CITY of CALABASAS

LAS VIRGENES CREEK

POLLUTION SOURCE INVESTIGATION

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INTRODUCTION

Las Virgenes Creek is the largest tributary to Malibu Creek, which is the second-largest stream flowing into Santa Monica Bay. The City of Calabasas straddles Las Virgenes Creek's middle reach for a distance of 3.5 miles. The creek's watershed is relatively pristine upstream from Calabasas. Several water quality monitoring programs have determined that water quality is typically good upstream from Calabasas and becomes impaired as it flows through the city.

Las Virgenes Creek is listed with the following impairments by the Los Angeles Regional Water Quality Control Board (LARWQCB):

Coliform
Nutrients (algae)
Organic enrichment/low dissolved oxygen
Scum/foam, sedimentation/siltation
Selenium
Trash

Sedimentation/siltation is described as having an "unknown source" and the others a "nonpoint source."

TMDL's for some of these parameters have either not yet been established or are subject to change.

Other water quality monitoring projects that sample in Calabasas have included Las Virgenes Creek in the context of Malibu Creek's watershed, the Santa Monica Bay, or other more regional perspectives. This investigation concentrates on water quality within and adjacent to Calabasas. It is not intended to determine where TMDL exceedances occur. This study is an effort to determine sources of listed pollutants within the City of Calabasas. Data from this study will be used in the City's efforts to improve water quality in Las Virgenes Creek.

<u>Potential influences to water quality within Calabasas:</u>

Roads
Urban, suburban, and rural residences
Livestock grazing
Equestrian activities
Imported domestic water
Reclaimed water irrigation
Sewage sludge used as a soil amendment

Pollutants potentially associated with influences listed above (EPA 1993):

Sediment
Petroleum products
Nutrients
Bacteria
Trash
Pesticides
Herbicides

Land uses outside Calabasas but within the upper watershed that have the potential to influence water quality include:

Liberty Canyon Landfill
Rocketdyne Space Research Facility
Horticulture (A commercial nursery upstream from Calabasas has been closed for several decades)

Pollutants potentially associated with these land uses include (EPA 1993)::

Perchlorate
Radioactive substances
Nutrients
Herbicides
Pasticides
Toluene
A wide range of other toxics

The Malibu Creek Water Monitoring Project (MCWMP) samples Las Virgenes Creek both upstream from Calabasas (at the Los Angeles-Ventura County Line) and downstream (at De Anza Park) (Reinhart and Medlin, 2006). Consistently low pollution loads upstream from the city and much higher loads downstream strongly suggest the existence of persistent sources of water quality impairment within the City of Calabasas.

Heal the Bay's Malibu Creek Stream Team sampled Las Virgenes Creek during the early 2000's just upstream from A.E. Wright Middle School and at a site approximately 1 km upstream from the Los Angeles-Ventura County Line (Abramson, 2002). The Stream Team also mapped portions of the stream bed with high embeddedness (fine-grain sedimentation) and with greater than 30% algae cover in the entire reach of Las Virgenes Creek that flows through Calabasas. They found consistently high nutrient loads, bacteria loads, sedimentation, and algae cover within Calabasas. Upstream from Calabasas, the stream had high sediment loads but much lower amounts of bacteria, nutrients, and algae.

Heal the Bay's data suggests that in addition to bacteria, persistent sources of nutrients also exist within the City of Calabasas.

BENEFICIAL USES

The United States Environmental Protection Agency (EPA) determined that Las Virgenes Creek has the following "Beneficial Uses":

REC 1	Water contact activities such as swimming and fishing.
WARM	Warm water fisheries (bass, bluegill, catfish, et. cet.) habitat
WILD	Wildlife habitat
RARE	Federal and/or State listed Rare and/or Endangered species habitat.
WET	Wetland habitat and/or wetland function

The EPA also designated the following potential beneficial uses:

MUN	Municipal (domestic) water resource
REC 2	Non-water contact activities such as boating
COLD	Cold water fisheries (trout) habitat
MIGR	Migration corridor for aquatic species
SPN	Spawning habitat for aquatic species

The potential beneficial uses COLD, MIGR, and SPN are designated to facilitate the eventual return of wild steelhead trout to Las Virgenes Creek and other Malibu Creek tributaries. Steelhead historically spawned in Las Virgenes Creek's lower reaches (Dagit, 2004) but have been absent since migration access from the ocean was blocked by construction of Rindge Dam on lower Malibu Creek in the 1930"s.

Rindge Dam and surrounding property are now owned by California Department of Parks and Recreation (State Parks) and the agency plans to remove the dam (U.S. Army Corp, 2002). With the dam gone, steelhead trout will again have migration access to Malibu Creek's major tributaries Cold Creek and Las Virgenes Creek. State Parks also has long-range plans to remove two migration restrictions (one concrete culvert road crossing and one small concrete dam) on Las Virgenes Creek downstream from Calabasas.

When those projects are implemented, steelhead trout will have migration access from the ocean upstream to the Lost Hills Road crossing. At that time, all remaining steelhead migration restrictions on Las Virgenes Creek will be within Calabasas.

STUDY METHODS

This study used the same field methods, field instruments, and data sheets used by the Malibu Creek Water Monitoring Program. Lab analysis of water samples was performed by American Environmental Testing Laboratory, Inc.

The following parameters were analyzed to evaluate specific water quality impairments:

IMPAIRMENT	TEST	(units)	Field (F) or LAB (L)
Coliform	Total coliform	(MPN/100ml)	L
	Fecal coliform	(MPN/100ml)	L
Nutrients (algae)	Nitrate as N	(mg/l)	L
	Nitrite as N (mg/l)	(mg/l)	L
	Ammonia as N	(mg/l)	L
	N, total Kjeldahl	(mg/l)	L
Organic enrichment/low DO	Dissolved oxygen	(mg/l)	F
Scum/foam	Surfactants	(mg/l)	L
Sedimentation/siltation	Total susp.	(mg/l)	L
Selenium	Selenium	(ug/l)	L
Trash	Trash	(# of items visible from station)	F

Water quality was analyzed at twenty-nine stations within and upstream from Calabasas:

Ten stations were in Las Virgenes Creek, seven within Calabasas and three upstream from the city boundary.
Seven stations were at storm drain outlets adjacent to Las Virgenes Creek within Calabasas.
Five stations were on tributary streams, two within Calabasas and three upstream from Calabasas.
Two stations were at weep holes where groundwater flows through a hole in a concrete-lined channel from alluvial substrate into the stream channel within Calabasas.
Two stations were at opposite ends of the small pond adjacent to the dog park within Calabasas.
Two stations were in road gutters where runoff flowed from the road surface into a storm drain catchment basin.
One station was at small perennial pond at a suspected reclaimed irrigation water leak.

Sampling was performed from 1 November 2006 through 11 March 2007. No major storms occurred during this time, but several minor storms generated small amounts of runoff**.**

DATA and DISCUSSION

Coliform bacteria

Las Virgenes Creek downstream from Calabasas is a popular family picnicking and swimming destination during the summer season. With the presence of people, especially children, in the water, bacteria pollution in Las Virgenes Creek presents a potential public health hazard.

Coliform TMDL's for fresh water in Southern California are not yet determined. The marine water TMDL of 1000MPN/100ml is used for the purpose of discussion in this report,

Three rounds of bacteria sampling were conducted. Results from the first round are presented below. Where stations were sampled twice, both values are included.

STATION	TOTAL COLIFORM MPN/100ml
LAS VIRGENES CR	
LVA	>1,600 33.0
LVB	34.0 900
LVC	>1,600
LVD	>160,000 170
LVE	50000 350
LVF	21 ND
LVG	50
LVG REP	>1,600
LVI	>1,600
LVII	>1,600

STORM DRAINS	TOTAL COLIFORM MPN/100ml
SDA	>1,600
SDB	>1,600
SDC	>1,600 23,000
SDH	>1,600
SDI	>1,600

TRIBUTARY STREAMS	TOTAL COLIFORM MPN/100ml
TSA "101" Creek	300 230
TSB	300 ND

Gates Creek	
TSC	24,000
Sulfur spring at confluence	
TSD	<2.0
Sulfur spring outlet	
TSE	>1,600
East LV Creek	
TSE REP	>1,600

This investigation initially tested samples for total coliform only. High coliform loads (>1000MPN/100ml) were found in 19 out of 38 samples. 8 out of nine stations sampled on Las Virgenes Creek in November exceeded 1000MPN/100ml. This included 5 out of 5 stations within Calabasas.

Exceedances for coliform were found in 5 out of 6 stations in the open space north of (and upstream from) the northern Calabasas boundary.

Five station on Las Virgenes Creek (LVA, LVB, LVC, LVD, and LVE) were sampled in both November and December. In November four out of these five samples exceeded the Marine TMDL, but none exceeded the standard in December. This suggests that the November sampling sessions could be considered to some extent “First Flush” events.

All six samples collected from storm drains downstream from Gates Creek (adjacent to City Hall) had coliform exceedances. All three storm drain discharges upstream from Gates Creek had low or non-detect coliform levels.

Discharge from the storm drain on Lost Hills Road with the dry weather diversion system (SDB) exceeded the TMDL for coliform (>1,600 MPN/100ml) during relatively dry weather. At the time of sampling, this system was not operating.

Four tributary streams were sampled just upstream of their confluences with Las Virgenes Creek. These include the trib that parallels the 101 freeway (TSA), Gates Creek (TSB), the sulfur spring just north of the county line (TSC), and East Las Virgenes Creek (TSE). Samples from East Las Virgenes Creek and the sulfur spring (both upstream from Calabasas) had coliform exceedances. The two tribs that meet Las Virgenes Creek near City Hall had low coliform loads.

Both samples collected from road gutters (AM and PSR) had high coliform loads (>1,600 MPN/100ml). The water sampled at these stations was runoff from landscaped areas that had been over-watered and from sprinklers that spray water directly onto paved surfaces. In a very short amount of time (only a minute or less at Station PSRI) the water apparently picked up coliform and transported it into the storm drain system.

Sample AI also had a very high coliform load. Station AI is a small pool of standing water (~ 1ft x 1ft x 2 inches deep) on the top of the streambank adjacent to the Archstone residential community just south of Meadowcreek Lane. This is a persistently saturated area covered with grass turf and irrigated with LVMWD’s reclaimed water. I have observed this feature for several years and it has been saturated at all times of year, even through the hottest driest summers.

To summarize, coliform bacteria is widespread throughout the city. Potential sources of coliform are waste from birds, dogs, and other animals, trash and litter, and decomposing vegetation. Coliform was so prevalent in our water samples that our bacteria data gave little insight concerning potential bacteria pollution sources.

An additional round of bacteria sampling was performed on 1 March 2007 to answer the many questions left unanswered by the initial investigation. Samples were collected from twenty stations and were analyzed for E. coli, fecal enterococcus, fecal coliform, and total coliform.

Bacteria data are presented in the following table. Station types (e.g. storm drain, weep hole) are listed separated and in order progressing downstream. The total stream segment sampled for this event includes the entire reach within the City of Calabasas, extending from De Anza Park (at the downstream boundary of the city), north (upstream) to the Los Angeles-Ventura County Line.

STATION	**E.COLI**	**FECAL ENTERO**	**TOTAL COLIFORM**	**FECAL COLIFORM**
	MPN/100ML	MPN/100ML	MPN/100ML	MPN/100ML
LV CREEK				
LVE	ND	12.0	23.0	23.0
LV3	ND	16.1	>23.0	>23.0
LVD	1.1	12.0	>23.0	>23.0
LVC	ND	3.6	>23.0	>23.0
LV12	ND	3.6	>23.0	>23.0
LVII	2.2	9.2	>23.0	>23.0
LV15	ND	5.1	>23.0	>23.0
LVB	1.1	6.9	>23.0	>23.0
LVA	1.1	9.2	>23.0	>23.0
LV 20	2.2	NA	>23.0	>23.0
STORM	**E.COLI**	**FECAL ENTERO**	**TOTAL COLIFORM**	**FECAL COLIFORM**
DRAINS	MPN/100ML	MPN/100ML	MPN/100ML	MPN/100ML
SD M	ND	12.0	>23.0	>23.0
SDC	ND	6.9	>23.0	>23.0
SDJ	>23.0	9.2	>23.0	>23.0
SDI	ND	5.1	>23.0	>23.0
SDH	ND	6.9	>23.0	>23.0
SDB	ND	9.2	>23.0	>23.0
SDA	3.6	>23.0	>23.0	>23.0
TRIBUTARY	**E.COLI**	**FECAL ENTERO**	**TOTAL COLIFORM**	**FECAL COLIFORM**
STREAMS	MPN/100ML	MPN/100ML	MPN/100ML	MPN/100ML
TSB	ND	9.2	>23.0	>23.0
TSA	2.2	9.2	>23.0	>23.0
WEEP	**E.COLI**	**FECAL ENTERO**	**TOTAL COLIFORM**	**FECAL COLIFORM**
HOLE	MPN/100ML	MPN/100ML	MPN/100ML	MPN/100ML
WH1	ND	ND	>23.0	>23.0

Dilutions used for analysis of these samples gave a maximum value of 23 MPN/100 ml. With the exception of the sample from WH2, which tested “non-detect” for total coliform and fecal coliform, all samples equaled or exceeded this threshold for both parameters.

Dilutions used to analyze the 1 March samples were insufficient to produce meaningful data for the purpose of delineating coliform sources. As a result, a third round of bacteria testing was performed at ten stations on 29 March 2007. these samples were analyzed for both total coliform and fecal coliform. Results are presented in the table below.

STATION		
LV CREEK	**TOTAL COLIFORM**	**FECAL COLIFORM**
LVA	5,000	80.0
STORM	**TOTAL COLIFORM**	**FECAL COLIFORM**
DRAINS	MPN/100ML	MPN/100ML
SDA	8,000	900
SD B	>160,000	2,400
SDC	1,700	19.0
SDH	7,000	3,000
SDI	2,400	2,400
SDJ	50,000	50,000
TRIBUTARY	**TOTAL COLIFORM**	**FECAL COLIFORM**
STREAMS	MPN/100ML	MPN/100ML
TSB	3,000	140
WEEP	**TOTAL COLIFORM**	**FECAL COLIFORM**
HOLE	MPN/100ML	MPN/100ML
WH2	ND	ND

Discussion of bacteria data

When water is deposited on permeable soil surfaces much of it percolates into the ground Any bacteria in the soil, in the water, or on the ground surface that is mobilized by the water is transported downward into the soil. Water that is not utilized by evapo-transpiration or adsorbed to soil particles continues downward through soil and substrate until it eventually enters the groundwater. The aquifer along Las Virgenes Creek is shallow and is hydrologically connected to the creek through highly permeable alluvium, so at least a portion of the groundwater in this aquifer will eventually seep into Las Virgenes Creek. Ideally, during its movement from the ground surface to the stream channel, microbial activity and filtration through the soil removes pathogens from the water.

Water deposited on impermeable surfaces quickly washes away any bacteria present on the ground surface. Ideally, bacteria-laden runoff is directed onto a permeable area where it percolates into the ground. If there is no opportunity for infiltration, the runoff washes the bacteria into a storm drain and then into the creek.

Our coliform data for storm discharge suggests that there are not sufficient opportunities for runoff to infiltrate into the ground to prevent bacteria-laden runoff from flowing through storm drains into Las Virgenes Creek.

Runoff data from stations upstream from Calabasas, however, could be interpreted as a contradiction to the abovementioned conclusion. Total coliform was the only bacteria parameter tested in this study, and total coliform exceedances were found at 5 out of 6 stations upstream from Calabasas that drained relatively pristine watersheds. The only station upstream from Calabasas without a coliform TMDL exceedence was at the outlet of the sulfur spring, where discharge had no exposure to surficial conditions before samples were collected.

Sedimentation / Siltation

Water samples collected during this investigation were analyzed for total suspended solids (TSS) and most were found to contain little or no sediment.

9 samples from Las Virgenes Creek within Calabasas ranged from non-detect to 11 mg/L.

6 samples from Las Virgenes Creek upstream from Calabasas ranged from non-detect to 77 mg/L.

8 samples from storm drains ranged from 7 to 256 mg/L.

2 samples collected from road gutters had the highest TSS levels (AI: 1,520 mg/L and AM: 2,580 mg/L).

Erosion and sedimentation processes are most active during rain storms. No significant storm events occurred during the time of this investigation, so as a result no meaningful sediment data was obtained.

Image 1: East bank at Station LVH

Despite the lack of suspended sediment data, geomorphic features observed along the stream channel during the investigation offer clues regarding Las Virgenes Creek's long-term sedimentation and erosion processes.

Las Virgenes Creek's erosion/sedimentation processes are quite complex, as exhibited by the photo above of the stream bank at Station LVG. The light-colored horizontal bands are a succession of sandy sediment layers that are strengthened against erosion by root systems that developed soon after the sediment layers were deposited. This series of sediment layers represent a time period during which sediment was accumulating in the channel and the stream bed elevation was rising.

Image 2

The photo above is looking downstream at the same location as Image 1. Willow roots that originally grew in the stream bed are now elevated several feet above the thalweg. These exposed tree roots demonstrate that the stream is now downcutting. That is, sediment is now being flushed out of the channel and the stream bed elevation is declining.

While no evidence for the causes of features described above was gathered during this investigation, the processes they suggest are typical of stream channels impacted by urban development. Soil grading associated with urban construction typically generates large amounts of sediments that are stored in the channel. When construction is completed, graded areas that have experienced erosion are replaced by pavement and homes. These impervious surfaces increase storm water runoff and reduce sediment input. Subsequent storm runoff events tend to deliver increased amounts of water and reduced amounts of sediment to the stream channel, which results in stream downcutting through sediment stored in the channel.

Urban development along Las Virgenes Creek has been accompanied by stream channel alterations, which have further complicated the stream channel's hydrologic and geomorphic regimes and processes.

If the City of Calabasas wishes to further investigate this issue, information on erosion and sedimentation is available from Heal the Bay's Malibu Creek Stream Team. The Stream Team conducted a watershed inventory on Las Virgenes Creek from 2003 through 2005, and that project compiled extensive data on erosion and sedimentation on Las Virgenes Creek's entire length. Heal the Bay's data was submitted to the Water Board and was considered in their decision to list Las Virgenes Creek for erosion/sedimentation impairment. The author participated in this project.

Stream Team data documents large amounts of sedimentation in the stream channel well upstream from Calabasas, where extensive soil erosion and streambank landslide activity delivers large amounts of sediment into the channel. Sediment generated in Las Virgenes Creek's undeveloped upper watershed was exacerbated by the 2005 wildfire.

Although Las Virgenes Creek's slopes are naturally susceptible to soil erosion, anthropogenic activities can increase sediment production from these slopes. During e course of this investigation, bare soil was observed on the steep slope east of the Agoura Rd./ Las Virgenes Rd. intersection. This appears to be caused by overgrazing by livestock including sheep and/or goats.

Organic Enrichment / Low Dissolved Oxygen

The currently-used TMDL for dissolved oxygen (DO) in Las Virgenes Creek is a minimum of 5.0 mg/l. DO was analyzed in the field at each station at the time of sampling. DO levels were acceptable (>5mg/l) at all stations on Las Virgenes Creek within Calabasas. DO below the minimum standard was found in the sulfur spring just upstream from Calabasas (TSC and TSD) and in Las Virgenes Creek (LVE) immediately downstream from the sulfur spring confluence.

Decomposing organic muck up to one foot deep was observed on the stream bed at many of the stations but was not analyzed or tested. This organic enrichment often results from decomposition of large amounts of dead aquatic algae. Heal the Bay's Malibu Creek Stream Team documented the presence of organic muck with very low DO levels in Las Virgenes Creek from its Malibu Creek confluence upstream to approximately the upstream boundary of the City of Calabasas. They observed much smaller amounts of muck farther upstream. Organic muck on the stream bed is closely associated with organic enrichment/low dissolved oxygen impairment.

Biologic activity in this material can reduce DO levels in the lower water column to zero. Since photosynthesis generates DO, and photosynthesizing algae is prevalent in Las Virgenes Creek, DO levels here are greatly influenced by sunlight intensity. A more thorough DO analysis would include day and night sampling, and would analyze DO through the water column and into any organic muck that lies on the stream bed.

Selenium

Selenium is an element that is essential to health for most organisms. The United Nations World Health Organization recommends a selenium level of 10 ug/L in drinking water for human health. The USEPA standard for selenium is 50 ug/L and other entities recommend a standard of 5 ug/L. Selenium is toxic at higher concentrations and was responsible for the massive bird kill in the 1970's at Kesterson Wildlfe Refuge near Bakersfield, California.

Selenium in Las Virgenes Creek is most likely derived from marine sedimentary bedrock formations that underlie most of the upper watershed. Although this substance occurs naturally in the environment, anthropogenic activities have a large influence on how selenium is stored in sediment and leached into surface water and groundwater.

Selenium was found in all of our samples, ranging from 1.48 to 201 ppb. 33 of a total of 38 samples had more than 5 ug/L selenium. 4 samples had greater than 50 ug/L selenium.

Previous research by Dr. Hibbs suggests that where selenium is present in insoluble forms in the sediment, nitrate in the water tends to convert these bound selenium compounds into soluble forms which results in increased selenium levels in surface water. Perhaps not coincidentally, the sample (WH1) that had the highest selenium (201 ug/L) also had the highest nitrate load (8.15 mg/L).

Dr. Hibbs conducted A study of selenium and nitrate in Las Virgenes Creek in early 2007 (Hibbs and Andrus, 2007). Most of the samples analyzed were shallow groundwater collected from weep holes in concrete-lined stream banks along Las Virgenes Creek within the City of Calabasas. City Environmental Services Division has a digital copy of his report on its computer "f drive."

Hibbs' research results are described below in the section on nutrients (algae), organic enrichment / low dissolved oxygen and scum / foam.

Nutrients (algae), Organic Enrichment / Low Dissolved Oxygen and Scum / Foam

These impairments are closely related because increased nutrients results in more algae growth in the stream. Algae blooms, then dies. Decomposition of the dead algae contributes to organic enrichment, low dissolved oxygen, and increased scum/foam.

Nitrate concentrations greater than 1mg/L were found in many samples from storm drains. These samples had high conductivity (2+milliseimens) suggestive of locally-derived (not imported) water.

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Hibbs’ research project determined that shallow groundwater is a major source of both selenium and nitrate. Conductivity and sulfate/chloride ratios identify this groundwater as locally-derived and not imported water. Thus, the high levels of selenium and nitrate are not associated with urban runoff.

Farming occurred over much of the Las Virgenes valley bottom within Calabasas where residential areas now exist. Hibbs identified this past legacy of farming activity as a possible source of nitrate now found in shallow groundwater in the area.

Trash

While working in Las Virgenes Creek for several years, the author has observed an annual cycle in which trash accumulates in the stream channel during periods of dry weather, and then much of it is flushed out of the stream during high winter storm flows. Since plastic debris gets caught on trees and shrubs, riparian vegetation plays a large role in trash storage in the channel. High-water levels from past storm runoff events are often apparent from the “high trash level” remaining in streamside vegetation.

High stream flow events effectively removed most trash from Las Virgenes Creek during the winter of 2005-2006, leaving the channel quite clean at the beginning of 2006’s summer season. The City of Calabasas conducted a community volunteer creek cleanup during the summer of 2006 which further reduced the amount of trash in Las Virgenes Creek.

At the time of sampling for this project, trash had been allowed to accumulate for several months in what had essentially been a clean stream channel. This afforded a good opportunity to observe locations where trash had recently been deposited, dumped, and/or transported into the creek.

Trash was evaluated in the field during sampling events by counting the number of pieces visible from the sampling location. At most of the stations, small amounts of trash (0-5 items) were observed. 10 items were found in the channel just upstream from the Meadowcreek Road crossing (LVB).

A large amount (~100 items) of trash was observed just upstream from the Las Virgenes Road crossing (LVC). This station is at the downstream end of a long reach of concrete-lined channel where a lack of vegetation or other obstacles allows trash to easily move downstream. Streamside vegetation at LVC tends to catch trash that has washed down from the concrete lined channel immediately upstream.

Large amounts of trash were consistently observed in the tributary channel adjacent to the trash bins at the southwest corner of the parking lot at the business park on the southeast corner of the Las Virgenes Road/Mureau Road intersection. The trash bins have been observed to be closed, but somehow trash seems to be scattered from these bins into the adjacent stream channel.

Large amounts of trash were consistently observed at storm drain outlets downstream from Calabasas City Hall. At stations SDA, SDB, SDC, and SDH, 15-50 items were observed.

Our trash data suggests that trash in Las Virgenes Creek is not dumped directly into the creek, but is instead is transported into the stream through storm drains and other processes.

RECOMMENDATIONS FOR MITIGATING IMPAIRMENTS

NITRATE

This study did not determine the source(s) of nitrate that finds its way into Las Virgenes Creek. Highest levels were found in shallow groundwater that seeps into the creek through countless seeps, springs, and weep holes (see Hibbs and Andrus 2007). Reducing this most significant source is problematic.

Samples from storm drains also contained nitrate, in concentrations up to 4+ mg/L. Reducing storm drain discharge, therefore, will reduce the amount of nitrate that reaches Las Virgenes Creek. See the following section on bacteria for ways to reduce storm drain discharge and urban runoff.

BACTERIA

Two of the samples highest in Coliform bacteria (50,000 and >160,000 MPN/100 ml) was collected from Las Virgenes Creek and East Las Virgenes Creek in some of the most pristine locations sampled. Based on these data, it seems that Total Coliform bacteria alone is not an appropriate measure of bacteria pollution in Las Virgenes Creek.

Fecal coliform/Total coliform ratios might be a better measure of water quality. Results from our Fecal coliform/Total coliform testing are given in the table below.

STATION		
LV CREEK	**TOTAL COLIFORM**	**FECAL COLIFORM**
LVA	5,000	80.0
STORM	**TOTAL COLIFORM**	**FECAL COLIFORM**
DRAINS	MPN/100ML	MPN/100ML
SDA	8,000	900
SD B	>160,000	2,400
SDC	1,700	19.0
SDH	7,000	3,000
SDI	2,400	2,400
SDJ	50,000	50,000
TRIBUTARY	**TOTAL COLIFORM**	**FECAL COLIFORM**
STREAMS	MPN/100ML	MPN/100ML
TSB	3,000	140
WEEP	**TOTAL COLIFORM**	**FECAL COLIFORM**
HOLE	MPN/100ML	MPN/100ML
WH2	ND	ND

Fecal coliform is seen in all storm drain samples but is absent from the sample from the weep hole. Some storm drain discharge is from urban runoff, and some is from groundwater seepage. Even if much of the dry-weather storm drain discharge is from groundwater seepage, the volume of this bacteria laden discharge into Las Virgenes Creek can be reduced by reducing urban runoff.

Urban runoff is responsible for numerous water quality impairments, including erosion/sedimentation, coliform, and nutrients. Reducing the amount of urban runoff that reaches the creek will help reduce all of these problems.

Storm drain diversions

An increasingly popular method to mitigate bacteria is installing storm drain diversions that direct runoff into the sewage treatment system. Their performance does not always meet water quality goals. As City Staff gains experience with the Lost Hills storm drain diversion, costs can be reduced and benefits enhanced. Lessons learned operating this facility can be applied to additional storm drains that deliver chronically-polluted water to Las Virgenes Creek.

Preventing runoff from impervious surfaces into storm drains and watercourses will reduce the amount of coliform entering the creek. Infiltration structures that serve this purpose are gaining in popularity, and are becoming more effective as experience with them grows. When properly designed and constructed, infiltration structures allow bacteria-laden irrigation water and first-flush rainfall runoff to percolate into the ground before it can enter a storm drain or watercourse.

Infiltration structures

Infiltration structures typically consist of gravel backfilled holes or trenches sunk into well-drained soils. They are commonly used to prevent off-property runoff from roof gutters. Infiltration structures are increasingly being installed along the downslope edges of parking lots to prevent parking lot runoff, with its automobile-derived toxics, from flowing off-site. Infiltration structures could also be located beneath road gutters adjacent to storm drain inlets that have a rigid but permeable cover.

Infiltration structures are potentially an effective way to reduce storm drain discharge. Such structures are already required on new construction. Although not required to do by existing laws, landowners have a strong incentive to add them to the margins of preexisting parking lots and driveways. Many private business are increasingly striving for a “Green” image, since that image makes them more attractive to potential customers and clients. If the City of Calabasas partners with private businesses to help design, install, and even fund such structures, their cost could be minimized. Installing these structures to infiltrate runoff from all impervious surfaces on private property would benefit the entire community.

The City could also investigate the possibility of designing infiltration structures at storm drain inlets. These would allow low flows in street gutters as well as “first flush” runoff from rainstorms to flow through a grate just upstream from storm drain inlets and into the ground. The author has never seen such a structure, but it’s design seems relatively simple and costs seem reasonable. City engineers could look into this possibility.

Treatment Wetlands

As in just about all communities, dog waste is perceived as a source of coliform pollution. The Dog Park pond tested clean for coliform, which suggests that this treatment wetland is effective at preventing the discharge of coliform into the creek. Treatment wetlands are applied in numerous scenarios to mitigate a multitude of water quality problems. Calabasas staff should investigate other possible applications of treatment wetlands throughout the city.

Public Education

Several instances were observed during sampling events where water from irrigation on landscaped areas was flowing into sidewalks and streets, and parking lots and flowing into a storm drain. This practice adds considerably to the volume of urban runoff discharged into the receiving water body, in this case Las Virgenes Creek. This practice is also easily prevented by proper watering system design and use.

An extreme example of over-watering was observed on 8 December at the south end of Poppyseed Lane.

Image 3: Irrigation runoff at south end of Poppyseed lane entering a storm drain

Image 4: Runoff from Poppyseed Lane entering Las Virgenes Creek

Urban runoff could most likely be reduced significantly if people that construct and use watering systems are educated in the problems caused by over-watering and misdirected sprinklers. Once they are aware of the problem, they can easily avoid sending irrigation water down the storm drain system.

Problems with over-irrigation can be located by driving around the city looking for irrigation-derived runoff and/or by utilizing LVMWD's system for identifying customers that use excessive amounts of water.

EROSION / SEDIMENTATION

Although much of the sediment in Las Virgenes Creek may be produced by natural processes, Las Virgenes Creek's listing for erosion/sedimentation impairment require the City to take every reasonable precaution to avoid adding to the sediment problem.

The EPA published a document titled "Guidance specifying management measures for sources of non-point pollution in coastal waters" (United States Environmental Protection Agency, 1993) that gives an excellent overview on water pollution causes and mitigation. The issues of erosion and sedimentation are well-addressed in that publication.

EPA guidelines mandate that soil characteristics be considered in the design of erosion control BMPs. Much of Calabasas within the Las Virgenes Creek watershed is underlain by fine-grained poorly consolidated marine sedimentary rocks of the Calabasas Formation. Sediment produced by erosion of this material consists primarily of clay, silt, and fine sand. When it is entrained in turbulent flow, gravity drives these fine particles downward through the water column very slowly. It settles to the bottom after a significant amount of time in standing water.

Stream bank erosion

Stabilize eroding stream banks by employing bioengineering techniques along Las Virgenes Creek from Agoura Road to Lincoln Middle school to enhance stream banks' resistance to bank erosion and bank

Reduce peak flows by enhancing and strictly enforcing regulations that require rainfall storage and/or infiltration. This can be accomplished by increasing the use of pervious asphalt and "grasscrete," settling basins, recharge wells, and other techniques that encourage infiltration.

Soil Erosion from grading sites

Comply with all EPA recommendations:

Consider soil erosion potential.

Cover exposed soil surfaces.

Construct soil traps and/or settling basins that are sufficient to separate all sediment from runoff before it leaves the site.

Plus, very importantly:
Do not allow winter grading in highly-erodible soils.

TRASH

Storm drains have been observed to be a significant source of trash in Las Virgenes Creek. Possible solutions to this problem include:

1. Increased street sweeping.
2. Trash screens at storm drain inlets.
3. Enhanced public education and awareness in reducing litter.
4. Increased enforcement of anti-litter laws.

Of particular concern is the bridge where Las Virgenes Road crosses Las Virgenes Creek just north of the 101 freeway.

West bank immediately upstream from Las Virgenes Road

Concrete walls along the stream bank at this location are popular among graffiti vandals. They routinely leave spray paint cans, used paint brushes, and even cans partially full of highly toxic oil-bases paint in the stream channel, where it is subject to entrainment by high storm flows.

This problem is not easily solved. Here are a few recommendation, but it can be reduced by:

1 Catching, arresting, and prosecuting vandals.
2 Posting signs that warn of littering penalties and/or explain toxic paint's potential destructive environmental effects.
3 Place a trash bin near the location and post signs imploring graffiti "artists" to use them for their painting debris.

CONCLUSION

Sources of trash in the creek were easily located but will be difficult to mitigate. Causes of other water quality impairments in Las Virgenes Creek are much more complicated than expected at the opening of this investigation. Discreet sources of pollution were not found. Instead, the investigation revealed a complex interaction of water chemistry, urban runoff, past land use practices, local and imported water, and geologic substrate.

Solving many of Las Virgenes Creek's water quality problems requires the expertise of Hydrogeologists, City Engineers, and other water quality professionals. It will also require partnering with private property owners and with other municipalities that have experience solving similar problems.

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