CHAPTER 3: HYDROLOGY

Hydrology Overview

This chapter is about water — the supplies of water that exist in and around the Parkway Vision Plan area, the ways that water moves between the earth's atmosphere, surface, and subsurface, the demands that people have placed on this resource, and finally, the impacts that those demands have had on the Lower Ventura River, the site of this Vision Plan.

Water is addressed at four scales in this Vision Plan:

- The County of Ventura is the political unit that encloses nearly all of the Ventura River Watershed. Although it is not a geographical unit for looking at the physical behavior of water in and around the Ventura River, the County is significant for the important impacts that its planning decisions will have on the Parkway Vision Plan area.
- The watershed is the most important geographical unit for studying the physical properties and behavior of water as a resource for this Vision Plan, and a discussion of the movement of water through the watershed is a prelude to consideration of the parkway area.
- The Lower Ventura River, comprising the core of the Parkway Vision Plan area, is the overall site of this project and in this chapter, the focus for discussion of the impacts that development has had on the quantity and quality of water in and around the river.
- Finally, each of the four smaller design sites that are addressed in the Design section of this plan pose specific challenges and opportunities, addressed in that section, for utilizing the Parkway as a means for restoring the flow and the quality of water in the river and enhancing peoples' appreciation for and understanding of the river.

[FACING PAGE] FIGURE 3.1 *A channel of the Lower Ventura River meandering over nearly flat ground north of the Main Street Bridge, near downtown Ventura. In this reach, the river runs in multiple channels within a floodway (riverbed) that is much wider than the single channel shown in this photo.*

The sequence of this chapter is as follows:

- A discussion of water resources and hydrological processes in the watershed
- An introduction to the Ventura River as a whole
- A discussion of the Lower Ventura River, the site of this Vision Plan, with particular regard to the developments that have changed the functioning of the lower river
- Finally, a discussion of water quality and issues arising from pollution in the Lower Ventura River

FIGURE 3.2 *Looking upstream from the top of the proposed parkway corridor.*

Ventura River Watershed Hydrology

EXCHANGES: HOW WATER MOVES IN AND AROUND THE WATERSHED

The river that forms the backbone of this Vision Plan originates in hydrologic processes at the watershed scale. The land and ocean surface continuously interact with the atmosphere, receiving water in the form of precipitation, humidity, and fog. The fact that precipitation is concentrated in the upper, mountainous portion of the Ventura River Watershed (see chapter 2, Foundations) means that most watershed water originates there. The area's Mediterranean climate pattern with wet winters and dry summers corresponds with seasonal variation in the levels of water in streams and groundwater basins.

However, the spatial and seasonal pattern of precipitation is counteracted to a limited degree by fog, which is concentrated in the lower watershed near the coast and is heavy on summer mornings as well as during winter Santa Ana conditions (Noonkester 1979). Fog is perhaps under appreciated as a significant source of water; in one area of Northern California, fog delivers the equivalent of ten annual inches of precipitation to coastal watersheds (Gilliam 1962; Bakker 1971).

The land also returns water to the atmosphere through the processes of evaporation and transpiration, collectively referred to as evapotranspiration. Transpiration is the evaporation of water from plant surfaces and tissues. Transpiration is a significant factor in the Ventura River Watershed, where a majority of the land surface has vegetative cover, either wildland or agricultural. One large oak tree delivers approximately 40,000 gallons of water to the atmosphere annually, and an acre of corn gives up 3,000 to 4,000 gallons per day (Leopold 1974).

The two engines that drive all of these processes are the heat from the sun, which not only evaporates water but also drives the air and ocean currents that result in precipitation, humidity, and fog; and the force of gravity (Leopold 1974). (See figure 3.3: Watershed Hydrological Processes)

There are also constant exchanges of water between the surface and the subsurface. Groundwater basins are recharged by surface waters running over portions of the watershed with permeable soils. Surface waters, in turn, receive a large portion of their water from the flow of groundwater, called base flow. Exchanges of water also occur between the surface and the sub-surface; these are referenced in the "Groundwater" section of this chapter.

Finally, where a watershed meets the sea, there are exchanges of water between the ocean and the land. When ample river water is flowing, freshwater and river sediment flowing into the ocean can mix with saltwater in a plume that can reach far offshore. In addition, tidal action may naturally bring seawater into the river mouth forming a brackish condition in lagoons at the river's mouth (Leydecker and Grabowski 2006).

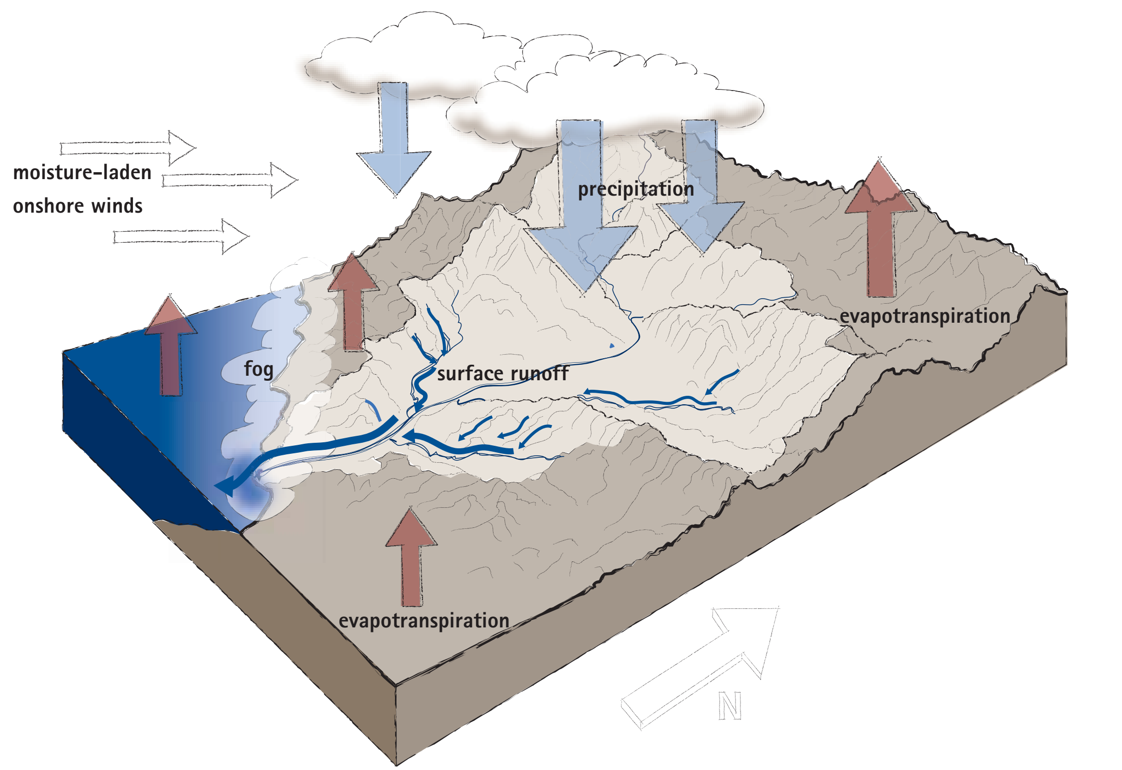


FIGURE 3.3 *Exchanges of water between the surface , atmosphere and ocean in the Ventura River Watershed. For an illustration of water exchanges between the surface and the sub-surface, see the Groundwater section of this chapter.*

HYDROLOGY IS . . .

"Hydrology is the science that treats the waters of the earth, their occurrence, circulation and distribution, their chemical and physical properties and their reaction with their environment including their relation to living things. The domain of hydrology embraces the full life history of water on the earth" (Federal Council for Science and Technology 1962, quoted in Chow 1964).

Who uses this science? This Vision Plan envisions a process in which individuals from many related disciplines will work together to fulfill multiple objectives, including stream and floodplain restoration and flood risk management. Some of these individuals will be water scientists from several fields. River or fluvial morphologists measure and predict the flows of water and study the formation and the restoration of streams according to long-term, natural geomorphic processes. Hydraulic engineers design structures for the diversion or control of water for urban design, agricultural, or flood control purposes (Riley 1998). Occasionally seen as antagonistic, these disciplines have successfully worked together on innovative projects designed for both stream and habitat restoration and flood control (Riley 1998).

SURFACE WATER RESOURCES

The entire Ventura River Watershed is drained by the Ventura River and by streams that are tributary to the river. The river is formed by the convergence of the main fork of Matilija Creek with the North Fork of the same creek in the upper watershed, and from that point it flows about sixteen miles to the Pacific Coast. Along the way, the river receives the waters of three other main tributaries. One of those, San Antonio Creek, joins the main stem approximately one and one-half miles upstream from the parkway vision plan area. The other two, Coyote Creek and the Cañada Larga, converge with the main stem of the river within the parkway area (See figure 3.4, Surface Water).

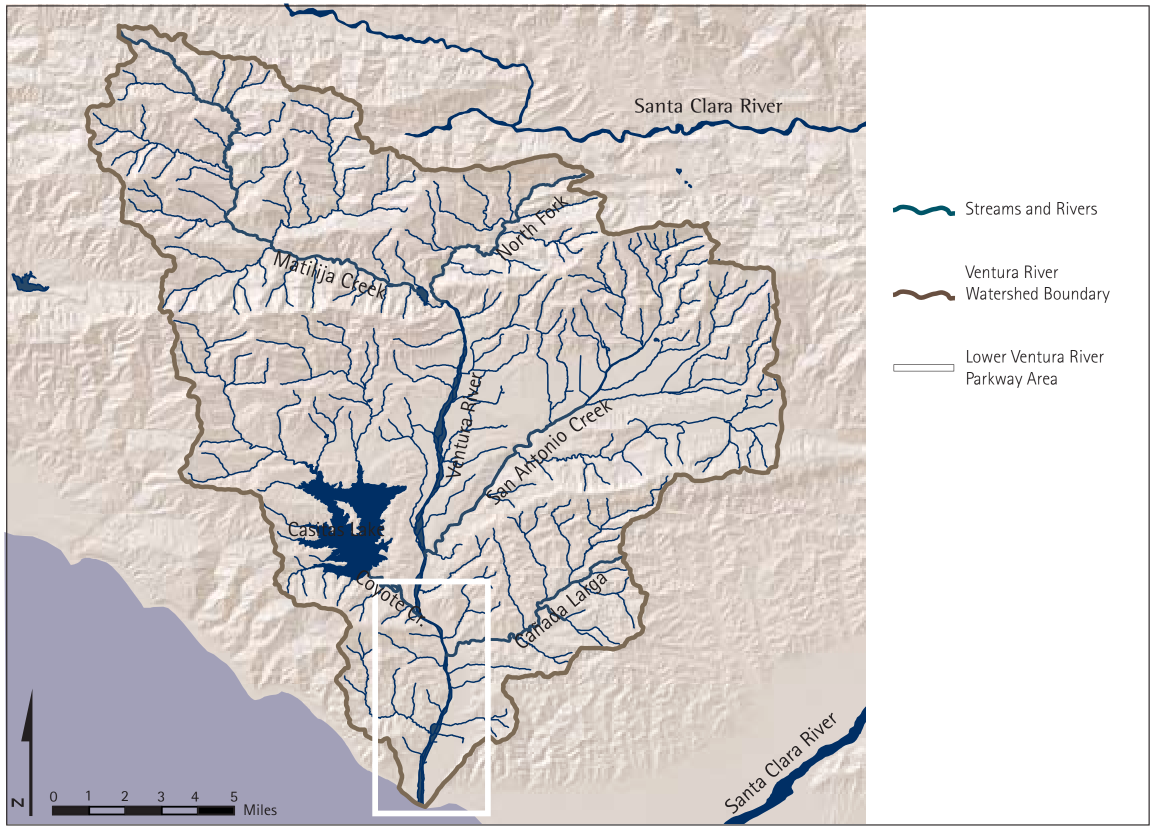


FIGURE 3.4 *Surface water in the Ventura River Watershed. The entire watershed is drained by the Ventura River and its tributaries. One major surface water feature, Lake Casitas, is a man made reservoir. Data from Ventura County Watershed Coalition; USGS.*

The Ventura River varies widely in its slope and its form from the top of the watershed to the sea (figure 3.5: The Ventura River: From top to bottom). Near the highest ridges in the watershed, at nearly 5,500 feet in elevation, the waters of Matilija Creek and North Fork Matilija roll over bedrock and boulders that fall from the steep, relatively unconsolidated sandstone slopes. In the middle elevations of the watershed about five miles upstream from the top of the parkway vision plan area (about 500-600 feet elevation), the river runs frequently in shallow braids over alluvial soil and stone cobbles. Under low-flow conditions, the river often disappears from the surface in this area, running underground as base flow (see figure 3.24), only to reemerge further downstream.

At the top of the Vision Plan area at Foster County Park, sections of the river channel are hidden behind dense stands of invasive giant reed (*Arundo donax*) competing with native mulefat (*Baccharis salicifolia*), and stone cobbles still abound. Just above the estuary at the river mouth, the river runs in several deeper channels over finer sediment, and the stands of *Arundo donax* and *Baccharis salicifolia* are still thick. The Ventura River is notable for the extreme variability of annual rainfall in its watershed, leading to a corresponding variability in river flow from one year to the next (mean annual flows from 5 – 3,400 cubic feet per second (cfs), with an extremely wet year having potentially almost 700 times more flow than an extremely dry year (Leydecker and Grabowsky 2006).

THE VENTURA RIVER AND ITS HEADWATERS: FROM TOP TO BOTTOM

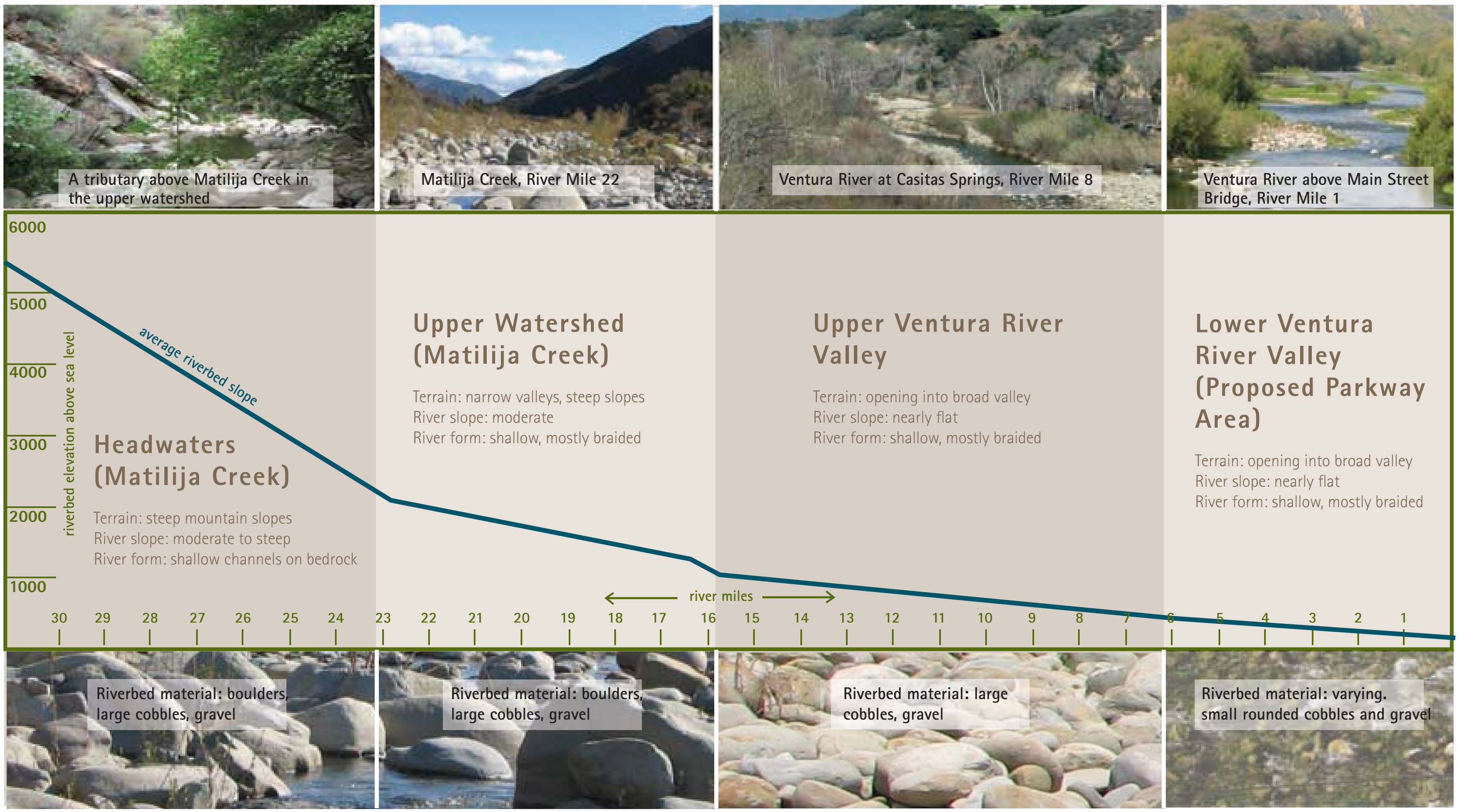


FIGURE 3.5 *Some characteristics of the Ventura River and its headwaters at Matilija Creek and North Fork Matilija. This illustration incorporates a graph (not to scale) displaying the average stream gradients along the Ventura River from RM (river mile) 0 at the river mouth to RM 16 (confluence with Matilija Creek), and continuing upstream along Matilija Creek to the creek's headwaters (RM 31)above 5000 feet in the Santa Ynez mountains. Elevation data from USGS Digital Elevation Model.*

WATERSHED GROUNDWATER RESOURCES

The three significant groundwater basins, Upper Ojai, Ojai Valley, and Ventura River (the latter divided into the Upper Ventura River and Lower Ventura River sub-basins) are confined to the lower half of the watershed, and generally follow the major water courses. All of these basins consist of alluvium and are unconfined (i.e. have their upper boundary at the water table near the ground surface). None of these basins are adjudicated – that is, there is no strict regulatory oversight over the amounts withdrawn by consumers. Natural sources of recharge include precipitation, infiltration from surface water bodies and inter-basin water movement (of which the Lower Ventura sub-basin is the most significant recipient). Artificial sources of recharge include excess irrigation water in all of the basins, intentional recharge through groundwater spreading basins in the Ojai Basin, and effluent from the Ojai Wastewater Treatment Plant (discussed later in this chapter). Although some Ventura County aquifers have been seriously over drafted, a 2003 State of California inventory concluded that the four basins in the Ventura River Watershed had shown stable levels without significant overdraft in recent years (California Department of Water Resources 2003).

The Lower Ventura River in the Parkway Vision Plan area runs over nearly flat ground with permeable alluvial soils and a high water table. Under these conditions, streams and groundwater basins quickly pass water back and forth, and can quickly replenish or deplete one another (Watersheds Coalition of Ventura County (WCVC) 2006). Between rainy periods, the river receives much of its natural water from groundwater flowing directly into its banks and bottom.

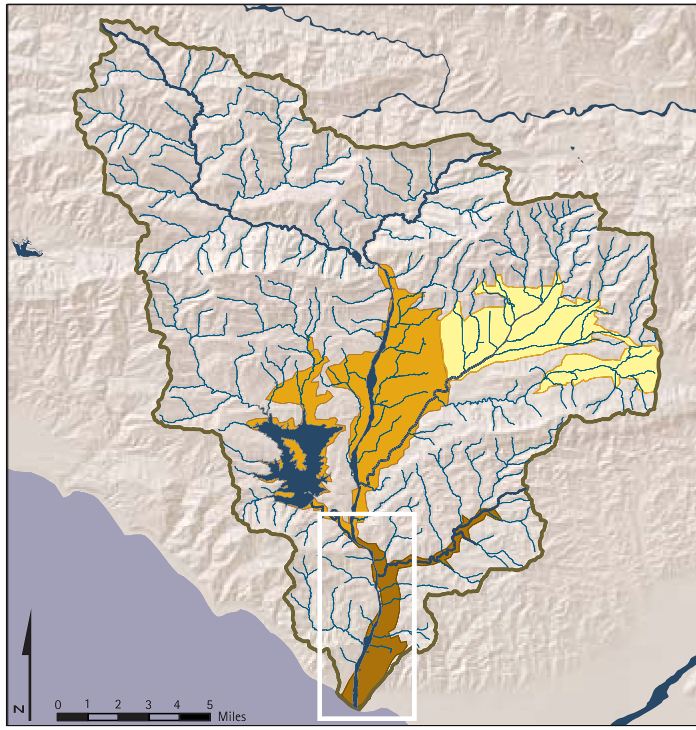


FIGURE 3.6 *Groundwater basins in the Ventura River Watershed are generally contiguous with water courses, shallow, and close to the surface. Data from CalWater; Ventura County Watershed Coalition; USGS.*

In the Oxnard area of Ventura County, in the Calleguas Creek, saltwater intrusion in the coastal plain has been greatly accelerated by the overdraft of groundwater basins, with the result that potable water supplies have been threatened. Since 1982, this condition has been partially ameliorated through extensive regulation of groundwater pumping, desalination, and through wells that inject freshwater into the coastal groundwater basin. However, this phenomenon has not been an issue in the Ventura River Watershed, where, although some overdraft has occurred, groundwater levels are normally at 70% capacity or better (WCVC 2006; California Watershed Council 2003).

Ventura River: Form and Function

FLUVIAL MORPHOLOGY: THE FORM OF THE RIVER

Like all rivers, the Ventura River has taken its form from the landscape that it runs through. The steepness or slope of the terrain, the surface or drainage area of the watershed, the bedrock type, and the degree to which the watershed captures precipitation are all landscape characteristics that have an influence on the quantity and velocity of water flow, the amount and type of sediment entering a stream, and the composition and smoothness or roughness of the stream's bed. Those factors, in turn, determine the width, depth, and shape of a stream channel as well as the degree to which it bends or meanders, i.e. its sinuosity (Riley 1998).

Streams also give form *to* the landscape. Rather than being a simple channel with water running in it, a stream is actually a system comprised of a dominant channel (also called the active or bankfull channel) combined with a wider floodplain. Under natural conditions, a stream periodically overflows the banks of its dominant channel, causing a flood that runs over an area determined by water quantity, velocity and land topography. Over time, the deepening of the stream channel combined with the action of periodic flooding influences the shape of a river valley, often leaving abandoned floodplain terraces at the valley edges (Riley 1998) (figure 3.7).

Following is a discussion of some relevant aspects of river morphology, and of the way in which the Ventura River reflects the unique characteristics of its landscape.

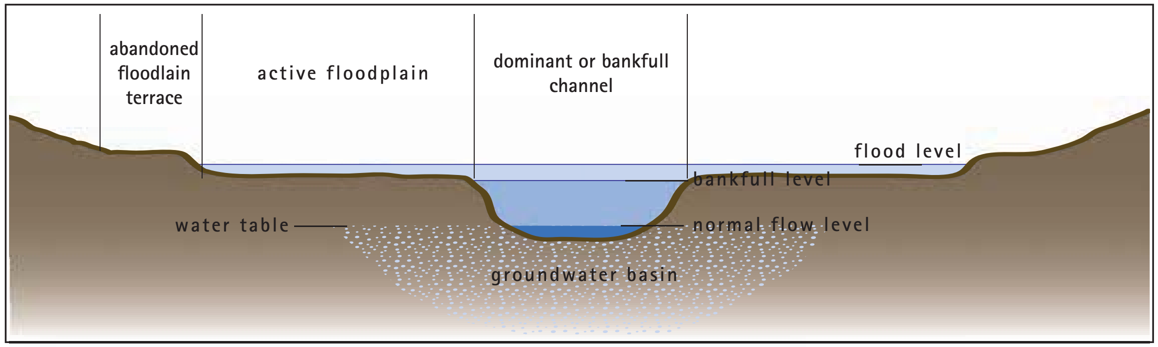


FIGURE 3.7 *A river is not just a flowing channel, it is a unit consisting of a dominant or active channel along with the surrounding floodplain.*

THE CONCEPT OF THE BANKFULL CHANNEL

A prevalent theory in geomorphology holds that land is given its form not primarily by extreme or catastrophic events but by unusual events that have intermediate recurrence. Applied to river formation, this suggests that a river channel is formed not by extreme floods and not by daily normal flows, but by higher-than-normal flows that occur relatively frequently. Empirical studies of stream channel shape and size in comparison with flows show that a dominant channel is formed by the action of flow events that have an average recurrence of one to two years, with an average of one and one-half years. The dominant or *bankfull* channel is the channel that will hold the bankfull discharge, the amount of water that flows in a storm event on the average of every one-and-one-half years. The bankfull channel is a way of expressing what the characteristic form of a river channel is, and a combination of a bankfull channel and an adequate adjacent floodplain is the target of planners who seek to restore a stream to more natural conditions (Leopold 1974; Riley 1998).

SEDIMENT AND STREAM EQUILIBRIUM

A river is much more than water; it conveys massive quantities of rock and soil collectively termed sediment, breaking down large, rocky boulders into smooth stones, gravel, and finally sand and silt. A river constantly forms and reforms its own banks and bottom by capturing and releasing the sediment that flows through it. Sediment is captured through the process of deposition, and released through the process of erosion.

Coarse particles of sediment that are pushed down steep, high velocity streams in the upper watershed settle out into the stream banks and bottom when the water reaches flatter, lower velocity terrain in a river valley (figure 3.8). Under certain conditions, the gradual deposition of such sediment in the valley will eventually block the course of the stream, causing a lateral movement to another section of the floodplain and forming a bend or meander. In stream bends, sediment is deposited on the inner bank of the curve, while the outer bank erodes, resulting in even more lateral movement (Riley 1998) (figure 3.9).

Thus, a stream channel under natural conditions is subject to constant change due to deposition and erosion, variances in flow, and changes in sediment load. It will constantly undergo adjustments in size, shape, sinuosity and elevation in order to continue to convey the rock and water that is flowing in it. The theoretical balance point between deposition and erosion is the point where the amount of sediment entering a section (reach) of the stream is equal to the amount of sediment leaving it. The tendency of a stream to seek this balance point under changing conditions, through the processes of deposition and erosion, is termed dynamic equilibrium (Riley 1998).

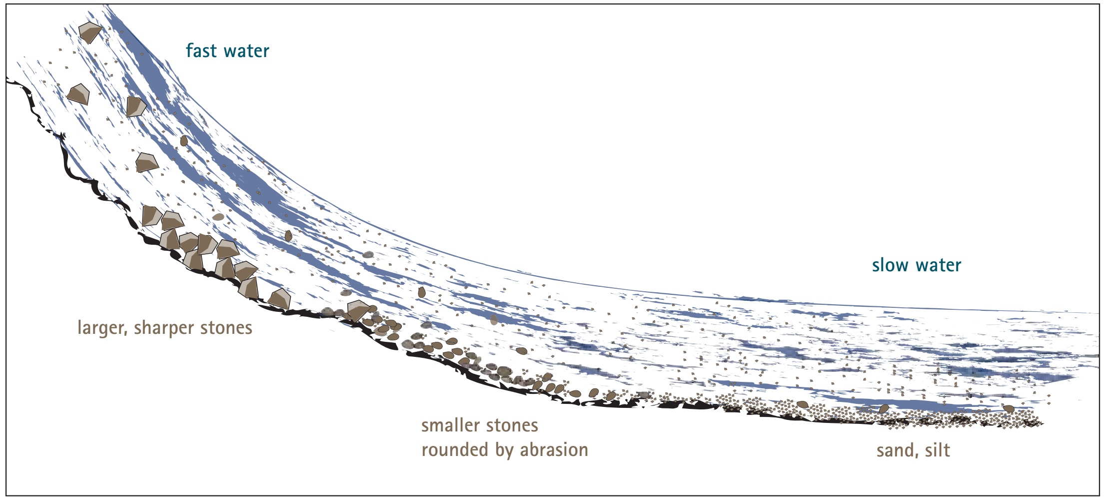


FIGURE 3.8 *Sediment composition of the river's flow, and riverbed composition, are partly determined by stream gradient or slope. Finer sediments remain suspended until the flow slows down on flatter ground near the river's mouth, where they settle out.*

A UNIQUE SOUTHWESTERN RIVER

The Lower Ventura River is a particular variation on the general concepts discussed above, an example of what happens when a steep, geologically active terrain composed of soft rock interacts with arid Southwestern climate. The result is unusually high sediment production, unstable channel formation, and flooding.

The Upper Ventura River Watershed is a giant generator of loose rock and sediment. As described above, the land that forms the Ventura River Watershed was originally formed under ancient seas, then uplifted to mountainous heights. Through the processes of weathering and erosion accelerated by the constant upward movement of these young, geologically active mountains, soft sandstones gradually break up on the mountain slopes. The relatively steep slopes of the upper watershed make it easy for these rocks to detach from the slopes (Scott and Wouldiams 1978, cited in Greimann 2006) (figure 3.10).

This combination of factors produces one of the highest rates of debris and sediment production in North America (Greimann 2006). One study based on data from 1933 to 1975 estimated that the watershed, prior to the construction of dams that trapped sediment (discussed later in this chapter), produced 2.1 acre feet of sediment per square mile per year (figure 3.11), for a total of 468 acre feet (Brownlie and Taylor 1981, cited in Greimann 2006).

How does all of this rock find its way to the river? Rock falls and landslides bring boulders to the bottom of the slopes while less dramatic rock fragment flows and dry slides bring fragments up to two and one-half inches in diameter down; all of these form deposits at the base of the slopes and along or in streams. This material is enough to fill up or entrench the streambeds of tributaries in the upper watershed until periodic floods move the sediment downstream and scour the streambed back down to bedrock (Scott and Wouldiams 1978, cited in Greimann 2006).

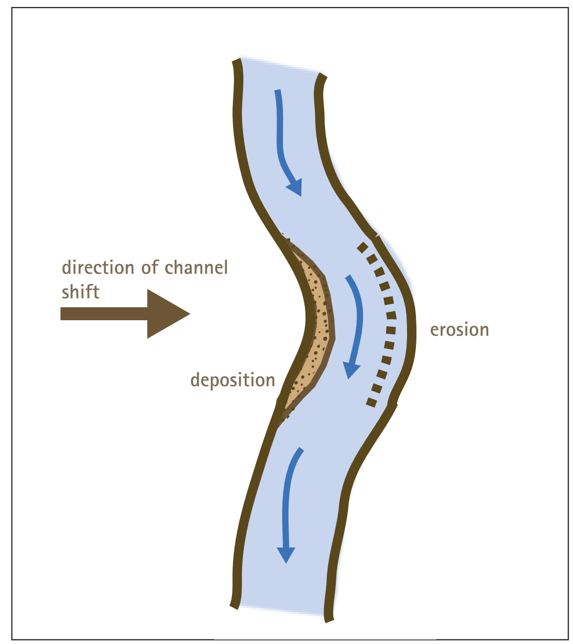


FIGURE 3.9 *Deposition and erosion combine to cause lateral movement of a stream channel across the floodplain.*

FIGURE 3.10 *Tectonic uplift, steep slopes and soft sandstone bedrock result in a lot of rock moving in the upper watershed. This boulder appeared overnight in the road above Matilija Dam.*

Once sediment accumulates at the bottom of the slopes, further movement is through the water of the river, and most of the material is moved during relatively infrequent floods. Ninety-eight percent of the sediment is moved in the form of small sand particles up to 0.08 inch suspended in the flowing water (Hill and McConaughy 1988, cited in Greimann 2006). Coarser material consisting of gravel and cobbles is moved only by floods; while it makes up a small percentage of the total sediment, there is enough of it to make up the dominant material on the riverbed and to play an important role in forming the shape and size of the Ventura River (Greimann 2006; Scott and Wouldiams 1978, cited in Greimann 2006).

The Ventura River bed consists predominantly of stones with sands interspersed between. Riverbed material generally decreases in size as the river proceeds downstream. Where the slope of the river itself is steep in the upper watershed, cobbles averaging 12 inches diameter or larger collect on the bed while the swift-flowing water carries smaller stones and sediments downstream. Where the river slope flattens on the lower river, the flow slows down, allowing smaller stones and suspended sediments to fall to the bottom (figure 3.8). In the area of the proposed parkway, riverbed cobbles are, on the average, about the size of a softball (Greimann 2006). These cobbles are also deposited at the river mouth, where they help to form one of the best surfing breaks in California (Jenkin 2002).

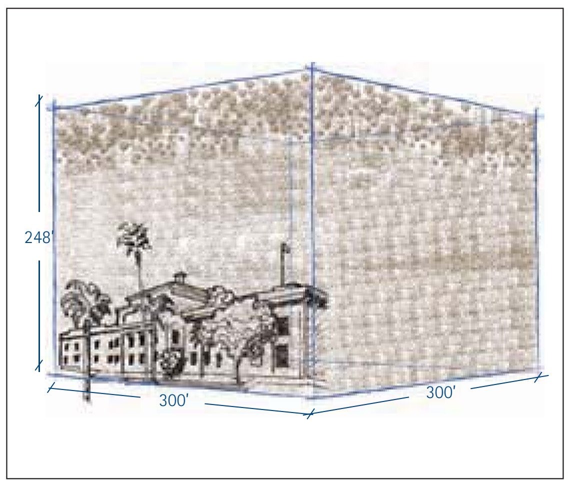


FIGURE 3.11 *What would 468 acre feet of sediment look like? That is one researcher's estimate of the amount of sediment produced annually by the Ventura River Watershed. It would fill a box larger than the city of Ventura City Hall, 248 feet deep.*

BRAIDING AND UNSTABLE CHANNEL FORMATION ON THE LOWER VENTURA RIVER

A combination of high sediment production, extreme variability in peak and low flows, and a river gradient that nearly flattens in the lower portion of the watershed, results in the Lower Ventura River, in the proposed parkway area, being a notable Southwestern exception to the general model of river channel formation. Under normal low-flow conditions, the river does not have high enough water velocity to convey all of the sediment that enters it. Instead of tending to form a single, relatively stable, wide and deep meandering river channel, it forms into multiple shallow channels, or braids, that change location relatively frequently under non-flood conditions (Keller and Capelli 1992). Then, during the occasional extreme flood event, the sediment is blasted out of the channels and the river is radically reformed (see Flood Scouring).

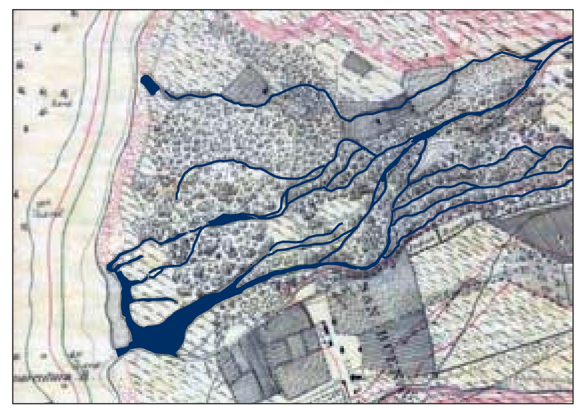


FIGURE 3.12 *This 1855 map of approximately the lowest mile of the Ventura River shows its naturally braided character. Map: Museum of Ventura County (highlighting added).*

FLOODING: A NATURAL RIVER FUNCTION

Flooding has been a frequent and dramatic event on the Lower Ventura River, aggravated in modern times by the effects of human development.

A flood is a natural event, defined by the river morphologist as any event in which water overflows the banks of a stream's dominant or bankfull channel.

> *The river cannot form a channel that would convey without overflow all possible flood events. In fact, the channel can contain within its banks only a discharge of modest size. The greater discharges must overflow the valley floor within which the channel occurs. For this reason the flat valley floor or flood plain is indeed part of the channel during unusual storm events (Leopold 1974).*

The Ventura River Watershed is a natural generator of huge floods. In the upper watershed, high variations in the rate of precipitation, that is, drought interspersed with occasional torrential rains, produce a dramatic variability in water flow in the river, with peak flows that can be *seven hundred* times the amount of the lowest flows (Keller and Capelli 1992; Greimann 2006). Combined with steep slopes, these peak flows produce fast-moving water. At the same time, the high rate of sediment production amplifies this effect by leaving stream beds that are often choked with rock and gravel, constricting water channels and speeding the flow, until a flood clears the material out. All of this makes the Ventura River a "flashy" river: during a storm, water levels in the river and its tributaries rise quickly in response to the level of rain (figure 3.13).

Flooding can have positive impacts on wildlife and human culture. It assists groundwater storage by temporarily increasing the surface area for recharge in periods of surplus surface water, and deposits sediment on the floodplain that builds good plant habitat or agricultural soils.

However, when an overflow of the river channel due to periodic rains encounters incompatible human land uses, the results can be death, destruction of communities, and displacement of thousands of people.

A FLASHY RIVER

A hydrograph is a way of showing visually how long it takes for floods to build up in response to rain. The example below compares the intensity of rainfall (in red) with the flood stage (water height, in blue) in the Ventura River at Foster Park during the December 2004-January 2005 flood event. Once watershed soils were saturated by the earliest stages of the rainstorm, dramatic changes in flood height followed almost immediately after corresponding changes in rainfall. This illustrates the flashy character of the river. Urban development, with its increase in storm water runoff, can aggravate this effect. However, this data was recorded at Foster County Park, upstream from most urban development in the watershed, and it illustrates a natural condition.

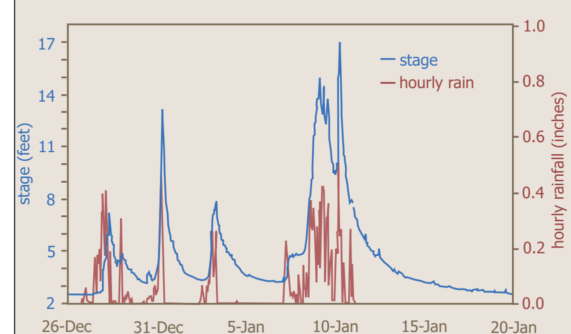


FIGURE 3.13 *Flood hydrograph at Foster Park, December 2004 – January 2005. Adapted from Leydecker 2006.*

SEVENTY-FIVE YEARS OF FLOODING

The graph below depicts the largest peak flood event for each of the years from 1933 through 2006. The five largest events, all in the last thirty-five years of the period, are highlighted below. The most recent event, in 2005, was comparable in size to the 1938 flood that inundated Ventura Avenue and left marks that are visible today on the Lower River.

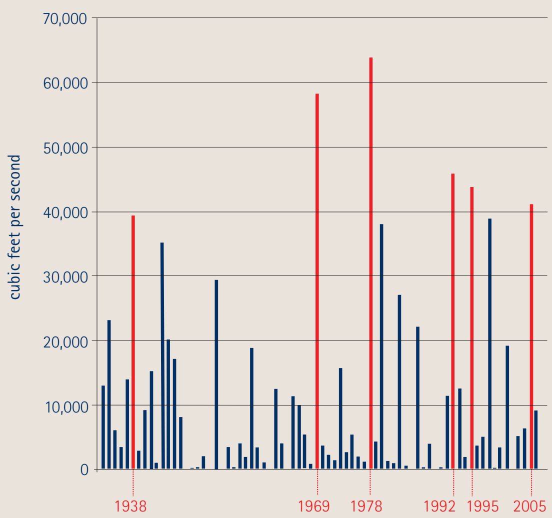


FIGURE 3.14 *Largest peak flow event for each year from 1933 through 2006. Data source: Ventura County Watershed Protection District.*

FLOOD SCOURING – – DRAMATIC CHANGES ON THE RIVER

Frequent high-energy flood events – the result of extreme rainfall variability in the watershed – have a dramatic cyclical effect on the form of the Lower Ventura River and its habitat. On an average of every seven years (the actual historical interval has varied from three to thirty years), a flood event occurs that is forceful enough to scour the banks and beds of the channels and the floodplain around them, removing gravel, fine sediment, and aquatic life from the river bottom and also removing most riparian vegetation from the banks and sections of the floodplain. The result is a combination of higher water temperature (due to absence of canopy), the release of high concentrations of nutrients (nitrogen and phosphorus) that have accumulated in groundwater prior to the wet season, and the disappearance of gravel and sediment exposing larger stones and bedrock.

All of this favors the growth of filamentous algae, just when aquatic plants that compete with algae have been removed. With the passage of drier years afterward, stream bank vegetation, aquatic plants and sediment re-establish, excess nutrients are absorbed, and algae recedes, until another large flood event starts the cycle anew (Leydecker 2006; Leydecker, Simpson et al. 2003). Most recently, a flood event in early 2005 caused these scoured conditions – sections of the Lower Ventura River are currently bright green with filamentous algae, mature plants are missing from many sections, and bedrock can be seen on the river bottom.

FIGURE 3.15 *Flood scouring. Looking downstream at the Ventura River from Shell Road on October 2, 2004 and February 2, 2005, before and after the flood event in early 2005. Photo source: Leydecker 2006.*

Development and Change

SUPPLY AND DEMAND

Urban development in and around the Ventura River floodplain has brought demands for hydrological engineering for two purposes. First of all, humans need water for drinking, agriculture, and industry. Ventura County residents currently use the majority of their water (68%) for agriculture but significant amounts also go for residential (22%) and industrial/commercial (10%) use. Twenty-five percent of that water is imported from outside the county through the State water project, and nearly all of the remainder comes from a combination of surface (8.5%) and groundwater (65%) from the County's three major watersheds, including the Ventura River Watershed. Less than two percent of the County's water is reclaimed (WCVC 2006).

The City of Ventura, the largest user of water from the Ventura River, plans to derive 49% of its water, an annual average of nearly 15,000 acre feet per year, from the river for the immediate future (figure 3.17). This water is derived both from wells and surface diversions at Foster County Park and from water that is diverted from the river and its tributaries into storage at Casitas Lake. In contrast to the county with its dominance of agricultural demand, the city needs 65% of its water for residential uses and none for agriculture (figure 3.17) (City of Ventura Department of Public Works 2005). The city is not the only user of Ventura River water, some is also pumped from wells by farmers and

1 Matilija Dam

2 Robles Diversion Dam

3 Debris Basins (approximate locations)

4 Casitas Lake and Dam

5 Foster Park Wells/Groundwater Dam

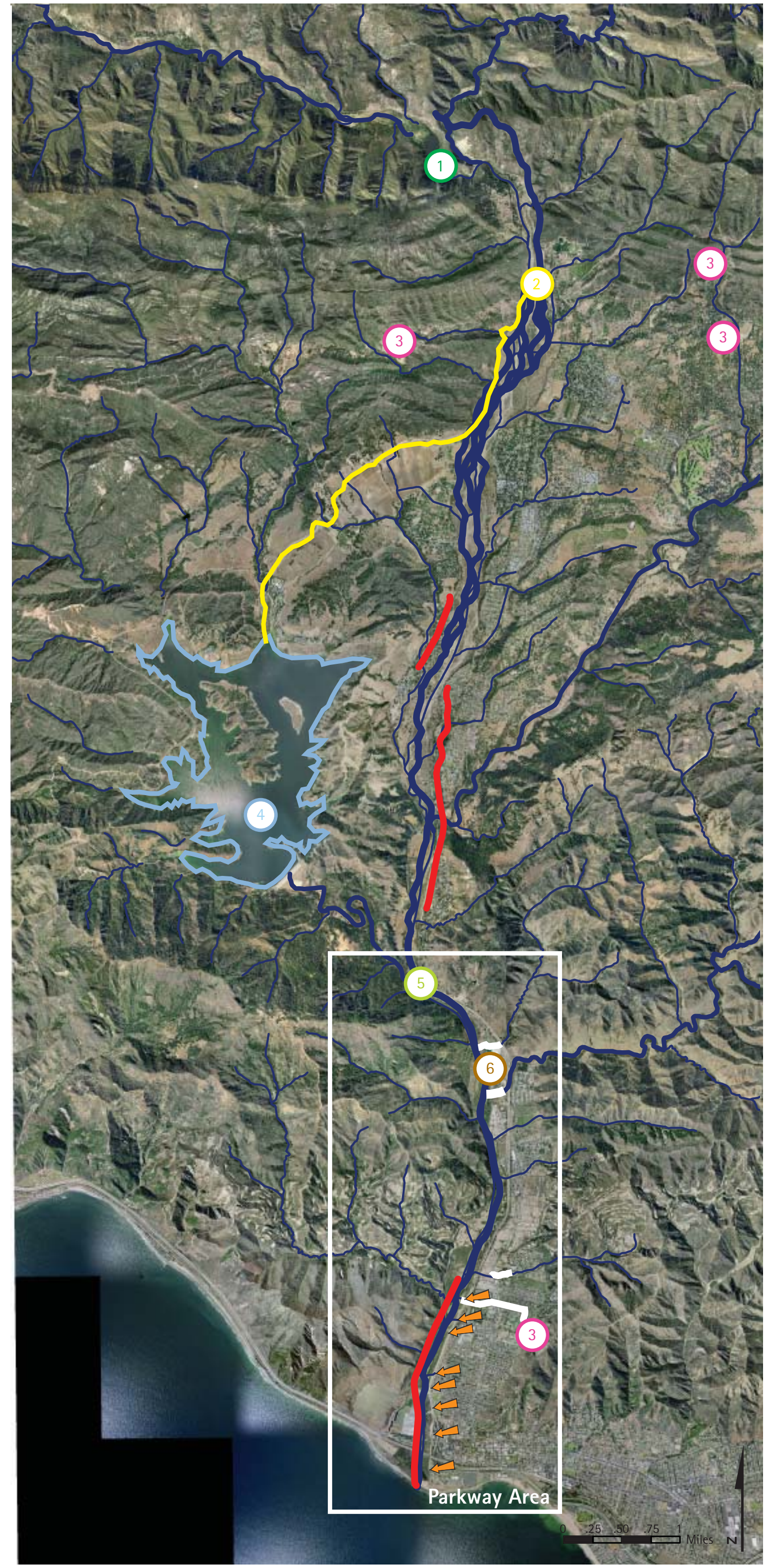
6 Ventura Water Plant and Ojai Valley Wastewater Plant

Storm Drains into Ventura River

Levees

Robles Diversion Canal

Concrete Channel or Culvert



other individual property owners outside the city.

The other demand of hydrological engineering is for protection from the flood risk that inevitably follows urban development in the floodplain. Floods causing injury or property damage in Ventura County have occurred on average every five years, at least since the first report of such an event in 1862 (URS 2004). The greatest damage was from the 1969 event that cost thirteen lives and $60 million in damage in the Ventura and Santa Clara watersheds (URS 2004).

These two demands have led to the construction of hydrologic structures, described below, that have changed

[FACING PAGE AND ABOVE] FIGURE 3.16 *The illustration on the facing page shows major structures altering the function of the Ventura River. The diagram above locates the illustration within the watershed. Orthophotography from CIRGIS.*

and to some extent impaired the natural function of the Ventura River, primarily during the past 70 years (figure 3.16).

Located approximately ten miles upstream from Foster Park (the northern end of the proposed parkway corridor), **Matilija Dam** was built in 1947 primarily for flood control purposes. It was designed for a reservoir capacity of 7,018 acre feet, but sediment has built up to the point that reservoir capacity is less than five hundred acre feet, with the result that the dam has negligible effect on peak water flows in the Ventura River. However, the dam does hold back approximately 45% of the sediment that enters from upstream. The dam has the potential to release 250 cubic feet of sediment per second, and under ordinary operating conditions, water releases are adjusted to produce the optimal capture of water at the Robles diversion (Greimann 2006). In 2007, the United States Congress approved the first stage of funding for a program to remove the dam.

The **Robles Diversion Dam (figure 3.16)**, located approximately eight miles upstream from Foster Park, was built in 1958 for the purpose of diverting water from the Ventura River through a canal to Casitas Lake, where it is stored for agricultural, industrial, and municipal use by the Casitas Municipal Water District. The dam can divert a maximum 500 cubic feet per second, but the rate of diversion is highly variable and occurs primarily during the wet season from December through March. The dam operates under restrictions which generally provide that a flow of at least 20 cubic feet per second will be passed down river. The dam effectively blocked steelhead trout from passage to optimal spawning grounds in the upper watershed until 2005, when an effective fish passage facility was built. Current proposals provide for water passed through the facility to be increased to 50 cubic feet per second during optimal periods for steelhead trout passage and spawning from January through June each year. The period of increased flow for these purposes will be opened earlier if the sand bar breaks at the mouth of the river before January (Greimann 2006). The dam does not trap suspended sediments (clays, silts and sands) but it does trap a significant portion of gravels, cobbles, and boulders coming down river, with the result that debris removal by the Water District is necessary after every major flood (Greimann 2006).

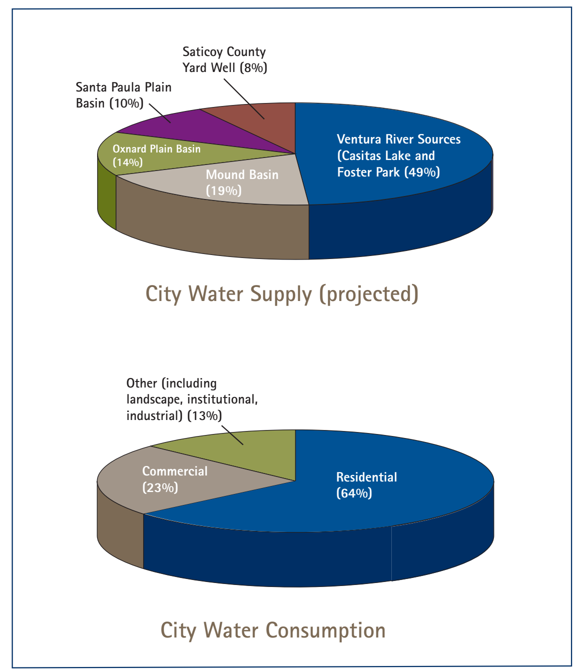


FIGURE 3.17 *[From top to bottom] City of Ventura, projected sources of water, fiscal years 2005-2020 and average water consumption by user group, fiscal years 2000-2005. Data: City of Ventura Department of Public Works.*

Casitas Dam (figure 3.16, and figure 3.21) was built the same year as the Robles Diversion dam for the purpose of creating a 250,000 acre foot reservoir to store water from the Ventura River (via the Robles facility) as well as from the Coyote Creek sub-watershed. Construction of the dam reduced the contribution of Coyote Creek to the Ventura River flow from 18% to 5%. The dam traps all sediment that enters the reservoir, and has no fish passage facility (Greimann 2006).

City of Ventura Diversions at Foster Park (figure 3.16) Ventura currently removes an average of approximately 6000 acre feet of surface and groundwater annually at this location. The city operates a shallow intake pipe in the river, as well as a concrete surface diversion dam (often called a groundwater dam) that forces subsurface water flow near to the surface where it can be collected (a shift in the river channel in 2000 rendered the groundwater dam inoperable). The city also operates several wells at this location, and plans to construct several more in conjunction with the removal of Matilija Dam. (Greimann 2006) (figure 3.24).

Numerous wells are operated by water companies and owners along the Ventura River. No comprehensive water budget has been prepared for the watershed, and the amount of groundwater removed is undetermined.

The Ojai Valley Sanitary District Wastewater Treatment Plant (figure 3.16) was constructed in 1963 for secondary treatment of sewage from the city of Ojai. During the 1990's, the plant was upgraded to tertiary treatment; the resulting effluent is released into the Ventura River in the proposed parkway corridor at a rate of 2.31 cubic feet per second (average from 1990 to 2001). During dry periods, the effluent often comprises two-thirds of the water in the lower four and a half miles of the river (Leydecker and Grabowski 2006; California Regional Water Quality Control Board, Los Angeles Region (CRWQCB-LA) 2003).

Three major **levees (figure 3.16),** at the community of Live Oak, the community of Casitas Springs, and the city of Ventura, are designed to protect those communities from flood. The Ventura levee was built by the United States Army Corps of Engineers in 1947 and constrains the eastern bank of the Ventura River from the river mouth to a point near Stanley Road, 2.3 miles upstream (Greimann 2006). The levee is constructed of compacted earth armored by grouted or ungrouted rock (in different sections). The Ventura County Watershed Protection District has constructed terraces at the foot of the levee in locations where the shifting Ventura River channel threatened to erode the levee. (Interview with Joe Lampara, Ventura County Watershed Protection District, April 29, 2008). Numerous smaller levees exist along the Lower Ventura River, some of them constructed by landowners.

FIGURE 3.18. *The 1938 flood was smaller than several events that have occurred during the past twenty years. However, it caused over one million dollars in damage (URS 2004) and inundated oil fields along Ventura Avenue. Nine years later, the Army Corps of Engineers completed construction of a levee to protect structures that intruded on the floodplain in this area and in the city of Ventura to the south. Photos: Museum of Ventura County; Ventura County Star.*

Four **debris basins (figure 3.16)** exist along the Ventura River. One of them, the 80-foot wide by 3-feet high Dent Debris Basin, is located adjacent to the proposed parkway corridor. This basin is designed to capture 928 cubic yards of sediment and debris in a 25-year flood event (Greimann 2006).

IMPACTS OF DEVELOPMENT ON VENTURA RIVER HYDROLOGY: FLOODING

Human development does not cause flooding, and even the most progressive urban development practices such as reduction of impervious surfaces (discussed in chapter 7) will not prevent a catastrophic flood resulting from extended rainstorms (Leopold 1974). The main cause of human and property damage in these events is not flooding itself, but the clash between inevitable flooding and incompatible human structures and land uses in the floodplain. The objective of contemporary hydrologists and hydraulic engineers is not flood control, but flood damage reduction (Riley 1998).

Urban development in the Ventura River Watershed has increased the risk of flood damage in three ways:

First, the construction of urban industrial facilities and residential neighborhoods on the West side of Ventura, in the historic floodplain of the river, has long presented a risk of damage to those developments, a fact illustrated by the floods that rolled across the Ventura Avenue area prior to construction of the Army Corps of Engineers levee (figure 3.18). With much of the city otherwise in harm's way, the continued existence of the levee is a likely feature of future watershed plans.

Second, development in the floodplain has constricted the path available for floods. When flood waters cannot spread out, it follows that the depth and velocity of flood waters will increase in the narrowed floodway that remains (figure 3.19).

The Ventura River would be flashy in any major storm, even without urban development. However, development aggravates the extent of flooding by increasing the amount of surface runoff, since water cannot infiltrate into impervious surfaces such as concrete. And, it increases the speed with which runoff travels across the land surface, accumulating downstream into floodwaters because water runs more quickly across smooth constructed surfaces. All of this alters the storm hydrograph (figure 3.13) by shortening the time period between the onset of a storm and the accumulation of life-threatening floodwaters.

ARRESTED DEVELOPMENT: IMPACTS OF DEVELOPMENT ON RIVER FORMATION

As discussed earlier in this chapter, many factors influence the width, depth, sinuosity, and channel geometry of a natural river, including topography, bedrock geology, and sediment supply. In its natural state, the Lower Ventura River once spread across a broad alluvial valley in numerous, shallow braids (figure 3.12). By the 1940s, oil production and farming in the floodplain had pushed the river channels into a narrower corridor against the hills to the west (figure 3.19). Then, the construction of the Army Corps levee and adjacent Highway 33 constricted the river still further and created a hard edge to its eastern bank (figure 3.19). Among the impacts of this constriction are reduced habitat, a reduced floodway leading to faster, deeper floods in the remaining corridor, and a vastly altered sensory experience for human visitors.

IMPACTS OF DEVELOPMENT: A CONSTRICTED RIVER

FIGURE 3.19 *Arrested Development. These two aerial photographs compare the same section of the Lower Ventura River in 1946 (left) and 2004 (right). The floodway available to the river (light blue) and the river channels (dark blue) are highlighted on each photo based on the author's estimate. With the passage of time, a river will move laterally back and forth across its floodplain and will develop meander or sinuosity, a rhythm of bend determined by the river's slope and the velocity of its water. However, most of the Lower Ventura River floodway is now constricted by levees and other encroachments that alter this development. Orthophotography: City of Ventura (1946); Channel Islands Regional Geographic Information Systems (2004).*

REDUCED SEDIMENT FLOW AND EROSION

River formation is greatly affected by the amount and type of sediment being supplied to the river and moving through it. The construction of Matilija Dam (figure 3.16 and figure 3.20) held back much of the sediment that had previously been supplied to the river by the upper watershed. Casitas Dam holds back sediment previously supplied by the watershed of Coyote Creek.

A radical reduction in sediment flowing in the river creates “hungry water” that washes away more earth than it supplies to the river banks and bottom (Riley 1998). The result can be increased erosion. Some reaches of the Lower Ventura River in the proposed parkway area have experienced so much erosion during the past half century that the base elevation of the river has been lowered by 10 or more feet in elevation, exposing bedrock on a river bottom once covered with alluvial soils. This is partly due to unusually high water flow in the river between 1975 and 1999, but hungry water continues to play a major part in this problem (Greimann 2006).

An additional effect of sediment reduction in the river is the starving of beaches on Ventura’s coast, where the shoreline of the river delta has been receding approximately one and one-half feet per year for the last 50 years (Jenkin 2002). Matilija Dam is slated for removal during the next several decades (see chapter 13, Beyond the Parkway). One anticipated result is the gradual rebuilding of riverbanks and river bottom and the return of a limited amount of sand to the beaches. This recovery will be limited, however, by the continued trapping of sediment by the Casitas and Robles Dams.

BARRIERS TO WILDLIFE

The construction of Matilija Dam and Casitas Dam cut off the passage of steelhead trout to the upper watershed where they once spawned (see chapter 5, Ecosystems), greatly contributing to the decline of this species in the Ventura River Watershed. The attempted restoration of this species is one major motivation behind the anticipated removal of Matilija Dam. The Los Robles Diversion Dam (figure 3.16 and figure 3.21) also blocked the passage of steelhead trout until a fish passage facility was built in the mid-1990s.

INSTREAM FLOW

During the dry months in late summer and fall, the Lower Ventura River often runs dry on the surface in some areas downstream from the Robles diversion dam. Under these conditions, some groundwater still flows under the surface. Low flows are related to both natural and man-made factors. and it is difficult to determine the relative contribution of those factors. Without human interference, seasonal low flows would still occur due to the dry Mediterranean climate and the permeability of the alluvial soils that transmit water quickly to groundwater basins. However, removals of both surface water and groundwater for domestic and agricultural uses also play a significant role. The impact of diversions from the Robles dam is mitigated by policies, discussed above, that restrict diversions during low flow periods. However, it is clear that every drop removed for domestic use at the Robles facility or by the city at Foster Park reduces the amount that is left to flow in the lower river.

FIGURE 3.20 *Matilija Dam, approximately ten miles upstream from the top of the proposed parkway area, holds back approximately 53% of the sediment that would otherwise flow in the Ventura River. Photo: Greimann 2006.*

FIGURE 3.21 *The Robles Diversion Dam removes up to 500 cubic feet per second of surface water from the Ventura River approximately eight miles upstream from the proposed parkway area. The canal to Casitas Lake can be seen leading from the diversion structure on the left. To the right of that diversion is a fish passage facility constructed in the mid-1990s . Photo: Greimann 2006.*

Groundwater withdrawals through well pumping in the watershed also effectively hold back water from the river. The lower river throughout the proposed parkway area flows over coarse gravelly sediments (alluvium) with a high water table. Under these conditions, groundwater easily flows in and out of the river through the riverbed and the sides of its channels. The river naturally depends on groundwater for much of its flow during frequent dry spells. Figure 3.23 shows a diagram of groundwater basins and municipal water withdrawals between the Robles Diversion Dam and the city wells at Foster Park. During dry summer conditions, surface flow often disappears in the area of the Robles Diversion. However, an underground barrier forces groundwater flow to the surface at Casitas Springs, just above the top of the proposed parkway area, and the Ventura River once again runs on the surface.

FIGURE 3.22 *During dry months, the Lower Ventura River often runs dry on the surface in some areas downstream from the Los Robles diversion dam. Some groundwater still flows under the surface.*

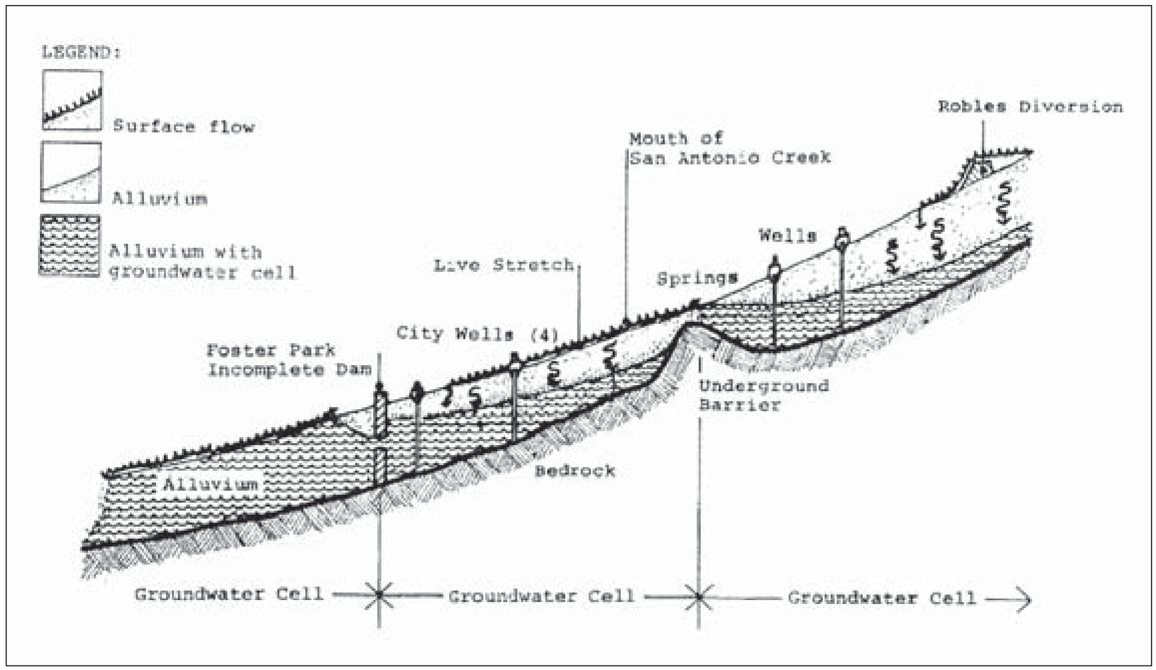


FIGURE 3.23 *Schematic diagram of groundwater basins and municipal water withdrawals between the Robles Diversion Dam and the city wells at Foster Park. Illustration: Turner 1971.*

GROUNDWATER: AN IMPORTANT SOURCE FOR INSTREAM WATER

Groundwater withdrawals by both agricultural and municipal users have an important impact on the health of the Ventura River because the river derives instream flow from groundwater as well as surface water.

The Lower Ventura River is an alluvial stream that flows through a relatively high water table. In this type of stream, during dry periods much water comes from base flow of groundwater, rather than from surface runoff. The diversion of surface water from the Ventura River has a great impact on how much instream flow remains, but groundwater pumping from wells also reduces instream flow. The significance of this factor for the health of riverine species is difficult to assess in a watershed where the quantity of water pumped from private wells is not legally monitored. Furthermore, not all groundwater in the watershed is connected to the river, thus instream flow in the river is not affected by all wells.

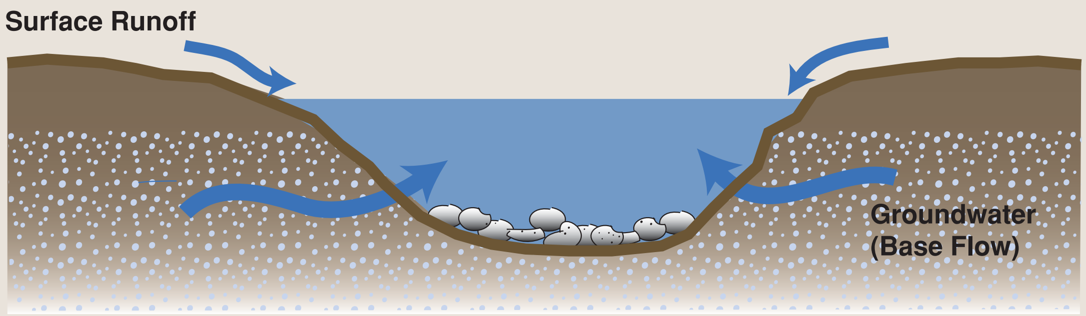


FIGURE 3.24 *The relationship between groundwater and instream flow.*

Water Quality

SURFACE WATER QUALITY

The quality of water is critically important for human users in the Lower Ventura River Watershed. Water for domestic users in the western portion of Ventura comes primarily from Lake Casitas via the Casitas Water District, and most of that water comes from the Ventura River, Matilija Creek, and North Fork Matilija. However, surface water quality is even more critical for wildlife, particularly steelhead trout and other fish which are sensitive to contaminants and temperature changes. Steelhead trout are an important indicator species for water quality in the Lower Ventura River, because the return of this species to viability in the river is an important habitat objective of this Vision Plan, and because "water good enough for steelhead trout is very good water indeed" (Leydecker and Grabowsky 2006).

Section 303(d) of the Federal Clean Water Act requires states to create lists of water bodies that are impaired, or are threatened with impairment, meaning that they do not meet water quality standards for one or more pollutants. The Section 303(d) list has the specific purpose of identifying water bodies that have priority for the establishment of total daily maximum load (TMDL) regulations, and is not intended to serve as a comprehensive survey of all water quality conditions. Impairments requiring mitigating action can be structural and mechanical conditions that affect wildlife health (e.g. water diversions or fish barriers) as well as those caused by organic or inorganic substances.

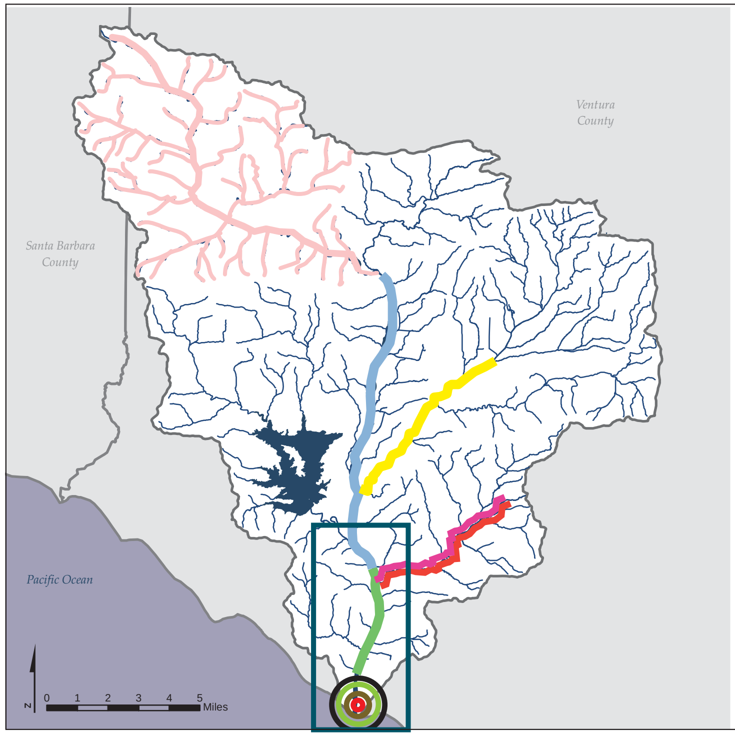


FIGURE 3.25 *Ventura River Watershed: Bodies of water listed as impaired under Section 303(d) of the Clean Water Act. Data from CRWQCB-LA 2006.*

The most recent Section 303(d) list prepared by the State Regional Water Quality Board in 2006 lists impairments within the Ventura River Watershed that are illustrated in figure 3.25. Most of the upper watershed is considered impaired for the purposes of Section 303(d) as the result of the fact that the Matilija Dam acts as a physical barrier to the passage of fish up and downstream. The middle reaches of the Ventura River, including the upper mile of the Parkway Vision Plan area, are impaired by groundwater pumping and surface water diversions that reduce instream flow and thereby reduce the quality of remaining water.

A CLOSER LOOK –THE LOWER RIVER

The watershed benefits from the efforts of citizen monitoring that provides a much more detailed supplement to the broad brush of Section 303(d). Since 2001, the Ventura Stream Team, a joint program of Santa Barbara Channelkeeper and the Ventura Chapter of the Surfrider Foundation, has monitored critical water quality indicators on the Ventura River and Cañada Larga on a monthly basis and has published comprehensive reports of the results. The Stream Team identifies significant water quality conditions, discussed below, that are important for the health of humans and wildlife.

Nutrient Pollution

The Ventura Stream Team concluded that nutrient pollution was the most serious problem encountered in the Lower Ventura River, with nitrate and phosphate levels far exceeding EPA suggested limits for wildlife health (Leydecker and Grabowsky 2006) (figure 3.26).

Temperature

Water temperature has a direct impact on sensitive species such as steelhead trout, and also acts in combination with other conditions to affect wildlife. During the monitoring period 2001 through 2005, temperatures often approached the lethal level for steelhead (figure 3.27).

Water temperatures can rise as the result of periodic flood events that "scour" the riverbed and adjacent floodplain with an average frequency of five to ten years, removing much of the vegetative canopy (Capelli 1997). Shallow, low-velocity water is more susceptible to solar heating, especially when vegetative cover is absent. The Ventura River frequently experiences low-flow conditions that raise water temperature during dry months, partly as a result of the ambient Mediterranean climate but also as the result of withdrawals and diversions of instream water for human consumption.

Some researchers have suggested that steelhead in Southern California waters have evolved some tolerance to higher temperatures, and that like most fish, they can actively seek out the most favorable conditions (Mathews and Berg 1997; Stoecker 2002). However, it is clear that temperature remains an important consideration for steelhead revival (RWQCB 2003; Leydecker and Grabowski 2006). Any unnecessary environmental stress would seem to be unwarranted in the Ventura River, where conservation

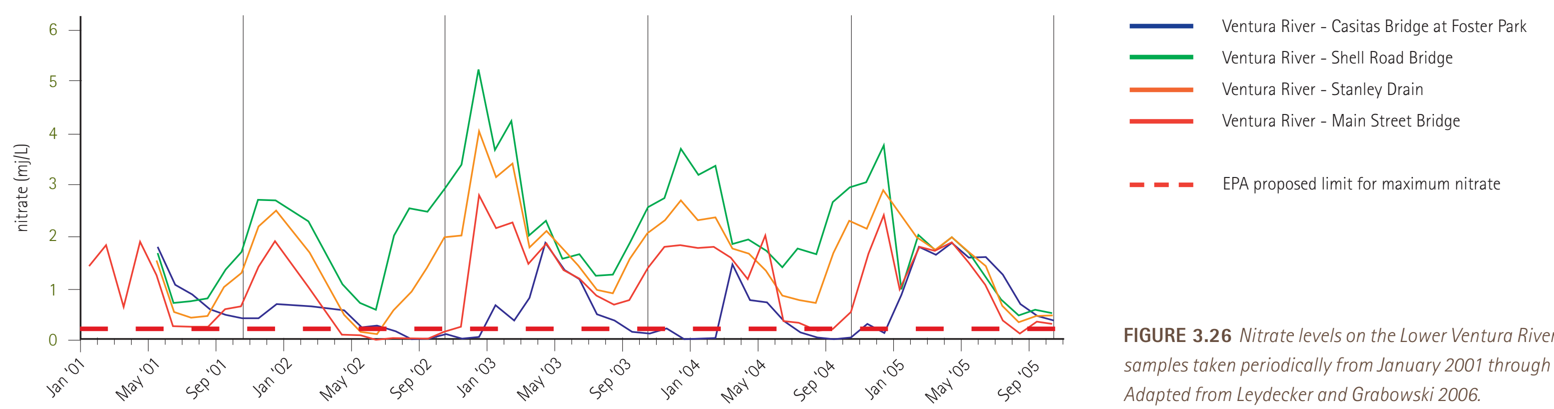


FIGURE 3.26 *Nitrate levels on the Lower Ventura River. Data from samples taken periodically from January 2001 through October 2005. Adapted from Leydecker and Grabowski 2006.*

biologists are seeking the return of a species that has nearly disappeared from the river.

Three temperature requirements are critical for steelhead: Temperatures below 52°F in the winter are ideal for spawning, temperatures at 61°F or below are healthy dry season conditions. As temperatures rise, the amount of oxygen dissolved in water decreases and fish have increasing difficulty extracting it. For steelhead, temperatures above 75°F can lead to death. Seasonally low winter temperatures are important for the creation of ideal spawning conditions, while diurnal fluctuations have an important impact on the amount of dissolved oxygen in the water, such oxygen being necessary for aquatic life (Leydecker and Grabowsky 2006, 32).

Impacts from the Wastewater Treatment Plant

The Ojai Valley Wastewater Treatment Plant provides tertiary treatment of wastewater for approximately 23,000 Ojai residents, discharging an average 2.17 million gallons of treated effluent per day into the Ventura River, a significant augmentation of instream flow (CRWQCB-LA 2003). The effluent discharged provides benefit to wildlife by replacing water that has been removed from the river upstream for domestic uses and agriculture (figure 3.28).

The Regional Water Quality Control Board (CRWQCB-LA) concluded in 2003 that an upgrade to the treatment plant facilities had reduced nitrates in its effluent to an average 5.3 milligrams per liter (mg/L) (CRWQCB-LA 2003). While this level is well below the EPA's maximum contaminant limitation (MCL) for human safety, it far exceeds a tentative limit of 0.16 mg/L for the purposes of ecosystem health that has been suggested by the EPA. Nitrate in the effluent is added to that which is already present in the river, with the result that nitrate levels are measurably higher downstream from the plant (Leydecker and Grabowski 2006). The graph in figure 3.28 compares nitrate levels in the river at Foster Park (one mile upstream from the treatment plant outfall) with the nearest downstream sampling site at Shell road (approximately 1.8 miles downstream from the outfall) for a representative period. While the upstream curve is close to the EPA's suggested nitrate limit of .16 mg/L for ecosystem health for much of the year, the samples downstream from the water treatment plant are significantly higher than the EPA guideline (figure 3.29).

The wastewater treatment plant shows how human development can alter the seasonal and diurnal changes in water temperature that are discussed above, in ways that are both helpful and potentially harmful. On the one hand,

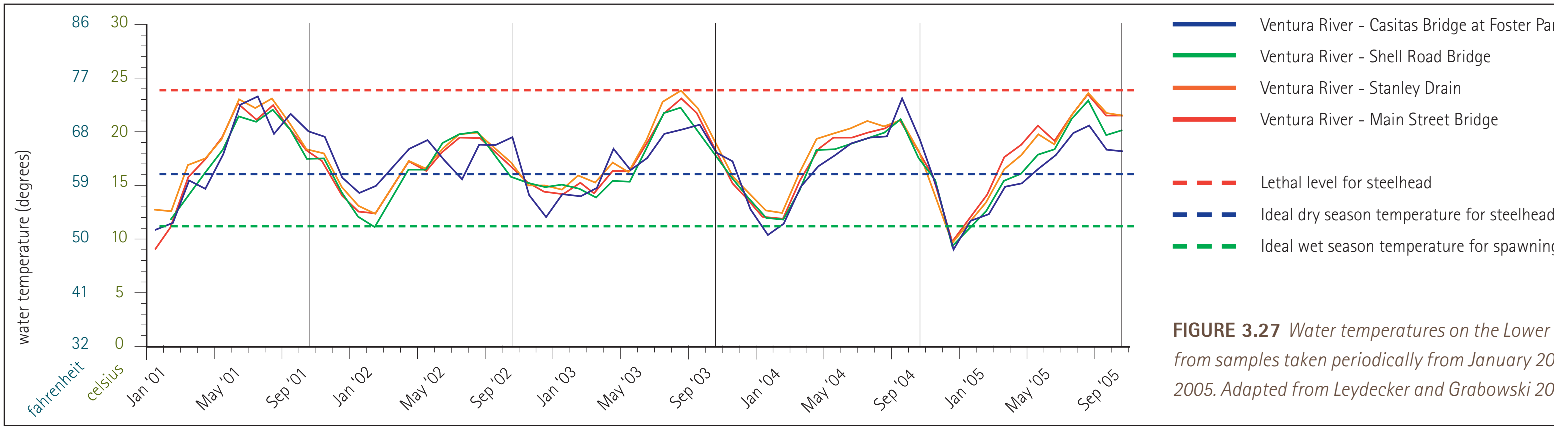


FIGURE 3.27 *Water temperatures on the Lower Ventura River. Data from samples taken periodically from January 2001 through October 2005. Adapted from Leydecker and Grabowski 2006.*

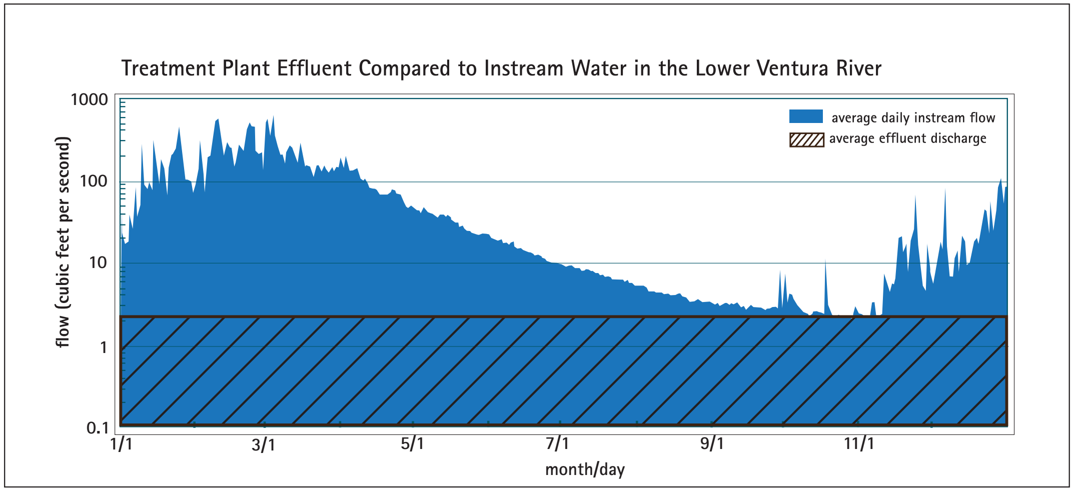


FIGURE 3.28 *Comparison of average wastewater treatment plant effluent and and average instream flow. During dry periods, effluent may make up a large percentage of the water in the lower river. Adapted from Cappelli 1997; RWQCB 2003; Ventura County Watershed Protection District.*

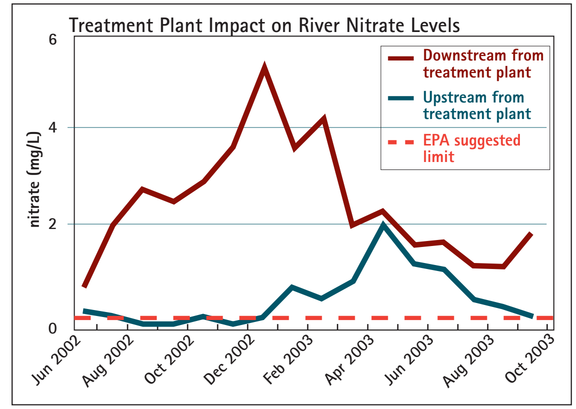


FIGURE 3.29 *Comparison of nitrate levels above and below treatment plant. Adapted from Leydecker and Grabowski 2006.*

the large quantity of effluent released by the treatment plant increases instream flow in the lower river and this deeper flow can result, at times, in water temperatures that are lower than those in the upper reaches of the river (Leydecker and Grabowski 2006). On the other hand, the daily fluctuations in temperature and dissolved oxygen that naturally exist upstream from the treatment plant have been "flattened" downstream from the plant, and temperature increases of five degrees Fahrenheit or more have been measured immediately downstream from the treatment plant, triggering regulatory concern (CRWQCB-LA 2003).

Effluent from the Ojai Sanitation District Water Treatment Plant makes up two-thirds or more of water in most of the Lower River during dry summer and fall conditions, making the temperature of that effluent a critical factor for water quality during the dry season. When the discharge permit for the Plant was renewed in 2003 by the Regional Water Quality Control Board (CRWQCB-LA), the Board found that despite a major engineering upgrade during the 1990's, "the data from the downstream station showed much less of the diurnal character" of natural stream water for both dissolved oxygen and temperature, and the temperature difference between water upstream and downstream of the Plant exceeded five degrees Fahrenheit. The Board concluded that the temperature differential could be resolved by addressing the excessive withdrawals and diversions of freshwater upstream (i.e. mixing more cold river water with the warmer water from the Plant) (CRWQCB 2003).

Testing of the treatment plant effluent between 1997 and 2002 indicated that effluent temperature fluctuated between a minimum 63 degrees Celsius and a maximum 78 degrees, with an average 70 degrees. Both the minimum and the average were in excess of the ideal temperature for steelhead in both dry and wet seasons, and the maximum exceeded the lethal limit for the fish (CRWQCB-LA 2003). In a forty-eight hour continuous study of diurnal temperature and dissolved oxygen levels in the river, Ojai Valley Sanitation District staff found that the difference in water upstream and downstream from the water treatment plant exceeded five degrees Fahrenheit.

Algae and Eutrophication

The Section 303(d) listing identifies algae as an impairment that impacts the entire Lower Ventura River. Algae is a naturally present organism, not necessarily an impairment. Excessive algae is the result of a combination of conditions that can include high temperature, excessive nutrients, low water flow and erosion from natural or man made causes, and algae combined with these other conditions can lead to eutrophication that harms wildlife.

Although the Environmental Protection Agency lists algae as a pollutant in the Lower Ventura River under Section 301 of the Clean Water Act , experts disagree on whether algae itself is a contaminant -- under the conditions described above, explosive algal growth occurs even in pristine streams in the upper watershed (Leydecker 2008). However, algal "bloom" may be seen as a symptom of conditions -- such as high water temperature and absence of riverbed gravel -- that discourage steelhead spawning, and the periodic removal of riparian vegetation may be a serious impediment to the restoration of riparian wildlife habitat.

Brownfield Contamination

Industrial and agricultural byproducts such as volatile organic compounds and heavy metals have not been sampled in the Ventura River at levels that would cause concern. However, chapter 10 discusses the fact that at brownfield sites in the proposed parkway area, groundwater has been contaminated by petroleum compounds and by the gasoline additive MTBE. Because groundwater in these areas moves toward the Ventura River, the possibility exists that these pollutants have reached the river and will do so in the future, perhaps in greater amounts.

Trash

Although most of the Lower Ventura River is surrounded by private property and off limits to recreational visitors, the river is frequently visited by homeless dwellers and by other casual visitors who leave trash. Although the EPA has listed only the river mouth as impaired by trash under Section 303(d), this pollutant can be seen by any observer along the river throughout the proposed parkway zone.

A CLOSER LOOK AT CAÑADA LARGA

Cañada Larga, a tributary that figures significantly in this Vision Plan, is Section 303(d) listed for low dissolved oxygen and fecal coliform (bacteria). The Stream Team found that the stream was unsuitable for public water contact due to excessive bacteria, and that it contained excessive phosphorus, conductivity (a measure of dissolved solids), and algal growth leading to low dissolved oxygen, probably the result of ranching and agriculture upstream, and possible metals contamination near the confluence, possibly resulting from past industrial activities nearby (Leydecker and Grabowski 2006).

A CLOSER LOOK AT THE RIVER MOUTH

The estuary at the mouth of the Lower Ventura River is Section 303(d) listed for excessive trash, total coliform (bacteria), algae, and eutrophication. Many pollutants in the upper part of the Parkway Vision Plan area are reduced by natural processes before they reach the river mouth (Leydecker and Grabowski 2006). However, storm drains deliver polluted storm water runoff from sections of urban Ventura directly to the estuary, and unauthorized campers at the river mouth leave human waste and trash there.

GROUNDWATER QUALITY

The quality of groundwater is a critical consideration for users in the Ventura River Watershed. Groundwater is used to meet 67% of all water needs county wide. Groundwater pumping is a major source of domestic drinking water for the Cities of Ojai and Ventura (WCVC 2006). Agricultural users in the watershed rely on groundwater pumping – mostly from their own private wells – for most of their irrigation water (WCVC 2006), and, as discussed below, the quality of that water can impact crop production.

River morphologist Luna Leopold emphasized that surface water and groundwater are the same water, simply moving through the watershed's hydrological system (Leopold 1974). This is especially true in the Ventura River Watershed, where shallow groundwater basins in the watershed trade water readily with surface water bodies, rapidly replenishing or depleting each other (Watersheds Coalition of Ventura County 2006). This suggests that surface water quality – including urban and agricultural runoff – can have an immediate impact on groundwater quality, and vice versa.

Groundwater quality issues in the Ventura River Watershed are similar to those that confront the State of California generally. Statewide, the single largest cause of well closures is elevated levels of nitrates in groundwater (Watersheds Coalition of Ventura County 2006). Nitrates, a form of dissolved nitrogen, find their principal sources in agricultural fertilizer, animal waste, and leakage from septic tanks, and are a known short-term health risk in drinking water with a federal and state public health (drinking water) limit of 10 milligrams per liter (mg/L) (USEPA 2006). Groundwater is susceptible to nitrate contamination because these substances are easily soluble in water, do not bind to soils, and do not evaporate from water (USEPA 2006). Although levels of groundwater nitrate in the Ventura River Watershed generally do not exceed state and federal maximum contaminant levels (MCL's), elevated nitrate is present in all of the groundwater basins of the watershed, and several well closures have resulted (California Department of Water Resources 2003).

Enforceable federal maximum contaminant levels (MCLs) are set for pollutants such as nitrates, but secondary maximum contaminant levels or (SMCL's) guidelines which are not federally enforceable are also set for nuisance chemicals which are not considered health threatening but which affect the aesthetic qualities of water or its practical usability in industry, agriculture, and plumbing systems (USEPA 1992). One significant measure of secondary contaminants in groundwater is total dissolved solids (TDS), representing all inorganic and organic substances dissolved in a volume of water. Total dissolved solids have an impact on taste and odor, and color, corrosion, and scaling on plumbing fixtures. For these purposes, the federal guideline or secondary maximum contaminant level for TDS is 500 mg/L (USEPA 1992). All groundwater basins in the Ventura River Watershed exceed this level, but the Lower Ventura River sub-basin, which underlies most of the Parkway Vision Plan area, is especially significant in this regard, with average TDS of 900 mg/L and peaks that can reach 3,000 mg/L during extended dry spells (California Department of Water Resources 2003).

Total dissolved solids also have an impact on agriculture. Increasing salinity (TDS) in irrigation water can inhibit plant growth by reducing the uptake of water through plant roots (California Department of Water Resources 2003) (Ayers and Westcot 1985). The San Joaquin Valley Drainage Program recommends slight restrictions on irrigation use of water with TDS of greater than 500 mg/L, moderate restrictions above 1,250 mg/L, and severe restrictions above 2,500 mg/L (California Department of Water Resources 2003), indicating a cause for concern for agricultural groundwater use from the Lower Ventura River basin.

To some extent, total dissolved solids in groundwater have natural sources such as the elevated levels of phosphate that exist in bedrock underlying the Lower Ventura River Watershed (Leydecker and Grabowsky 2006). However, they also have significant man made sources such as sewage, urban storm water runoff, agricultural runoff, and point sources (Wilkes University Center for Environmental Studies).

In the project area, groundwater in basins downstream from Foster Park is not used for human drinking. This is partly due to concerns over nitrates and TDS. However, it is also important to note that industrial by-products, the remnant of the Valley's petroleum production history, have been detected in the groundwater in large enough concentrations to cause concern.

River parkways provide accessible open space that helps remedy the severe shortage of park and open-space areas that plague many urban and suburban communities, small towns, and rural areas.

California River Parkways Act of 2004
California Public Resources Code §5751(d)