PRELIMINARY WATERSHED ASSESSMENT
ATASCADERO GREEN VALLEY CREEK WATERSHED

INTRODUCTION

A review of watershed conditions, land uses, stream networks and geology for the Atascadero Green Valley Watershed was completed by Laurel Marcus and Associates (LMA) under contract to the Goldridge Resource Conservation District (GRCD). This review was completed in conjunction with the Atascadero Green Valley Watershed Council and other local citizens through a series of workshops. The purpose of completing a watershed assessment is to document and analyze the natural physical features of the drainage basin, or watershed, inventory land uses and other information and use this information to identify likely limiting factors and issues and create a monitoring and management strategy that is specific to the features of that watershed.

The watershed assessment looks at the overall conditions in the system that create and sustain creek habitats for fish and wildlife and human uses such as groundwater supply. Over the past decade many restoration efforts have been aimed at manipulating the active channel of the creek to create pools riffles and other features. Several recent studies have found that these projects need to include an assessment of the overall condition of the watershed to be successful. The Environmental Protection Agency has developed a set of "Restoration Guiding Principles." These principles incorporate and emphasize the need for watershed assessment and monitoring as a fundamental part of all restoration projects.

Another federal agency, the National Marine Fisheries Service (NMFS) reviewed stream restoration techniques and projects completed by community groups for their success. This study found: *"Millions of dollars are spent annually in individual river basins in an effort to enhance habitat for salmonids and other fish species…The majority of this money is being allocated to local citizen watershed groups for watershed restoration and recovery. Unfortunately local citizen groups often lack adequate guidance on which types of restoration or enhancement to conduct first or which techniques are most successful. More importantly, it is often unclear how individual site-specific actions might fit into a large context of watershed and recovery of salmon stocks."*

"Land use can affect habitat by disrupting the processes that form and sustain habitats, such as the supply and movement of sediment from hillslopes, woody debris recruitment, shading of the stream by the riparian forest and delivery of water to the stream channel. Many processes that create habitat operate on time scales of decades or longer (e.g. channel migration and the formation of off-channel habitats). Interrupting these processes (e.g. stabilizing banks or constructing roads and levees) can lead to loss of fish habitat over the long-term.

"The simplest way to avoid these problems is to focus on restoring processes that form, connect and sustain habitats."

Watershed assessment allows for the use of an adaptive management approach to habitat restoration. Under this approach a combination of restoration projects along the creek and sediment reduction and other types of projects in the watershed occur simultaneous with the establishment of monitoring stations and data collection and analysis. The monitoring documents overall conditions and trends and allows for the refinement of restoration actions and identification of additional management and restoration needs. Monitoring also fulfills regulatory mandates such as TMDLs, or total maximum daily load, restrictions under the Clean Water Act by establishing baseline conditions and measuring improvements in these conditions.

Under this first phase of watershed assessment and training for the stewardship group, Laurel Marcus and Associates (LMA) was under contract for the following tasks:

Task 1 Training session 1
Introduction to watershed processes and their effects on riparian and fishery habitats.
Review of how land uses alter these processes and affect habitats.

Task 2 Training sessions 2
Overview of monitoring and assessment methods and why they are needed to address the particular features of each watershed and prioritize restoration and management actions.

Task 3 Training session 3
Creating an atlas for the Atascadero Creek watershed
Delineation of stream networks
Collection of existing monitoring and mapping information – stream flow, rainfall, geology, soils, fish and wildlife studies, water quality, vegetation and other items.
Review of aerials and discussion of use

Task 4 Training session 4
Delineating land uses, road systems, road crossings, historical records of land uses, vegetation, and other items.

Task 5 Evaluation of potential study reaches and stations
This task will be completed by LMA for use by the RCD and the watershed group.

LMA has included this report and additional analysis without charge due to our interest in furthering ecosystem and watershed-based restoration and to provide technical support to the Goldridge RCD and Atascadero Green Valley Watershed Council.

METHODS

The Watershed Stewardship Workbook written by Laurel Marcus and Dennis Jackson sets out a series of steps to create an atlas for each watershed. As part of creating an atlas, readily available materials are collected including topographic maps, aerial photographs, geologic maps and studies, soils maps, monitoring data if available and other studies, historic and other information. The stewardship group the Atascadero Green Valley Watershed Council, working with the watershed scientists at LMA, used these materials to inventory the following features:

- Stream network and watershed boundary
- Subwatershed boundaries
- Steep slopes in excess of 30%
- Soils and slope classifications
- Land uses
- Roads
- Geology
- Vegetation
- Historic maps

The group completed a summary table of watershed conditions for each subwatershed. This assessment summarizes the work completed by the stewardship group, additional analyses and a set of recommendations for the watershed completed by LMA.

WATERSHED ASSESSMENT

Defining the Watershed, Stream System and Subwatersheds

The Atascadero Green Valley (AGV) Watershed encompasses approximately 38 square miles. The AGV watershed stretches from Barnett Valley Road at its southern end to the immediate west of the towns of Sebastopol, Graton and Forestville and joining the main stem of the Russian River at Rio Dell. The primary tributary streams are Atascadero Creek, Jonive Creek, Purrington Creek and Green Valley Creek. Figure 1 shows the overall watershed and its subwatersheds.

As part of the workshops the group delineated the entire stream system of the AGV watershed on a set of 7.5-minute topographic maps. On these types of maps certain types of creeks are indicated. Solid blue lines indicate year round or perennial creeks and dashed lines indicate seasonal or intermittent creeks. The map is an approximation of conditions at the time the map was made and is not a reliable source of information regarding flow in a particular creek. Ephemeral creeks are not indicated with blue lines on the maps, but may be delineated through a review of the topographic lines. These topo lines show a set of Vs where an indentation occurs in the hillside with an ephemeral creek. These creeks only carry water in big storms, but are an essential part of the overall stream system. Figures 2-4 show the overall stream system for the AGV watershed.

Using the delineation completed in the workshops, LMA delineated the streams on these figures and measured the acreage of each subwatershed using a computerized mapping program. Table 1 lists these acreages.

Insert Figures 1-4

Table 1
Subwatershed Areas

SUBWATERSHED	ACREAGE (SQUARE MILES)
UPPER ATASCADERO	4510 (7.05)
LOWER ATASCADERO	4353 (6.8)
JONIVE	4191 (6.55)
PURRINGTON	2310 (3.6)
UPPER GREEN VALLEY	4197 (6.56)
LOWER GREEN VALLEY	4633 (7.4)
TOTAL	20294 (37.96)

This stream system was also outlined on to aerials of the Atascadero Creek portion of the watershed. These 2002 aerials were ordered by the Goldridge RCD for this project. Only the Atascadero Creek portion of the watershed was originally proposed for this effort and funding limitations restricted the purchase of aerials to this area. Therefore the aerials only cover this area, but LMA has included the entire watershed in all the other portions of the assessment.

Use of the Stream System and Subwatershed Delineation
The delineation of the stream system is used to identify the network of steams that conduct stormwater in the watershed; to identify the land uses surrounding the streams and to review the condition of the stream network and the need for revegetation. Ephemeral creeks are subject to landslides or debris flows on steep areas. Removal of vegetation or urbanization, which increase storm flow volumes, can cause major erosion problems in ephemeral creeks and delivery of fine sediment to the creek system. Roads, which are very numerous in this watershed, can direct and concentrate storm flows into ephemeral creeks and cause erosion.

Steep Slopes
Steep slopes were evaluated using both topographic maps and soil survey maps. Slopes in excess of 30% were delineated by the group. On each topographic quad sheet the contour intervals and scale of the map are listed. As part of the workshop, the group calculated the number of contour lines per inch for each separate map required for 30% slopes or greater. The soil survey maps were copied and all areas indicated to have a slope class in excess of 30% were colored in by members of the group. These maps are stored at the Goldridge RCD office.

Use of Steep Slope Delineation
The delineation of steep slopes is used in conjunction with the delineation of roads, land uses, stream networks and geologic and soils information to evaluate area with greater potential for erosion. For example land uses which increase runoff onto steep slope areas can create erosion and even landslides. Vegetation removal and soil disturbance on steep slopes also induce erosion and sliding. Flatter areas are far less susceptible to erosion than steeper areas.

Land Uses and Roads

The aerial photos used cover the watershed of Atascadero Creek and its tributaries and a portion of Green Valley Creek watershed and its tributary Purrington Creek. The group spent one workshop closely reviewing copies of the aerials and delineating the following land uses: intensive agriculture (orchards and vineyards primarily), rural residential/buildings, and roads. Grazing lands were left undesignated. Although the group did this delineation carefully and it may have some errors, it is still very useful for describing the general land uses in each subwatershed. Not all roads or buildings are indicated. One land use that could not be delineated from the aerials is timber harvest activities unless they were ongoing at the time the photo was taken.

Use of Land Use Delineations

Land use has an enormous effect on watershed functions. Buildings and roads are impervious surfaces that greatly reduce infiltration and recharge processes. Although rural residential development is spread out over the landscape the total coverage of impervious surfaces and roads can be quite large. There are studies that indicate that a total of 15% impervious surfaces in a watershed or subwatershed can significantly alter watershed functions and reduce aquatic habitats. Several subwatersheds in the AGV system exceed this 15% figure. Conversion of forestlands to vineyard and other uses also changes the infiltration rates although not to the same extent as paving over these areas (see Table 2). Conversion of highly grazed lands to vineyards can sometimes increase infiltration rates.

Erosion is also associated with most land uses. Agriculture on steep slopes (10-30%+) has the potential to erode soil if management is not completed to protect and stabilize all soil areas prior the rainy season. Urban and rural residential land developments are often done in winter and may generate significant erosion. Rural roads are well documented as sources of sediment whether associated with housing or agriculture.

Land uses can also affect the recharge of groundwater, a major concern for this particular watershed. The expansion of impervious surfaces on certain types of geologic formations can restrict the available area for recharge of the overall groundwater basin.

Vegetation

The aerials were also used to generally review the extent of vegetation of different subwatersheds and along streams.

Geology

The general geologic features of the watershed were reviewed from the Geologic Map of California, Santa Rosa Quadrangle 1”=250,000 completed by the Ca. Division of Mines and Geology, a focused geologic study “Geology and Slope Stability of the West Sebastopol Study Area by the Ca. Division of Mines and Geology, and another focused geologic study, “Geology, Groundwater and Wells in the Green Valley Study Area” by Eugene Boudreau. Geology determines a number of basic features of a watershed including erosion, potential faulting and ground movement, groundwater features and other characteristics.

Table 2 Soil Loss and Runoff with Different Land Uses

Table 15-1 Some measurements of soil loss from hillside plots.

LAND USE	LOCATION	SOIL LOSS (TONS/ACRE/YR) [1 TONNE/HECTARE = 0.4474 TONS/ACRE]	SOURCE
FOREST			
Primeval	Oklahoma	0.01	Smith and Stamey (1965)
Burned annually	Oklahoma	0.11	Smith and Stamey (1965)
Primeval	North Carolina	0.002	Smith and Stamey (1965)
Primeval	Kenya	0.09	Dunne, unpublished
Burned semiannually	North Carolina	3.08	Smith and Stamey (1965)
Second growth	Ivory Coast	0.40	Nye and Greenland (1960)
Woodland, protected	Texas	0.05	Smith and Stamey (1965)
Woodland, burned annually	Texas	0.36	Smith and Stamey (1965)
Woodland, protected	Ohio	0.01	Smith and Stamey (1965)
Woodland, protected	North Carolina	0.08	Dils (1953)
AGRICULTURE, CULTIVATED GRASSLANDS			
Bluegrass	Midwestern U.S.	0.02–0.34	Smith and Stamey (1965)
Alfalfa	Midwestern U.S.	0.03–0.15	Smith and Stamey (1965)
Clover and grass	Virginia	0.01–0.07	Smith and Stamey (1965)
Bermuda grass	S.W. United States	0.00–0.10	Smith and Stamey (1965)
Fescue grass	Georgia	0.20	Barnett (1965)
Hayland	Washington	0.01–0.08	Smith and Stamey (1965)
Hayland	North Carolina	0.31	Smith and Stamey (1965)
Tropical perennial grasses	Puerto Rico	1.20	Smith and Stamey (1965)
Tropical kudzu	Puerto Rico	0.18	Smith and Stamey (1965)
Hayland	India	1.05–8.30	Vasudevaiah et al. (1965)
Tropical pasture grasses	India	0.20	Vasudevaiah et al. (1965)
Dubgrass	India	0.47	Battawar and Rao (1969)
Grass	India	1.4–1.8	United Nations (1951)
AGRICULTURE, CROPLANDS			
Bare fallow	Georgia	100	Barnett (1965)
Bare fallow	Tanzania	59.2	Rapp et al. (1972)
Bare fallow	Ivory Coast	45	Dabin (1959)
Bare fallow	Midwestern U.S.	69	Bennett (1939)
Bare fallow	India	14.6–15.4	United Nations (1951)
Maize (corn)	India	4.7	Battawar and Rao (1969)
Maize	India	10.54	Vasudevaiah et al. (1965)
Maize	Midwestern U.S.	17.86	Jamison et al. (1968)
Maize	Rhodesia	2.1–4.5	Hudson and Jackson (1959)
Maize	Midwestern U.S.	73.2	Bennett (1939)
Millet	Tanzania	31.6	Rapp et al. (1972)
Hill rice	India	1.0	Battawar and Rao (1969)
Hill rice	India	9.4	Vasudevaiah et al. (1965)
Hill rice	Java	11.2	Nye and Greenland (1960)
Hill rice	Guinea	0.4–1.8	Nye and Greenland (1960)
Arhar grain	India	5.5	Battawar and Rao (1969)
Cowpeas	India	1.9	Battawar and Rao (1969)
Urid grain	India	21.0	Vasudevaiah et al. (1965)
Peanuts	India	6.2	Vasudevaiah et al. (1965)

continued

Table 15-1. *continued*

LAND USE	LOCATION	SOIL LOSS (TONS/ACRE/YR) [1 TONNE/HECTARE = 0.4474 TONS/ACRE]	SOURCE
RANGELAND			
Dry woodland and rangeland	Southern California	2.7	Krammes (1960)
Dry woodland and rangeland, after fire	Southern California	24.7	Krammes (1960)
Dry woodland and rangeland	New Mexico	21.2	Leopold et al. (1966)
Sparse grassland	Alberta	7.7	Campbell (1970)
Dry woodland and rangeland, heavily cut and grazed	Kenya	13–76	Dunne, measurement
Grass and scrub	India	1.5–1.8	United Nations (1951)
URBAN			
Road cuts	Georgia	79–237	Diseker and Richardson (1961)
Building sites	Maryland	125–219	Wolman and Schick (1967)
Building sites	Maryland	189	Guy (1965)
MINING			
Land devegetated by smelter fumes	Ontario	26.1	Pearce (1973)
Spoil bank	Ohio	87	*Geotimes* (1971, Dec)
RURAL ROADS			
Forest roads in a jammer unit	Idaho	29.7	Megahan and Kidd (1972)
Forest roads	Idaho	7.9	Copeland (1965)
Rural road	N. Kenya	53.7	M. Norton-Griffiths,

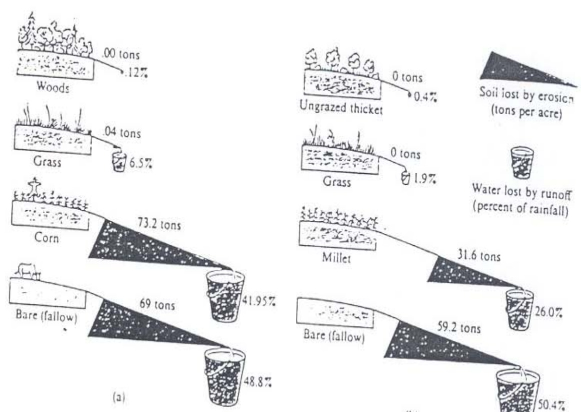


Figure 15-15 Results from plot studies of runoff and erosion under various types of land use. (a) Midwestern United States. (Soil Conservation Service.) (b) Mpwapwa, Tanzania. (From Rapp et al. 1972.)

Use of Geologic Maps and Information

The Atascadero Green Valley Watershed has several geologic formations – the Franciscan Formation, ultramafic rock and the Merced or Wilson Grove Formation (see Figure 5). Atascadero and Green Valley Creeks flow along a northwest/southeast trend following the general direction of the San Andreas Fault system, a dominant feature of the coastal ranges.

The Franciscan Formation, the primary geologic formation for much of the northern coastal ranges, dominates the northern portion of the AGV watershed. The Franciscan Formation, also called the Franciscan Melange, is a mixture of various rocks within a matrix or melange of fine-grained material. This formation was a seabed for over 100 million years and was uplifted through the tectonic activity of the Pacific Plate subducting the North American Plate. Franciscan Formation is known for its landslides and high erosion rates due mostly to the lack of strength and structure in the melange. Franciscan Formation in this area is up to 50,000 ft. thick. Franciscan Formation also has a low groundwater holding capacity overall. Groundwater tends to move along fault lines and cracks in the formation becoming surface flow as springs or where a creek channel intersects a fault or crack or other feature. Recharge rates are low and groundwater resources in the Franciscan are generally scarce. In addition to the lower AGV watershed and most of the Green Valley Creek subwatershed, the Franciscan Formation also occurs in the headwaters of Atascadero Creek near English Hill.

Another geologic formation associated with faults and the coastal ranges is ultramafic rock or serpentine. Serpentine rock is also known for its high erosion levels and the high levels of magnesium in soils derived from this formation. The magnesium limits growth in most plants and a group of highly specialized plants, termed serpentine endemics, have evolved in California to grow in these soils. Serpentine occurs in the AGV watershed along the very western areas of the Purrington Creek subwatershed.

The Merced or Wilson Grove Formation dominates most of the AGV watershed. Wilson Grove Formation is only 1-5 million years old and varies in thickness up to 120 feet at the maximum. This formation typically overlies the much older Franciscan Formation and is made up of fine-grained loosely consolidated sandstone with layers of beach or dune sand. The Wilson Grove Formation was once a shallow marine embayment that gradually filled in and was uplifted as part of the general uplift of the coastal ranges. There is also a layer of discontinuous volcanic tuff in this formation in this area that is from the same source as the Sonoma Volcanics that cover most of the Sonoma Mountains and upper Napa Valley. This tuff layer is harder and denser than the sandstone above and below it creating an impervious layer for groundwater movement that creates springs as well as landslides.

Recharge rates for the Wilson Grove Formation were estimated by Boudreau at 25% of rainfall amounts (8”to 40”) and 300 acres of the Wilson Grove Formation in a natural state (no impervious surfaces) recharges 600 acre-feet of groundwater. This study also discusses the relationship of residential development to groundwater recharge. A family of four need 200 gallons of water per day per person or .9 acre-feet of water annually. Annual recharge/acre in the Wilson Grove Formation is .6 acre-feet/acre meaning that the average family would need 1.5 acres to recharge a domestic well in an average rainfall year and 3 acres or more in low rainfall year. These numbers only apply where the Wilson Grove Formation is 50 ft or greater in thickness and recharge areas are natural land without buildings or roads. This minimum size would be much greater where the formation is thinner and impervious surfaces are involved which remove surface area from the recharge process (see Figures 6 and 7).

The Boudreau report was part of a 1978 Sonoma County Green Valley study that addressed groundwater concerns in the lower AGV watershed area as well as the concerns of many residents at the time regarding conversion of agricultural land to rural residential development. This study recognized that almost all the housing in the AGV watershed used domestic wells and septic systems and that additional housing development could reduce groundwater below levels needed to support the housing. Despite this 1978 study rural residential housing development in the AGV watershed has continued with no additional major water supply development.

Insert Figures 5, 6 and 7

Historic Maps

A set of historic topographic maps where reviewed by the group and are included as Figures 8 and 9. These maps are useful in showing the level of development and roads in this area. Additional research on historic conditions of the AGV watershed could be used to evaluate where significant historic clearing of vegetation has occurred as part of rangeland creation, timber harvest and housing development. There is some speculation that the watershed once had a greater coverage of woody vegetation (forest, shrub) that has been converted to grassland, farmland and housing.

Studies by Others

In addition to the geologic and groundwater studies the Ca. Department of Fish and Game has completed stream surveys of Purrington Creek (1994), Atascadero Creek (1995) and Green Valley Creek (1994). These surveys use a Fish and Game method and inventory stream conditions occurring at the time of the survey. These surveys found:
Purrington Creek has steelhead trout and Coho salmon.
Roads and road crossings are eroding increasing fine sediment into the streambed. Garbage and dumping along the road is common. Wood cover in the stream should be retained and increased.

Atascadero Creek was surveyed from the Occidental Road crossing to upstream of the Barnett Valley Road crossing along with the lower portion of Jonive Creek. Steelhead trout historically (1969) were found in Atascadero Creek but were not found in the 1995 survey. Both Atascadero Creek and Jonive Creek had high levels of silt in the stream, high water temperatures, channel incision and low habitat values.

Green Valley Creek was surveyed from its confluence with the Russian River to a point about 10 miles upstream. Steelhead trout and Coho salmon were found in the stream in 1995. Lower Green Valley Creek is channelized, incised and has low habitat values. Upstream of the confluence with Atascadero Creek the survey found Green Valley Creek also exhibits channel incision and increased bank erosion and a lack of suitable spawning habitat. Channel incision may also be contributing to fish barrier problems.

All three surveys found a need for increased riparian habitat and a reduction of fine sediment loads.

No stream flow gages were found to be operating in this watershed. General rainfall information for the area is included in Figures 35 and 36.

There may be additional studies and monitoring data that should be identified and collected including water quality and sanitary survey data, well drilling logs and well level monitoring, any GIS layers on vegetation and watershed features, creek road bridge crossectional surveys, flow data, flood mapping and modeling if available, road maintenance records and other items.

Insert Figures 8 and 9

SUMMARY OF PRELIMINARY WATERSHED ASSESSMENT BY SUBWATERSHED

Upper Atascadero Creek Subwatershed

- This subwatershed extends from the headwaters of Atascadero Creek near English Hill, Burnside Road and Pleasant Hill Road to the confluence with Jonive Creek.
- This subwatershed covers 7.05 sq. miles.
- Figures 10 – 19 include this subwatershed.

Stream system

- This subwatershed has numerous ephemeral creeks and small tributaries that join to form the main stem of Atascadero Creek.
- The upper Atascadero Creek subwatershed appears to have a large area of western Sebastopol draining into ephemeral creeks creating a high potential for incision and erosion.
- The ephemeral streams in the areas of the upper portion of this subwatershed have a good to fair cover of vegetation. However efforts to increase and maintain native vegetation should be encouraged through workshops for landowners.
- The specific conditions of ephemeral streams near public and other major roads should be evaluated particularly near Pleasant Hill, Barnett Valley, Burnside, Hwy 116 and Water Trough Roads.
- The main stem of Atascadero Creek is a low slope meandering channel with a wide floodplain that supports riparian forest and wetland habitats. The quality and extent of existing habitats should be assessed as well as the channel form and degree of channel downcutting or incision and need for reconstruction of a functional steam channel to floodplain relationship.

Geology/slopes

- This subwatershed is dominated by Wilson Grove Formation and includes the steep headwaters of Atascadero Creek that drain into several large ephemeral streams. These two factors indicate this subwatershed may serve a critical function to recharge groundwater in this area.
- The English Hill area has an outcrop of Franciscan Formation making its steep slopes particularly prone to erosion. The southern portion of this subwatershed has slopes in excess of 30% that are prone to erosion if disturbed. Roads should be carefully maintained and land uses focus on limiting ground disturbance in the winter.

Land use/roads

- There are numerous roads and houses in this subwatershed and increases in impervious surfaces in this recharge area could decrease infiltration functions of the subwatershed.
- Impervious surfaces can also increase peak storm flows and contribute to channel erosion and incision in ephemeral creeks leading to higher silt levels in the main stem of the creek. Quantitative monitoring of channel conditions such as channel form,

embeddedness and silt levels should occur in the main stem of Atascadero Creek along with more detailed evaluation of the condition of stormdrain outlets, road culverts and other concentrated flow locations.

- Fish and Game surveys indicate excess sediment in Atascadero Creek that can be generated from roads and impervious surfaces as well as from agricultural land uses. Erosion control workshops would be beneficial as well as increased erosion control efforts in managing county roads.
- Individual landowners both large and small can have a beneficial effect on the creek system and workshops to improve land management practices for farmers as well as rural residential owners should be held.
- Land uses are located with little buffer along the main stem of Atascadero Creek. Increasing buffer areas and revegetating these areas with riparian habitat could be accomplished over time through the purchase of conservation easements and cooperation with landowners both residential and agricultural.
- There are numerous septic systems and wells in this subwatershed and water quality monitoring should be done for bacteria, nutrients and temperature.

Lower Atascadero Creek Subwatershed

- This subwatershed consists of Atascadero Creek downstream of the confluence with Jonive Creek and upstream of the confluence with Green Valley Creek.
- This subwatershed encompasses 6.8 sq. miles.
- Figures 20-34 include this subwatershed.

Stream system

- This subwatershed has a moderate number of ephemeral creeks.
- Most of the major ephemeral creeks drain the urban areas of Graton and the Barlow/Occidental Road area creating a high potential for erosion.
- Many public roads - Graton, Green Valley, Occidental, Mill Station and others follow the course of ephemeral creeks and have major fill and bridges in the main stem creek and floodplain of Atascadero Creek. The specific condition of the ephemeral creeks and the main stem of the creek near these roads should be evaluated.
- The ephemeral creeks appear to have a fair to poor level of vegetative cover and could benefit from activities to revegetate with native plants.
- The main stem of Atascadero Creek is a low slope meandering channel with a wide floodplain that supports some riparian forest and wetland habitats. It is likely that the channel has been leveed, channelized and cleared of vegetation in various sections in the past. The quality and extent of existing habitats should be assessed as well as the channel form, sinuosity, degree of channel downcutting or incision, the need for reconstruction of a functional steam channel to floodplain relationship and an adequate meander corridor to support and sustain habitat areas.

Geology /slopes

- This subwatershed is dominated by Wilson Grove Formation and may function to recharge the groundwater basin.
- This section of the watershed has relatively modest slopes.

Land use/roads

- This subwatershed has a relatively large area of roads and houses and impervious surfaces that can increase peak storm flows and contribute to channel erosion and incision in ephemeral creeks leading to higher silt levels in the main stem creek. Quantitative monitoring of channel conditions such as channel form, embeddedness and silt levels should occur along with more detailed evaluation of the condition of stormdrain outlets, road culverts and other concentrated flow locations.
- Fish and Game surveys indicate excess sediment in Atascadero Creek that can be generated from roads and impervious surfaces as well as from agricultural land uses. Erosion control workshops would be beneficial as well as increased erosion control efforts in managing county roads.
- Individual landowners both large and small can have a beneficial effect on the creek system and workshops to improve land management practices for farmers as well as rural residential owners should be held.
- Land uses are located with little buffer along the main stem of Atascadero Creek. Increasing buffer areas and revegetating these areas with riparian habitat could be accomplished over time through the purchase of conservation easements and cooperation with landowners both residential and agricultural.
- There are numerous septic systems, several wastewater discharges, and wells in this subwatershed and water quality monitoring should be done for bacteria, nutrients and temperature.

Jonive Creek Subwatershed

- This subwatershed encompasses the headwaters of Jonive Creek near Barnett Valley, Burnside and Jonive Roads to the confluence with Atascadero Creek.
- This subwatershed encompasses 6.55 sq. miles.
- Figures 20-29 illustrate conditions in this subwatershed.

Stream system

- The ephemeral creeks of the upper portion of this subwatershed are well vegetated
- The ephemeral creeks of the middle and lower portion of this subwatershed do not appear to have as much vegetation and may benefit from revegetation activities.
- There are a number of major public roads such as Bodega Road, Jonive Road, Barrett Valley Road, Burnside Road, Goldridge Road, Sexton Road, Ferguson Road and others in this subwatershed. These roads likely have an effect on creeks and could be a source of increased peak stormflows and channel erosion. The specific conditions of the creeks near these roads should be evaluated.

Geology/slopes

- This subwatershed is composed primarily of Wilson Grove Formation with some Franciscan Formation. The upper portion of this subwatershed has slopes in excess of 30%. It is likely that areas along the ridge tops composed of Wilson Grove Formation provide recharge for the groundwater basin in the lower area of Atascadero and Green Valley Creeks.
- The large ephemeral creeks in this subwatershed are underlain by Franciscan Formation and therefore are highly erosion prone.

Land use/roads

- This subwatershed has rural residential uses and agriculture.
- There is a large forest covering the upper portion of this subwatershed. Retaining forested ridge tops and open land will assist in protecting the recharge function and benefit the overall watershed and groundwater.
- This subwatershed has a relatively large area of roads and houses and impervious surfaces that can increase peak storm flows and contribute to channel erosion and incision in ephemeral creeks resulting in higher silt levels in the main stem creek. Quantitative monitoring of channel conditions such as channel form, embeddedness and silt levels should occur on the main stem of Atascadero and Green Valley Creeks along with more detailed evaluation of the condition of stormdrain outlets, road culverts and other concentrated flow locations.
- Fish and Game surveys indicate excess sediment in Atascadero Creek that can be generated from roads and impervious surfaces as well as from agricultural land uses. Erosion control workshops would be beneficial as well as increased erosion control efforts in managing county roads
- Individual landowners both large and small can have a beneficial effect on the creek system and workshops to improve land management practices for farmers as well as rural residential owners should be held.
- Land uses are located with little buffer along the main stem of Jonive Creek. Increasing buffer areas and revegetating these areas with riparian habitat could be accomplished over time through the purchase of conservation easements and cooperation with landowners both residential and agricultural.
- There are numerous septic systems and wells in this subwatershed and water quality monitoring should be done for bacteria, nutrients and temperature.

<u>Purrington Creek Subwatershed</u>

- This is a small subwatershed that is tributary to Green Valley Creek and stretches from headwaters near Occidental and Occidental Road to Green Valley Creek near Graton Road.
- This subwatershed encompasses 3.6 miles.
- Figures 26-29 illustrate conditions in this subwatershed.

Stream system

- The ephemeral creeks in the upper portion of this subwatershed are well vegetated but ephemeral creeks in the lower portion of the subwatershed appear less vegetated and replanting efforts may be needed.
- Graton Road runs along Purrington Creek and both Graton and Occidental Roads cross through the steep slopes of this subwatershed. The specific condition of creeks near these roads should be evaluated.
- The main stem of lower Purrington Creek appears to have a very narrow riparian corridor.

Geology/slopes

- This subwatershed includes Franciscan Formation and a large serpentine outcrop and Wilson Grove Formation.
- The headwaters of Purrington Creek appear to be underlain by serpentine and are relatively steep. These areas are likely to be erosion prone.

Land use/roads

- The upper portions of this subwatershed is relatively undeveloped with either housing or agriculture. There are scattered houses but several major roads that cross through the watershed.
- The lower portion of the subwatershed has a great deal of agricultural development.
- This subwatershed retains forest cover in its upper portion. Retaining forested ridge tops and open land will assist in protecting recharge functions, reduce erosion and benefit overall watershed conditions and groundwater.
- Fish and Game surveys indicate excess sediment in Purrington and Green Valley Creeks that can be generated from roads and impervious surfaces increasing stormflow and causing channel incision as well as from agricultural land uses. Erosion control workshops would be beneficial as well as increased erosion control efforts in managing county roads.
- Individual landowners both large and small can have a beneficial effect on the creek system and workshops to improve land management practices for farmers as well as rural residential owners should be held.
- Land uses are located with little buffer along the main stem of lower Purrington Creek. Increasing buffer areas and revegetating these areas with riparian habitat could be accomplished over time through the purchase of conservation easements and cooperation with landowners both residential and agricultural.

Upper Green Valley Creek Subwatershed

- This subwatershed extends from the steep headwaters of Green Valley Creek to its confluence with Atascadero Creek.
- This subwatershed encompasses 6.56 sq. miles.
- Figures 25 –29 partially show this subwatershed.

Stream system

- The ephemeral creeks in the upper portion of the subwatershed appear to be well vegetated but the ephemeral and main creek in the middle and lower portion of the subwatershed have narrow corridors of vegetation or little vegetation.
- Green Valley Road and Harrison Grade Road as well as many smaller roads pass through this subwatershed and the condition of ephemeral creeks and the main creek channel near these roads should be evaluated.

Geology/slopes

- Franciscan Formation dominates this subwatershed in its steep upper portions with Wilson Grove Formation only in a small portion of its lower area. There are a number of large reservoirs in this subwatershed reflecting the differences in geology and need for surface water storage in this area. This is not likely to be an important area for groundwater recharge.
- The combination of steep slopes and Franciscan rock makes this subwatershed highly erosion prone. In these circumstances landslides are often associated with the Franciscan Formation.

Land use/roads

- Aerial photographs only partially cover this subwatershed. A portion of the headwater forest in this subwatershed was recently developed for agriculture. Stormwater increases from this conversion need to be carefully managed to avoid inducing downstream erosion and hillslope failure.
- Housing and road drainage also need to be carefully managed.
- In general land uses in this subwatershed can create more erosion than many of the other areas in the AGV basin due to the steep slopes and geology. This subwatershed retains forest cover in its upper portion. Retaining forested ridge tops and open land will assist in reducing erosion and benefit overall watershed conditions.
- Fish and Game surveys indicate excess sediment in Green Valley Creek that can be generated from roads and impervious surfaces increasing stormflow and causing channel incision as well as from agricultural land uses. Erosion control workshops would be beneficial as well as increased erosion control efforts in managing county roads.
- Individual landowners both large and small can have a beneficial effect on the creek system and workshops to improve land management practices for farmers as well as rural residential owners should be held.
- Land uses are located with little buffer along the main stem of Green Valley Creek. Increasing buffer areas and revegetating these areas with riparian habitat could be accomplished over time through the purchase of conservation easements and cooperation with landowners both residential and agricultural.

Lower Green Valley Creek Subwatershed

- This subwatershed stretches form the confluence Green Valley Creek and Atascadero Creek to the Russian River.
- This subwatershed encompasses 7.4 sq. miles.

- The aerial photographs do not include this subwatershed.

Stream system

- A major tributary to this subwatershed drains the Forestville area and maybe affected by impervious surfaces.
- The ephemeral creeks in the upslope portion of this subwatershed appear to be well vegetated.
- There are a number of roads in this subwatershed including Hwy 116, Pocket Canyon Road and others. The condition of ephemeral creeks and the main creek should be evaluated near these roads.

Geology/slopes

- Franciscan Formation dominates this subwatershed in its steep upper portions with Wilson Grove Formation in a small portion of its eastern area near Forestville. There are a number of reservoirs in the western portion of this subwatershed reflecting the differences in geology and need for surface water storage in this area.
- The combination of steep slopes and Franciscan rock makes this subwatershed highly erosion prone. In these circumstances landslides are often associated with the Franciscan Formation.
- The area of Wilson Grove Formation likely provides groundwater recharge to the area.

Land use/roads

- Housing and road drainage need to be carefully managed. Timber harvest activities also need to be carefully reviewed to avoid erosion most particularly in the western portion of this subwatershed.
- In general land uses in this subwatershed can create more erosion than many of the other areas in the AGV basin due to the steep slopes and geology.
- This subwatershed retains forest cover in much of its area. Retaining forested ridge tops and open land will assist in reducing erosion and benefit overall watershed conditions.
- Fish and Game surveys indicate excess sediment in Green Valley Creek that can be generated from roads and impervious surfaces increasing stormflow and causing channel incision as well as from agricultural land uses. Erosion control workshops would be beneficial as well as increased erosion control efforts in managing county roads.
- Individual landowners both large and small can have a beneficial effect on the creek system and workshops to improve land management practices for farmers as well as rural residential owners should be held.
- Land uses are located with little buffer along the main stem of Green Valley Creek. Increasing buffer areas and revegetating these areas with riparian habitat could be accomplished over time through the purchase of conservation easements and cooperation with landowners both residential and agricultural.

Insert Figures 10 -36

SUMMARY

Table 3 summarizes the assessment for each subwatershed and was completed by the watershed group.

In general the AGV watershed has a mixture of land uses – urban /rural residential, intensive agriculture and a relatively large number of public and private roads. These land uses combined with the topography and geology create the need for a broader evaluation of certain conditions and the monitoring of particular aspects of the watershed system. Workshops and projects are also recommended to improve watershed and ultimately stream conditions. The following actions are recommended but will require funding and cooperation with landowners (see next section):

Evaluations

- Evaluation of roads and the condition of both ephemeral creeks and main stem creeks next to roads to identify erosion problems and formulate repairs and changes in management
- Identification of urban stormdrain outlets and evaluation of sites with erosion problems to formulate repairs
- Evaluation of ephemeral creek channels downstream from steep slope agricultural areas for revegetation and repair

Monitoring

- Establish 1-3 study reaches along the main stem of Atascadero /Green Valley (AGV) Creek (see next section). Annually measure stream channel cross sections, channel bed composition including pebble counts and embeddedness, vstar, riparian diversity and extent and other features. Protocols for these measurements are contained in the Watershed Stewardship Workbook.
- Measure bank heights, channel sinuosity, width to depth ratio of main stem of AGV Creek to determine if the channel is incised and use this information in design of restoration projects (see next section for further discussion)
- Establish a set of water quality stations for bacteria, nutrients, water temperature, and water flow monitoring and incorporate this information into restoration and upstream projects. (see next section for details)

Workshops

- Many of the factors that affect the conditions in the creeks of this watershed arise from land uses and land management activities. These activities are carried out by a large and diverse group of people in both the private and public sectors. In most cases management actions are not evaluated for their effects on fish and wildlife habitats and therefore many residents are unaware of the potential harm their actions may be causing to the environment of the AGV creek system. Education and collaboration with all residents and landowners produces change in land management actions and may have the greatest long-term improvement for this populated watershed.

- For agricultural owners we recommend a series of Fish Friendly Farming workshops, Rangeland Water Quality workshops and erosion control workshops. These workshops cover a diverse and comprehensive array of subjects including all aspects of vineyard, rangeland and road management to reduce the generation and delivery of fine sediment to streams and the management and restoration of riparian corridors and habitats within the context of an agricultural operation. The Goldridge RCD should work in cooperation with the Sotoyome RCD to arrange funding and times for these workshops
- Road management workshops for both private landowners and public works agencies are needed. The Goldridge RCD should seek funds for the workshops and work with rural residential groups, homeowners associations and the county public works department or other road maintenance groups to assure these groups attend.
- The Goldridge RCD could work with the Sotoyome RCD to hold several workshops for small homeowners and urban residents using the House and Garden Audit, a tool for reducing the contribution of contaminants and sediment from small home sites and urban gardens.
- Additional workshops on riparian restoration and erosion control may be beneficial.

<u>Projects</u>

There is a need in the AGV watershed to work with the Sonoma County Open Space District, Sonoma County Planning Department, large and small landowners and the RCD to create a collaborative partnership to protect and restore particular features of the watershed. These include:

- Headwater and forested areas particularly those that serve to recharge groundwater supplies. The addition of impervious surfaces to this watershed will over time likely result in a major overdrafting of the limited groundwater basin through a combination of increases in the number of wells and reductions in open land to recharge the groundwater.
- Restoration of ephemeral creeks especially those highly affected by roads and impervious surfaces.
- Restoration of a riparian corridor along the main stem of the AGV creek through the purchase of conservation easements from willing landowners and expansion of the corridor through both natural meandering processes and revegetation with native species appropriate to the area. A qualified restoration ecologist should design the restoration and instream manipulation of the creek should be reduced unless essential to eliminate a fish passage barrier until the corridor is adequate to allow for natural stream meandering (see next section for more details)
- In all projects more success will be gained from establishing working partnerships between all the parties and recognizing that the condition of the AGV watershed is affected by all residents and land uses and therefore all parties need to be involved.

Table 3
WATERSHED ATLAS WORKSHEET

WATERSHED NAME: ATASCADERO/GREEN VALLEY CREEK DATE: December 2002

1. Major Tributary	2. Drainage Area	3. Steep Slopes	4. Frequency of Roads on Steep Slopes	5. Primary Land Use	6. Primary Land Use On Steep Slopes	7. Dominant Vegetative Cover Type	8. Amount Of Urban Area Or Impervious Surface
Upper Atascadero	4510 acres (7.05 sq. miles)	Medium	Medium	Urban, agriculture	Agriculture, rural residential	Grassland	25-30%
Lower Atascadero	4353 acres (6.80 sq. miles)	Low	Low	Urban, agriculture	No slopes over 30%	Cultivated/ Urban	35%
Jonive	4191 acres (6.55 sq. miles)	Low/ Medium	Low	Agriculture, timber and scattered residential	Timber	Forest/ Agriculture	<10%
Purrington	2310 acres (3.60 sq. miles)	Low	High	Agriculture forest	Forest	Forest cultivated	<10%
Upper Green Valley	4197 acres (6.56 sq. miles)	High	Medium/High – needs better assessment	Agriculture, forest, and livestock	Forest/ Vineyard	Forest cultivated	<10%
Lower Green Valley	4633 acres (7.40 sq miles)	High	High	Timber, quarry, agriculture and urban	Timber, Agriculture, horse	Forest cultivated	>20%?

** See attached notes for an explanation of each column.

Table 3 (Cont)
WATERSHED ATLAS WORKSHEET
WATERSHED NAME: ATASCADERO/GREEN VALLEY CREEK **DATE: December 2002**

Page two

Major Tributary	9. Historic Land Uses	10. Fire History	11. Proposed Land Uses Under General Plan	12. Land Uses Along Creeks	13. Density Of Land Uses Likely To Directly Affect Water Quality (Other Than Siltation)	14. Existing Monitoring Types, Dates And Locations	15. Other Features And Observations From Group
Upper Atascadero				Agriculture, urban, roads	Urban runoff, Septic systems, livestock	Fish and Game Stream Survey	
Lower Atascadero				Agriculture, urban	Horses, septic systems, agriculture, and industry	Green Valley Road gage, Fish and Game Stream Survey	
Jonive				Road, agriculture, timber, urban	Low level of residential areas	Fish and Game Stream Survey	
Purrington				Roads, vineyard, forest	Low level of residential areas	Fish and Game Stream Survey	
Upper Green Valley				Livestock, vineyard, timber, roads	Livestock	Fish and Game Stream Survey	Lots of irrigation ponds
Lower Green Valley				Agriculture, timber, roads	Secondary wastewater – in winter, agriculture, commercial septic	Fish and Game Stream Survey	

The Watershed Atlas Worksheet: Notes

Column One: Major Tributary
A major tributary is defined as a sub-watershed that contains at least 10% of the entire watershed area.
.
Column Two: Drainage Area
This information was calculated for each of the major tributaries.

Column Three: Steep Slopes
This column uses the overlay of steep slopes (greater than 30%) for each subwatershed. This overlay incorporates the review of topographic maps, soil survey slope classification and aerial photographs. Decide which of the following best fits the amount of steep slope area in the tributary watershed or along the main stem:
High degree of steep slopes - more than 50% of the drainage area is steeper than 30%
Medium degree of steep slopes - 25-50% of the drainage area is steeper than 30%.
Low degree of steep slopes - 25% or less of the drainage area is steeper than 30%.

Column Four: Frequency of Roads on Steep Slopes
For the steep slope areas (greater than 30% slopes) review the density of roads that crisscross the slope or how much of the slope has roads on it. If you know the roads in a certain steep area have problems, you should note this as well, regardless of slope type.
If there are numerous roads or many miles of roads records a **High** rating.
Fewer roads are a **Medium** rating unless the roads are known to have large erosion problems or failures.
Few to no roads rate a **Low.**

Column Five: Primary Land Use
Record the primary land use in the basin.

Column Six: Primary Land Uses on Steep Slopes
In addition to looking at the overall land use in the watershed, record the primary land uses on steep slope areas

Column Seven: Dominant Vegetation Types
Record the dominant vegetative cover type as one of the following:
Forest
Shrub
Grassland (including grassland with oaks and grazed rangeland)
Agriculture (intensive not rangeland)
Urban (both high and low density)

Column Eight: Amount of Impervious Surfaces or Urban Areas
Estimate the percentage of land covered by impervious surfaces in each major tributary of your watershed. If there is urban development, all of the area enclosed by the development is considered impervious surface. For rural residential areas, assume that 50% of the total rural

residential area is impervious. Roads are should also counted in this evaluation. We will assume that roads are 20-foot wide (10 feet in each lane) and that each mile of road is equivalent to 2.42 acres of impervious surface.
Enter one of the following ratings on the worksheet. If more than half the area (>50%) is covered by impervious surfaces the rating is **High**. Coverage of 25%-50% is **Medium** and **Low** is less than 25% covered by impervious surfaces.

Column Nine: Historic Land Uses
Summarize information on land use and significant events revealed by your historical research.

Column Ten: Fire History
If you are aware of areas in the watershed that have had large fire and the date of the fire record them.

Column Eleven: Proposed Land Uses
This section uses the General Plan information to record the future proposed uses if different from present. If there is not a proposed change, just record "Same".

Column Twelve: Land Uses along Creeks
Review the overlays for land uses and for each of the major tributaries and record the primary land uses that are immediately next to the creek. If there are many types, list them all.

Column Thirteen: Density of Land Uses Likely to affect Water Quality
This column will be used to identify the location of land uses near to the creek that may affect water quality. These land uses include, but are not limited to, livestock including dairies, horse and grazing operations, intensive agriculture, nurseries, urban areas and rural residential. There may be particular industries or other sources to record as well.

Column Fourteen: Existing Monitoring
If your group has found that there are other monitoring efforts, or past efforts, in certain areas of the watershed, note the types of monitoring, dates and locations in the tributary.

Column Fifteen: Other Features and Observations
This column is for the other types of knowledge and information you have collected and want to record.

EVALUATING THE STREAM SYSTEM FOR STUDY REACHES

The following discussion is adapted from the Watershed Stewardship Workbook

“Discussion of the Monitoring Approach

Salmon and steelhead require gravel bed streams to spawn. The presence of too much fine material in the gravel can adversely affect the development of salmon eggs into fry and can reduce the number of aquatic insects. Sediment is transported by winter storms. However, it is very difficult and dangerous to measure the amount of sediment being transported during a flood. Besides, the biological health of the stream is more directly related to composition of the streambed than it is to the concentration of sediment suspended in the water. Therefore, the composition and form of the streambed will be monitored during the summer when the water levels are low.

Land uses and management practices, in the watershed, affect the amount of sediment, large wood and water delivered to a stream. Rock and soil eroded from the hillsides of a watershed enters the channel as sediment during floods. Once in the channel, the material is transported downstream. The sediment may be deposited on the streambed and then moved downstream by subsequent floods several times before it reaches the main river. The deposits of sediment help shape the stream channel.

It would be too labor intensive to examine changes in the composition and form of all of the streambed in a given watershed each year. Hence, only short sections of the channel can be monitored each year. By taking the same type of measurements in the same section of channel, it is possible to see how the channel changes through time.
A stream channel is a complex and dynamic environment. Channels exhibit many types of features such as pools, riffles, and rapids, gravel bars and logjams. Riffles, and gravel bars are places where coarse sediment is deposited and stored. Pools are deep spots in the streambed. These features are created in response to the interaction of flood events with the streambed.

A *stream reach* is defined as a segment of channel that demonstrates similar features throughout its length. For example, it is common to see a sequence of pools and riffles in certain sections of a stream. Other channel segments contain a series of cascades. Some types of reaches respond more to changes in the sediment load of the creek. That is, obvious changes occur in the form and composition of the streambed in certain types of reaches.

Two of the objectives of this monitoring approach are to track changes in both the amount and type of sediment supplied by the watershed and the sediment is moving through the channel system. A study reach is a section of channel where annual changes in the channel form and composition are measured. It is easier and more productive to monitor only the channel reaches that have the greatest potential to respond to changes in the stream’s sediment load.

This monitoring approach focuses on making repeated measurements in selected study reaches to track changes in the sediment supply. The reasons the study reach approach is used are summarized below.

- method to monitor the streambed
- can't sample the entire channel network, so only certain areas are chosen to sample
- some locations respond readily to changes in sediment supply, that is they are indicators or early warning systems
- need to continue monitoring the same location so that changes can be noticed and recorded
- safer and more reliable method than sampling suspended sediment during floods
- changes in the composition and form of the streambed can directly affect salmon and steelhead
- need for Quality Assurance/ Quality Control (QA/QC) by qualified scientists

The following features can be monitored for the entire length of each study reach:
- locations where the channel goes dry
- composition of the channel bed
- embeddedness of cobble in the channel
- overall condition of the channel banks
- location, size and depth of pools
- depth of fine sediment in pools
- changes in channel form will be evaluated by:
- channel cross sections
- longitudinal profile of the lowest point in the channel
- photographs of the channel
- extent and composition of riparian forest
- amount of shade over the channel
- aquatic macroinvertebrates
-

Water quality tests will be performed at both the study reach and additional locations. The next section discusses determining the locations in your watershed for the water quality tests. Water quality tests include:
- air and water temperature
- dissolved oxygen
- pH
- conductivity
- alkalinity
- nitrate
- ammonia
- phosphate
- presence of algae, oil sheen or unusual odors

Hobo-Temp dataloggers will also be placed in the stream at various locations to record daily and seasonal temperature variations.

The Basis for Selecting Study Reaches

The condition of the stream channel network indicates the health of a watershed. For this reason, a section of the stream channel will be monitored. The size of the study reach will be scaled to the size of the channel being investigated. The minimum length of a study reach is defined as ten (10) *bankfull channel widths* along the stream.
The physical forces exerted on the streambed shapes the channel. That is, streams shape their own channel. The high flows in winter have enough energy to move the material on the streambed. The greater the flow in the stream, the greater the size and amount of material that can be transported by the stream.

Researchers have found that, over a period of many years, frequent moderate-sized floods that occur do the most work to shape the channel. These floods occur on average, about every 1.5 years to 2 years. Floods of this modest size are called the *bankfull discharge*, or the dominant discharge.

Early in the history of the study of rivers, it was noted that, for streams with a well-defined floodplain, the flows that shaped the channel came to the top of the bank. These flows were called the *bankfull discharge*. Later, it was recognized that in channels that lack a well-defined floodplain, similar-sized flood events were responsible for shaping the stream channel. Hence, the name "bankfull" is now applied to all types of streams. A floodplain is a broad flat area next to the stream channel that occasionally floods.
Since, over time, bankfull discharge shapes the channel it is possible to observe features along the channel edges that indicate the elevation of the water surface during these events. The bankfull width is measured by identifying bankfull indicators on each streambank and then measuring the horizontal distance between them.

The bankfull width is one way to compare the size of streams. The bankfull width is also related to channel features such as the size of the bends (i.e. meanders) of a stream. Thus, it is reasonable to measure the length of a section of stream channels in terms of the number of bankfull widths. The minimum length of a study reach is defined as ten (10) bankfull channel widths along the stream. For example, if the bankfull width is 21 feet, then the study reach will be 210 feet long.

Overview of Study Reach Selection

Channel conditions provide a practical way of assessing overall watershed conditions. The shape and condition of the channel reflect its capacity to store or to transport the sediment load it receives. Throughout the watershed, there are different types of channels. Each type of channel has a different sensitivity and response to changes in sediment supply. The study reach is our main tool to assess the impact of fine sediment on the channel. The study reach needs to be located in an area where the channel will rapidly respond to changes in the sediment load.

This monitoring approach uses topographic maps to identify potential study reaches. All of the potential study reaches are identified and marked on the topographic maps. Next, a smaller group of potential study reaches are selected for a field visit. The field visit is used to confirm the information obtained from the topographic map, check for physical access and verify that the section has features of interest such as pools.

The following information, from the topographic map, was used to divide the stream channel into a series of reaches; each of these factors will be discussed below.

- channel slope
- channel confinement
- significant or major tributaries
- on-stream reservoirs

Channel slope

Slope, or gradient, is vertical distance divided by horizontal distance. Channel slope is a measure of how far the channel drops over a horizontal distance. Channel slope is one of the major factors that determine the speed of water in the channel. The speed and depth of the water determines how much sediment it can transport. Slope is one of the primary factors that control both what a steam looks like and whether sediment deposits or is transported during a flood.

A contour line, on a topographic map, is a line of constant elevation; that is, each point along a contour line has the same elevation. The vertical distance between contour lines is known as the contour interval. The contour interval is usually printed on the bottom of the topographic map. Contour intervals are typically 20 feet, 40 feet or 80 feet; depending on the ruggedness of the landscape, however, other contour intervals can be used. Occasionally, *intermediate contour intervals* are included on a map. Intermediate contour intervals are used when a topographic map covers both mountainous and flat areas. Intermediate contours lines are used on the flat areas on the map because the contour interval that is appropriate for the mountainous area is not the same as the one needed for the flat area.

By measuring the distance between contour lines on a topographic map, it is possible to determine the approximate slope of a stream channel.
Streams with approximately the same slope respond roughly the same to changes in discharge or sediment load. Therefore, it is reasonable to group stream segments by their slope. A slope class is a range of channel slopes. Researchers have identified six slope classes that exhibit distinct channel patterns (Montgomery, 1993). A slope class is a small range of slope values. These six slope classes are listed in the following table and their features are described below.

Table 4. Relationship between Slope Class and Channel Pattern

Slope Class	<1%	1-2%	2-4%	4-8%	8-20%	>20%
Channel Pattern	Pool-Riffle or Regime	Pool-Riffle or Plane-Bed	Plane-Bed or Forced Pool-Riffle	Step-Pool	Cascade	Colluvial

Table 4 shows that there are seven types of channel patterns associated with six slope classes. Features of many of the channel patterns are described in the following sections. Factors other than slope-class play a role in determining the channel pattern. The composition of the streambed is one factor that influences the channel pattern. The channel bottom can be covered by a mixture of varying proportions of sand, gravel, cobbles and boulders, or the channel bottom can be exposed bedrock. The presence or absence of large woody debris (LWD) can also play a role in determining the channel pattern.

The steepest segment of the channel network (colluvial channels) supplies sediment to the channel and is called the source reach. Transport reaches quickly move sediment loads downstream. Transport reaches include cascade, step-pool and bedrock channels. Response reaches are channels with a low slope. The low slope of response reaches allows sediment to accumulate. Increased sediment loads cause a significant change in response reaches. Response reaches include plane-bed, pool-riffle, regime and braided channels.

Braided channels are wide and shallow and exhibit a braided pattern of gravel bars. A high sediment supply and easily erodible banks are required for the formation of a braided channel. A lack of valley confinement is also required for braided channels to form. For example, when a stream leaves its narrow mountain canyon and flows across a wide plain it may become braided where it leaves the confinement of the narrow canyon. Braided channels are not included in the classification scheme for this monitoring program because no monitoring activities are planned for them and they are relatively rare in the Russian River watershed.

Bedrock channels were excluded from the classification scheme for this monitoring program because they cannot be located on the topographic map using channel slope and because they are resistant to changes in sediment supply.
Other types of stream channel classifications are available. This classification scheme was chosen because it allows a preliminary classification from information that is easily obtained from a topographic map. For example, the Rosgen classification system is popular but its application requires extensive fieldwork.

Regime channel pattern
Regime channels typically have a very low gradient with a sand bed. These types of channels are uncommon in the mountainous tributaries to the Russian River. Regime channels may occasionally be found near the confluence of some the tributaries with the Russian River. Ripples and dunes provide the primary resistance to flow.

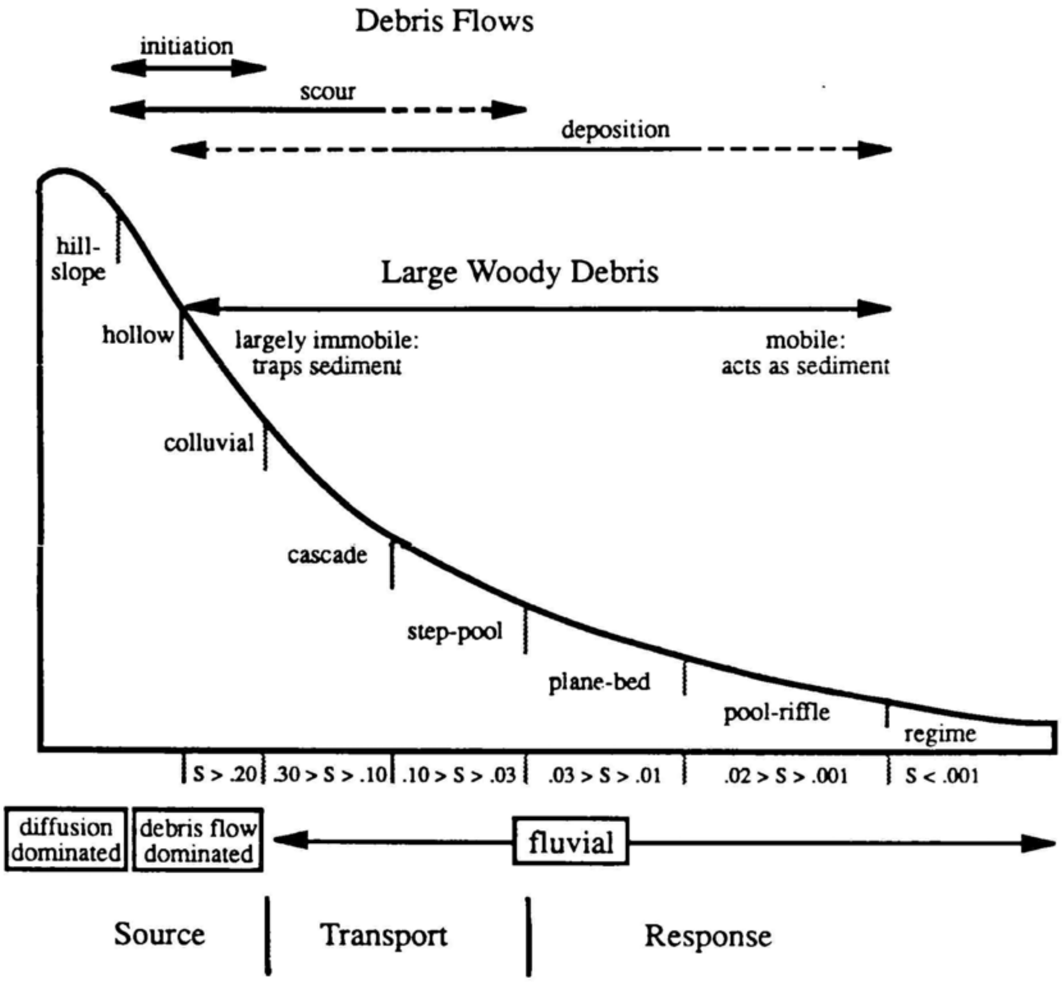


Illustration of idealized stream showing the general distribution of channel types from the hilltop down through the channel network. From Montgomery and Buffington, 1993.

Features such as pools and riffles are typically absent in regime channels but may be "forced" by the channel geometry. For example, in regime channels, pools are present only at bends. The great force of the water going around the bend helps to create the pool. Regime channels tend to have the lowest relative transport capacity and thus are very sensitive to changes in sediment supply or water discharge. The banks are usually made of material that was transported by the stream in the past. An increase in sediment supply can lead to channel widening. Regime channels generally do not have an armor layer of coarser rock covering the surface of the channel. Consequently, the size of material on the surface of the bed does not change with an increase in sediment supply. Thus, regime channels respond to changes in sediment supply by changing their shape, i.e. channel geometry, and sediment transport rates.

Pool-riffle channel pattern
The pool-riffle channel type is what most people picture when they think of a stream. Pool-riffle channels have an undulating bed that defines a series of bars, pools and riffles. Pool-riffle channels typically occur on slopes of less than 2%. However, channel geometry or large woody debris can "force" a stream to adopt a pool-riffle pattern when the slope is between 2% and 4%. The forced pool-riffle pattern is discussed on the next page.

The channel bed is typically composed of sand and gravel. Pools are deep areas in the channel. The water surface of pools appears flat and smooth during periods of low-flow while the water surface of a riffle is rough. During periods of low-flow, riffles are visible as the steep section of the channel between pools. Bars and riffles are areas where sand and gravel are stored. The term "bar" refers to a deposit of sediment in the stream channel; there are several different types of bars. Riffles are one type of bar. The upper surface of bars is exposed during periods of low-water flow.

The general pattern of pools and riffles is stable over time. However, deposition and scour can occur on the riffles and bars and in the pools in response to flood events. Pool-riffle channels have the widest variety of possible responses to changes in the sediment supply or water discharge. An increase in sediment load can lead to a widening of the channel, pool filling, and a reduction in the size of material exposed on the surface of the streambed. A decrease in the sediment supply can lead to an increase in the size of material covering the bed. This coarsening of the bed surface is referred to as armoring. A decrease in sediment supply can increase pool volume.

Plane-bed channel pattern
The plane-bed channel pattern includes features such as glides, riffles and rapids. Plane-bed channels lack well-defined bedforms, that is, the channel bed is plain. Plane-bed channels are characterized by long sections of flat channel bed that may have the occasional rapid that spans the width of the channel. The slope of plane-bed channels ranges from 1% to 3%. Plane-bed channels typically have an armor layer. That is, the surface material is coarser than the material found below the surface. The lack of depositional features and the presence of surface armor indicates that plane-bed channels have low sediment loads.

An increase in sediment supply may result in more fine material being seen on the bed surface (fining) or in a build-up of the channel bed (aggradation). Aggradation can affect the geometry of the channel (width and depth). Addition of significant amounts of large woody debris (LWD) can transform a plane-bed channel into a forced pool-riffle channel. Conversely, a reduction in the supply of LWD can convert a forced pool-riffle channel to a plane-bed channel.

Forced pool-riffle channel pattern
Forced pool-riffle channels have a slope of 2-4%. The forced pool-riffle channel can be converted to a plane-bed channel by the removal of obstacles that help form pools.

Bends, boulders and LWD are the typical obstacles that help form pools in forced pool-riffle channels.

An increase in sediment supply may result in pool filling, an increase in the percentage of fines on the bed or in a build-up of the channel bed (aggradation). Aggradation can affect the geometry of the channel (width and depth).

Step-pool channel pattern
Large rocks organized into low dams that stretch across the channel characterize step-pool channels. These rock dams form a series of steps. Pools are found between the rock dams (steps). Smaller material is found in the pools. The rocks that form the dams are roughly the same height as the depth of the bankfull discharge. The pools are spaced from one to four bankfull channel widths apart. The spacing of the steps decreases with increasing channel slope. Step-pool channels have a slope between 4% and 8%.

The ability of the stream to transport sediment exceeds the sediment supply in steep-pool channels. Step-pool channels respond to an increase in sediment by storing the sediment in the pools. However, significant deposition in the pools decreases the turbulence of the water. A decrease in turbulence increases water velocity. The increase in water velocity allows the stream to transport more sediment. Thus, a decrease in pool depth increases the sediment transport capacity of the channel. Hence, step-pool channels can quickly transport an increased sediment load downstream.

Cascade channel pattern
The cascade channel pattern is similar to the step-pool pattern. The largest rocks tend to be large than the bankfull depth. Most of the bed material is made up of boulders and cobbles with limited amounts of gravel and sand. The gravel and sand is typically found in protected areas created by the large rocks. Only small pools are present. The spacing between pools is less than one bankfull channel width. The smaller spacing between pools is one of the key features that distinguish cascade channels from step-pool channels.

Cascade channels have slopes ranging between 8% and 20%. Cascade channels have a high sediment transport capacity. Cascade channels are subject to debris flows. However, their high sediment transport capacity allows them to recover quickly from even complete burial.

Colluvial channel pattern
Colluvium is material deposited at the foot of hillslopes chiefly by gravity. Colluvial channels occur on slopes greater than 20%. Colluvial channels cut through soil and rock that has been deposited in small valleys on hillsides. Colluvial channels occur high in the watershed. Colluvial channels are the beginning of the channel network. In steep landscapes, colluvial channels have only a thin layer of alluvium (material deposited by flowing water).

Colluvial channels respond to changes in sediment supply by changing the amount of sediment stored in the channel. Debris flows are the dominant sediment transport process. Colluvial channels are a source of material for the rest of the channel network.

Debris flows
A debris flow is a moving mass of rock fragments, soil and mud. Debris flows can reach speeds of 80 miles an hour. They start on slopes greater than 20%. The distance a debris flow will travel depends on the nature of the channel types it passes through and the amount of material in the flow. Debris flows are a powerful force and can quickly change the channel bed.

Significant Tributaries
Increasing the discharge (flow) of a stream increases its ability to transport sediment. For the same slope, doubling the discharge, more than doubles the sediment transport capacity. Since tributaries add more water to the channel, the size of the main channel often changes downstream of a tributary. Measurable changes in the characteristics of the channel may occur downstream of a tributary that contributes more than 10% of the bankfull discharge. A tributary that contributes more than 10% of the bankfull discharge is called a significant tributary. Some of the characteristics of the channel that may change with an increase in discharge are the bankfull width and depth, the channel slope and the size of material on the surface of the bed. Watershed area is a good predictor of bankfull discharge. Therefore, significant tributaries are those with a watershed area greater than or equal to 10% of the watershed area above the tributary confluence. Imagine following a stream from the watershed divide to its mouth during a bankfull discharge event. At first, the flow is small. As you proceed downstream, the flow increases. Then, a smaller stream joins the stream you are following. To determine if the small stream is a significant tributary, you must estimate its watershed area and compare it with the watershed area of the stream you are following. As you proceed downstream, tributaries need a larger watershed area to be considered significant.

Major Tributaries
A major tributary is defined as a tributary whose drainage area is:
- a minimum of one square mile and
- greater than or equal to 10% of the drainage area of the entire watershed being studied.

By this definition, major tributaries are significant tributaries. However, a significant tributary in the upper part of a watershed may not be a major tributary.

On-stream Reservoirs
An on-stream reservoir traps coarse sediment that is moving along the streambed. The coarse sediment is made of sand, gravel, and cobbles. The coarse sediment load is an important part of a stream since it forms the streambed. When a reservoir traps coarse sediment, the bed of the channel downstream of the reservoir erodes. The streambed below a reservoir typically develops a surface layer of larger material called the armor layer. The streambed below a reservoir will often look quite different from the streambed

above the reservoir, even if the channel has the same slope. Consequently, presence of on-stream reservoirs will divide stream reaches.

<u>Channel Confinement</u>

A channel is confined if the valley walls are very close to the banks of the river, or form the banks of the river. A channel is unconfined if it has a well-defined floodplain. A floodplain is a broad flat area adjacent to a stream that is frequently flooded.. A terrace is a former floodplain that is too high above the channel to flood anymore.

The form of a channel and its response to changes in sediment load are influenced by the degree of confinement of the valley walls. The features in a channel are formed during flood events. The depth of the water determines the weight of the water on the streambed. For a given slope, deeper water moves a greater amount of heavy material such as rocks and cobbles than shallower water. Because of the greater water depth, a confined channel transports more sediment during a large flood than an unconfined channel with the same discharge and slope. During large floods, the water in a confined channel gets progressively deeper as the flood increases. On the other hand, the depth of water in an unconfined channel is limited to slightly more than the height of the banks because the water can spread out over the floodplain. Therefore, a confined channel can transport more sediment than an unconfined channel.

Channel confinement is expressed as the ratio of channel width to valley width. The following table defines the confinement classes used in this monitoring program.

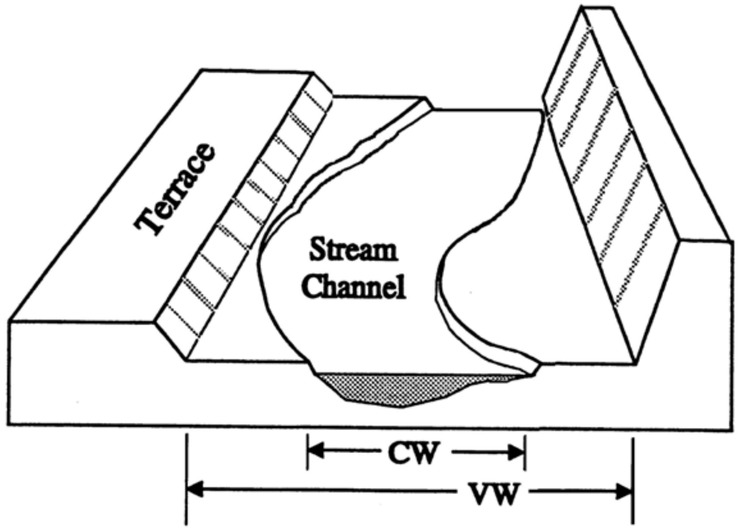
Table 5. Definition of Channel Confinement

Confinement Class	**Definition**
Confined	VW < 2 CW
Moderately Confined	2 CW < VW < 4 CW
Unconfined	VW > 4 CW

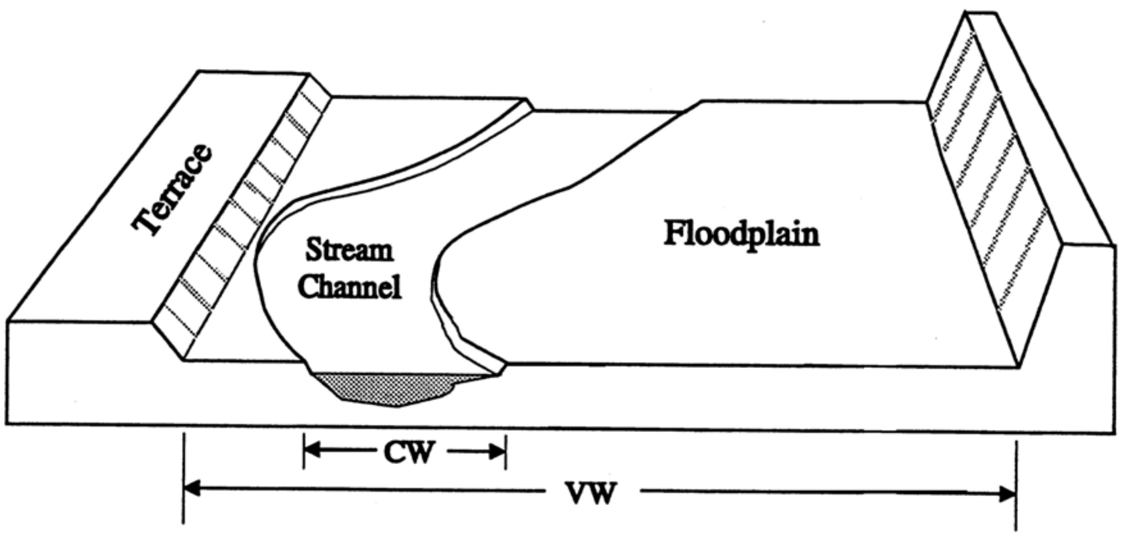
VW = valley width
CW = channel width

There are three classes of confinement. A stream is confined if the valley width, including the channel, is less than 2 bankfull channel widths. It is moderately confined if the valley width is 2 to 4 bankfull channel widths. A channel is unconfined if the valley width is greater than 4 bankfull channel widths.

Channel confinement cannot be measured on a topographic map. However, the topographic map can indicate the potential for channel confinement. If the topographic map indicates that a stream is flowing in a very narrow valley, the potential for channel confinement is high. If the map shows the stream is in a broad valley the potential for channel confinement is low. A low potential for channel confinement does not mean the channel is unconfined. A low potential for channel confinement indicates that the valley walls are far enough apart so that the stream can develop an unconfined channel. Other mechanisms, such as channel incision, can lead to a confined channel.



CW = Channel Width
VW = Valley Width



CW = Channel Width
VW = Valley Width

The upper illustration shows a confined channel. The valley width (VW) in the upper illustration is less than twice the channel width (CW). The lower illustration shows an unconfined channel. The valley width, in the lower illustration, is greater than four times the channel width. A terrace is a former floodplain that is too high to flood."

Atascadero/Green Valley Creek Study Reaches

Using this methodology LMA evaluated potential study reaches along the main stem of the Atascadero Green Valley creek. Appendix A includes the details of this evaluation and Figures 37-39 indicate the results of the analysis.

For the most part AGV creek is a low slope, unconfined, alluvial stream along much of its main stem with a wide floodplain. Under natural conditions these types of creeks have a sinuous meandering channel that has a high width to depth ratio. The channel is wide and meandering and not deeply incised into the floodplain. Overbank flooding is common and riparian and wetland habitats can be extensive. Instream fish habitats are formed through the meandering process – the scour of pools, transport of bank material to create riffles and bars and the recruitment of wood through stream bank erosion and from forested tributaries during floods. Summer groundwater flows towards the lowest point in the channel and the depth of the pool exerts control over the amount of cold water and its temperature.

Straightening and clearing of these types of channels or adding increased stormflow volumes from impervious surfaces increases both the volume of stormflow and its velocity while restricting flows to the active channel. This causes the flow to erode at its bed and banks resulting in channel downcutting and incision. Incision reduces the incidence of overbank flow, can isolate floodplain habitats from the channel and may reduce summer groundwater levels by reducing the bottom elevation of the channel and the depth of the pools.

Monitoring the AGV channel would improve future restoration projects by creating a clear understanding of the geomorphic processes and trends in this system and addressing these processes to create long term sustainable projects.

Field Checking the Potential Study Reaches

The next step in selecting the AGV study reaches is to visit each and note the following.

- Does the channel appear as you expected?
- Is a channel that you expected to be unconfined actually confined?
- Is the channel slope much higher than you expected?
- Is the channel highly modified? Is there riprap? Has it been straightened?
- Can you get to the streambed safely? Don't trespass if you can't tell.
- Is there a place to park?
- Is there a trail to the stream?
- Are the banks too steep to walk down? Remember you will have to haul equipment down to the channel.
- Is the area heavily populated?
- If the area is densely populated a large number of property owners must be contacted to get permission to work in the channel.
- The potential for the study reach to be disturbed is much greater in populated areas.

Inert Figures 37-39

Monitoring requires leaving permanent stakes on the banks as reference markers. These stakes could be removed in populated areas.

- Eliminate any of the potential study reaches that do not meet these needs.

Selecting Water Quality Monitoring Stations

Land uses, erosion and the condition of the stream channel all affect the quality of the water in the creek. Water quality varies over the time of day, season and location in the watershed, so it must be measured at several locations and several times in a year. Generally the water quality monitoring will provide indications about how land uses affect water quality, but will not lead to direct conclusions regarding the effects of any single site or property.

The water quality monitoring protocols for nutrients**,** temperature, pH and dissolved oxygen are contained in the Watershed Stewardship Workbook. These are general indicators of the ability of the water to support fish and other aquatic life. Additional specific protocols for bacteria, pesticides and other pollutants can also be done.

Water quality stations should include each study reach as well as a variety of sites on tributaries. A site at the mouth of each major tributary and a site on the main stem above the confluence, or a site above and below the inflow from the tributary can be monitored to define sources of contaminants. Several sites should be monitored on the same day. Select additional sites as your group has time to complete the monitoring. Water temperature data loggers are placed from early spring to late fall in a variety of locations and checked regularly . The data loggers are expensive and easily lost in urban areas so locations need to be chosen carefully and reflect ambient conditions in the creek and a safe location..

Getting Permission and Raising Funds

Written access permission from the landowners is needed to establish the monitoring sites in the channel. The Resource Conservation District can assist with outreach to landowners.

Monitoring programs and equipment also require funding and the involvement of landowners and community volunteers. LMA is willing to work with the Goldridge RCD and the AGV watershed council to develop a cooperative community based watershed restoration and monitoring project for the AGV watershed..

Table 6. The length of channel required for a study reach can be estimated from the following table.

Drainage Area (Sq. Mi.)	Estimated Bankfull Width (Feet)	Estimated Length of Study Reach (Feet)	Reach On Topo Map (1/16 of Inch)
1	13.0	130	1.0
2	18.4	184	1.5
3	22.5	225	1.8
4	26.0	260	
5	29.1	291	
6	31.8	318	2.5
7	34.4	344	2.8
8	36.8	368	2.9
9	39.0	390	3.1
10	41.1	411	
11	43.1	431	
12	45.0	450	
13	46.9	469	
14	48.6	486	
15	50.3	503	

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