff from other areas of the property could easily be diverted to this area for infiltration.

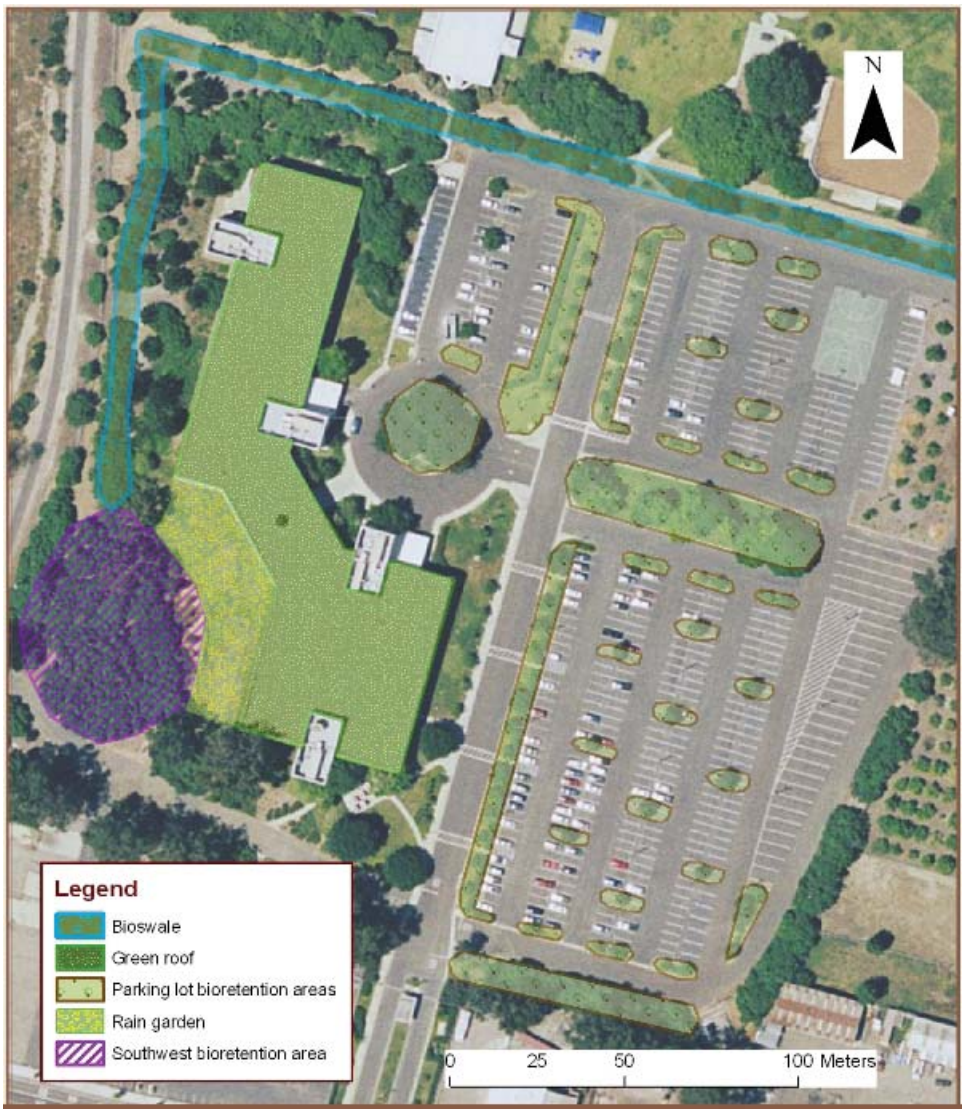

Figure 56. Conceptual Low Impact Design (LID) retrofit design for the Ventura County Unified School District Facility

D) **Northern bioswale** - A 250-meter strip of curbing with storm drain inlets runs along the northern border of the parking lot from east to west. This drainage system could be modified into a large bioswale to capture and treat stormwater runoff without encroaching into the parking area. The eastern end of the drainage area could be modified to redirect runoff towards the southwest infiltration area.

E) **Rooftop retrofits** - Rooftop runoff could easily be diverted to the rain garden and southwest infiltration area. The large, flat rooftop also makes the facility a potential candidate for a green roof. Green roofs can be highly effective in arid or semi-arid areas in capturing and treating stormwater runoff (U.S. EPA 2010). Although some irrigation may be required for green rooftop maintenance in arid climates, this water demand could easily be offset by improving water efficiency in landscaping elsewhere at the facility, by using drought-tolerant plants, increasing growing media depth, applying drip irrigation, and harvesting rainwater and air condition condensate. A green roof would have the added benefits of providing lunch or break areas for facility staff and significantly reducing energy costs associated with heating and cooling.

Figure 55. Bioswale area at north end of property

9. Harry A. Lyon Park and De Anza Middle School

Figure 57. Rooftop gutters are directly connected to impervious drainage areas.

These two facilities are quite large and present several opportunities to minimize or eliminate stormwater runoff from entering the municipal storm sewer system. Combined, Harry A. Lyon Park and De Anza Middle School cover approximately 26 acres. The majority of this space is covered in turf grass for recreational use, although eight acres is covered by impervious rooftops, playground areas, and parking lots. Currently, most of the rooftops are directly connected to the impervious parking area (Figure 57) that drains to the municipal storm sewer system. Ample pervious space exists near and around most school buildings such that rooftop runoff could fairly easily be redirected for infiltration and bioretention. The installation of tree pits or planters would greatly enhance these processes.

Figure 58. This large grass median could be converted to a 300-meter dry swale

To the east of De Anza Middle School is a large grass median bisecting De Anza Drive (Figure 58). The median covers approximately one acre in size and is 372 meters long. This site is well-suited for a large dry swale to treat upstream stormwater runoff.

Figure 59. Non-residential stormwater retrofit opportunities throughout the lower Ventura Avenue study area

Non-Residential Private Retrofit Opportunities

Non-residential retrofit opportunities on private property can require extra effort to acquire landowner support and to coordinate, but incorporating private properties would greatly increase the amount of acreage covered by a watershed improvement program. Additionally, several implementation mechanisms can be applied to increase private participation in a retrofit program. The City of Ventura and Ventura County could consider subsidizing retrofits on private property by providing technical assistance or financial incentives. Subsidies could be funded through grants or municipal operating budgets. Agencies could also consider qualifying stormwater retrofit projects as off-site mitigation for various development projects. Hundreds of private property retrofit opportunities may exist in the lower Ventura Avenue study area, though it would be difficult to identify and implement all of them. The following is a brief summary of a few larger projects that may present significant benefits.

1. Patagonia/Lost Arrow Corporation

Figure 60. Existing pervious pavement lot at the Patagonia/Lost Arrow Corporation headquarters

Patagonia is an outdoor clothing company that is famous for its progressive environmental ethics. Patagonia exemplifies those ethics at their Ventura campus headquarters, located at the end of West Main Street. In addition to environmentally sensitive campus features such as green building design, a 66 kilowatt solar array, and numerous environmental stewardship programs available to employees, the Patagonia campus also includes stormwater management improvements. In 2005, Patagonia installed roughly 7,200 square feet of pervious pavement (Figure 60) in their employee parking lot. Facility managers report that the pavement drains vertically as was intended.

Figure 61: Existing planters and impervious pavement provide additional opportunities for stormwater retrofits

Additional opportunities may exist on the Patagonia campus. For example, there are numerous planters with drought-tolerant plants throughout the parking area. With the addition of curb cuts and minimal modifications, these planters could further treat stormwater runoff leaving the facility. Retrofits on the Patagonia campus could serve as prime demonstration projects for the community.

Figure 62: Existing planters and impervious pavement provide additional opportunities for stormwater retrofits

2. Vons Plaza

Just a block away from the Patagonia facility is the Vons shopping center at 115 West Main Street. The entire shopping center covers over seven acres and is almost entirely impervious except for some planter areas in and around the parking lot. The parking area itself is expansive, and currently runoff from the parking lot is designed to flow directly into municipal storm drains (Figure 62). At a minimum, existing planter areas could be modified with curb cuts to enhance infiltration and bioretention. The parking area would be an ideal candidate for the installation of permeable paving at strategic locations such as in strips in front of existing storm drain inlets. A more rigorous approach could consider converting the grass right-of-way along West Main Street into a dry swale or infiltration trench to help treat and minimize storm water runoff before it reaches storm drains.

3. Venwood Condominium Complex

This condominium complex was designed to direct all rainfall directly to the municipal storm sewer via concrete gutters that extend down the middle of all driving lanes. By simply redirecting roof downspouts to existing pervious areas,

this complex could significantly reduce and partially treat stormwater runoff. For example, a drainage pipe currently extends the length of the property underground from east to west along the southern boundary of the parcel. With minimal effort, this existing drainage ditch could be modified to infiltrate runoff rather than sending it directly to the street. Runoff could be further treated by redirecting the end of the pipe to a rain garden in the existing grass turf area near the southwest corner of the property.

4. Paseo del Mar Condominium Complex

The Paseo del Mar Condominium complex covers approximately 17 acres and is located between Seneca Street and Shoshone Street. All roof runoff is currently directed to the street and parking area. Concrete drains bisecting each street carry runoff directly to Dent Drain. Features have been added to the complex to deliberately bypass existing planter areas. Significant improvements could be made to this complex by installing dry wells and tree planters and modifying and improving drainage patterns to take advantage of existing infiltration and bioretention areas.

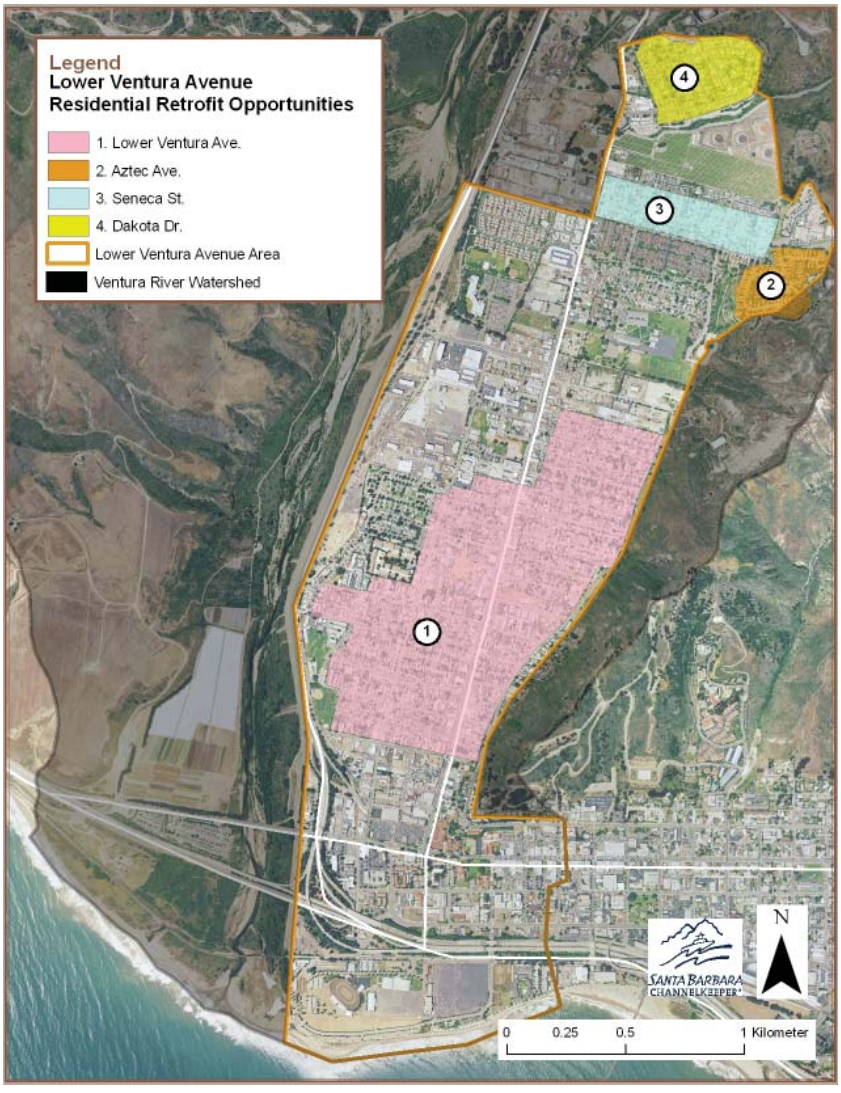

Figure 65: Residential stormwater retrofit opportunities throughout the lower Ventura Avenue study area

Figure 63: Existing drainage features bypass natural infiltration and bioretention areas at Venwood Condominium Complex.

Figure 64: Existing drainage features bypass natural infiltration and bioretention areas at Paseo del Mar Condominium complex.

Residential Opportunities

A subsidized education and retrofit program targeting single family residences could produce multiple benefits for water quality throughout the watershed. The City should work with existing community and environmental groups to encourage residents to implement simple on-site residential retrofits such as rain gardens, rainwater storage tanks, downspout disconnections, infiltration devices such as (i.e. french drains), and conservation landscape measures.

♦ Rain gardens are vegetated depressions strategically designed and placed in a landscape to collect rainwater from impervious surfaces. Redirecting rooftop runoff to rain gardens reduces peak storm flows, recharges groundwater, improves neighborhood aesthetics, reduces demand from municipal water sources, and provides partial treatment of storm runoff. By using native, drought-tolerant plants, rain gar-

dens minimize the amount of water and chemicals needed to maintain landscapes.

- Rainwater harvesting tanks such as cisterns and rain barrels provide storage of rooftop runoff, reducing peak storm flows and providing water which can later be used for landscape irrigation or other residential uses. Use of these storage devices can significantly reduce demand for municipal water. Rainwater tanks come in a wide variety of shapes and sizes and can be installed on roofs, along the outside of building walls, underground, or above-ground in yards.

- Infiltration devices such as French drains and drywells are simple drainage features appropriate for residential use that are designed to capture and infiltrate rooftop, landscape, and driveway runoff. These features are basically pits or trenches that are filled with gravel and collect stormwater runoff. As the well or drain fills, stormwater is temporarily stored and given time to infiltrate into the soil. Overflow devices are typically installed to direct excess runoff to the storm drain once the storage capacity is exceeded. Sediment control features can also be incorporated to help prevent clogging by silt or fine materials.

- Conservation landscape measures should also be taught to local residents and included in any residential retrofit plan. Such measures include choosing local drought-tolerant plants, minimizing high water-demanding grass lawn area, installing and implementing efficient irrigation controls, contouring, and mulching. Each of these measures provides benefits to water supply, water quality, and flooding and can also improve aesthetics.

These measures are relatively inexpensive and simple to install, require little engineering, are designed to treat small areas, and can take advantage of local community groups for education, outreach, and labor. Many municipalities across the country have successfully implemented residential education and retrofit programs. These programs increase community awareness of water issues and promote environmental stewardship at the household level.

Figure 65 depicts neighborhood segments in the lower Ventura Avenue study area that demonstrate good potential for a residential retrofit program. Each area has been delineated to represent neighborhoods with unique development characteristics. Most of these delineations represent individual development tracts. Brief surveys were conducted of each neighborhood to identify retrofit opportunities.

Each neighborhood and individual residential lot may have unique characteristics or constraints that may make retrofit projects more difficult. Constraints may include poor soil infiltration, the presence of basements, the lack of sufficient pervious area for gardening or for dewatering rain barrels, a lack of awareness, or the absence of an active homeowners association to assist with project outreach and implementation. However, each of these constraints can often be overcome with appropriate design, education, and outreach mechanisms.

1. Lower Ventura Avenue Residential Zone

The southern portion of Ventura Avenue from approximately Comstock Avenue to Park Row Road consists primarily of single and multi-family residential lots. Based on County Assessor data, together these residentially zoned parcels cover approximately 200 acres of land. Channelkeeper conducted a sidewalk survey of 95 residential lots in the southern Ventura Avenue study area and observed that 70 of these lots contained impervious driveways. Of the lots surveyed, 67% had building rooftops that drained to impervious surfaces connected directly to storm drains. Based on an aerial analysis of ten randomly selected residential lots throughout this area, the average residential lot is 62% impervious. Certain constraints in this area may exist, such as a low level of awareness or concern and lack of an active homeowners association. However, a residential retrofit education and outreach program could, over time, dramatically reduce the effective impervious cover of the lower Ventura Avenue study area with the added benefits of recharging groundwater, conserving domestic water supply, and increasing watershed awareness and stewardship.

2. Aztec Avenue Neighborhood

The Aztec Avenue neighborhood is a development tract comprised of approximately 80 homes along the southern half of Aztec Avenue, Cayuse Lane, Chinook Drive, Iroquois Lane, Kickapoo Drive, Tuscarora Avenue, and Algonquian Street. This neighborhood is located at the base of the Ventura hillsides. Nearly all of these homes have been

constructed with direct rooftop connections to the municipal storm sewer via an underground pipe with a curb outlet. Redirecting these rooftop drains to individual rain gardens or French drains would reduce peak storm flows directed towards Dent Drain.

3. Seneca Street Neighborhood

The Seneca Street neighborhood extends from Zuni Court to Aztec Court and consists of approximately 200 evenly distributed residential lots. The average lot includes a large roofed area, impervious driveway, and down-gradient yard area, which would be well-suited for a rain garden or rain barrel. A combination of rooftop rainwater harvesting and neighborhood street retrofits (described below) could significantly reduce the amount of peak stormwater runoff to Dent Drain from this neighborhood.

Figure 66: Dakota Drive dead ends directly into Canada de San Juaquin creek.

4. Dakota Drive Neighborhood

The Dakota Drive neighborhood consists of approximately 170 evenly distributed residential lots with large roofed homes, impervious driveways, and ample down-gradient yard area for rain gardens or rain barrels. No underground storm drain network appears to have been constructed for this neighborhood. Currently, the majority of storm runoff appears to flow down street surfaces to Mohawk Avenue. The southern 100 feet of Mohawk Avenue serve as a storm drain outlet into Cañada de San Joaquin Creek. As described above, Cañada de San Joaquin Creek is experiencing severe erosion, which is threatening buildings and infrastructure. A combination of residential retrofit education and street retrofits (described below) could significantly alleviate flooding and erosion at Cañada de San Joaquin Creek.

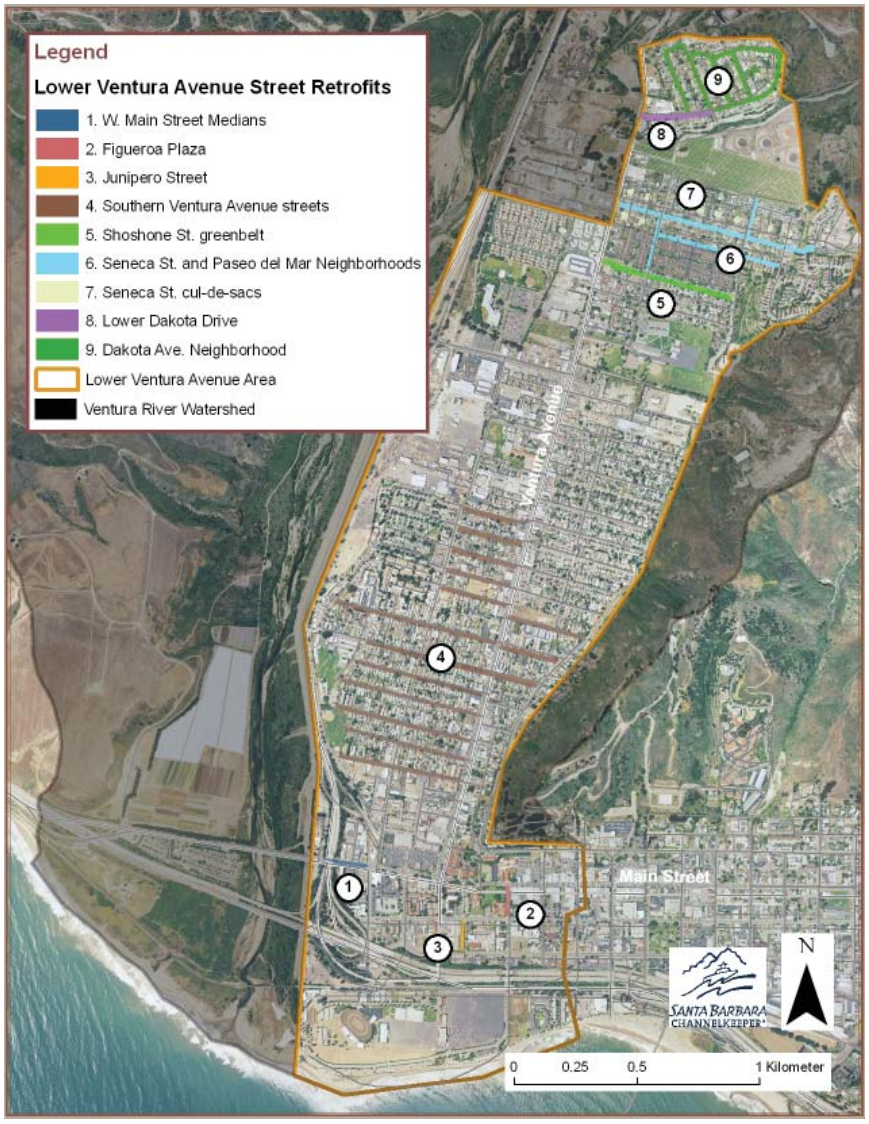

Figure 67. Street stormwater retrofit opportunities in the lower Ventura Avenue study area

Street Retrofit Opportunities

The City of Ventura recently approved a policy to incorporate "Green Street" elements into repaving projects on a citywide basis. According to the City, street improvements will provide numerous benefits, including reduction of flooding, improvements to water quality, improved aesthetics, and a reduction in the City's carbon footprint (City of Ventura, 2008). As a part of this program, the City will earmark 20% of the street paving fund for Green Street elements. A pilot project is currently being designed

to install improvements along South Catalina Street. The project will include widening the west parkway, installing permeable concrete paving, planting 36-inch box trees, and constructing bulb-outs with stormwater detention and percolation curb inlets.

Based on our analysis, streets account for 214 acres of impervious surfaces in the lower Ventura Avenue study area. Nearly all of the streets in this area are maintained by public agencies. None of the lower Avenue streets were designed with water quality in mind, and it appears that many streets in this area have been designed to be wider than is necessary to handle local traffic patterns. Many of these oversized streets represent good opportunities for future City "Green Street" projects.

The following list identifies additional opportunities throughout the lower Ventura Avenue study area for future street retrofits.

1. W. Main Street Medians

Several small medians and planter areas have been constructed along W. Main Street near the Highway 33 overpass. Curb cuts could easily be installed to provide basic bioretention within each planter area. Planter beds could be modified to enhance infiltration and treatment by providing 18 to 48 inches of sand/soil with a surface mulch layer. An underdrain could be installed to carry treated stormwater back to storm drains, or the planters could be left without an underdrain to enhance infiltration. Plenty of street area exists such that median areas could easily be enlarged without impacting the flow of traffic. Street parking demand is low in this area so bulb-outs could be installed along the sides of the streets to provide further stormwater treatment or infiltration.

Figure 68. Existing medians along West Main Street.

2. Lower Junipero Street.

The 100 block of Junipero Street could provide stormwater treatment options for this commercial and semi-industrial section of the downtown area. This stretch of under-utilized street spans over 60 feet between the outer edge of each sidewalk. Traffic and parking demand is extremely low relative to the size of this transportation corridor. A swale or bioretention cell could be installed along the eastern side of the street. Ventura Unified School District (VUSD) owns and operates a facility on the eastern side. Any potential retrofit will have to provide adequate space for school buses to maneuver into and out of the VUSD parking lot, however sufficient space exists such that this should not preclude a street retrofit.

Figure 69. Lower Junipero Street at mid-day

Figure 70. This large pedestrian plaza is currently paved with impervious materials and drains directly to the municipal storm drain.

3. Figueroa Plaza

Figueroa Plaza, across from the San Buenaventura Mission, is a small pedestrian street that extends between Main Street and Santa Clara Avenue. Currently the plaza is covered with decorative impermeable paving. A fountain runs the length of the plaza, along with intermittent small bench planters. Plaza aesthetics could easily be improved by resurfacing the plaza with a decorative, permeable paving option. Planter areas could be expanded or tree pits installed. While on-site, project surveyors observed maintenance crews pressure washing the plaza surface. Turbid wash water ran the length of the plaza to a municipal storm drain off Santa Clara Avenue. This site could be redesigned such that no stormwater runoff reaches

Figure 71. Runoff from Figueroa Plaza entering the municipal storm sewer

storm drains during small storms or from nuisance flows.

4. Southern Ventura Avenue Cross Streets

The cross streets along the southern end of Ventura Avenue have great potential for an extensive network of street retrofits. Nearly every Ventura Avenue cross street from Park Row Avenue to Vince Street is wider than necessary for this predominantly residential community. From sidewalk to sidewalk, the average width of these streets is 50 feet. The vast majority of residential lots in this area have driveways for off-street parking. A well designed program to install green street retrofits on one or both sides of these streets could provide significant stormwater treatment benefits and provide much-needed beautification to this urbanized community. The installation of landscaped bioretention cells such as bulb-outs, medians, or expanded right-of-way planters and tree pits would improve water quality and aesthetics. Properly designed, these features could provide water quality benefits without significantly impacting parking availability. Many streets provide above or underground utility corridors along one side, which could cause site constraints. However, given street and right-of-way widths throughout this area and the potential availability of off-street parking, a well-designed network of stormwater treatment retrofits is very feasible.

Figure 72. Romona Street is wide enough to provide opportunities to install bulb outs or other infiltration and bioretention features without significantly impacting traffic flow or parking.

Based on an inspection of street storm drain inlets (Figure 73), this lower Avenue residential area may contribute to the trash impairment on the lower Ventura River. An intensified effort to eliminate trash from the storm drain system throughout the southern Ventura Avenue study area should be a priority. Such an effort could include increased street sweeping, installation of catch basins, a targeted education and outreach program, and the potential installation of trash separator technology such as continuous deflective separation (CDS) units to reduce the amount of trash carried to the Ventura River through the municipal storm drain system.

Figure 73. Trash and debris in a Ramona Street storm drain inlet

5. Shoshone Green Belt

This large open space extends for over half a kilometer along the south side of Shoshone Street from Ventura Avenue to the Ventura hillsides and covers over two acres. The 'green belt' is currently landscaped with turf grass and trees and includes a meandering sidewalk. From the hillsides to Cameron Street, this green belt provides over 40 feet of open space. The area widens to approximately 80 feet across between Cameron Street and Ventura Avenue. A large network of residential storm drains converge here and join Dent Drain, which runs parallel with the green belt. The property is currently owned by the City of Ventura. The installation of large swales of bioretention areas could be designed to provide significant stormwater treatment and infiltration while reducing peak flows to Dent Drain. Additionally, the City should consider alternative landscaping along the greenbelt. By converting a portion of the greenbelt landscaping to native, drought tolerant plants, the City could save water and reduce or eliminate the need for chemicals.

Figure 74. The Shoshone Street green blet is over 500 meters long

6. Seneca St. and Paseo del Mar Neighborhoods

Seneca Street and the streets surrounding the Paseo del Mar condominium

Figure 75. Oversized Seneca Street

complex, including Cameron Street, Arapaho Street, and Cedar Street, are excessively wide. These transportation corridors are only used for residential access to the surrounding neighborhoods. Each neighborhood has ample off-street parking. By expanding the right-of-way on one side of each of these streets by several feet, a large network of bioretention cells could be installed to provide stormwater treatment and infiltration. Because these neighborhoods are near the top of the watershed, these retrofits would be in a good position to reduce peak storm flows, minimizing the required capacity of downstream stormwater infrastructure along the Dent Drain corridor. Combined with a residential education and retrofit program for the Seneca Street neighborhood (described above) and potential stormwater treatment options within the Paseo del Mar neighborhood (described below), a network of street retrofits in this area would produce significant benefits.

7. Seneca Street Cul-de-sacs

Ten large, evenly distributed, cul-de-sacs are located in the Seneca Street neighborhood, which extends from Ventura Avenue to Aztec Court (Figure 76). The center of each of these cul-de-sacs could be converted into planter areas to provide bioretention of stormwater. Combined with a residential retrofit and education program, these cul-de-sacs along with additional street retrofits described above could significantly minimize neighborhood stormwater runoff directed towards Dent Drain, providing flood control and water quality benefits.

Figure 76. Cul-de-sac neighborhood along Seneca Street in close proximity to Dent Drain

8. Lower Dakota Drive

The lower quarter-mile of Dakota Drive from Ventura Avenue to Mohawk Avenue is egregiously oversized for its purpose. The street is used solely for the purpose of accessing a small residential neighborhood and yet has been constructed to be approximately 85 feet wide from sidewalk to sidewalk. At least half of this distance could be used to install street retrofits, providing approximately one acre in stormwater treatment. This location would be particularly beneficial for a street retrofit as it could be used to treat a portion of the runoff from the Dakota Drive neighborhood which currently that is now contributes to severe erosion problems in Cañada de San Joaquin Creek.

Figure 77. Lower Dakota Drive is egregiously oversized

Figure 78. Dakota Drive and right-of-way

9. Dakota Drive Neighborhood

Street retrofits throughout this upper watershed neighborhood could help to minimize erosion issues along Cañada de San Joaquin Creek. Street and right-of-way width is sufficient to allow construction of retrofits along one or both sides of the street. To improve conditions along Cañada de San Joaquin Creek, a Dakota Drive neighborhood retrofit should be aimed at minimizing imperviousness and increasing infiltration. A network of bulb-outs and expanded right-of-ways combined with infiltration enhancement and a residential education and retrofit program could provide numerous benefits, including groundwater recharge, stormwater treatment, and reduction of peak storm flows.